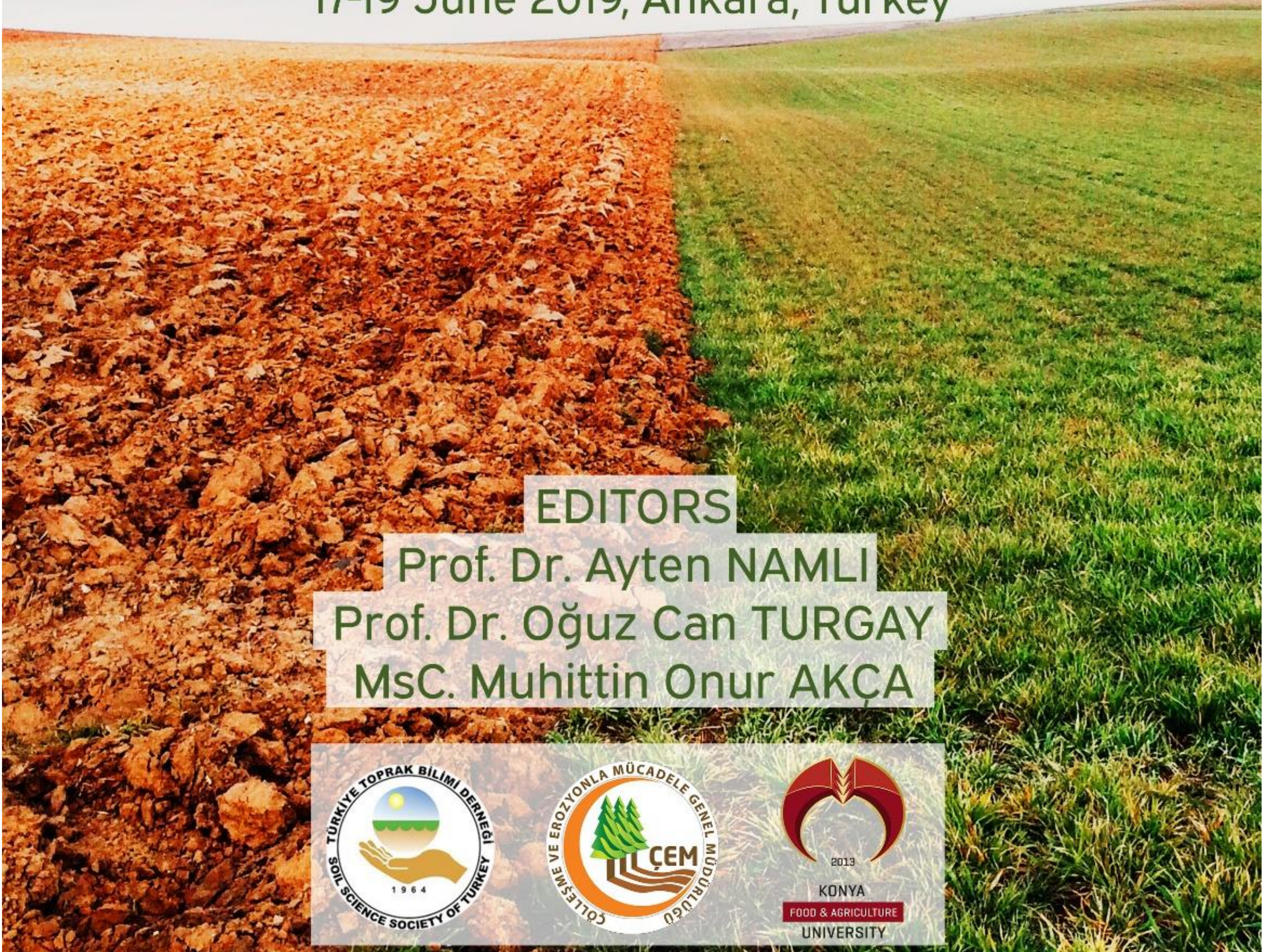
PROOCEDINGS

10th International Soil Congress 2019

Successful Transformation toward Land Degradation Neutrality: Future Perspective

17-19 June 2019, Ankara, Turkey



EDITORS
Prof. Dr. Ayten NAMLI
Prof. Dr. Oğuz Can TURGAY
MsC. Muhittin Onur AKÇA

TÜRKİYE TOPRAK BİLİMİ DERNEĞİ – SOIL SCIENCE SOCIETY OF TURKEY – 1964

ÇÖLLEŞME VE EROZYONLA MÜCADELE GENEL MÜDÜRLÜĞÜ – ÇEM

KONYA FOOD & AGRICULTURE UNIVERSITY – 2013

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This book of proocedings has been prepared from different articles sent to the congress secretary only by making some changes in the format. Scientific committee regret for any language and/or aim-scope

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PREFACE I

The Soil Science Society of Turkey (SSST) was founded by a leading of soil scientist Prof.Dr. Kerim Ömer Çağlar in 1964. The main objectives of SSST is to create a scientific atmosphere bringing scientists, reseachers and students related to soil science; to support knowledge and experience exchange and to increase scientific and public awareness in relation to the topics and problems threatening soil resources of Turkey. The SSST as a member of the International Union of Soil Science has more than 900 members. The organization of International Soil Science Congresses is a long established custom for the SSST. The 10 International Congress held so far are listed below: 1st International Congress on Soil Science 1998, Izmir: 2nd International Congress on Soil Science 2000, Konya; 3rd International Congress on Soil Science 2002, Çanakkale; 4th International Congress on Soil Science2004, Erzurum; 5th International Congress on Soil Science 2006, Şanlıurfa; 6th International Congress on Soil Science 2008, Aydın; 7th International Congress on Soil Science 2010, Samsun: 8th International Congress on Soil Science 2012, Izmir: 9th International Congress on Soil Science 2014, Antalya and 5th Eurosoil Congress, 2016, İstanbul.

The 10th International Congress on Successful Transformation toward Land Degradation Neutrality: Future Perspective was held at the Congresium in Ankara, Turkey, from June 17th to 19th, 2019. The congress was organized by Soil Science Society of Turkey (SSST), General Directorate of Combating Desertification and Erosion, and Konya Food and Agriculture University. Within the frame of 10th International Congress, we received more than 280 abstracts from 13 countries worldwide. After a rigorous evaluation process, 155 of these were found to be eligible for oral and poster presentations during the congress. There were two plenary lecturers: Dr. Barron Joseph Orr, Lead Scientist of UNCCD, and Luc Gnacadja, *Former Executive Secretary of* UNCCD. In addition, young participants have been given an opportunity to express their views on the land degradation neutrality within a youth forum session, took part at the congress. SSST Board kindly consider that the oral and poster presentations, discussions and recommendations given during this congress would support valuable information to a broad group of soil scientists for their future activities. We would like to give special thanks to organizing committee for their excellent efforts to develop this Congress and additionally General Directorate of Combating Desertification and Erosion, Konya Food and Agriculture University, and Secretariat of the United Nations Convention to Combat Desertification (UNCCD) for the immense facilities they have.

The scientific papers have been organized according to topics for the Congress Proceedings Book. The on-line version of proceedings is accessible at: **https://soil2019.gidatarim.edu.tr/en** and **http://www.toprak.org.tr/tr/**. We would like to take this opportunity to express our thanks to all the authors for their efforts in the preparation of these excellent contributions.

Prof. Dr. Ayten Namlı, President of SSST

PREFACE II

Humanity depends on terrestrial ecosystems for survival. However, these ecosystems are facing big challenges and pressures to meet the needs of the developing world. More precisely, between 1998 and 2013, around 20 per cent of the Earth's vegetated land surface has shown persistent trends towards declining land productivity[i]. Today, about 14.5 hectares of forest are cut down every minute[ii]. The consequences are alarming: food insecurity, poverty, conflicts, reduced availability of clean water and increased vulnerability of affected areas to climate change. It is estimated that 1.5 billion people across the world are directly affected by deforestation and land degradation through reduced income or diminished food security[iii]. Competition for the limited land and water resources is further intensified by the growing world population and increased competition over natural resources[iv].

By 2050, the world population is expected to reach 9.7 billion[v], increasing pressure on land to meet the growing need for food. If we continue to apply conventional approaches to agriculture, the arable land will expand by 70 million ha globally, [vi]much of it at the expense of the world's forests.

Sustainable Development Goal (SDG) 15 urges us to *"Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*[vii]. At its heart is the concept of Land Degradation Neutrality (LDN),

[i] JRC (2017): World Atlas of Desertification (WAD), forthcoming 3rd edition.
[ii] FAO (2016a): Global Forest Resources Assessment 2015: How are the world's forests changing? Second edition. Rome, 978-92-5-109283-5.
[iii] ELD (2014): Economics of Land Degradation (ELD) Initiative: A global initiative for sustainable land management, Available at: https://www.giz.de/fachexpertise/downloads/eld2014-en-eld-a-global-initiative-for-slm.pdf
[iv] UNCCD (n.d.): Sustainable land management (SLM), Available at: http://knowledge.unccd.int/topics/sustainable-land-management-slm
[v] UN Department of Economics and Social Affairs, Population Division (2015): World Population Prospects: The 2015 Revision, Key Findings and Advance Tables'. Working Paper No. ESA/P/WP.241.
[vi] FAO (2009): Global agriculture towards 2050, High Level Expert Forum: How to Feed the World in 2050, 12-13 October 2009, Rome. http://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf
[vii] United Nations, General Assembly resolution 70/1, Transforming our world: the 2030 Agenda for Sustainable Development, A/RES/70/1 (21 October 2015), available from undocs.org/A/RES/70/1.

which strives to achieve a balance between three processes: land degradation, land restoration and sustainable land management[viii].

The twelfth session of the Conference of the Parties of the United Nations Convention to Combat Desertification (UNCCD COP 12) defined LDN as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems[ix]".

An LDN approach upholds two complementary pathways of action: sustainable land management and ecosystem restoration[x]. It encourages countries to pursue an optimal mix of measures designed to avoid, reduce and reverse land degradation in order to achieve a state of no net loss of healthy and productive land. It also provides a useful framework for protection, sustainable management and restoration of forests. In this scope, Turkey, by 2030, will increase her forest cover by 5 per cent by implementing afforestation and soil conservation projects on an area of 1.5 million ha. Turkey will also implement forest rehabilitation projects on an area of 1.5 million ha. To achieve her LDN targets that include forests, Turkey will invest USD 5 billion in these projects by mostly employing the poor and rural people[xi].

Preventing further deforestation and land degradation must become a priority if we want to make a transition to a more sustainable future. Learning to manage land and forest resources together will ultimately mean creating new jobs, providing food and water security, and making concrete contributions to the climate change mitigation and adaptation.

I believe that the International Congress on "Successful Transformation toward LDN (Future Perspective)", which creates a unique platform by bringing broad groups of scientists, experts, policy makers and young researchers from different national and international institutions, will give us some tips on successfully transforming the agricultural and forest sector for LDN, and planning and sustainably managing the land and forest resources together.

Özlem Yavuz
Deputy General Director,
General Directorate on Combating Desertification and Erosion

[viii] UNCCD (2016): A natural Fix: A Joined-up approach to delivering the global goals for sustainable development, Available at: http://www2.unccd.int/sites/default/files/documents/22042016_A%20Natural%20Fix_ENG.pdf
[ix] UNCCD (2016b): Report of the Conference of the Parties on its twelfth session, held in Ankara from 12 to 23 October 2015
[x] UNCCD (n.d.): Frequently Asked Questions: Land Degradaton Neutrality. Available at: http://www.unccd.int/Lists/SiteDocumentLibrary/FAQ/LDN.pdf
[xi] Ministry of Forestry and Water Affairs (2016): The Land Degradation Neutrality National Report of Turkey, http://www.cem.gov.tr/erozyon/Files/yayinlarimiz/brosurler/LDNxTurkeyxReportxINGxEPSx9Aral%C4%B1k.pdf

PREFACE III

Dear Participants,

The International Congress on "Successful Transformation Toward Land Degradation Neutrality: Future Perspective" was held in Ankara, Turkey, between 17 and 19 June 2019, marking the 25th anniversary of the United Nations Convention to Combat Desertification (UNCCD).

On behalf of Konya Food and Agriculture University, as one of the co-hosted organizations of the congress, I would like to express with pleasure that the congress was a good opportunity to bring together senior scientists, academicians, experts, policy makers, young researchers and students from national and international institutions to analyse the current and future trends of soil and land resources, establish new policies based on the principles of Land Degradation Neutrality (LDN) and create a universal message for the sustainable use of soil and land resources.

The main topics of the congress included: Successful transformations of agricultural and forest sectors for LDN, Integrated planning approaches for sustainable use of land/soil resource, Unlocking the investment for LDN, Role of gender in LDN to achieve the sustainable development goals (SDGs), and Sustainable value chains for LDN. Young scientists were also took part in the Youth Forum on “Land Degradation Neutrality from Local to Global Scale.”
During the congress, the distinguished participants all over the world shared their research results and recent innovations in relevant fields. They also discussed the current problems and offer specific solutions in terms of LDN and other related subjects. I wish that this electronic congress proceedings will be useful for everyone who work in the related fields.

As has already been known, the United Nations declared June 17 as “The World Day to Combat Desertification”, with a decision taken in 1994 to draw attention and raise awareness on the risks of desertification and drought in the world. The World Day to Combat Desertification is celebrated every year by hosting a different country of the world. The ceremony, held in Ankara on June 17, 2019 under the auspices of the President of the Republic of Turkey, corresponding to the 25th year of the contract has also been a source of pride and honour for us.

As a final point, I would like to thank to all those who has contributed to the congress in any way.

Prof. Dr. Cumhur ÇÖKMÜŞ
Rector of Konya Food and Agriculture University

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THEME 1:
Land Degradation Neutrality

Changes in Soil Organic Carbon Following of Land Neutralization Studies in a Marginal Area

Ahmet ÇELIK[1], Erhan AKÇA[2]

Abstract

The most frequently used definitions for the future of humanity are the production potential of natural resources (soil and water), food safety, environmental degradation and climate change. The rehabilitation of degraded areas and the protection and sustainable use of natural resources are among the most urgent measures that humanity should take in order to improve above said issues. Adıyaman located in a semi-arid region of Turkey experienced land degradation and desertification phenomena due to overgrazing, deforestation, and population pressure. So, majority of its territory requires land degradation neutrality studies. In this study, the organic carbon contents of the samples taken from three different land used (with the majority of the marginal area) namely the forest, unprotected and protected pasture area where the last one is under protection for a period of ten years in an area of 125 ha were investigated for evaluating various land uses effect on soil carbon. The research area is composed of marl bedrock with steep slopes. Soils of the study area have clay loam texture with high lime content. Soil analysis revealed that organic carbon content increased in protected areas. In addition to organic matter increase, following the protection of the land, with the decrease of human pressure, the species, which is not seen outside the land, started to be seen.

Erosion control studies, terracing and tree planting activities have affected soil-plant-water relationship as well as stabilized soil losses. Finally, it is suggested that even at very marginal lands with semi-arid climate land protection with basic activities revealed soils' and plants' strong resilience capacity.

Keywords: Pasture, Marl Soils, Marginal Lands, Resilience

1. Introduction

Since 1950s population growth along with the availability of agricultural machinery marginal lands have been used for crop production and animal husbandry, which all leads degradation (Akça et al. 2016). FAO and ITPS (2015) reported that 20% of the cultivated areas, 30% of forests and 10% of grasslands are degraded. Thus, combatting to degradation and desertification studies accelerated in early 1980s (Kapur and Akça 2006). Turkey is one of the pioneering country in combatting desertification with projects initiated in late 1960s in Karapınar (Central Turkey) (Akça et al. 2016). TEMA, which is one of the globally biggest NGO in terms of voluntary members, started soil protection studies following its establishment in 1992. The study represented here outlines the protection project achievement as of 2017which was started in 1998 in Adıyaman (SE Turkey) in a marginal land developed on marl soils (Figure1).

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Figure 1. The marl deposits of the project area

2. Methodology

2.1 Fact and Figures of the Project Area

The study area is located in Kuyulu village on the south of Adıyaman Province covering an area of 200 ha (Figure 2). The protection project was initiated in 1998 with the cooperation of Southeastern Anatolian Project Administration and TEMA, and results presented in this paper manifested the soils status as of 2017 ie app. 20 years of protection. As no soil samples were collected in the beginning project, unprotected site soils are used witness samples. The land was surrounded by wire and no human or flock was allowed to enter the protection site.

The elevation of the project site is approximately 550-640m. The continental climate prevails in the region with an annual precipitation of 674mm. The free water surface evaporation is close to 2000mm (Bahadır 2011).

Natural vegetation is almost disappeared from the study area because of the intensive grazing and firewood around the Project Site. However, relatively dense dwarf shrubs, spurge, thistle that are drought-resistant thorny perennial plants were observed in the protected site (Figure 3).

According to IUSS Working Group-WRB (2015), there two dominant soil types. One is CalcaricLeptosol with high erosion caused by previous misuses in the sloped (15% and over) land (Figure 2). Second is CalcaricFluvisol with low organic carbon and relatively fines texture than Leptosols.

Figure 1. Location of the study area

Figure 2. Vegetation cover in protected area

2.2 Methods

Soil samples were collected from genetic horizons. Soils air dried and sieved for analyzed for their pH, EC, $CaCO_3$, texture, cation exchange capacity, and organic matter by methods described in Soil Survey Staff (2011).

3. Results and Conclusion

The 20 years of protection of soils did not change soils' pH, CaCO3 and texture (Table 1). However significant change is observed on soil organic matter content of protected sites even the achieved value is far below desired level of 3-5%.

Table 1. Soils physical and chemical properties in protected and unprotected zones

Area	Soil Type and Land Cover	Horizon	Depth	pH	EC	CEC	CaCO3	Organic Matter	Texture (%)		
			cm	1:1	dS/m	cmol. kg^{-1}	%	%	Sand	Silt	Clay
Protected area	CalcaricLeptosol	A	0-10	7,9	0,4	12	38	1,0	46	22	32
	Without vegetation	CR	10-40	8,1	0,3	5,4	55	0,7	51	23	25
	CalcaricLeptosol	A	0-9	7,8	0,5	11	37	1,6	45	24	31
	With vegetation	C	9-37	8,3	0,4	5,7	61	0,5	53	23	24

Area	Soil Type and Land Cover	Horizon	Depth	pH	EC	CEC	CaCO3	Organic Matter	Texture (%)		
			cm	1:1	dS/m	cmol. kg^{-1}	%	%	Sand	Silt	Clay
Protected area	CalcaricLeptosol	A	0-8	8,1	0,3	10	36	0,8	43	25	32
	Without vegetation	CR	8-42	8,3	0,4	5,4	56	0,4	41	28	31
	CalcaricLeptosol	A	0-9	8,3	0,3	13	32	1,1	47	32	21
	With vegetation	CR	9-35	8,3	0,3	5,8	58	0,5	48	28	24

Area	Soil Type and Land Cover	Horizon	Depth	pH	EC	CEC	CaCO3	Organic Matter	Texture (%)		
			cm	1:1	dS/m	cmol. kg-1	%	%	Sand	Silt	Clay
Protected area	CalcaricFluvisol	A	0-14	7,9	0,3	27,7	34	1,2	44	23	33
	Without vegetation	A2	14-38	7,8	0,4	29,3	33	0,7	38	24	38
	CalcaricFluvisol	A	0-15	7,9	0,4	28,2	32	2,1	48	24	28
	With vegetation	Bw	14-42	7,9	0,4	30,2	36	0,9	38	32	30

Area	Soil Type and Land Cover	Horizon	Depth	pH	EC	CEC	CaCO3	Organic Matter	Texture (%)		
			cm	1:1	dS/m	cmol. kg-1	%	%	Sand	Silt	Clay
Unprotected area	CalcaricFluvisol	A	0-13	8,2	0,3	28,5	36	0,7	47	24	29
	Without vegetation	A2	13-40	8,3	0,4	27,6	38	0,4	41	25	34
	CalcaricFluvisol	A	0-15	7,9	0,3	29,3	33	1,7	42	28	30
	With vegetation	Bw	15-39	7,9	0,3	28,7	37	0,6	44	27	29

In areas outside the protected area, intensive grazing pressure is still in progress. As a result, the weak vegetation is removed and soil is transported by erosion. On the other hand, naturally occurring plants in the protection area relatively prevented erosion although vegetation is not very dense. The most significant development in the conservation area is the increase in the organic matter, which is the most important quality criterion of the soils and therefore the carbon emission that leads to climate changes. Due to the fact that the main area of the conservation area is marl, the low number of plant nutrients causes these soils to have a very fragile structure.After conservation of the land, with the decrease of human pressure, species that are not seen outside the land are observed and the diversity of the plant species has increased. 20 years ago, while wildlife was limited in this area, it has become an area where partridge, fox, rabbit and other animals have survived.With the accumulation of knowledge gained in the field of conservation, the increase of genetic diversity will be an important source for scientific studies in national and international fields. Genetic diversity constitutes one of the main pillars of this project because there is no similar study area in the nearby region. In this context, the project area can serve as a genetic pool if protection continues.

3.2 Acknowledgments

Authors would like to thank TEMA Foundation for the assistance of field study and sharing project information

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Land Degradation Neutrality (LDN): Some Constraints to Put Conception into Practice and Recommendations to Eliminate Them

Ahmet ŞENYAZ[1]

Abstract

Striving to achieve a Land Degradation Neutral World is one of the ambitious targets of the Sustainable Development Goal 15 called "Life on Land". As a custodian agency of Land Degradation Neutrality (LDN), the United Nations Convention to Combat Desertification (UNCCD) 12th Conference of the Parties (COP 12) defined LDN as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems". The UNCCD Science Policy Interface (SPI) produced a report on "Scientific Conceptual Framework for LDN" that underlines main principles for the formulation and implementation of LDN. As of May2019, 122 countries have committed to setting LDN targets. Turkey is one of the countries supporting and willing to participate to LDN Target Setting Programme. Its LDN targets were identified in "Turkey Land Degradation Neutrality National Report 2016-2030".

This article represents main principles of LDN and some bottlenecks in formulating national LDN targets in line with scientific conceptual framework and recommends some improvements for LDN target setting process accordingly.

Keywords: Land Degradation Neutrality, Scientific Conceptual Framework for LDN, LDN Target Setting

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Spatial Distribution of Soil Quality Indexes in Alaca Basin (Çorum)

Ali İMAMOĞLU[1], Orhan DENGİZ[2]

Abstract

Soil is not only the main source of agricultural production, but it also serves as an important part of the terrestrial ecosystem. Soil quality, soil characteristics of the characteristics of the soil can contribute to how much it contributes to the nature of the soil and these properties are expressed. The aim of this study is to determine and map the spatial distribution of the basin soils using Geometric and Nemoro soil quality index models. The study was carried out in Çorum Alaca Basin, which is located in the northern part of the Central Kızılırmak Section of Central Anatolia Region. The total working area is 2754.5 km2. The research area consists of different morphological units ranging from 825 m to 1726 m. A total of 312 surface (0-20 cm) soil samples were taken at every 2.5 x 2.5 km intervals according to grid method in the study area. Some properties of soils were determined and geometric and nemoro soil quality index values of each point were calculated. The values of the sample points were calculated by using the appropriate interpolation methods. It is determined that the IDW conforms to both index models within the encapsulation models. According to the results of the geometric model, approximately 97% of the total area was of medium quality. In the Nemoro model, 81% of the area is defined as medium quality soils. It is concluded that the distribution is far from homogeneous.

Keywords: Soil Quality, Interpolation models, Geometrik and Nemoro Models, Alaca Watershed

1. Giriş

Toprak sadece tarımsal üretimin temel kaynağı olmayıp, sunmuş olduğu hizmetlerle karasal ekosistemin en önemli bir parçasını da oluşturmaktadır. Dolayısıyla sadece biyokütlesel üretimin değil, tarımsal verimliliğin de artırmasının yolu topraktan geçmektedir. Lewandowski ve Zumwinkle (1999), verimli bir toprak denildiğinde toprakların organik madde ve biyolojik aktivitede yüksek düzeye, stabil agregatlara, makro ve mikro besin elementlerinin yeterli ve uygun oranlarda kök bölgesinde bulunduğu, bitki köklerinin kolaylıkla hareket edebildiği bir ortama, yüzeyde suyun kolaylıkla infiltre olabildiği bir toprak yapısına sahip olmasının akla geldiğini bildirmişlerdir. Bu nedenle, sürdürülebilir toprak verimliliği açısından toprak kalitesinin önemi büyüktür. Karlen ve ark. (1997) ve Shukla ve ark. (2006) göre toprak kalitesi aslında toprağın fonksiyon gösterme kapasitesini ifade etmektedir. Toprak kalitesi, toprağın sahip olduğu karakteristik özelliklerin bitkisel üretime ne kadar katkı sağlayabildiği ve toprağın doğasında var olan bu özelliklere hangi oranda sahip olduğunu ifade etmektedirler.

Toprak kalitesi, hava ve su kalitesi gibi içinde yer aldığı ekosistemin sağlığını etkiler. Ancak, toprak oldukça karmaşık bir yapıya sahip olduğundan standartları belirlenmiş olan su ve hava kalitesine göre tanımlanması ve sayısallaştırılması zordur (Doran ve Parkin 1994). Bu nedenle; toprak kalitesi direkt olarak ölçülememekte, ancak; sürdürülebilir tarım ve çevresel sistemler için önemli olan ve ölçülen bir kısım fiziksel, kimyasal ve biyolojik parametrelerle göstergelerin sayısallaştırılması şeklinde değerlendirilebilmektedir (Karlen ve ark.

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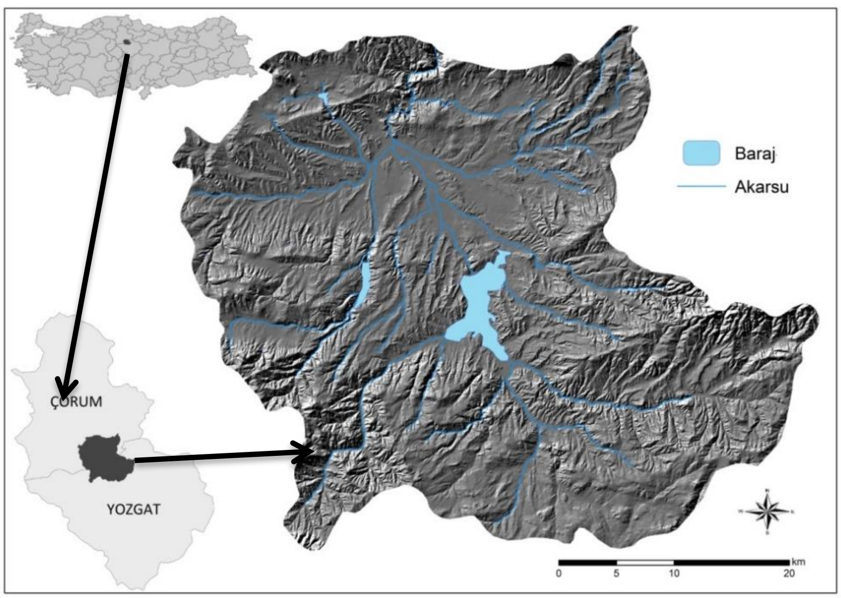
1997). Bu nedenle kalite özelliklerinin bir göstergesi olan toprakların üretkenlik kapasiteleri ya direk olarak sera veya tarla denemeleri sonucu veya dolaylı olarak, geliştirilen çeşitli modellemeler ile yapılan hesaplamalar sonucu belirlenmeye çalışılmaktadır. Son birkaç on yılda, coğrafi bilgi sistemi, jeoistatistik programlar ve simülasyon modelleri gibi gelişmiş bilgisayar programları, planlama sürecinin hız ve verimliliğine katkıda bulunmuştur ve büyük miktarda bilginin hızla işlenmesine izin vermiştir. Tüm bu gelişmeler ile birlikte bazı verimlilik ve kalite modelleri geliştirilmiştir.

Çalışmanın amacı, Çorum Alaca havzasında dağılım gösteren topraklarının Geometrik (SQIg) ve Nemoro (SQIn) toprak kalite indeks modeller kullanılarak, farklı enterpolasyon modeller yardımıyla konumsal dağılımının belirlenmesi ve haritalanmasıdır.

2. Materyal ve Metot

2.1 Araştırma Sahası Doğal Ortam Özellikleri

Çalışma alanı İç Anadolu Bölgesi'nin Orta Kızılırmak Bölümü'nün kuzey kısımlarında bulunmaktadır. Araştırma sahası Alaca havzasının tamamından oluşmaktadır. Havzanın idari sınırlarına bakıldığında güney ve güneydoğudan Yozgat'ın Sorgun ilçesi sınırlarına girmekte, güneybatıdan ise Sungurlu sınırlarına girmektedir (Şekil 1).



Şekil 1. Araştırma sahası lokasyon haritası

Çalışma alanının toplam alanı 1656.4 km^2'dir. Araştırma sahasının güney kesimleri Bozok platosunun kuzeyidir. Yeşilırmak'ın su toplama havzasında bulunan havza Kızılırmak havzası ile sınır oluşturmaktadır. Sahanın suyunu Alaca Çayı toplamakta ve bu akarsu araştırma sahasından çıkınca Çorum Çayı'na katılmakta Çorum Çayı'da Çekerek Irmağı ile birleşmektedir. Alaca meteorolojik istasyonun verilerine göre yıllık yağış miktarı 364.8 mm, en çok yağışın ise Nisan (46.5 mm) ve Mayıs (54. 1 mm) aylarında düştüğü görülmektedir. Alanın yıllık sıcaklık ortalaması ise 9.5 °C'dir. En soğuk ay Ocak (-1.8°C), en sıcak ay Temmuz ve Ağustos aylarıdır (20.1°C) (Tablo 1).

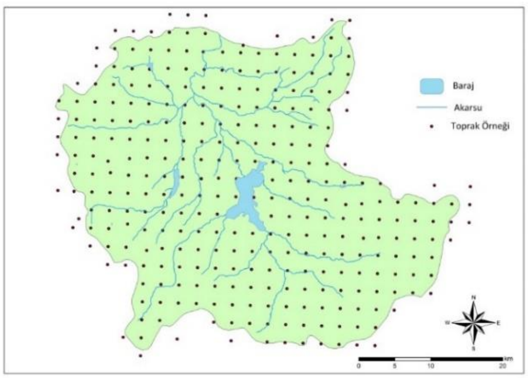
Tablo 1. Alaca meteoroloji istasyonu aylık ortalama yağış ve sıcaklık değerleri (mm, °C)

Çorum						AYLAR							
Alaca	O	Ş	M	N	M	H	T	A	E	E	K	A	Yıllık
P, mm	32.4	26.3	33.6	46.5	54.1	37.6	11.6	12.1	15.1	25.4	34	36.1	364.8
T, ºC	-1.8	-0.7	4.1	9.4	13.6	17.4	20.1	20.1	16	10.8	4.7	0.4	9.5

P: Yağış, T:Sıcaklık.

2.2 Toprak Örnekleme ve Analiz Yöntemi

Havza topraklarının toprak kalite indekslerinin hesaplanması ve alan içerisinde bu indekslerin dağılımlarının belirlenmesi amacıyla ArcGIS 10.2v enterpolasyon modelleriden yararlanılmıştır. Bu amaçla alandan grit yöntemine göre her 2500 m aralıklarla toplam 312 yüzey (0-20 cm) toprak örneği alınmıştır.



Şekil 2. Araştırma sahasından alınan örnek noktaları

2.3 Parametrelerin Skorlanması ve Indekslerin Hesaplanması

Toprak kalite indekslerine ait toprak özelliklerini birimsiz hale dönüştürüp 0 ile 1 değeri arasında skorlamanın elde edilebilmesi için Tablo 2'de verilen standart skorlama fonksiyonları (SSF) kullanılmıştır. Genellikle 3 adet skorlama fonksiyonu vardır (Karlen ve Scott, 1994; Wymore, 1993). Burada, parametrenin yüksek skor değer elde etmesi toprak kalitesi ile parametre arasında pozitif ilişki olduğunu dolaysıyla pozitif SSF kullanılıştır. Diğer durumda ise, iyi bir toprak kalitesinde düşük değer istenen parametrenin elde edilmesinde negatif SSF kullanılmıştır. Ayrıca, Toprak kalitesiyle pozitif ilişkili parametreler optimum SSF skorlama formülü ile belirlenmiştir (Armenise et al., 2013). Bu çalışmada, pozitif fonksiyon kil ve organik madde parametreleri için uygulanırken, kum, silt, USLE-K, hacim ağırlığı, EC, kireç için negatif skorlama fonksiyonu kullanılmıştır. Optimal aralıktaki parametreye yönelik skorlama fonksiyonu ise hidrolik iletkenlik ve pH parametreleri için uygulanmıştır. Buna göre, pH değeri 6.8 ile 8.2 arası pozitif fonksiyon iken, 8.2 ile 8.6 arası negatif fonksiyon olarak değerlendirilmiştir. Hidrolik iletkenlikte ise, 2.0 ile 10.0 arası optimum fonksiyon ele alınırken, 2 cm/h den az ve 10 cm/h ile 15.59 cm/h arası negatif fonksiyon olarak değerlendirilmiştir.

Tablo 2. Toprak kalite indekslerine ait toprak özellikleri standart skorlama fonksiyonları

Parametreler	FT	L	U	SSF
Kum %	N	16,04	93,03	$f(x) = \begin{cases} 0.1 & x \leq L \\ 1 - 0.9 \times \frac{x - L}{U - L} + 0.1 & L \leq x \leq U \\ 1 & x \geq U \end{cases}$
Silt %	N	3,55	37,33	
USLE-K	N	0,01	0,14	
Kireç %	N	1.0	48,53	
HA gr/cm^3	N	1,27	1,6	
EC dS/m	N	0,03	0,99	
Kil %	P	2,74	62,82	$f(x) = \begin{cases} 0.1 & x \leq L \\ 0.9 \times \frac{x - L}{U - L} + 0.1 & L \leq x \leq U \\ 1 & x \geq U \end{cases}$
OM %	P	0,21	6,62	
Hi cm/sa	O	L1	U1	$f(x) = \begin{cases} 0.1 & x \leq L \, or x \geq U \\ 0.9 \times \frac{x - L1}{L2 - L1} + 0.1 & L \leq x \leq L2 \\ 1 & \end{cases}$
		2.0	100.	
		L2	U2	
		< 2 ile >10	15,59	$f(x) = \begin{cases} 0.1 & \\ 0.9 \times \frac{x - U1}{U2 - U1} + 0.1 & L2 \leq x \leq U1 \\ 1 & U1 \leq x \leq U2 \end{cases}$
pH	O	L1	U1	
		6,8	8,2	
		L2	U2	
		8,2	8,62	

FT: Fonsiyon türü, L: Minumun değer, U: Maksimum değer, N: Negatif, P: Pozitif, O: Optimum, SSF: Standart Skorlama Fonksiyon

Toprak kalite indeks modelleri olarak Geometrik kalite indeksi (SQIg) ve Nemoro kalite indeksi (SQIn; Qin ve Zhao, 2000) eşitliği kullanılmıştır.

$$SQIg = \sqrt{a1 \; x \; a2 \; x \ldots\ldots an}$$

$$SQIn = \sqrt{\frac{Pave^2 + Pmin}{2} \; x \; \frac{n-1}{n}}$$

Burada; a: parametereye ait skor değeri, Pave: parameterelere ait skorların ortalama değeri, Pmin: paremetre skorlarının minimum değeri gösterir. Toprak kalite indeksi değerlendirmesi ise Tablo 3’ de verilen sınıf aralıkları kullanılarak yapılmıştır (Da Silva et al., 2015; INPE, 2001).

Tablo 3. Toprak kalite indeks sınıfları

Sınıf	Tanım	İndeks
1	Çok kötü	< 0.00
2	Kötü	0.00-0.19
3	Zayıf	0.20-0.39
4	Orta	0.40-0.59
5	İyi	0.60-0.79
6	Çok iyi	0.80-1.00

2.4 İstatistiksel Analizler ve Enterpolasyon Yöntemleri

Araştırma sahasından alınan 312 toprak örneğinde 10 adet toprakların fiziksel ve kimyasal özellikleri ve 2 adet toprak kalite incelenmiş ve bu özelliklerin tanımlayıcı istatistiksel hesaplamaları yapılmıştır. Bu analizlerin yapılmasında SPSS 17.0 paket programı kullanılmıştır.

Toprak indeks parametrelerinin değerinin alansal dağılımının belirlenmesinde en çok kullanılan enterpolasyon yöntemlerinden IDW, RBF (Spline) deterministik yöntemler ile stokastik yöntemlerden de (temelde Kriging olarak da bilinmektedir) doğal (ordinary), evrensel (universal), basit (simple) kriging yöntemleri kullanılmıştır. Yöntemlerin karşılaştırılmalarında ölçülen değerler ve tahmin edilen değerler arasındaki ilişkiyi sorgulayabilmek, ölçülen değerlere en yakın sonucu veren başka bir ifade ile yöntemler arasından en uygun olanının seçebilmek için literatürde farklı karşılaştırma yöntemlerinin dikkate alındığı görülmektedir. Genel anlamda en yaygın kullanılan yöntemler; karesel ortalama hata (RMSE), ortalama mutlak hata (MAE), yöntemlerdir. Bu çalışma için RMSE seçilmiş ve jeoistatistiksel çözümde kullanılan 5 yöntem karşılaştırılmıştır. En düşük RMSE değerini veren yöntem, en uygun yöntem olarak değerlendirilmiştir. RMSE'nin hesaplanmasında formül kullanılmıştır.

Eşitlikte;

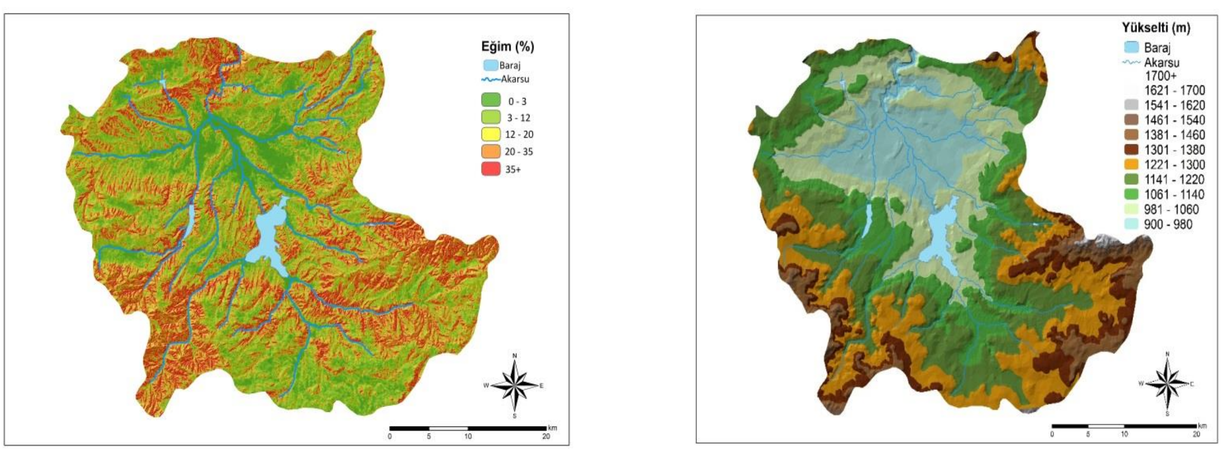
$$RMSE = \sqrt{\frac{\sum (z_{i^*} - z_i)^2}{n}}$$

Z_i : tahmin edilen değer, Z_{i^*} ölçülen değer ve n örnek sayısını ifade etmektedir.

3. Bulgular ve Tartışma

3.1 Çalışma Alanın Topografik Özellikleri ve Arazi Kullanımı Arazi Örtüsü

Çalışma alanına ait farklı topoğrafik özelliklerin çıkartılmasına yönelik 1:25.000 ölçekli topoğrafik harita CBS ortamında sayısallaştırılarak alana ait sayısal eş yükselti, yükselti, eğim ve kabartı gibi haritaları oluşturulmuştur (Şekil 3). Araştırma sahası 825 m ile 1726 m arasında değişen düz, engebeli ve dağlık alanlardan oluşan farklı topoğrafik yapılardan oluşmaktadır.



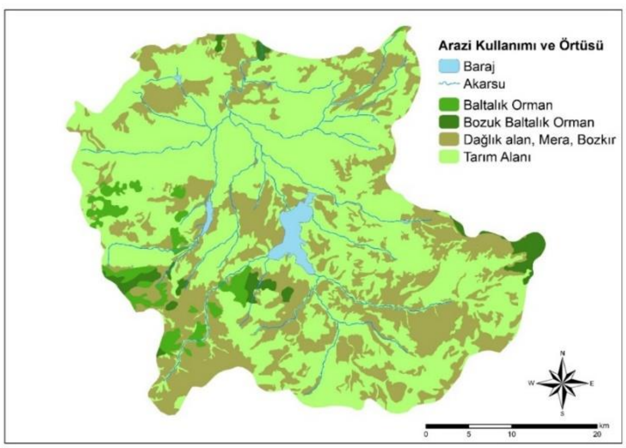
Şekil 3. Çalışma alanına ait eğim ve yükseklik dağılım haritası

Araştırma sahası eğim haritasına bakıldığında sahanın özellikle güney ve doğu kesimlerinin daha eğimli olduğu görülmektedir. Yükselti arttıkça topoğrafyanın eğimi artmaktadır. Güneybatıda Akçadağ ve çevresi, doğuda Toprakdede Tepesi ve çevresi, kuzeyde ise Çorum depresyonu ile Alaca depresyonunu birbirinden ayıran Büyükcamili ve İbrahimköyü yerleşmelerinin bulunduğu sahalar çalışma alanında en fazla eğimin olduğu yerlerdir. İbrahimköyü'nden güneybatı yönlü devam eden Ezinepazar fayı boyunca eğimli sahalar görülmektedir. Bu sahaların yanında özellikle Seyitnizam, Büyüköz, Eymir, Kırımözü dereleri vadilerinde eğim değerleri oldukça yüksektir. Araştırma sahasında yüzeylenen bazı formasyonların dirençsiz ve gevşek yapıda olması vadilerin derine yarılmasına ve kısa mesafede yükselti farkına bağlı eğim değerlerinin yüksek olmasına sebep olmaktadır. Araştırma sahasının genel eğimine baktığımızda sahanın yaklaşık % 70'inin %3'ün üzeri eğimli, yaklaşık % 30'unun ise düz ve düze yakın alanlardan oluştuğu görülmektedir (Tablo 4).

Tablo 4. Araştırma sahası eğim sınıflarının alansal ve oransal dağılımı

Eğim Sınıfı (%)	Alan (km^2)	Oran (%)
0-3	466.85	28.2
3-12	874.01	52.8
12-20	240.88	14.5
20-35	73.67	4.4
35+	0.99	0.1
Toplam	1656.4	100.0

Araştırma sahasında arazi kullanımı ve arazi örtü dağılımı bakımından incelendiğinde meşelik alanlar, mera sahaları, dağlık alanlar, bağ bahçe, çıplak kayalık, sulu ve kuru tarım alanları bulunmaktadır (Şekil 4). Hakim arazi kullanımı ise kuru tarımdır.



Şekil 4. Çalışma alanı arazi kullanımı ve arazi örtü haritası

3.2 Toprak Özelliklerine Ait Tanımsal İstatistikler

Araştırma sahasından toplam 312 yüzey (0-20 cm) toprak örneği alınmıştır. Bu noktalardan alınan toprak örneklerinde yöntemde belirtilen analizler yapılmıştır. Toprak kalite indekslerine ait haritalarının bu şekilde oluşturulmasının nedeni, özellikle farklı arazi kullanımı ve arazi örtüsü altında, havzadaki farklı topoğrafyalarda meydana gelen toprak özellikleri ve kayıplarının değişkenlik göstermesidir. Bu amaçla, önce toprak özelliklerinin tanımlayıcı istatistikleri hesaplanarak normal dağılıma uygunlukları Kolmogorov-Smirnov testi SPSS (Karaatlı, 2010) ile kontrol edilmiştir. Araştırma sahasından alınan toprak örneklerinin bazı fiziksel ve kimyasal analiz sonuçlarına ait tanımlayıcı istatistikleri Tablo 5' de verilmiştir. Tablo 5' den görüldüğü üzere havza topraklarında, kum miktarı % 16.04-93.06, kil miktarı % 2.74-62.82 ve silt miktarı ise % 3.55-37.33 arasında değişmekte olup, hâkim bünye sınıfı kil, killi tın ve kumlu killi tındır. Toprakların tekstür bileşenleri incelendiğinde kil ve silt içeriğinin normal dağılımlar sergilediği, kum içeriğinin ise sağa çarpık bir dağılım sergilediği görülmektedir. En düşük (6.80) ve en yüksek (8.62) değerlere göre, nötr ve kuvvetli alkali reaksiyon arasında değişen toprak pH'sının sola çarpık dağılım gösterdiği görülmektedir. Havza topraklarının %89.1 hafif alkali özellik göstermektedir. Araştırma topraklarının EC değerleri 0.03-0.99 dS m^{-1} arasında değişmektedir. Ayrıca değişkenlik katsayısı çok yüksek olan EC değerleri sağa çarpık bir dağılım göstermektedir. Değişkenlik katsayısı yüksek olan çok düşük ve çok yüksek kireçli özellikler gösteren kireç miktarının sağa çarpık bir dağılım gösterdiği görülmüştür. Havza topraklarında kireç miktarı 0 ile 48.53 arasında değişkenlik gösterirken, toprakların %45.5'i orta kireçli sınıfına girmektedir. Yüksek değişebilirlik gösteren organik madde miktarının 0.21 ile 6.62 arasında değerler gösterdiği görülmüştür. Havza topraklarının % 34.6'sının az, % 31.4'ünün orta derecede organik madde içerdiği görülmüştür. Değişkenlik katsayısı yüksek olan hidrolik iletkenliğin sağa çarpık dağılım sergilediği görülmüştür. Toprakların en düşük ve en yüksek değerleri 0.02–15.59 (cm/h) arasında değişmektedir. Havza topraklarının hidrolik iletkenliğinin yüzde oranına baktığımızda ise % 47.4'ünün çok yavaş, % 16.7'sinin yavaş, %2 4.7'sinin yavaş ile orta, % 8.3'ünün orta % 2.2'sinin orta hızlı ve % 0.6'sının hızlı iletkenlik özelliği gösterdiği görülmektedir. İnceleme alanı topraklarının hacim ağırlığı normal dağılım sergilemektedir. 1.27 ile 1.60 değerleri arasında değişen hacim ağırlıklarının % 83.3'ünün 1.32 ile 1.52 arasında değiştiği görülmektedir. Araştırma sahası topraklarının USLE-K faktörünün sola çarpık bir dağılım gösterdiği görülmüştür. En düşük (0.01) ve en yüksek (0.14) değerlere göre çok az aşınabilir ve orta derece aşınabilir değerler gösteren USLE-K faktörünün % 50'sinin az aşınabilir sınıfına girerken, % 38.8'inin ise orta derece aşınabilir sınıfına girdiği görülmektedir. Toprak fiziko–kimyasal özelliklerine ilişkin çarpıklık katsayıları incelendiğinde, normal dağılımdan en uzak değer gösteren toprak özelliğinin hidrolik iletkenlik olduğu, en yakın değer gösteren toprak özelliğinin ise USLE-K faktörü özelliği olduğu görülmüştür. Toprak kalite modellerinin istatistik sonuçlarına göre, SQI_n en yüksek değeri 0.60 ve en düşük değeri ise 0.30 olarak belirlenmiştir. En yüksek ve en düşük değerler arasındaki fark 0.29'dur. Ortalama SQL_n değeri ise 0.41'dir. SQI_g ise ortalama değeri 0.46 olup, 0.29 ile 0.64 arasında değişmektedir.

Tablo 5. Araştırma sahası toprak analiz sonuçlarının tanımlayıcı istatistikleri

	n (örnek sayısı)	En düşük ve en yüksek değer arasındaki fark	En düşük değer	En yüksek değer	Ortalama	Standart hata	Standart sapma	Varyans örnek
SQI_g	312	0,35	0,29	0,64	0,46	0,001	0,06	0,001
SQI_n	312	0,29	0,30	0,60	0,41	0,001	0,04	0,001
Kil %	312	60,08	2,74	62,82	36,50	0,75	13,28	176,36
Silt %	312	33,78	3,55	37,33	19,99	0,31	5,53	30,60
Kum %	312	77,02	16,04	93,06	43,51	0,83	14,72	216,65
pH	312	1,82	6,80	8,62	8,12	0,02	0,33	0,11
Ec dS/m	312	0,96	0,03	0,99	0,23	0,01	0,12	0,01
Kireç %	312	48,33	0,20	48,53	10,30	0,47	8,36	69,91
OM	312	6,41	0,21	6,62	2,42	0,07	1,17	1,37
HI cm/h	312	15,57	0,02	15,59	0,98	0,11	1,93	3,73
HA g/cm^3	312	0,33	1,27	1,60	1,42	0,001	0,07	0,01
USLE-K	312	0,13	0,01	0,14	0,09	0,001	0,03	0,001

3.3 Enterpolasyon Modeller ve SQI Dağılımı

Çorum Alaca havzası toprak kalite indekslerinin alansal analizi kapsamında 14farklı enterpolasyon yöntemi kullanılmıştır. Hangi dağılımın en doğru olduğunun belirlenmesi amacıyla her bir yöntemin RMSE değeri belirlenmiştir. Yöntemlere ait RMSE değerleri Tablo6'da verilmiştir. Tablo6' da görüleceği üzere en küçük RMSE değerini veren yöntemin IDW'e ait SQIg için 2'inci ve SQIn için 1. modeller uygun olduğu belirlenmiştir.

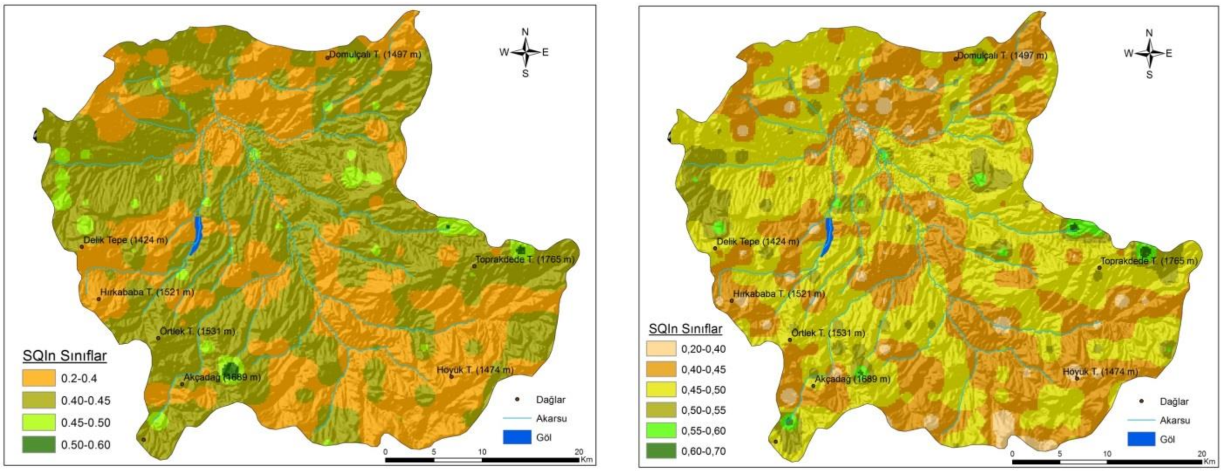
Tablo 6. Enterpolasyon modeller ait RMSE değeri

Enterpolasyon Modeller			SQIg	SQIn
			RMSE	
IDW (Inverse Distance Weighting)		1	0,0569	**0,0393**
		2	**0,0550**	0,0396
		3	0,0584	0,0400
RBF (Radial Basis Functions)		Completely Regularized Spline	0,0588	0,0402
		Thin Plate Spline	0,0706	0,0476
Kriging	Ordinary Kriging	Spherical	0,0561	0,0394
		Exponential	0,0562	0,0405
		Gaussian	0,0562	0,0394
	Simple Kriging	Spherical	0,0556	0,0394
		Exponential	0,0556	0,0395
		Gaussian	0,0555	0,0395
	Universal Kriging	Spherical	0,0561	0,0394
		Exponential	0,0562	0,0405
		Gaussian	0,0562	0,0394

IDW'e ait 1 ve 2. modeller kullanılarak araziden alınan toprak örnekleri için her bir noktaya yönelik olarak belirlenen SQIg ve SQn değerlerinin alansal dağılımını Tablo 7' de verilmiş ve dağılımı gösteren haritalar ise Şekil 5'de gösterilmiştir. Tablo 7 anlaşılacağı üzere alanın büyük bir çoğunluğu her iki toprak kalite modelinde de orta kalite özellik gösterdiği belirlenmiştir. Ayrıca, iyi kalitede toprak sınıfı çok az miktarda (%0.1) SQIg belirlenirken, zayıf kaliteli toprak miktarı SQIn de %19 civarında olduğu belirlenmiştir.

Tablo 7. Araştırma sahası SOI sınıflarının alansal ve oransal dağılımı

SQIn			SQIg		
Sınıf	ha	%	Sınıf	ha	%
zayıf	52630,19	19,11	zayıf	8400,47	3,05
orta	222827,3	80,89	orta	266811,5	96,86
			iyi	245,48	0,09
Toplam	165640	100	Toplam	165640	100



Şekil 5. Toprak kalite indeks modellerine ait sınıfların dağılım haritaları

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The Monitoring of Turkey's Forest Lands within the Scope of Land Degradation Neutrality

Ayhan ATEŞOĞLU[1]

Abstract

Land resources provide food and materials, and the often overlooked. The world's population increases is increased demand for global Land resources. This situation revealed health and productivity of land and food safety. The aspirational goal of a land degradation neutral world, to be realized by reducing the rate of land degradation and increasing the rate of restoration of degraded land, was agreed at the Rio+20 Conference in 2012. The planning should be essential that Land degradation neutrality (LDN). LDN and sustainable land management (SLM) should be evaluated together. The potential for LDN to facilitate the adoption and assessment of SLM is important. The most appropriate indicators and measures of LDN at global, regional and local levels can serve as a target and indicator of SLM. LDN is a simple idea and a powerful tool. It is based on better land management practices and better land-use planning that will increase foundation, economic, social and ecological sustainability for present and future generations. The United Nations Convention to Combat Desertification (UNCCD) one of the adopted following indicators (associated metrics) for LDN targets is trends in land cover (vegetative land cover). Forest is important land resources for monitoring of trend in land cover. The unplanned land use politics is negative affect forestlands and accelerate negatively effects of global climate change. At Identification of LDN indicators, Collect Earth methodology, tool of United Nations Food and Agriculture Organization (FAO), offers a new approach for Multi-purpose land monitoring and evaluation. The Collect Earth method directly and indirectly contributes to the determination of LDN indices using high and medium resolution satellite image data. In this study, Turkey's Forest area per Intergovernmental Panel on Climate Change (IPCC), the trend and change/conversion between 2000 and 2017 years in forestlands, loss or greening forest detection in forestlands and forest area per land cover will be determined using Collect Earth methodology.

Keywords: Turkey, Land use/cover change, Forest, Collect Earth

1. Introduction

Due to the amount of land in the world, there is a competition to control the supply and flow of land-based goods and services. However, when this competition starts to conflict, it contributes more to environmental/land degradation. The present findings show that 25% of all lands are highly degraded, 36% are moderately degraded, 10% are in stable condition, and 10% develops positively (FAO, 2011). Although the global vegetation efficiency is continuously decreasing, "While the overall health and efficiency of land is decreasing, the demand for land resources is increasing" expression is the most important problem today.

The major acquisition agreements for"Rio Conventions" (United Nations Framework Convention on Climate Change, The Convention on Biological Diversity, and United Nations Convention to Combat Desertification (UNCCD)), and sustainable land management (SLM).SLM was unique to many countries but it was approach that slowly process (Cowie et. al., 2018; Kust et. al., 2017; Schuster et. al., 2017). Therefore, in it was not

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enough to some countries for prevent, mitigate and reverse land degradation. The concept of Land Degradation Neutrality; LDN (Figure 1) was first raised at the Rio+20 conference of the United Nations and recorded. (Lal et al.,2012; UNCCD,2012).

This was urgent action plan.The purpose of the LDN,together with 15 of the Sustainable Development Goals (SDGs), "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss". In 2015 the twelfth Conference of Parties (COP 12) defined LDN as: 'a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security, remain stable or increase within specified temporal and spatial scales, and ecosystems'.

LDN is a bi-directional approach that prevention of land degradation and recovery of degraded land. Therefore, the first occurrence should be the planning of land cover/use. "Avoidance>Reduce>Reverse" hierarchy must be the main theme (UNCCD/Science-Policy Interface 2016). It is sub-indicators of UNNCD;

- Land cover and land cover change
- Land productivity
- Carbon stocks above/below ground (Figure 1)

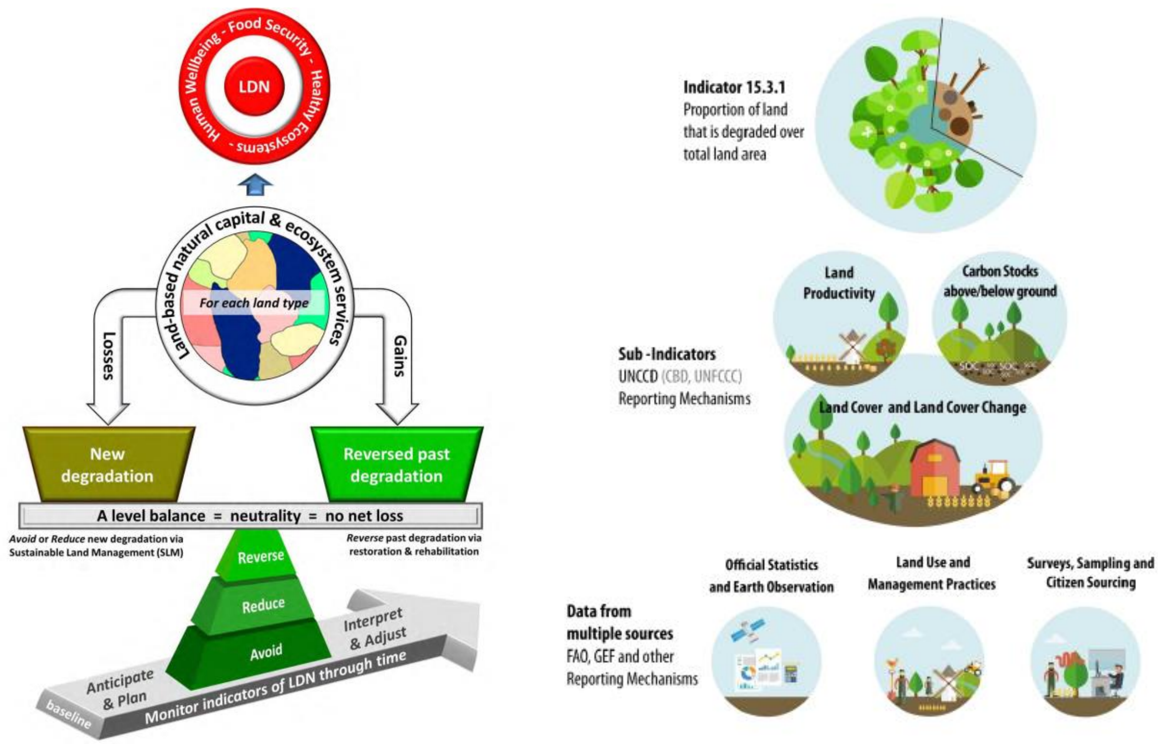

Figure 1.LDN concept (Orr et. al., 2017) (left); Indicator framework for monitoring and reporting on SDG's 15,3. (Source: UNCCD et. al., 2016) (right)

Accurate and sensitive data are required for Land cover and land cover change, one of LDN Sub-Indicators. So simple ideas but effective methods should be considered. With the help of remote sensing data (especially satellite data), environmental and natural resources management, global and regional land cover/use changes

are implemented effectively. Remote sensing data provides fast, economical and up-to-date information on the earth and can be used in different application areas based on Geographical Information Systems (GIS) (Lillesand ve Kiefer., 1994; Ma et. al, 2001).Because the results of the ATD at the regional scale provide more effective results, high-resolution data and medium resolution data should be analyzed and evaluated together. High-resolution data gives more accurate numerical information. medium-resolution data is effectively used in mapping of large areas. In addition, it offers a very effective planning to use free global data with high accuracy and precision due to the lack of land data and achieve the findings of the ATS targets.
In this study, Turkey’s Forest area per Intergovernmental Panel on Climate Change (IPCC), the trend and change/conversion between 2000 and 2017 years in forestlands, loss or greening forest detection in forestlands and forest area per land cover will be determined using Collect Earth methodology.

2. Material and Methods

Turkey (77076 km² except water areas) was chosen as the study area. A total of 61685 plots (0.5 ha) were measured in the test area using Collect Earth methodology (Figure 2). Plot areas are systematically placed. The distances between the plot areas are approximately 3.2 km in East-West direction and approximately 4 km in North-South direction. Each plot was evaluated visually and graphically within the scope of Collect Earth methodology and interpolated to the entire study area.

Figure 2. Distribution of plot areas within the study area

In this study, Collect Earth software that allows use of Google technology is used (Figure 3). Collect Earth, which was first developed and used by Food and Agriculture Organization (FAO), is a software that experts and non-experts can use within the scope of land monitoring. Built on Google technology and with many interfaces, it provides access to open source and free satellite image (SPOT, Sentinel2, Landsat and MODIS etc.) via Google Earth, Bing Maps, Yandex Maps, Earth Engine, Timelaps, Open Street Maps etc. Most support software is available online for free from Google Earth, web browser and Open Foris Collect (Open Foris, 2015). Bey et. al., 2016 and Bastin et. al., 2017 references can be examined for the methodology.

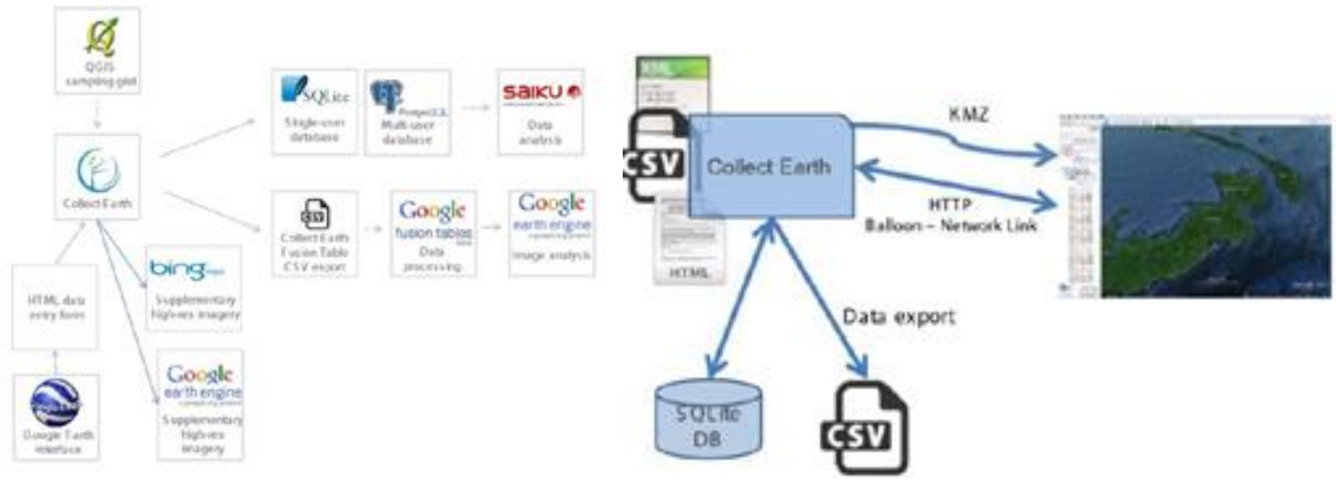

Figure 3. Open Foris Collect Earthmethodology

3. Result and Conclusions

According to the 61685 plot evaluation results using the Collect Earth method, according to the The Intergovernmental Panel on Climate Change (IPCC), the largest land class is Cropland of Turkey (25.6 million Ha; 33.2%). The other land classes are Forest Land (19.04 million ha; 24.7%) and Grassland (20.2 million ha; 26.2%). According to the IPCC definition has a total of 19.04 million ha of forests in Turkey. According to Aridity Index, most forest areas (11.71 ha; %61.5) are located in semi-humid areas. According to this study, 99.75% of Forests from year 2000 remained intact until 2017. A proportion of the others land (Cropland, Grassland, Wetland, Settlement, Other Land; total area: 47483 ha) has been noticed converted to Forest in this period. Similarly, A proportion of the Forest land (108750.7 ha) has been noticed converted to others land in this period (Table 1).

Table 1. Land cover conversion in the 2000-2017

*Land cover conversion (ha); **Gains***	***Initial land use (2000)***				
Current land use (2017)	***Forest***	***Cropland***	***Other land***	***Grassland***	***Settlement***
Forest	*19000044*	*1250*	*16244*	*28739*	*1250*

*Land cover conversion (ha);**Loses***	***Current land use (2017)***					
Initial land use (2000)	***Forest***	***Grassland***	***Cropland***	***Settlement***	***Wetlands***	***Other land***
Forest	*19000044*	*38735*	*28739*	*19992*	*6248*	*14994*

When the Greening/Desertification-Land degradation areas within the forest area were examined, the greening area was 989611 ha, desertification-Land degredation areas was 151190 ha (Table 2, Figure 3).

Table 2. Greening and desertification trends in forestland

	1. Forest	
2.	3. Greening	4. Desertification
5. Area (ha)	6. 989611	7. 151190

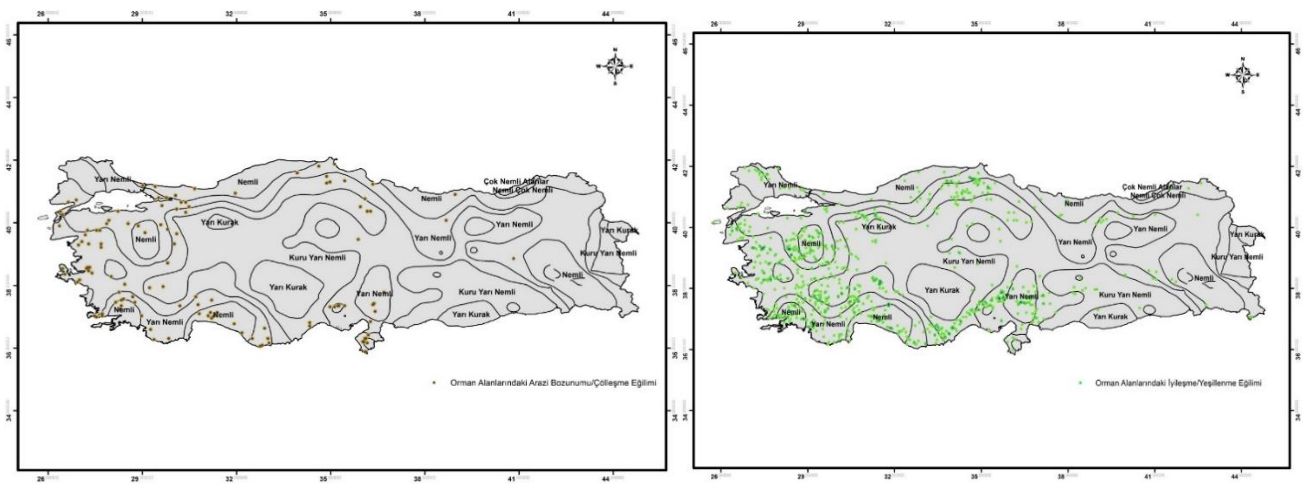

Figure 3. Greening (Right) and desertification (Left) areas in forestland in Turkey

4. Acknowledgements

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GIS-Based Decision Support for Water Table Monitoring Works

Aynur FAYRAP[1], Şerife Pınar GÜVEL[2]

Abstract

Investigation of potential and quality of water resources, including land surveys and observations, online data supply techniques and office works is of great importance for sustainable water and soil resources management. The evaluation of historical development processes and future projections is possible through information systems that provide analysis of big data. Data stored in the computer environment in accordance with the design purpose through information systems can provide a dynamic archive at every stage of water structure projects. Geographic Information System (GIS) technique as a decision support tool is widely used in engineering applications in complex systems, including big data and is preferred due to ability to predict spatial and temporal changes during project management. The use of GIS technique, with its geographic analysis and geographic inquiry capabilities, provides preparing thematic maps. The evaluation of monitoring activities and engineering measurements, modelling of the distribution of water quality parameters, evaluation of water resources conservation works in river basin or sub-basin scales are possible by using GIS.In this study, contributions provided by GIS supported analysis within the scope of water resources management is evaluated in a general framework, and it is aimed to present the importance of GIS-based decision support in evaluation of water table level monitoring studies and operation works of water structure projects.

Keywords: Irrigation Management, Water Table, Geographic Information System

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Determination of Land Degradation in the Ceyhan Plain During Last 35 Years from Soil Data Base

Batuhan KELEŞ[1], A.Oğuz DİNÇ[2], Yavuz Şahin TURGUT[2], Suat ŞENOL[2]

Abstract

Detailed soil survey of Ceyhan Plain has been completed between 1977 and 1982. During last 35 years irrigation and drainage projects implemented. Unavoidable result of that income of the farmers and population have been increased rapidly. 35 years ago, remote sensing and GIS techniques were not available too. Therefore, in this research, detailed soil map of the Ceyhan Plain digitized and from soil properties obtained its report soil data base performed. Soil data belong to 642 mapping units having geographic locations from 28 soil series were digitized and soil data were entered into the attribute table. Various maps such as; soil pH map, soil texture map of study area created and thus provided convenience information for users. Changes in the area of settlements from 1981 to 2015 that occupied agricultural land in the study area were determined. It is found that the total area occupied by settlement areas was 1.924 ha in 1981, but by the year of 2015 it reached an area of 3.361 ha with an increase of 93,61%. Due to increase in very productive agricultural land by increase of settlement areas, have been another indicator of soil degradation with human impact due to misuse of agricultural lands.

Keywords: GIS, Ceyhan Plain, soil, soil information system, database

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Effects of Land Degradation on Soil Organic Carbon and Nitrogen Contents in Mediterranean Region

Bilal BORAN[1], Emre BABÜR[2], Turgay DİNDAROĞLU[3]

Abstract

Soil isone of the important carbon sequestration resources.Land degradation is the major causes for increasing the atmospheric carbon dioxide content by releasing the stocks held in the soil. Especially, land use change from forest to agriculture caused by human activities is one of the important reasons for soil carbon sequestration changes.However, the relationships between soil organic carbon and nitrogen stocks are not completely understood in degraded areas. For this, the study was carried out into degraded areas out of forest status (2B) and in adjacent agriculture and forest areas in the villages of Karaisali in Adana, where land use form has been converted from degraded forest into agricultural useaccording to the Forest Law No. 6831 (2B).In this study 30 different land use locations were investigated. According to the results, the soil organic carbon (SOC) and total nitrogen (TN) were found highest in forest area (3.08% and 0.145%, respectively). The agriculture areas contain less SOC (1.48%) and TN (0.106%) compared to "2B" areas (1.62% and 0.107%, respectively) and they are in the same group by Duncan test. Consequently, land degradation due to human activities have a negative impact on the amount of carbon and nitrogen stored in the soils. In the future, the impact of different land degradation processes on soil carbon dynamics and other soil properties will need to be further investigation.

Keywords: Land degradation, forest, agriculture, soil organic carbon, total nitrogen, 6831(2B)

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Assessing Desertification Through Soil Biological Monitoring

Carlo JACOMINI[1], Marco Di LEGINIO[1], Francesco BIGARAN[2], Cristina MANTONI[3], Anna LUISE[1]

Abstract

UNCCD defines desertification as "the degradation of land in arid, semi-arid, and dry sub-humid areas. It is a gradual process of soil productivity loss and the thinning out of the vegetative cover because of human activities and climatic variations such as prolonged droughts and floods. (...) Among human causal factors are overcultivation, overgrazing, deforestation, and poor irrigation practices. Such overexploitation is generally caused by economic and social pressure, ignorance, war, and drought."

Desertification is therefore strictly related to global climate change and loss of biodiversity. Synergies between the three Rio conventions - the United Nations Convention to Combat Desertification (UNCCD), the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biodiversity (CBD) - are focusing more and more on soil processes and ecosystem services provided by soil biota (edaphon) to assess the impact of desertification processes and the efficacy of the measures undertaken to fight it.

Soil biological monitoring offers a unique chance to coordinate activities related to environmental protection and natural resource management and to address the complementary nature of the three conventions at all levels.

Biological processes are key factors to monitor effective soil degradation and desertification intensification, though up-to-now seldom soil monitoring programmes have used soil biological assays to assess these calamities.

A review of the existing methodologies and recent updates on this issue highlight the huge potential role of using soil biological techniques on different processes and ecosystem services in the assessment of the desertification effects. Case studies on soil biological monitoring for the different soil threats, and the potential for rapidly inverting this situation, will also be discussed.

Keywords: Soil Biological Monitoring, Desertification Assessment, Soil Threats.

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Drought and LDN in the Rangelands of western NSW, Australia

Deirdre DRAGOVICH[1]

Abstract

LDN is an aspirational global policy initiative directed towards achieving land resource sustainability through balancing development and conservation. Although adopted and legislated national levels, effective implementation of LDN policy requires local actions and engagement for its realization. An essential component of the process is the monitoring and evaluating of actions and outcomes for varying existing land uses. Using a regional focus, potential responses to LDN objectives are here considered when management decisions may be constrained by drought. In the arid to semi-arid rangelands of western New South Wales (NSW), extensive commercial pastoralism is based on natural pastures. The rangelands experience variable rainfall, prolonged dry periods and serious droughts, leading to over-grazing and accompanying land degradation. Using continuous rainfall records available from 1892, median annual rainfall is 204 mm (ranging from 65.3 mm to 712.3 mm). Consecutive years with below median rainfall included the major 'Federation drought' of 1895-1905 (when sheep numbers dropped from about 15 million to 3 million in western NSW). Droughts continue to recur and a general increase in their intensity and frequency is predicted. National and State policy responses to drought-associated land degradation have included land capability assessment and assistance for local volunteer Land Care and Community Dust Watch groups. In NSW the recently- developed semi-quantitative tool of 'Land Management within Capability (LMwC)' provides a mechanism for identifying and monitoring land degradation at a State level; wind erosion is the key poorly-managed hazard in the rangelands. LMwC provides spatial identification of localized high-risk areas where educational and extension inputs would be valuable in attempting to reduce adverse impacts of existing uses on land resources. Achieving LDN in rangelands would involve reducing grazing pressure to encourage long-term vegetation recovery; possible options include transferring land to national parks, permanently reducing commercial livestock numbers or changing management strategies, effectively eradicating introduced herbivore competitors, or introducing costly rehabilitation programs.

Keywords: Drought, land capability, erosion

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Desertification in Tekirdağ Province: Land Concretization

Duygu BOYRAZ ERDEM[1], Hüseyin SARI[2]

Abtract

Tekirdag is one of the most immigrant provinces of our country and Thrace Region.The biggest reason for such a huge metropolis as Istanbul is very close and is taking place in an area that connects Turkey to Europe.Thus, the region has become an important attraction center for investors and the investments started very quickly.In this process, it has caused rapid population growth. Along with the rapid migration, housing, living centers, public institutions, etc. as well as investments have increased the need for buildings.Cangir and Boyraz, in 1997, in the environment of the main roads in Thrace in agricultural land in the size of land use compared to 1985, summer tourism, cottage home, public investments, urbanization, industry, the average rate of increase in the soil industry 727.4% announced.In this study, it was aimed to reveal the dimensions of our lands that were lost in 1990, 2000 and 2018 in order not to come back with the concretization of the land by ignoring the desertification.

Keywords: Desertification**,** Land Concretization, Migration

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Determination of Suitable Micro Catchments for Organic Farming in Trabzon with Geographic Information System and Remote Sensing Techniques

Elif ÖZTÜRK[1], Orhan DENGİZ[2]

Abstract

Organic farming is a system that maintains balance in nature, provides continuity in soil fertility and life by controlling diseases and pests, and obtains optimum efficiency with optimum utilization of natural resources and energy. In organic agriculture, soil is not contaminated with pesticides and industrial fertilizers is desired. It is almost impossible to find suitable agricultural land according to these criteria. Turkey, as having extremely favorable climatic and soil conditions in terms of agricultural production as well with its rich biodiversity and land due to unaffected by pesticide and chemical fertilizer pollution of a large part is extremely suitable for organic farming. In parallel with developments in technology computer aided Remote Sensing (RS) and Geographic Information System techniques (GIS) are used extensively in agriculture today. From this point of view, purpose of this study was to determine suitable micro catchments for organic farming by using GIS and RS techniques in Trabzon Province located in the east of the Black Sea of Turkey. After removing forest, pasture, bare lands and also artificial areas such as settlement, road, industrial area and so on, 32 micro catchments were selected by considering of their arable land size using DEM by means of Hydrology Tools. Total 259 samples were collected from surface (0-20 cm) and subsurface (20-40 cm) depths to determine physicochemical properties, nutrient element status and heavy metal (HM) contents. Soils in the Province are generally light heavy textured, with acid reaction, salt-free, limeless and have medium organic matter values, low nitrogen, inadequate phosphorus and low potassium contents. According to the results, over threshold heavy metal contents of topsoil samples were determined in micro catchments located within the boundaries of Beşikdüzü, Çarşıbaşı, Şalpazarı and Akçaabatdistricts. Also Ni excess was determined in micro catchment coded as 12 located in Centre and Tonya districts. Excess of Cr was determined in micro catchments of Çarşıbaşı district. When the subsoils were evaluated, Cu excess was determined in the catchments coded as 6, 14, 15, 19, 24, and 29 like point pollution. In both top and subsoils Ni and very few Cr and Cu elements were concentrated in the micro catchments in Çarşıbaşı, Beşikdüzü, Şalpazarı and Akçaabat districts located in the west of the Province. Heavy metal pollution was not determined in the other catchments.

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Relationships Between Land Use Types and Soil Development in the Narman-Alabalik Micro-Catchment

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Abstract

The need for determining the effects of land use types and changes on soil quality is essential because of the increasing pressure on natural resources. The objective of this study was to evaluate the effects of land use changes on soil development in the Narman-Alabalik micro-catchment. Soil formation and erosion conditions of soils developed on different physiographic land groups (terraces, foot-slopes and back-slopes) in forestland, pastureland and cultivated land were evaluated. Top soil (Ap and A) development and thickness, horizons and layers, and other profile characteristics were obtained in situ. Physical and chemical properties of soil samples collected from different horizons and layers wereanalyzed for comparing and evaluating soils under different land use types. Due to the improper management of agricultural lands without considering topography and soil characteristics, early and overgrazing of pasturelands and misuse of forestlands have led to deterioration of soil properties and weakening of pasture vegetation and forests. Erosion caused by the deterioration of forest vegetation and pasturelands lead severe sediment accumulation in terraces. Land use methods and measures for land degradation and erosion prevention have been proposed by evaluating the socioeconomic structure of the micro catchment.

Keywords: Land use, physiography, soil degradation, erosion, Alabalik micro catchment

1. Introduction

Sustainable practices can halt the loss of forests, pastureland and agriculture areas. Anthropogenic impacts have important effects on land degradation (Baude et al., 2019). Misuse of lands has generally been considered a local problem, but it isday-by-day becoming a force of global importance. Land-use and land-cover changes are significantly affect soil behavior. The ecosystems is often modified by land use type, production practices and the land use intensity (Kasperson et al., 1995; Lambin et al., 2001).Such changes in land use have enabled humans to appropriate an increasing share of the land resources, but they also potentially undermine the capacity of ecosystems to sustain food production, maintain forest resources, regulate climate and air quality. Land use has also caused declines in biodiversity through the loss, modification of habitats and degradation of soil and water resources (Foley et al., 2005).

The objective of this study was to assess and compare soil development in farmland, pastureland and forestlands in the Alabalik micro catchment regarding to land use changes.

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2. Methodology

2.1 Description of the Study Area

This study was conducted in Alabalik micro catchment about 110 km north of Erzurum (40°22′–40°27′N and 41°49′–41°58′E), Turkey. Totalarea of the study catchment is 2.895 ha. Annual rainfall averages 340.75 mm and is concentrated during the spring and summer (May-June). The dry season extends during winter (December–March). Mean temperature of the warmest month (August) and coldest month (January) are 22.7 and -4.2°C, respectively.The soils in the study siteare shallow, sandy loam textured, colluvial and alluvial material originated without salinity and sodicity problems. Soils are classified commonly in Inceptisol. Average slope is 39%, very steep. Minimal slope (3%) was found in agricultural lands and maximum slope (66%) was found in forestlands.Intense human activities and topographic factors have hampered the regeneration of existing residual vegetation on degraded reforested lands and pasturelands. The forests have been extravagant exploited to meet the increasing demands for firewood and timber materials. Dominant tree species Pinus sylvestris L. in the forestlands. The pastureland in research area are very degraded by overgrazing. Dominant species Festuca ovina and Astragalus sp. in the pasturelands.

2.2 Soil Sampling and Vegetation Analysis

Fifty surface soil samples (0–30 cm depth) were collected from 4 different land use/land cover types(forest, plantation area, pastureland and cultivated fields). Each land use type were randomly sampled and mixed to obtain a composite sample that was sealed in a plastic bag. Soil samples were air dried for 24 h, sieved through a 2 mm mesh. For each soil sample, the following soil characteristics were measured: organic matter (SOM) by the wet method of Smith-Weldon(Nelson and Sommer, 1982), soil pH was determined in 1:2.5 soil–water suspension, using a combination glass electrode (McLean, 1982), soil particle size analysis was done by the Bouyoucos hydrometer method (Gee and Bauder, 1986), $CaCO_3$ contents by theScheibler calcimeter methot (Kacar, 1994) and soil EC was determined in saturation paste extraction, using a electrical conductivity instrument (Rhoades, 1982).

3. Results and Conclusion

The pH values of the forest, plantation area, pastureland and cultivated soils changed between 7.6 to 7.9 (Table 1). Forest, grassland and cultivated sites did not show alkalinity problem. Soil pH and EC were highest in cultivated lands (7.9 and 0.72 dS m^{-1} respectively), and lowest in forest areas (7.6 and 0.50 dS m^{-1} respectively) within the catchment. Soil pH and EC were likely more regulated in the more conventional cultivated land uses from fertilizer additions. Brye and Pirani (2005), similarly concluded that soil pH and EC were generally greater under tilled cultivated than under native land use. On the average soil organic matter content was 2.9 times higher in forestlands than that of cultivated land (Table 1). Similarly soil organic matter content was 4 times higher inforestlandsas compared that of pastureland (Table 1). The differences in SOM between land uses indicated that in the cultivated land use in general, the SOM pool is less diverse with other soil nutrients than in the forestland. The reason for the lowest SOM in the pasturelands, is the over grazing of sloping areas.Soil tillage, overgrazing and land use change greatly influence on SOM content. $CaCO_3$ content of the forest, plantation area, pastureland and cultivated lands varied significantly from 3.7 to 12.4%. $CaCO_3$ content were highest in cultivated sites (12.4%), and lowest in the forestlands (3.7%) (Table 1). $CaCO_3$ content was high at the cultivatedlands. Soils on limestone material are A-C horizon. Land use changes and management type, especially cultivation of deforested land rapidly diminish soil quality effects of misuse agricultural practices and overgrazing to pasture land. Land use changing resulted in deterioration of soil properties soils under forest and pastureland. As a result, degradation in soil quality may lead to a permanent reduce of land productivity.Overgrazing in the micro-catchment is very detrimental to soil fertility, resulting in a marked decrease in SOM contents. In the forest area, soils are systematically deeper in the pastureland and cropland positions compared. Despite differing types of managed land use type the micro catchment physiographic conditions region clearly had a greater influence. Results of this study demonstrate how the change of land use type, which constitutes the major differences between physiographic conditions that were investigated in this study, can have. Especially mismanagement can result in surface erosion at varying levels or quantities. Micro catchment are used for agriculture and livestock. Therefore, the local population needs to be developed economically to restore the natural balance in the micro-basin. To reduce erosion and sedimentation in micro catchment, management model that collaborates with native people should be using.

Table 1. Some average physical and chemical analysis results of soil sample

Soil properties	Cultivated land	Pastureland	Forest land
Clay,%	13	10	6
Loam, %	23	19	20
Sandy,%	64	71	74
Texture	Sandy loam	Sandy loam	Sandy loam
pH	7,9	7,8	7,6
EC, dS m^{-1}	0,72	0,65	0,50
$CaCO_3$, %	12,4	9,7	3,7
Organic matter, %	3,0	2,1	8,6

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How Can Land Use Planning Help to Reduce Flooding?

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Abstract

Flood disasters in Turkey are ranked as the issue among the natural disasters which is encountered frequently and have higher economic losses. The most important cause of floods is the deterioration of the natural equilibrium between soil-water-plant in the water collection zone at the upper parts of the basin. In addition, the change in the infiltration capacity of soil and soil cover associated with deterioration in land use due to rapid population growth increases the risk for future flood events. The most effective method of preventing flood is to take measures to restore the natural balance deteriorated in the water collection area. In other words, the planned use of land in a sustainable way is considered as an effective measure to prevent flood risk and reduce the loss of life and property. Regulation of land use planning at the local level supported by the increased knowledge of flood hazard is helpful to secure resilience to flooding. Hence, the systematic assessment of land and water potential and planning the most applicable land use options in the region can reduce the future risk. In consequence, it is necessary to establish the flood characteristics of the basins, to ensure their sustainable management and to determine the best land use options. It is also essential to develop and implement mathematical simulation models in order to quickly understand the short and long-term effects of changes in land use for the sustainable management plan of the basin.

In this respect, the Hydrological-Hydraulic Flood Model (HHFM), which is a GIS based, flexible, user-friendly, and grid-based, has been developed by the Ministry of Agriculture and Forestry that is applicable for Turkey. With this model, scenarios can be created on the investment decision, timing, cost-benefit analysis and estimation of the effects of the parameters with limited information, which should be made for the works to be carried out on the land. The scenarios created by this model will provide an opportunity to create a basis for the integrated planning approaches for the sustainable use of soil and land resources.

Keywords: Land Use Planning, Flooding, Flood Modeling, Sustainable Basin Management

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Measuring and Assessing Soil Organic Carbon to AchieveLand Degradation Neutrality in Kyrgyzstan

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Abstract

In Kyrgyzstan, desertification and climate change increase the exposure of mountain areas to multiple natural hazards and extreme events such as storms, landslides, avalanches, droughts and land degradation. Furthermore, population growth and an ever-increasing demand for land resources, and unsustainable land use and management are of great concern. This increases environmental uncertainties and hamper the development of the region. Responding to the dire need for mitigation of climate change and addressing the current land degradation problems, the Kyrgyz government in cooperation with international development agencies has been preparing the National Climate Change Communication, which includes the assessment of state the of soil organic carbon (SOC), which is alsoa key indicator of the Land Degradation Neutrality (LDN) agreement. This agreement is signed by the Kyrgyz government in the context of the sustainable development goal (SDG) 15.3. However, a proved and validated monitoring system including the measurement and upscaling of SOC is still missing in the Kyrgyzstan. To support this process, we develop innovative ideas for the SOC measurement and assessment methodology that builds on existing knowledge and incorporates the relation to the land cover and land productivity indicators. The methodology has been developed in a participatory and iterative process by Kyrgyz and German partners and will improve our knowledge and it's governance to support the evidence-based decision-making to combat desertification and mitigate climate change at the national level.

Keywords: Climate Change Mitigation, Soil Organic Carbon, Assessment, Land Degradation Neutrality, Kyrgyzstan.

1. Introduction

The impact of desertification and climate change on mountain areas is of key concern in the global climate change agenda as mountains supply freshwater to half of the world's population. Desertification and climate change increase the exposure of mountain areas to multiple natural hazards and extreme events such as storms, landslides, avalanches, and rockfalls(Kohler et al. 2010).In Central Asia, including Kyrgyzstan, mountainous ecosystems are vital to provide essential goods and services to the local population and control the water regime in the region(CEPF 2017; Hagg et al. 2013; Ibele, Fabian, and Donga 2012; World Bank 2015)Due to climatic and topographic conditions mountain areas of the region have a high degree of vulnerability to climate change, desertification and an increase of natural disasters as the region has limited resources to respond appropriately. The negative effect on local economies as well as on individual households and livelihoods is severe and is expected to rise even if global temperature remains below the target of a 2°C increase (Reyer et al. 2017). Floods, landslides and droughts increase environmental uncertainties and hamper the development of these regions.

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Furthermore, Kyrgyz land users and decision-makers are not yet sufficiently aware of the environmental problems, and this is not only due to a lack of specific knowledge but also to a general attitude towards environmental issues since the collapse of the Soviet Union. The main problems are current land use and pasture management as the use of arable land is predominantly determined by economic considerations. At both national and local level, knowledge, planning and resource management skills are not sufficient to implement ecosystem-based, climate-adapted land use.

On the one hand, to address climate change and desertification, there is a lack of evidence-based and adapted instruments for inventorying and evaluating carbon-rich soils and land use systems. Due to the absence of the baseline values (actual state), assessments of changes in carbon stocks and the greenhouse gas emissions based on them are challenging tasks. A transferability of results into the international context is very difficult, since the method of soil classification used in Kyrgyzstan is not internationally connectable and knowledge on methods of C-evaluation has not been updated - they correspond to the state of the art from Soviet times. Data on the carbon stocks of soils obtained so far are underdeveloped compared to the international standard. Information on the distribution of land use categories is only available analogously; knowledge on GIS-based data management is very limited.

One the other hand, the institutional framework for reporting on the inventory of carbon stocks and greenhouse gas emissions is missing. The capacity of state organizations in the field of climate protection is insufficient to carry out a structured, comprehensible inventory of carbon stocks in land use. The state organizations are underdeveloped in terms of their expertise and personnel, responsibilities are unclearly distributed, rights and duties of the individual hierarchical institutions are not clearly anchored. A lack of horizontal integration hampers a transparent flow of information. Due to a lack of feedback to the institutions that collect the data, their employees are not sufficiently motivated. There is a complete lack of facilities for advice and monitoring in order to make effective use of the potential sink functions in land use and to avoid emissions.

To address this problem, the “CARB-ASIA[1]” projectteam supports the development of a scientifically sound method for assessing the carbon storage of soils in various categories of land use in Kyrgyzstan that is adapted to international standards.

2. Institutional Framework

At the international level, Kyrgyzstan is a signatory to various international agreements aimed at minimizing greenhouse gases (especially CO_2) and sustainably protecting natural carbon stocks (Kyoto Protocol, United Nations Framework Convention on Climate Change, Sustainable Development Goals (SDG’s)). To protect natural SOC stocks, Objective 15.3 of the Land Degradation Neutrality (LDN) is of central importance within the framework of the SDG's objectives. In order to monitor and manage the LDN it is necessary that the member states establish a reasonable baseline (evaluation of the actual state) for the current situation of land degradation. Subsequently, they are urged to report at regular intervals (e.g. every 4 years) about the changes in land degradation (positive or negative) until 2030 (Orr et al., 2017).

At the national level, there are efforts made by the development agencies (e.g. UNDP, FAO and GIZ) that led to the initial activities in this direction. A group of experts was set up to assess the institutional and methodical

[1]Project CARB-ASIA- Development of methods for organic carbon stock assessment and improvement of climate change reporting on agricultural ecosystems in Kyrgyzstan.The project is implemented by Humboldt-Universitätzu Berlin in close cooperation and coordination with the Kyrgyz national authorities, Kyrgyz Soil Science Society, GIZ Bishkek, as well as NGOs and universities in Kyrgyzstan.

conditions in Kyrgyzstan to meet the obligations of the LDN agreement - the 15.3 Target "Land Degradation Neutrality" under Kyrgyz conditions in 2017. The first results were presented and discussed at the workshop in Kyrgyzstan (Bishkek, 21.01.2018). The experts confirm the gaps mentioned above by stressing that there is no systematic measurement and data analysis of SOC, and suggested that Kyrgyz methods should be further developed and tested.

3. Adaptation of LDN methodology and methods to Kyrgyzstan

Three indicators for the state of land degradation have been defined in the LDN methodology by the UNCCD: land cover, land productivity and soil organic carbon (SOC) in the upper 30 cm of the soil. An LDN is only achieved if none of the indicators shows negative changes, regardless of whether another indicator shows positive trends, i.e. a positive change in one indicator cannot compensate for a negative change in another indicator.

A method will be developed for evaluating national carbon stocks in soils, which meetsinternational standards and uses previous Kyrgyz technical data on the basis of a translation routine (hybrid method). This method will be exemplary implemented in theproject regions (selected representative units) in Kyrgyzstan.

The focus is the SOC in the upper 30 cm, which is the part of the soil strongly influenced by agriculture. For land cover and land productivity it is advisable to use the global default data supplied by the UNCCD, this is also their recommendation, since (a) it is already a matter of deriving certain classes, which are also to be reported on, and (b) deriving these two parameters from satellite data is very useful.Six land use categories specified by the UNCCD for LDN are quite rough, but since they are aggregated classes from originally 22-36 classes, the differentiated data could also be considered. For the determination of the SOC it is important to show which factors determine the SOC content (Fig. 1): land cover/use, soil type (especially texture), topographic position (corresponds to climatic influence, i.e. altitude, exposition and slope), management (difficult as no data is available).

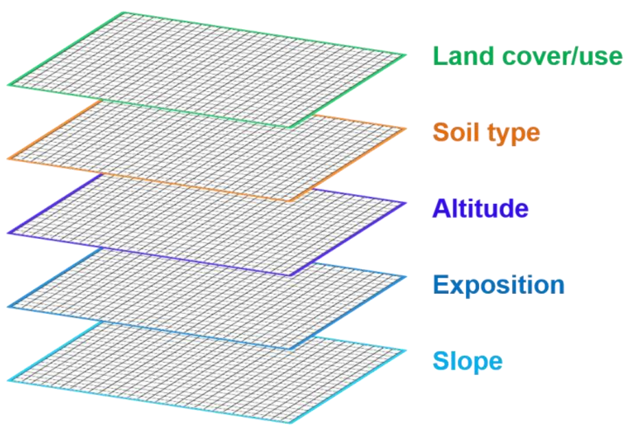

Figure 1. Factors determining the SOC

Based on this, representative units are to be selected for the field investigations. The aim is to cover the variability in the SOC via the representative units and to measure repetition of these units. Furthermore, the spatial variability in SOC will be considered within these units, i.e. in the result there are several values for a unit with e.g. certain land use, soil type and height, so that mean values and uncertainties can be calculated. The disclosure of the SOC with uncertainties is fundamental if the changes are to be reported, because only then it can be stated whether a change is significant or within the range of the error.

This approach is also useful to investigate the influence of individual parameters on SOC. For instance, if different land uses are measured on the same soil types and vice versa. So, it can be definedwhether land use/soil have a significant influence on SOC or not, if the other factors remain constant in each case. In particular, pasture land must be included, because this is a use that is particularly affected by degradation in Kyrgyzstan, which would perform poorly in the land productivity category and would probably require the greatest action.What is innovative about the project approach is the inclusion of the already existing regional soil data and research methodsavailable in Kyrgyzstan. This is a prerequisite for the acceptance of the method by national experts and responsible organisations.

4. Expected Results

The project was started in November 2018 and the Kick of Meeting have been organised in March 2019 with the objectives to launch the project and exchange ideas and experiences regarding the potential directions in which the method will be developed, as well as the organizational and institutional framework that will be adapted. The field work to collect empirical data is planned for summer 2019. The following results are expected in this project:

- For representative project areas in the high altitudes and valleys of Kyrgyzstan, the organisational and institutional framework conditions for transparent and comprehensible LDN reporting and inventory are proposed. Recommendations for official responsibilities of the specialist capacities have been developed so that reporting can be carried out on the basis of an updated, scientifically sound method, the use of which is anchored in administrative regulations.
- Kyrgyz experts responsible for reporting on greenhouse gas emissions and LDN have been trained and have improved knowledge of the C-balancing methodology for different categories of land use.
- A set of rules for the implementation of the assessment tool and the application of the results for reporting is available.
- Material for the multiplication of the evaluation method and proposals for the institutionalized implementation in national and regional administrations and educational institutions is available in the national languages (Kyrgyz and Russian) digitally and analogously. The evaluation method and its application for reporting is also known at research institutions and universities and is used in current research work.

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Variation of Aggregate Stability and Mean Weight Diameter of Soils Developed onNorth-western and South-easternToposequence

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Abstract

The aim of this study is to examine the changes and water resist aggregate stability (WRAS) and mean weight diameter (MWD) of soils developed on the different parent materials (marl, colluvium and alluvial), land form (flat on hill, back slope, footslope and flood plain), elevations, land cover and land use under semi-humid climatic conditions. In this context, four soil profiles were selected on northwestern and southeasterntoposequence and examined. According to Newhall simulation model, soil moisture and temperature regimes of the study area are Typic Xeric and Mesic, respectively. The study results showed that the lands located on back slope and flood plain were classified in the Lithic Xeroorthents and VerticXerofluvent subgroup of the Entisol order, while the lands on the flat on hill and footslope fields were classified as TypicHaplustert, and TypicCalcixerept, belonging to the Vertisol and Inceptisol orders. The formation of different soils on the northwestern and southeastern direction transect in the study area in other words, young and mature soils existing in a local area suggests that topography or local relief and parent material have a significant impact on the material and time involved in the soil formation process. It is seen that in the maturation of the soil and in the process that keeps the soil young, the soil transport and sedimentation, especially in the soils located on the back slopes due to water movement, is as effective as the formation that occurs on the spot. A significant difference was determined between the upper layer WRAS and MWD values of four soils used as dry and irrigated agricultures and this difference is thought to be caused in particular by agricultural use of the soils and by their organic matter and their pedogenic development. The soil classified as TypicHaploxerert has the highest WRAS and MWD values, whereasVerticXerofluvent has the lowest WRAS MWD values in surface horizons.

Keywords: Water Resist Aggregate Stability, Mean Weight Diameter, Toposequence

1. Introduction

The rapidly growing population has not only increased demand for herbal products, but also increased the pressure on agricultural areas. On the one hand, the human being must ensure the reliable food and ensure sustainability in agricultural production. The desire to obtain high yield from the unit area, it causes the exploitation of the soils and changes their the physical and chemical properties, as well as affects negatively on the quality of the soil.

Soil quality is an important criterion for evaluating the management practices, land degradation or improvement of land use sustainability. Because of soil quality, depending on factors such as soil management practices, ecosystem, environment, socio-economic and political priorities, it is defined as the umbrella characteristic of the soil (Doran and Parkin, 1994, Canbolat, 2006, Altıkatvd, 2009, Cebel, 2011, Kadıoğlu

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and Canbolat, 2014). Unconscious or out of purpose of land uses cause loss of functions associated with important physical, chemical and biological properties of soils, this case leads to land degradation.

The main objective of sustainable land management is to protect the fertility of the land and to transfer it to future generations. That's way, it is necessary to supply sufficient and detailed data about soil and land resources for protection practices. In other words, the most important step in the development of different strategic plans and management practices for the protection of the soil is the collection of information on the soil (Yakupoğluat all, 2012).

The majority of our geography position or topographic positions havehigh and steep slope degree. Therefore, it should be taken some precautions or measurements and fulfilment under control for cultivation which has slope land position. Because, shope has significantly role on pedogenetic development of soil in itssuit. Therefore, topography or relief is the most important factor for soil formation and affects how water and energy were added to and was lost from soil.Aggregates can be called as the smallest parts of the soil which can form by means of clay, silt and sand fractions mixed withorganic materials and living organisms create the most suitable condition for plant life(Ergene, 1982).It should be stimulate for aggregates formation particularly in cultivated land due to resist for field traffic and erosion

Aggregate stability that is an important parameter in determining of resistance against to environmental factors that deterioration (Hillel, 1982; Yılmaz and Alagöz, 2005), is often closely related to the soil's organic matter and clay content (Haynes and Swift, 1990; Chenu at all, 2000; Yakupoğlu at all, 2012). The effect of organic matter on aggregate formation is more pronounced in soils including low clay content (Hillel, 1982).Organic matter improves aggregation in fine texture, providing better airation and also helping to store more water (Lal, 1979). In addition, the average weighted diameter, expressed as a measure of the water resistance of soil aggregates, is also an indicator of the grain size distribution.

The aim of this study is to examine water resist aggregate stability (WRAS) and mean weight diameter (MWD) of soils developed on the different parent materials (marl, colluvium and alluvial), land forms (flat on hill, back slope, footslope and flood plain), elevations, land cover and land use under semi-humid climatic conditions.

2. Materials and Methods

2.1 Site Description

The study area is located at the Vezirköprü district of Samsun province in the Central Black Sea Region and coordinated between 35º 01-35º 48 east longitudes and 41º 00 V- 41º 19 'north latitudes. Vezirköprü district covers 1713 km² and 115 km away from Samsun provinceVezirköprü differs from the climatic conditions of the coastal zone in terms of the humid climate type of the coastal zone and the terrestrial climate of the inland, with its specific thermal and moisture characteristics of the transition zone. The winters are colder than the coast and the summers are warmer (Average monthly temperature in August is 22.3 ºC). Annual rainfall over 500 mm per year. With rainfall is increasing in high places, snowfall appears to be effective (Anonymous, 2019).Soil temperature and moisture regimes were determinedby Turanat all, (2018) as Mesic and Typic Xeric using the Newhall simulation model.

2.2 Soil Sampling and Analysis

The research was carried out atfour different topographic locations including foots, slopes, hill flats and floor terrains. In addition, in the study area formed on different parentmaterialwere defined four soils profiles developed under the same climate and land use (arable lands). Soils have been studied on along transect with representative four profiles illustrated in Figure1.

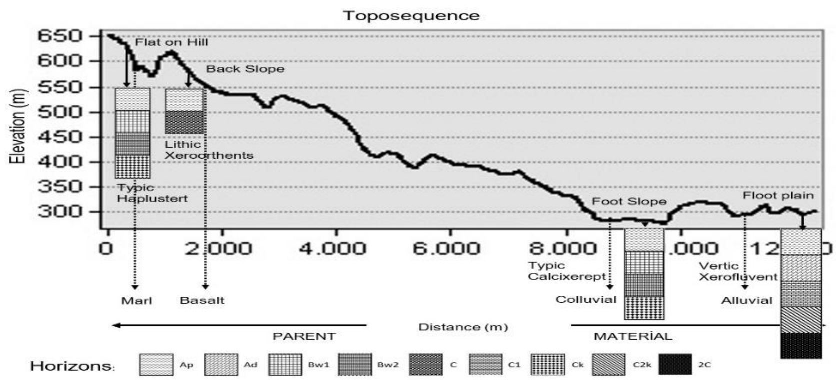

Figure 1. Transect of the four different soil pedons on different parent material and topographic positions

Morphological properties of these 4 profiles in the field were identified and sampled by genetic horizons and classified according to Soil Survey Staff (1993 and 1999). 15 soil samples were taken to investigate for their physical and chemical properties at the laboratory. Disturbed soil samples were then air-dried and passed through a 2 mm sieve to prepare for laboratory analysis. After soil samples were then air-dried and passed through a 2 mm sieve, particle size distribution was determined by the hydrometer method (Bouyoucos, 1951). Organic matter was determined using the Walkley-Black wet digestion method (Nelson and Sommers, 1982). pH, EC-electrical conductivity (ofthe saturation) by method of the (Soil Survey Labrotory, 1992). Lime content by Scheiblercalsimeter (Soil Survey Staff, 1992). Exchangeble cations and cation exchange capacities (CEC) were measured using a 1 N NH4OAC (pH 7) method (Soil Survey Labrotory, 1992).Aggregate Stability: According to the wet screening method, it was measured in the yoder type screening set (Kemper and Rosenau, 1986). Weighted Average Diameter: Air dried soil samples were found by sieving on sieve set with different sieve openings (Demiralay, 1993).

3. Results and Discussion

3.1 Morphological Properties and Classification

Morphological properties and classification of pedons was given Table 1. Soils in the study area exhibit difference with regard to particle size distribution, color and surface horizon depth. These differences represent the obvious effect of erosion, whereby surface soils have been carried from the shoulder slope to the foot slope, their accumulation leading to progressively darker, deeper and finer-textured soils with decrease in elevation. Soil colour is significantly related with the parent material, marlstone, with a value-croma ratio of 6/3on the flat on hillposition, darkening progressively to reach a maximum value of 4/3 on the footslope. The accumulation of calcium carbonate in Pedon I, II and IV is indicative of pedological developments reflected in the variations in color, particle size distribution and surface horizon depth. These three profiles has also carbonate nodules and micelles in Ck horizon.

For all profiles included a strongly or moderately developed A horizon with a granular structure; a strongly or moderately developed B horizon with an angular blocky structure (except for profile II which has no subsurface horizon); and a C horizon with a massive or graded structure. Particularly, Profile I has strong, coarse blocky structure in Bss horizon due to high clay content leading to slickenside formation

Table 1. Morphological properties and classification of pedons

Horizon	Depth (cm)	Color (dry)	Color (moisture)	Structure	Boundary	Special features
PI (TypicHaplustert, coordinate: 710510 E-4550925 N, elevation: 648 m)						
Ap	0-27	10 YR 4/3	10 YR 3/3	3cgr and 2mabk	ac	cracks
Bss1	27-72	10 YR 3/2	10 YR 2/2	3cabk	gw	slickenside
Bss2	72-116	10 YR 3/2	10 YR 2/2	3cabk	gw	slickenside
Ck	116+	10 YR 6/3	10 YR 5/3	mas	-	carbonate nodules and micelles
PII (Lithic Xerorthents, coordinate: 711075 E-4552105 N, elevation: 594 m)						
Ap	0-29	10 YR 4/4	10 YR 3/4	2mgr	aw	-
C	29-60	10 YR 3/4	10 YR 3/3	mas	-	-
PIII (TypicCalcixerept, coordinate: 707929 E- 4559170 N, elevation: 270 m)						
Ap	0-24	10 YR 4/3	10 YR 3/3	2fmgr	as	-
Bw1	24-52	10 YR 3/3	10 YR 4/3	2mgr	cw	structure development
Bw2	52-70	10 YR 3/3	10 YR 4/3	2msbk	gw	structure development
Ck	70+	10 YR 4/4	10 YR 3/3	mas	-	carbonate nodules and micelles
PIV (VerticXerofluvent, coordinate: 710574 E-4558674 N, elevation: 254)						
Ap	0-25	10 YR 4/4	10 YR 3/4	2mgr	aw	cracks
Ad	25-55	10 YR 3/3	10 YR 3/4	3mgr	cw	Density layer
C1	55-90	10 YR 3/3	10 YR 3/4	mas	gw	-
C2k	90-123	10 YR 3/3	10 YR 3/4	mas	gw	carbonate nodules and micelles
2C	123+	10 YR 4/3	10 YR 4/4	mas	-	-

Abbreviations: Boundary: a = abrupt; c = clear; g = gradual; d = diffuse; s = smooth; w = wavy; i = irregular. Structure: 1 = weak; 2 = moderate; 3= strong; sg = single grain; mas = massive; vf = very fine; f = fine; m =medium; c = coarse; gr = granular; pr = prismatic; abk = angular blocky; sbk = subangular blocky.

Descriptions and classification for soil profiles investigated from different topographic positions in the study area were conducted according to Soil Survey Staff (1999). Two of the profiles were classified as Entisol order due to low pedological process while, others fall into Inceptisol order due to their cambic horizon development.

3.2 Physical and Chemical Characteristics

The basic physical and chemical properties of the soils in each profile in the study area are given in Table 2. In the profiles investigated in the study area, their surface soils show significantly difference each other in terms of particle distribution, horizon depth, organic matter, lime content and soil reaction. According to Soil Taxonomy 1999, the profile classified as TypicHaplustert in flat on hill has clay texture. While the organic matter is 2.80% on the surface layer, it decreases along the profile depth and it becomes 0.76% in Ck horizon. In addition, while the pH content is slightly acid with 6.30 value on the surface soil, it reaches 8.17 and becomes slightly alkaline in Ck horizon due to basic ions leaching process. On the other hand, the lime content is less limy with 0.89% on the surface whereas, the Ck horizon contains 41.85% due to accumulation of calcium carbonate and parent material. The WRAS values were found between 54.72% and 31.84%. Besides, MWD which is a measure of the resistance of soil aggregates to water erosion varies between 0.85 and 0.71mm.

Table 2. Physical and chemical properties of soils formed on different parent material, topographic position, elevation and land use in the study area

Horizon	Depth (cm)	pH (H_2O) (1/2,5)	EC (dS/cm)	$CaCO_3$ (%)	O.M (%)	Exchangeable Cations (cmolc·kg-1)				P.S.D (%)				WRAS (%)	MWD (mm)
						Na	K	Ca	Mg	C	Si	S	Class		
Profiel I, TypicHaplustert / Flat on hill / Agriculture / 648 m / Marl															
Ap	0-27	6,30	0,14	0,89	2,80	0,23	0,51	30,35	11,30	50,36	20,62	29,01	C	54,27	0,74
Bss1	27-72	7,43	0,34	0,73	0,98	0,36	0,28	39,10	3,90	53,62	18,97	27,41	C	54,72	0,80
Bss2	72-116	7,89	0,25	1,86	0,68	0,27	0,38	56,45	7,75	57,71	21,11	21,18	C	53,86	0,85
Ck	116+	8,17	0,29	41,85	0,76	0,20	0,22	52,75	8,80	64,43	18,68	16,89	C	31,84	0,71
Profile II, Lithic Xerorthents / Back slope/ Agriculture / 594 m / Basalt															
Ap	0-29	7,78	0,03	1,53	2,25	0,26	0,49	30,00	19,45	43,00	26,57	30,43	C	57,51	0,81
C	29-60	8,05	0,25	12,04	0,63	0,33	0,25	35,75	27,15	31,24	27,44	41,32	CL	27,64	0,73
R	60+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Profile III, TypicCalcixerept / Foot slope/ Agriculture / 270m / Colluvial deposit															
Ap	0-24	7,95	0,26	13,25	2,22	0,33	1,09	17,35	31,50	31,90	30,09	38,02	CL	14,21	0,69
Bw	24-52	8,20	0,24	13,65	1,17	0,25	0,43	24,20	24,05	35,98	36,32	27,69	CL	30,97	0,72
Bw2	52-70	8,26	0,26	13,98	1,31	0,33	0,42	23,30	28,05	36,42	38,09	25,49	CL	38,12	0,70
Ck	70+	8,30	0,26	14,95	0,30	0,58	0,26	29,50	24,65	30,72	42,12	27,16	CL	25,11	0,63
Profile IV, VerticXerofluvent / Flood plain/ Agriculture / 254 m / Alluvial deposit															
Ap	0-25	8,15	0,26	10,83	1,21	0,37	0,91	21,60	30,45	25,71	34,92	39,36	L	14,63	0,62
Ad	25-55	8,15	0,29	12,84	1,27	0,68	0,57	23,75	26,25	54,44	24,78	20,77	C	42,74	0,77
C1	55-90	8,03	0,73	14,54	0,79	1,1	0,49	25,45	40,30	58,74	22,45	18,80	C	56,55	0,85
C2k	90-123	7,99	1,46	15,35	0,25	1,96	0,39	31,95	34,90	47,59	24,42	27,99	C	46,45	0,77
2C	123+	8,14	1,18	14,22	0,24	1,79	0,26	43,45	11,20	33,77	28,30	37,93	CL	18,29	0,66

Profile II was classified as Lithic Xerorthent. Slope was considered as one of the most significant factors controlling the pedogenic procedures in this pedon, which is located on a high back slope. Slope contributes to greater runoff, as well as to greater translocation of surface materials downslope through surface erosion and movement of soil. Soil horizons in Profile II were identified as surface soil symbolized as A, C (parent material) and R (rock), with no diagnostic subsurface horizons and low pedogenetic development, indicating it to be a young soil. While the organic matter is in the medium level with 2.25 on the surface, it is very small in the sub-surface horizon (0.63). Its pH value is 7.8 in surface and 8.05 in subsurface. The lime content is 1.53 limy in the upper soil and 12.04 in parent material. The WRAS value of the surface soil is 57.51% and its MWD value is 0.81 mm.

Profile III formed on the colluvial parent material has structural development and was classified as the TypicCalcixerept.This soil has dominantly clay loam texture along the profile depth and its soil reaction is slightly alkaline and changes pH values between 7.95 and8.30. Lime content varies also between 13.25-14.95% described as moderately limy. In addition, organic matter content of this soil changes between 2.22% in the surface and 0.30% in the Ck horizon. In this profile which located on low slope position, its WRAS value is 14.21% on the surface while, the MWD value is 0.69.

As for profile IV, Soil formed on the fine alluvial deposit and on flood plain has no any structural development and pedogenetic process was classified as VerticXerofluvent. Texure of this soil, dominantly clay loam texture in surface layer whereas, commonly clay texture becomes in subsurface soils. Its pH ranges between 7.99-8.15and the lime content varies between 10.83-15.35%. The WRAS value in the surface soil is 14.63% and the MWD is 0.62 mm

4. Conclusion

In this current study, the four profiles in the study area were evaluated based on their pedological development, classified according to Soil Taxonomy and investigated in terms of their water resistant aggregate stability and weighted average diameter under the same climate and land use but different topographic positions and parent materials. Soil erosion was found to be the main negative factor in soil formation on hillside positions (shoulder and back slope) in the study area. The determination of the water resistant aggregate stability of soil, there are important for determining the sensitivity of towards to erosion. Usually, soils which have well aggregated and high aggregates stability are also more resistance to abrasion. It is observed that the aggregate stability is 50% and more than it in the study area. On the other hand, water resistant aggregate stability values were found low values in soils formed on colluvial deposit and foot slope (low slope degree). This case can be explained due to cultivation practice and field traffic leading to negative influence for aggregate formation. Therefore, land management practices are significantly important to keep their stability against to soil erosion.

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Vegetation Cover Changes in Uludag National Park in Turkey

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Abstract

Uludag National park is one of the most famous national park in Turkey. It is located within the boundaries of Bursa province in the Marmara region. Uludag Mountain, which is the highest point of the Marmara region, has the height of 2543m. From the Bursa plain to the peak of the mountain, in the fact that all of the plant generations were in accordance with the definitions in terms of botanical science, Uludag Mountain has earned an international fame. Furthermore, Uludag Mountain is Turkey's most popular winter sports center and covered by snow for 4-5 months of the year. Apart from all these positive aspects, the Uludag national park is under a devastating human impact. In this study, it is aimed to reveal the change of vegetation cover in time of years within the borders of Uludag National Park. For this purpose, NDVI maps of satellite data of different years were produced, classified and compared with each other. According to the results vegetation was decreasing in areas where human are active. Nevertheless, in high altitudes where people cannot easily reach, the vegetation was protected and even it was slightlyincreased.

Keywords: NDVI, remote sensing, GIS, Uludag

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Soils Ecosystem Services: A New Look to Turkish Soils

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Abstract

There are several ways to define soils but quantification is not easy as soils are mixture of air, water, organics and inorganics shaped by climate, topography and vegetation where each component has almost infinite verities alike plants which exists with 391,000 species. Soils were quantified with their chemical, physical and biological properties however pH above 7, or cation exchange capacity is 80cmol.kg^{-1}does not mean a lot to a man-in-the-street. Thus, ecosystem services are introduced as of 1970, and pricing these services attracted attention of all segments of society, even politicians. Soils one of the main basics of the ecosystem have been threaten by land degradation and desertification following the appearance of humans on earth. According to the Millennium Ecosystem Assessment (MA) report prepared by the World Resources Institute, in the last 60 years people have caused 60% of ecosystems to deteriorate due to changes in land use, pollution, invasive species, excessive consumption of resources and climate change.The most realistic approach to understand the functions of soil is the detailed description of ecosystem services. Several countries are defining their soils based on their ecosystems capability and potential. Unfortunately, this is not the case for Turkey as soils are still considered as a real estate ie an economical identity for profit. This study reviews the literature on the relationship between soils and ecosystem services and aims to contribute to the scientific understanding on soil and ecosystem services and their interrelations for soils of Turkey. A well-defined soil ecosystem services will be used in local and national policy development and program on natural resource use and management which in turn can be utilizedto meet United Nations Sustainable Development Goals for 2030 when the Republic of Turkey already celebrated of its 100 years of foundation.

Keywords: Soil ecosystem, Turkish soils, Sustainable development goals

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Soil Information System

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Abstract

The economic development and growth of countries is closely related to the richness of their natural resources and the sustainable use of these resources. In order for our country to develop in a short time, it is necessary to study the natural resources that we have in a good way, to be investigated, to be mapped under the same roof and to be opened to the use of researchers, academicians and planners (Ozkalayci et al. 2015). One of the most important sources used in land planning studies is soil maps and reports. They are used in agriculture, forestry and pasture planning, in modeling of environmental impacts, in different engineering branches and in the planning and conservation of integrated natural resources. It is very difficult to understand and interpret the soil maps stored in paper in the archives by planners who work in different professional disciplines except soil scientists (Dinc 2008). Before analyzing local, regional and national plans, it is important to analyze the land resources qualitatively and quantitatively, to determine the potentials of the resources available, and to create databases and maps in parallel with the developing technologies. Because of this need, the General Directorate of Combating Desertification and Erosion (CEM), which works on the reduction of soil losses and damages about desertification, erosion, flood, landslide, etc., developed a project called "Soil Information System". It is aimed that Soil Information System, established through the integration of the Soil Database, Digitization, ARAZİmobil, Laboratory Registration System and Soil Portal, forms the basis of many studies especially in the agricultural and forestry sector. As the first stage of the project, Soil Database has been developed in 2013 by CEM. The Soil Database system architecture was designed with the needs of the agriculture and forestry sector, and the attribute table structure was determined with the participation of academicians and experts working in agriculture and forestry sector. The soil reports and maps in the previous projects made by General Directorate of Forestry are digitized and transferred to the Database which developed in accordance with the current GIS and database management systems, by making them compatible with the standards. Soil data collected from the field is also needed to be transferred to the Database. The data on the physical properties of the soil obtained from the field studies are transferred to the web based mobile software under the name of ARAZİmobil. Additionally, the chemical properties of the soil obtained in laboratories are transferred to the Database by developed Laboratory Registration System. Thus, the Soil Portal was developed to present the physical and chemical characteristics of the soil in the Database, as well as the reports, figures and tables to the users. As of 2015, the Portal is available at http://toprakportal.cem.gov.tr/.

Keywords: Soil Information System, Geographical Information Systems, Soil Portal

1. Introduction

One of the most important sources used in land planning studies is soil maps and reports. Soil maps and reports are used in agriculture, forestry and pasture planning, in modeling of environmental impacts, in different engineering branches and in the planning and conservation of integrated natural resources. One of the most important benefits of national plans for the development of land resources is the removal of inventories of resources. Before analyzing local, regional and national plans, it is necessary to analyze the land resources

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qualitatively and quantitatively, to determine the potentials of the resources available, and to create databases and maps in parallel with the developing technologies.

Today, the only soil data sources which is currently used and covering the whole of Turkey is ‘‘Major Soil Groups Map’’ which was established by the abrogated General Directorate of SoilWater based on the 1960’s. Since Major Soil Groups Map is produced by taking into consideration the needs of agricultural areas, it causes disruptions in projects and applications especially in forest and pasture areas and it is not to be a base for many current projects carried out in forest and pasture areas despite various updates and revisions in the years.

In order to overcome this problem, the related people make soil surveys and mapping studies with their own facilities and budgets and therefore repeated studies occur. Moreover, since the soil maps and reports produced by different institutions, organizations and individuals are not stored in a common GIS infrastructure, they produced and stored in a structure that is independent of each other.

In this context; “Soil Information System” has been developed by CEM with the aim of supporting the goal of producing the National Soil Map, avoiding the duplication of work and providing soil data to many sectors, especially in the forestry and agriculture sectors.

2. Material and Methods

2.1 Establishment of Soil Database

The General Directorate of Combating Desertification and Erosion organized a workshop in 2012 with the aim of establishing a common “Soil Database” which can meet the needs of forestry and agriculture sector with the participation of the relevant General Directorates of the abrogated Ministry of Forestry and Water Affairs and the abrogated Ministry of Food, Agriculture and Livestock, various institutes and universities. Meetings were held on different dates related to the issue and common soil data structure was determined with the contributions of the participants.

Based on these common soil data structure, the “Soil Database” has been established in 2013 under the coordination of CEM which works on the reduction of soil losses and damages about desertification, erosion, flood, landslide etc. Soil Database system architecture is designed by considering the needs of agriculture and forestry sector. The Soil Database has been developed in accordance with current GIS and database management systems.

Three main project activities were carried out to develop the Soil Database;

- Digitization of Soil Maps and Soil Survey Charts
- ARAZİmobil: Data Collection System in the Field with Mobile Devices
- Laboratory Registration System

2.1.1. Digitization of soil maps and soil survey charts

The soil maps, soil survey charts and soil analysis reports of projects such as erosion control, afforestation and pasture improvement in the archives of the General Directorate of Forestry are digitized, adapted to GIS and transferred to the Soil Database which was developed by CEM.

The first cycle of this project started in the year 2013 and as the end of 2016, 2,860 copies of soil maps and soil survey charts of the projects have been digitized and transferred to the Soil Database. Digitized projects have transferred about 4,000,000 hectares of forest area and 60,000 soil profile points to digital media.

With the project of digitization of soil maps and soil survey charts, soil maps, survey charts and analysis reports stored in various media in the archives are transferred to the soil database and digital archive quality is gained and users can access this data more easily and regularly. In addition, scanned documents can be used to access documents such as signatures, acknowledgements and information notes in the original documentary.

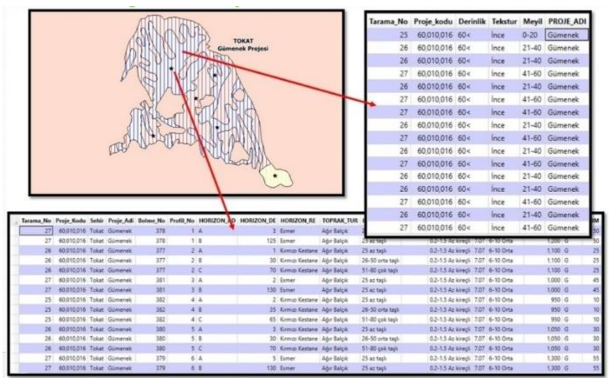

Figure 1. Feature tables obtained after digitization

Figure 2. Filing structure created after digitization

2.1.2. ARAZİmobil: data collection system in the field with mobile devices

Field teams are set up for projects that are carried out in many areas, primarily forestry and agriculture, and information is gathered from the land. In general, the cost of field work is high and the working time is long. Sensitivity and correctness of the data collected in field studies vary according to the difficulty of the conditions and data standards are not provided. There is also a resource consumption for the standardization and regulation of the data to the same standard. In this context; CEM has developed a mobile software that runs on Android, iOS (iPhone-iPad Operating System) and Windows operating system under the name of “Land Data Collection System (ARAZİmobil)” for data collection in the field. ARAZİmobil can work on all mobile devices, such as tablet computers and smartphones, which have integrated Android, iOS and Windows operating system, integrated GPS (Global Positioning System), internet connection available and digital cameras.

ARAZİmobil has been produced integrated with the Soil Database and it is aimed to prevent resource consumption in soil mapping studies. The main functions of this software are to enable data collection of a certain standard, quality and transparency, and the transfer of collected data to databases through mobile devices in all forestry activity sites that already support field data collection process. With the most general definition, ARAZİmobil is the web-based mobile software that collects land data from mobile devices, and can simultaneously present staff figures, positions, reports and job descriptions.

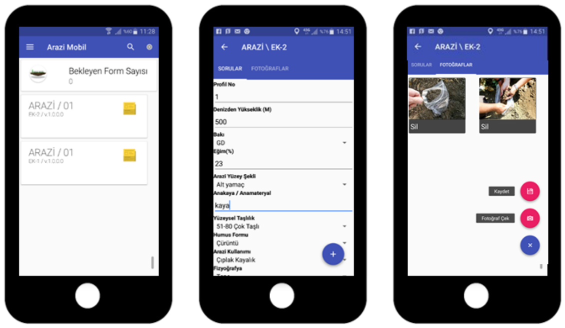

Figure 3. ARAZİmobil mobile device interfaces

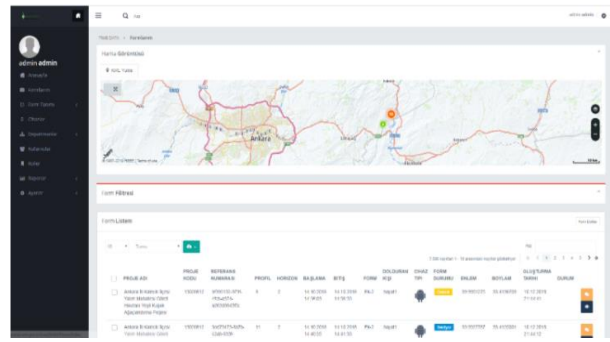

Figure 4. ARAZİmobil web interface

2.1.3. Laboratory registration system

Land transactions in many soil laboratories operating in Turkey are continuing with independent software or paper file, the inquiry and reporting processes related to the analysis results are slow. In this context, it is necessary to design a system that enables the information of the soil samples coming to the soil laboratories and the results of the analysis to be inputted by the institutional personnel quickly, accurately and in a standard way.

In 2015, CEM has developed a web-based Laboratory Registration System for Eskisehir Forest Soil and Ecology Research Institute with an interface that allows multiple users to log in, view and query within the authority of the user.Since the Laboratory Registration System is web-based, the hardware cost is kept to a minimum.The Laboratory Registration System has been developed integrated with the Soil Database and ARAZİmobil software, which was established by CEM.In this context, analysis results of samples collected from the field with ARAZİmobil software are automatically transferred to the soil database, and the project manager can monitor the analysis process of the soil samples through the web interface. With the Laboratory Registration System, transparency, reliability and speed are targeted in soil analysis processes.

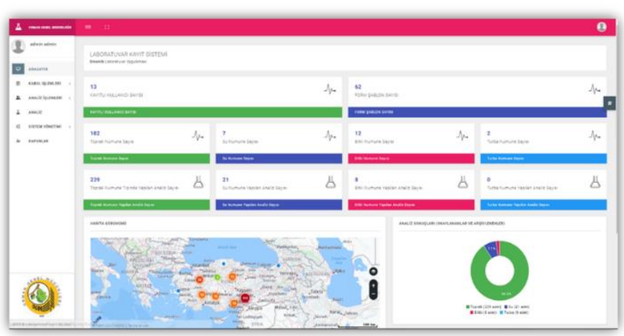

Figure 5. Laboratory Registration System interface

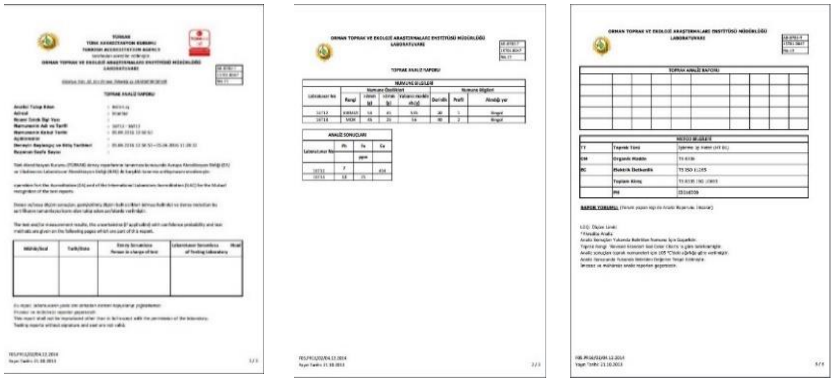

Figure 6. Sample analysis reports

2.2. Soil Portal

The Soil Database established by CEM is fed from many sources and soil data is stored in the determined standards. It is a web-based Soil Portal that opens the soil map and survey squares stored in the soil database to the users and allows them to do various interrogation and analysis. It is established by CEM and is available at http://toprakportal.cem.gov.tr. The Soil Portal provides the opportunity to load all the soil maps, etudes and analysis reports in the soil database, as well as the soil maps, study carvings and photographs in the appropriate form manually. Users can only download land maps, survey charts or raster files to their computers within the authority of the users and download all the data belonging to the selected projects to their computers at once. The Soil Portal is continuously improved according to the feedbacks and test results.

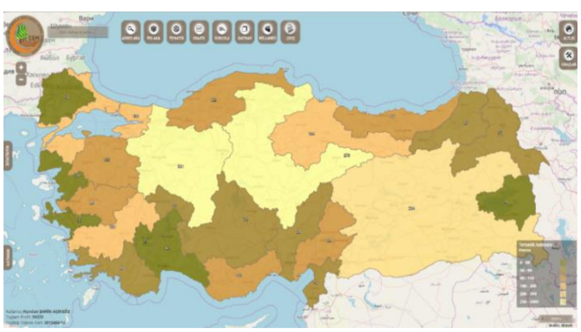

Figure 7. Soil Portal overview

Figure 8. Soil Portal map output

3. Results and Conclusion

Within the Soil Information System Project, the soil maps, soil survey reports and soil analysis reports of approximately 3,000 projects in the archives were digitized and transferred to the Soil Database and all these data were harmonized with the geographical information systems. With ARAZİmobil software, soil data have been obtained with mobile devices more accurately, faster and more reliably from the field. As of 2014, ARAZİmobil has been used all the projects carried out by CEM and the improvement works of software are continuing. All soil data collected within the context of the Soil Information System are presented through the Soil Portal (http://toprakportal.cem.gov.tr). There are approximately 60,000 soil profile points and approximately 4,000,000 hectares of forest area in the Portal. Many physical and chemical properties such as pH, depth and calcification of the profile points can be accessed through the Portal. CEM has also developed web based Laboratory Registration System and presented it to the use of the Eskisehir Forest Soil and Ecology Research Institute. With the Laboratory Registration System, all soil laboratories are allowed to have systems compatible with GIS and to be integrated with each other through Soil Information System. It is aimed that the current and GIS compliant soil data obtained through this System will provide a basis for many studies, especially in agriculture and forestry sectors.

3.1. Acknowledgements

This project was supported by the General Directorate of Combating Desertification and Erosion, the Ministry of Agriculture and Forestry. The authors acknowledge the General Directorate of Forestry for their effort in supplying the soil maps, soil survey charts and soil analysis reports of projects.

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Water Infiltration in Claypan Soils Influenced by Agroforestry and Grass Buffers for Row Crop Management Systems

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Abstract

Agroforestry buffers have been recently introduced in temperate regions to enhance conservation of soil and water resources in row crop management. The effects of agroforestry and grass legume buffers on in situ water infiltration relative to row crop management were assessed for a claypan soil in northeastern Missouri, USA. Infiltration rates were observed in early June in 2014 and 2015 for watersheds under corn (Zea mays L.)-soybean (Glycine max L. Merr.) management; these watersheds had agroforestry buffers or grass buffers. The dominant soil for the watersheds was Putnam silt loam (fine, smectitic, mesic VerticAlbaqualf). The watersheds were in no-till management and established in 1991 with agroforestry buffers and grass buffers implemented in 1997. Agroforestry buffers, 4.5 m wide and 36.5 m apart, consisted of redtop (Agrostis gigantean Roth), brome (Bromus spp.), and birdsfoot trefoil (Lotus corniculatus L.) with pin oak (QuercuspalustrisMenchh.), swamp white oak (Q. bicolor Willd.), and bur oak (Q. macrocarpaMichx.) trees. Grass buffers consisted of redtop, brome, and birdsfoot trefoil. Significant differences were found among the treatments in 2014 for the sorptivity parameter for the fitted infiltration equations with the highest values for agroforestry buffers. Significantly higher saturated hydraulic conductivity values were found for the buffer treatments in 2015. Soil water content measurements were assessed over time for years 2010 and 2011 with sensors at 5, 10, 20 and 40 cm depths for the agroforestry buffer and row crop areas. Water content decreased more rapidly during the summer season within agroforestry buffers relative to row crop areas; however, water infiltration was higher within agroforestry buffers during the recharge period.

Keywords: Infiltration rate, Saturated hydraulic conductivity, Sorptivity

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Importance of Inter-Sectoral Cooperation in Setting and Achieving Land Degradation Neutrality (Ldn) Targets and Opportunities

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Abstract

Land degradation, mainly referring to any reduction or complete loss of production capacity of land, not only signifies soil degradation, but also ecosystem destruction.It is not possible to prevent or to completely halt land degradation all around the globe. The LDN concept, which strives to achieve the ultimate goal of a land degradation-neutral world by 2030 through ensuring that restoration area outweighs degradation area, was introduced as the first concrete step in this respect. LDN necessitates the implementation of three measures to wholly address and safeguard ecosystem services, to reduce the risk of loss and to rehabilitate degraded ecosystems.Owing to its contributions to ensuring both food security and sustainable development, LDN approach presents a holistic perspective toward combating climate change. From this point of view, LDN approach brings about a whole new vision and opportunity for countries.

Land degradation-inducing activitiesmay vary according to each country. As such, associated measures may also vary accordingly. Activities, measures and objectives for the prevention of land degradation should be determined with the participation of relevant parties, and adopting a participatory approach.

LDN requires multi-stakeholder collaboration and planning at different scales and across various sectors. Hence, there is a need to establish a coordination unit for preparation, implementation and monitoring of an LDN National Action Plan. LDN targets should be integrated into countries' development policies, strategies and plans, government programs, sectoral development strategies and plans, and be neatly aligned with sectoral objectives. LDN targets and activities should further be included in activities of relevant institutions.

LDN process is generally monitored using three main global indicators, including land cover, land productivity (net primary productivity) and carbon stocks. These indicators are used to reveal land-based gains and losses. Relevant countries are required to determine supplementary activities and indicators in accordance with their own needs.

This article argues the significance of inter-sectoral coordination, cooperation, planning and the need to engage all segments of society in terms of supporting countries to set and achieve their national LDN targets. It also discusses the opportunities of LDN.

Key Words: LDN, Setting National LDN Targets, Sustainable Development

1. Introduction

Drought, land degradation and desertification are among the most important environmental problems of our age. Contrary to popular understanding, desertification is not the loss of land to desertor through sand-dune

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movement. Desertification is land degradationthat occursin arid, semi-arid and sub-humid areas resulting from various factors, including climate change and human activities. When land degradationhappens in the world's drylands, it often creates desert-like conditions. So land degradation that is observed all over the world is defined as desertification when it occurs in arid regions.

Desertification threatens the livelihoods of 1 billion people in more than 100 countries, and every year 12 million hectares of arable land is lost due to drought.The extent and severity of land degradation across the world combined with the negative impact of climate change, population growth and an ever-increasing demand fornatural resources requires immediate and assertiveaction. The economic costs of desertification and landdegradation are estimated to be 490 billion USD per year.Avoiding land degradation through sustainable landmanagement can generate up to 1.4 trillion USD ofeconomic benefits (UNCCD, 2016).

Policies and programmes to halt and reverse landdegradation have long suffered from the absence ofa clear overarching goal and quantitative, time-boundtargets to guide action and make progress measurable.In October 2015, in Ankara, country Parties of the United Nations Convention to Combat Desertification (UNCCD) reached an agreement on the LDN concept. In Ankara, country Parties of the UNCCD also agreed to integrate thesustainable development goals (SDGs) and target 15.3on LDN in particular, into the implementation of the Convention (decision 3/COP 12). The decision also statesthat "striving to achieve SDG target 15.3 is a strongvehicle for driving implementation of the UNCCD". Moreover, COP 12 recognized that"a significant proportion of land degradation occursbeyond arid, semi-arid and dry sub-humid areas" andthat "Parties may use the UNCCD to guide their policiesrelating to Desertification, Land Degradation andDrought and voluntary targets when striving toachieve LDN at the national and sub-national levels"(UNCCD, 2016).These decisions integrate SDGs and the target 15.3on LDN into theimplementation process of the UNCCD and invitecountries to formulate voluntary targets toachieve LDN by 2030.Turkeybecame a pioneer country in LDN targetssetting by determining her national voluntaryLDN targets in 2016. Some of these targets are to: increase forest area to 30% from 28.5%, decrease the area affected per fire to 2.2 hectare from 2.7 hectare, decrease human-induced fires to 85% from 88%, complete land consolidationworks in 14 million hectares, and expand irrigated areas up to 8.5million hectares, by 2030 (CEM, 2016).

This paper provides brief information on land degradation and its drivers, the LDN concept and its response hierarchy, and discusses the importance of management and organizationin achieving LDN, the significance of inter-sectoral coordination, cooperation, planning and the need to engage all segments of society in terms of supporting countries to set and achieve their national LDN targets. It also argues the opportunities of LDN.

2. Methodology

2.1. Land Degradation Neutrality (LDN)

2.1.1. Land degradation and its drivers

The Global Land Outlook of the UNCCD (UNCCD, 2017) defines land degradation as "the reduction or loss of the biological oreconomic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest, and woodlandsresulting from land uses or from a process or combination ofprocesses arising from human activities".The drivers of land degradation relateto factors that directly or indirectlyimpact the health and productivity ofland. Direct drivers are either naturalor human-induced. Deforestation, overgrazing, and the expansion ofagricultural, industrial, and urban areascontinue to be the most significantdirect causes of land degradation.Indirect drivers, on the other hand, are far morecomplex and operate at larger and longer scalesand farther from the area of degradation. Direct andindirect drivers interact, mutually reinforcing eachother and together drive land degradation in manyparts of the world (UNCCD, 2017).The causes of land degradation vary from country to country and region to region due to their unique characteristics.Thus, each country has to reveal its own reasons. Since land degradation is also ecosystem destruction, all activities leading to ecosystem destruction are also activities that cause land degradation.Therefore, all measures to prevent ecosystem destruction will also prevent land degradation.

2.1.2. What is land degradation neutrality?

The UNCCD defines LDN as "a state whereby the amount and quality of landresources necessary to support ecosystem functions and services and enhancefood security remain stable or increase within specified temporal and spatialscales and ecosystems" (Decision 3/COP.12, UNCCD, 2015). The goal is to maintain or enhance the land resource base– in other words, the stocks ofnatural capital associated with land resources and the ecosystem services thatflow from them. The definition emphasises the importance of ecosystem services in achieving sustainability of food production (Orr et al., 2017).

The LDN concept (Figure 1) was developed to encourageimplementation of an optimal mix of measuresdesigned to avoid, reduce and/or reverse landdegradation in order to achieve a state of no net lossof healthy and productive land. LDN aims to balanceanticipated losses in land-based natural capital andassociated ecosystem functions and services withmeasures that produce alternative gains throughapproaches such as land restoration and sustainableland management (UNCCD, 2016; Orr et al., 2017).

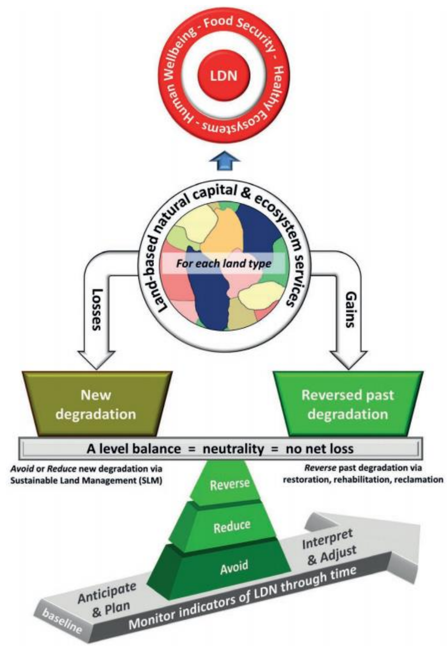

Figure 1. The key elements of the scientific conceptual framework for LDN and their interrelationships (UNCCD/Science-Policy Interface, 2016)

LDN is a simple idea and a powerful tool. It meanssecuring enough healthy and productive naturalresources by avoiding degradation whenever possibleand restoring land that has already been degraded.At its core are better land management practices andbetter land use planning that will improve economic,social and ecological sustainability for present andfuture generations. Many direct links exist between LDN and the SDGs, such as eradicatingpoverty, ensuring food security, protecting theenvironment and using natural resources sustainably.LDN serves as a catalyst in achieving these goals (UNCCD, 2016).

2.1.3. LDN Response Hierarchy

The LDN response hierarchy is an overarchingprinciple that guides decision-makers in planning measures to achieve LDN. The responsehierarchy of Avoid > Reduce > Reverse landdegradation is based on the recognition that “prevention is (much) better than cure”i.e., avoiding or reducing further land degradation will maximize long-term benefits and isgenerally more cost-effective than efforts toreverse past degradation.The LDN response hierarchy encourages broad adoption of measures to avoid and reduce land degradation, combined with localised action to reverse degradation, to achieve LDN across each land type (Orr et al., 2017).

2.2. Management and Organization

Land degradation can be prevented through cooperation among concerned sectors and all segments of society. Informing the public and raising awareness on issues such as degradation-causing activities, root causes and solutions of degradation; and establishing public pressure for the prevention of land degradation will contribute to mobilizing governments and relevant institutions and organizations, increasing sensitivity towards the subject and creating an enabling environment for LDN.

There is a need for good management, organization and coordination to prevent land degradation andto ensure LDN target-setting, implementation and monitoring.The causes of land degradation and measures to be taken accordingly are of direct concern to many sectors and a significant portion of society. As measures to be taken fall under the jurisdiction of a large number of institutions and organizations, it is necessary to select a coordinating institution that will concurrently lead all these tasks, ensure good communication between institutions, act as a secretariat and have full executive responsibility. There is also a need for a coordination unit consisting of representatives from relevant institutions and sectors that will be chaired by the coordinating institution.

In order to ensure good coordination and to carry out the tasks successfully, the coordinating institution should be selected correctly. It must have a sufficient amount of budget, management capacity and capability to act as a locomotive in mobilizing relevant institutions and organizations.The coordination unit will be largely responsible for informing relevant institutions, sectors and society on land degradation; and mobilizing opportunities and capabilities of NGOs, private sector, farmers, local authorities, along with directly and indirectly related institutions on economic, social, judicial, legal and technical solutions.

Organizations and relevant parties adopting and taking responsibility in setting and achieving LDN targets is the magical key for success. Establishing cooperation amongrelated sectors and parties, institutions and organizationsresponsible for implementing land degradationprevention activitieswill help adopt and embrace the issue.Creating national or regional action plans related to LDN and ensuring their inclusion into activities of institutions will be the most effective and permanent solution in providing necessary budget and financing for these activities.Preparing action plans and sharing them with the public will serve as a binding commitment for institutions. This will not only guide these institutionsto place more importance on the subject, to address their activities adopting a more disciplinary approach, but also facilitate the achievement of the goals.

2.3. LDN Planning and Implementation Process

2.3.1. LDN working group

Under the leadership of the LDN coordinating institution, it is essential to establish, if necessary, an LDN Working Group and a Specialized Commission, where related sectors, scientists, NGOs, parties and all segments of society are represented.It is necessary for working groups and specialized commissions to determine causes and impacts, dimensions, sensitive areas, and hotspot regions of land degradation, to present the current situation, and to predict the future by analysing the trend. Reports presented as a result of this study will guide decision-makers and managers.Determining the causes of land degradation; introducing necessary administrative, technical and legal measures, solutions, and needs; reporting national and international studies, best practice models, and scientific researches of organizations; and presenting them to the institutions will shed light on ongoing works.

2.3.2. Measures, activities and setting of targets

It is of utmost importance to determine responsible institutions regarding the measures to be taken, to reveal the potential of activities, and to achieve consensus among institutions in LDN target-setting.Ensuring trust and a culture of cooperation between stakeholders, establishing unity of purpose and interest, compensating losses between winners and losers or balancing them with alternative solution mechanisms, and assuring public support are the most relevant parameters in achieving LDN targets.

2.4. Opportunities of LDN

Land degradation prevention activities are of concern to many institutions and sectors. All segments of society need to be associated with and integrated into these activities. While conducting these activities, it is important to adopt an integrated and participatory approach and to ensure that all related sectors act cooperatively. These actions, in return, will create a synergy for the development of society and lead to sustainable development. This will be instrumental in both employment and development of various business lines. In addition to enhancing rural development, this will also contribute to establishing of food security and prosperity.

Sustainable development will be accelerated as a result of dissemination of good practices related to LDN, creation of new technical and alternative livelihoods, and optimization ofopportunities ofrelevant institutions, local governments, private sector, NGOs, scientists and farmers through an effective organization.

3. Results and Conclusion

It is necessary to integrate LDN into national policies and development plans for setting and achieving LDN targets, conducting necessary activities and providing permanent financial instruments to achieve these targets. For this purpose, it should be ensured that land degradation prevention activities are included in programs and action plans ofinstitutions, unions, local authorities, NGOs and political parties guiding country policies. In this case, it will be observed that sufficient financial tools for LDN are provided. This will happen only in accordance with the cooperation between related institutions and organizations, scientists and NGOs, and at request of society.

Informing the public and raising awareness on issues such as degradation-causing activities, root causes and solutions of degradation; and establishing public pressure for the prevention of land degradation will contribute to mobilizing governments and relevant institutions and organizations, increasing sensitivity towards the subject and creating an enabling environment for LDN.

It is only possible to set and achieve national LDN targets through ensuring coordination between relevant sectors, developing effective cooperation, adopting a participatory planning approach and assuring the involvement of stakeholders and all segments of society.

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Soil Degradation By Law

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Abstract

Misuses of natural resources besides voluntarily defending are protected by laws, regulations and directives in countries as population pressure is an increasing trend globally. Drivers of these pressures vary from socio-economic benefits to markets and trade. Although the objectives of the laws on land use and management are the protection and sustainable management of natural entities, exceptions to the law allow for land use changes, sub-regulations or administrative decisions prepared within the framework of laws may lead to land degradation. The huge investments since mid-1990s in Turkey lead excess infra and ultrastructure construction and by 2000s urbanization reached to 71%. This immense development brings along consumption of soils for settlement and an urgent precaution was taken by putting into force Law no 5403 in 2005 which was updated in 2014 as law no 6537. The main purpose of Law no 6537 is briefly to protect land by sustaining income of locals based on sustainable development approach. For obtaining land use permission getting a permission from soil protection board (SPB) is a legal requirement. The soil protection board consist of 9 members headed by the governor at each province. Non-governmental organization presence in this board is secured by law. TEMA Foundation (the Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitats) being the largest NGO of Turkey on soil issues generally represent in this board. TEMA Foundation also advocates for the protection of natural resources, raising awareness, applying to the judiciary in order to improve administrative decisions such as directives and regulations, which will lead to land degradation as well as exemplary projects. The lawsuits filed for the prevention of land degradation by the Tema Foundation were extended to 59 provinces out of 81. Of the 250 cases in total, 71% were for agriculture, 23% for forest and 4% for pasture lands, 1% for wetland and 1% for environmental pollution. The success rate in the finalized cases is 71%. This high number of lawsuits ironically shows that law is the driver of soil degradation although it is intended to protect soils. Definition of prime soils in Law no 6537 is at some cases misinterpreted by provincial SPBs. This necessitate a formal guideline that will be prepared with interdisciplinary study of relevant ministries, research institutions and NGOs of Turkey for securing country's food production and sustainable land use which are already under threat of climate change, desertification, land degradation, drought and biodiversity loss.

Keywords: Soil Degradation, Soil Protection Law, NGOs

1. Introduction

Soils are the main source of food production and several reports revealed that they are under severe threatsnamely contamination, erosion, nutrient imbalance, loss of soil organic carbon, loss of soil biodiversity, alkalinisation-salinisation, acidification, soil compaction and soil water management (FAO 2017). Among these soil sealing and land take is the main land degradation threat in countries in stage of economic development and population increase. Soil sealing is defined as the creation of impermeable layers over the soil, such as asphalt and concrete surfaces, isolates soil from the atmosphere and above-ground biosphere.

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Sealing is the most intense form of land "take" and is essentially an irreversible process (Cherlet et al. 2018). According to the European Environment Agency, since the mid 1950s the total surface area of cities in the EU has increased by 78 %, whereas the population has grown by only 33 % (EU 2019).

Lal (2010) stated that world is facing a modern soil crisis that eclipses those of the past due to the magnitude of losses. For example, the tolerable soil loss calculated using soil production rates range from 0.2 to 2.2 t ha-1 yr-1 and tolerable rates based on maintenance of crop production range from approximately 1 to 11 t ha-1 yr-1. However, estimates of mean annual soil loss from field plots are substantially higher varying from 8to 50 t ha-1 yr-1 which is 8 or 50 fold of the tolerable level (FAO, 2019). Moreover, climate change has severe effects on soils. According to a study conducted by the NASA's Goddard institute (NASA 2019), the Earth's average global temperature has risen by 0.8 degrees Celsius since 1880. Same study revealed that two degrees rise in global temperature by 2100 caused sea levels rise by a meter that will displace 10% of the world's population. These population pressures along with natural phenomena manifested the urgent need of soil protection. Almost all countries of the world protect their soils by laws and Turkey is not the exception.

Drivers of these pressures vary from socio-economic benefits to markets and trade. The huge investments since mid-1990s in Turkey lead excess infra and ultrastructure construction and by 2000s urbanization reached to 71%. This immense development brings along consumption of soils for settlement and an urgent precaution was taken by putting into force Law no 5403 in 2005, which was, updated in 2014 as law no 6537. The main purpose of Law no 6537 is briefly to protect land by sustaining income of locals based on sustainable development approach. However, cases opened against misuse of soils and land as laws are not applied properly. In addition, soils of Turkey has several limitations and prime soils of the country roughly covers 10% of the country's arable lands (Kapur et al. 2018).

2. Methodology

This study outlines the court cases against misuse of soils and lands since 1997 opened by TEMA or TEMA act as the intervener throughout Turkey.

3. Results and Conclusion

As of 2018 lawsuits on soils and land, which TEMA directly or partly took part totals to 256. Out of 81 provinces in Turkey, lawsuits opened at 58 provinces (Figure 1) which comprises agricultural land, environment, pasture, coast, forest, wetland, water body, and against law or regulation (Figure 2). The 71% of the lawsuits is on agricultural land whereas lowest with 1% is on environment. Provinces where no lawsuit was sued does not mean that soils, forests, wetlands and waterbodies are used properly, this is due to lack of monitoring the misuse in these areas for example in Kocaeli and Afyon soil sealing at prime soils are reported for several times since early 2000s (Yılmaz 2001, Kapur et al. 2006)

Figure 1. The lawsuits from 1997 to 2018 opened by TEMA

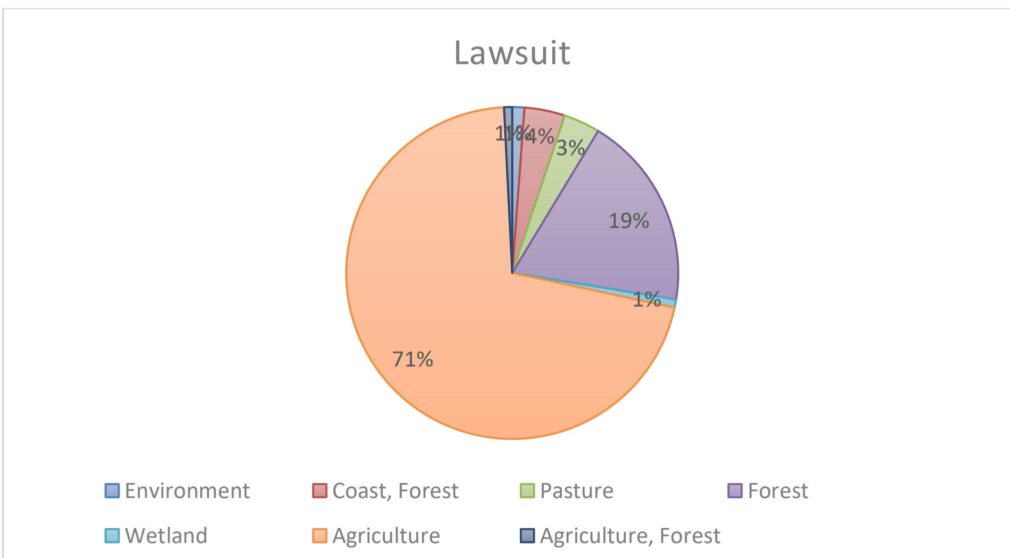

Figure 2. The issues of lawsuits opened by TEMA from 1997 to 2018

In case of provinces, the highest lawsuit is seen in Antalya with 14 cases followed by İstanbul with 13, Yalova with 11, Edirne and Manisa with 10 cases. This revealed that soils are seen as a real estate in these provinces. However, may be the number of cases is low at some provinces, the size of the affected area is another important factor that needs to be taken into account.

Another issue is insufficient classification of soils/lands for example lands of the olive orchards on sloping lands of Mediterranean where olive yield is high are classified as 6^{th} or 7^{th} class based on soil capability classification.

Thus, along with food security, Turkish economy still depends on agriculture, which forces the country to protect its soils. Also soils of Turkey have several limitations such as steep sloping, low organic carbon content and shallowness (Kapur et al. 2018). So soil protection laws, regulations necessitate a formal guideline that will be prepared with interdisciplinary study of relevant ministries, research institutions and NGOs of Turkey for securing country's food production and sustainable land use which are already under threat of climate change, desertification, land degradation, drought and biodiversity loss.

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Desertification, Soil Organic Carbon, Erosion against Fossil Fuel Plants: The Review of Struggle of Cross-Purposes in Turkey

Hikmet ÖZTÜRK[1], Özlem KATISÖZ[2], Erhan AKÇA[3]

Abstract

Development and sustainable land use are opposite characters while the former seeks economic benefits, the latter tries to protect environment. Global initiatives since mid-1900s sought to integrate these two opposite goals in one mutual win-win situation but this is seldomly attained. Turkey is not the exception as it is a developing country with environmental problems of desertification, erosion and low soil organic carbon. According to the Directorate General for Combating Desertification and Erosion (DGCDE), the Desertification Risk Map revealed that 19% of Turkey's soils are under high, 22% is at moderate to high-risk groups. Similar to desertification, the erosion sensivity map which is also produced by the same General Directorate manifested more than 50% of the country is susceptible to wind erosion. In addition, the soil organic carbon map of Turkey prepared in 2018 by DGCDE showed that Turkish soils are poor in organic carbon. Thus, desertification, erosion and low organic carbon are drivers of climate change, desertification and land degradation and loss of biodiversity namely the three global threads to humanity need urgent activities for mitigation, adaptation and protection. Turkey announced and brought into for climate change, desertification and biodiversity action plans since early 2000s. By contrast with these problems, Turkey plans to build new fossil fuel plants in coming years which will mainly fueled by coal and lignite. In this study, we located the fossil fuel plants on desertification, erosion and soil organic carbon maps and found that these plants are generally concentrated in areas with relatively low desertification, erosion and high organic carbon ie prime agricultural lands. This revealed that Turkey’s food security is under high risk as fossil fuel plants hazards to environment is well-documented, and several countries are now investing alternative environmental friendly energy production. So, cross-purposes of stakeholders in Turkey ask for a mutual win-win solution for securing country’s food and environmental security while sustaining its development.

Keywords: Desertification, Soil Organic Carbon, Erosion, Fossil Fuel Plants

1. Introduction

Humans provide almost 99% of their food from soils which are under great pressure for meeting this increasing demand. Soils not only meet food demand but undertake multirole for ecosystem services, and employed in industrial uses as raw material. All these intensive uses of soils necessitate utmost sustainable management as mentioned by several studies we are almost reached the limits of arable lands (FAO 2011). Moreover, it is estimated food production should increase by 50% more by 2050 to feed 9 billion people, and FAO (2017) reported that food production increase would be crucial in developing countries.Thus, countries initiated soil protection measures to maintain and enhance country’s food production capacity at its best. Arable soils for Turkey has a vital importance as the country is among the first 15 countries of largest agricultural output with 55 Billion USD Dollars as of 2016 (https://worldinfigures.com/rankings/index/103). So, Turkey needs to sustain its soils quality with utmost care although almost 50% of the soils are under high and moderate desertification and erosion risk along with low soil organic carbon (ÇEM 2017, 2018a, 2018b). However,

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Turkey also in the stage of development with special needs such as infra and ultrastructure's and energy which all threats soil productivity. Turkey recently announced that it will support construction of energy plants that will run with coals. Energy plants run with coal and coal mining both have negative effects on environment (Saini et al. 2016). This study reviewed the fossil fuel plantsdistribution and Turkey's desertification, erosion and soil organic carbon maps and possible consequences of cross-purposes.

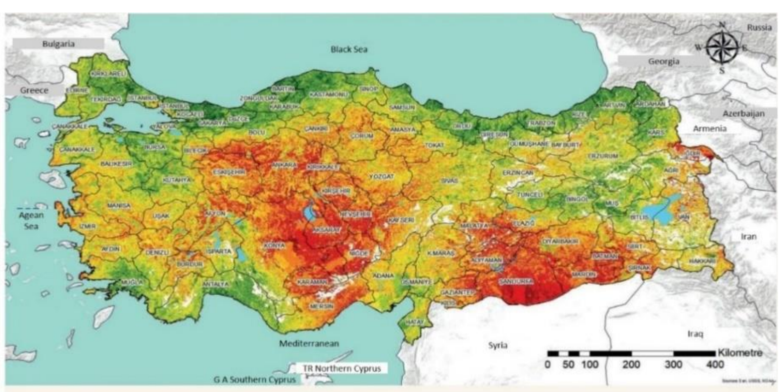
2. Methodology

2.1 Data Sources and Methods

Desertification and erosion risk maps along with soil organic carbon map produced by General Directorate of Combatting Desertification and Erosion of the Ministry (Turkish acronym ÇEM) of Agriculture and Forestry (ÇEM 2017, 2018a, 201b) are used for evaluating fossil fuel plants locations of Turkey. The fossil fuel plants distribution map is produced by GIS office of TEMA Foundation (The Turkish acronym for the Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitats).

3. Results and Conclusion

Desertification is relatively at low risk in areas with water availability as in the Northwest, North, Southwest and South of Turkey. Water availability also supports high soil organic carbon (Figure 1, 2). Unfortunately, fossil fuel plants of Turkey accumulated at these areas (Figure 3). This will in short and long term will have negative effects in these areas due to high water use for cooling, fly ash deposition, gases emitted to atmosphere (Raja et al. 2015). Although some studies suggest that state-of-the-art technologies significantly decrease emissions from coal powered plants solid wastes still create environmental problems (Meij and Te Winkel 2004). This revealed that fossil fuel energy plants created high riskTurkey's food security is under as fossil fuel plants hazards to environment is well-documented, and several countries are now investing alternative environmental friendly energy production. Both food and energy are required for humans' well-fare, Turkey is asked to put strict controls on coal powered fuel plant construction and it is recommended to focus on green energy as Turkey has a high potential in solar and wind energy production.



Risk group	Category	Category range	Definition	%
Low	1	1.00 – 1.27	Low	0.1
	2	1.28 – 1.34	Moderate	2.0
	3	1.35 – 1.40	High	10.6
			TOPLAM	12.7

Risk group	Category	Category range	Definition	%
Moderate	4	1.41 – 1.45	Low	17.4
	5	1.46 – 1.48	Moderate	12.7
	6	1.49 – 1.54	High	23.1
			Total	53.2

Risk group	Category	Category range	Definition	%
High	7	1.55 – 1.60	Low	16.5
	8	1.61 – 1.67	Moderate	8.1
	9	1.68 – 2.00	High	0.9
			Total	25.5

Figure 1. Desertification Risk Map of Turkey (ÇEM 2017)

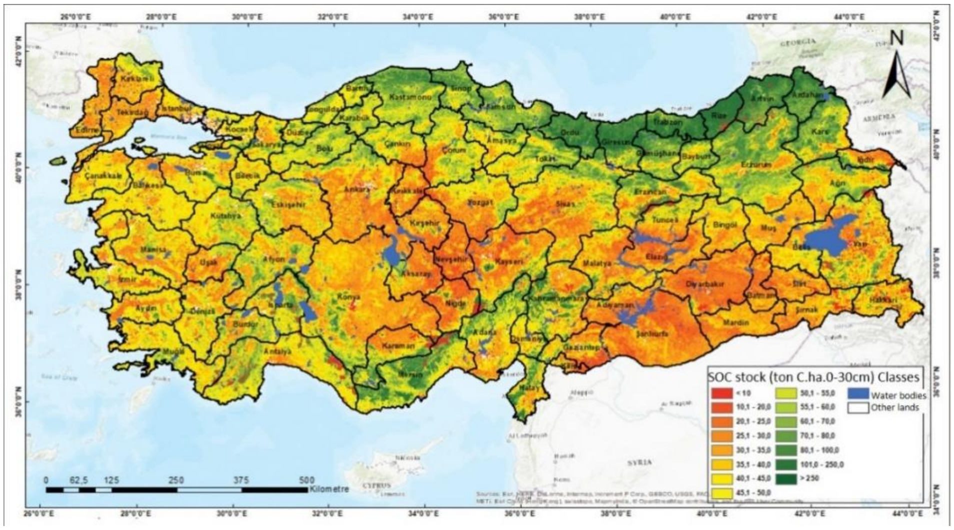


Figure 2. Soil Organic Carbon Stocks Map of Turkey (ÇEM 2018b)

This revealed that fossil fuel energy plants created high risk Turkey's food security is under as fossil fuel plants hazards to environment is well-documented, and several countries are now investing alternative environmental friendly energy production. For example as for wind energy, the total potential of the country is 48,000 MW andwith the wind potential to be installed on the sea is estimated to be 17,393 MW which totals to 65.393 MW.

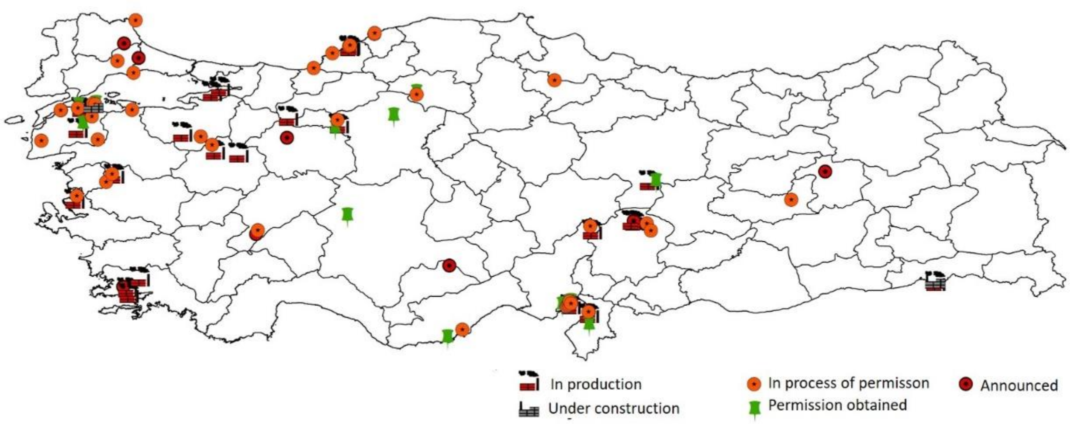


Figure 3. Fossil Fuel Energy Production Plants of Turkey

Finally, we suggest a mutual agreement among stakeholders in Turkey for their cross-purposes in order secure country's food and environmental security while sustaining its development.

3.1 Acknowledgments

Authors highly appreciate TEMA Foundation for supporting this study.

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Determination of Spatial Variability of Soil Quality Index based on Multi Criteria Decision Analysis

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Abstract

The objective of this research was to determine soil quality by taking into consideration the integrated Soil Quality Index (SQI) model on farm lands of Süleyman Demirel University which covers about 108.24 ha. In SQI model, soil indicators were weighted by means of the Analytical Hierarchy Process. Various indicator units were normalized by a Standard Scoring Function. A total of nineteen soil quality indicators were included in SQI model by grouping into four criteria which are; i- soil physical properties, ii- soil chemical properties and iii- nutrient elements. According to obtained results, more than half of the study area' soils (35.3%) was classified as low and very low quality level whereas, about 23,5% of the total area belong to high and very high SQI class in terms of agricultural suitability in surface depth. Moreover, all study area study soils in subsurface were found in medium SQI class.

Key words: Soil quality index, Analytical Hierarchy Process, Standard Scoring Function Soil indicator

1. Introduction

Protection of agricultural production areas is very important to increase the amount of products. Due to the rapid increase in the world population and the decrease in agricultural areas. The use of various inputs to the soil for more production on agricultural land that causing the deterioration of the natural structure and the unproductivity of the soil. It is important to check the soil quality for sustainable use of soils. Soil quality; the capacity of a soil within ecosystem to sustain plant and animal production, improve water and air quality, and provide a complete living environment for human health (Doran, 2002). Soil quality index models used in the evaluation of soil quality are used by many researchers (Dengiz, 2013). The quality of the soil is not only related to nutrient content but also with its physical and biological properties. Physical, chemical and biological soil properties should be prepared as data set for optimum yield and reliable interpretations in crop production. The soil is a dynamic structure and is in constant change. The negative change may lead to a decrease in soil productivity (Caravaca et al., 2002). This study was carried out on the farmlands of Süleyman Demirel University. Some soil physical and chemical properties of the soil were determined for two depths as surface (0-20cm) and subsurface (20-40 cm). Soil Quality Index (SQI) model was determined to assess the quality of the soil.

2. Materials and Methods

2.1 Field Description, Sampling and Indicator Scoring

The study area was conducted in farm lands of Süleyman Demirel University with an area of 150 ha. It is located between 38 ° 31 '- 38 ° 16' North latitude and 32 ° 16 '- 32 ° 19' East longitude. According to Newhall simulation

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model, soil temperature and moisture regimes are *Mesic* and *Dry Xeric*, respectively. The study area has been generally used for wheat, some vegetables and fruit trees. Field study was conducted in 2017and a total of 112 soil samples were taken from surface layer (0-20 cm) and subsurface layer (20-40) using 150m x 150m grit system in the study area.The location of each soil sample point was recorded using a handheld GPS (global positioning system) tool. Samples were air-dried and passed through a 2 mm sieve. A total of nineteen soil quality parameters were included in SQImodel by grouping in three classes which are; i- physical indicators [dry bulk density (BD,Blacke and Hartge 1986), saturated hydraulic conductivity (HC,Oosterbaan 1994), content of sand, silt and clay(Soil Survey Staff 1996), available water content(Klute and Dirksen 1986)] ii- chemical indicators [soil reaction(Soil Survey Staff 1996), electrical conductivity(Soil Survey Staff 1996), organic matter(Nelson and Sommers 1982), and $CaCO_3$content (Soil Survey Staff 1993)], iii- nutrient elements content [nitrogen, phosphors, potassium, iron, copper, manganese and zinc content(Bremner and Mulvaney 1982)].In this study, due to variation of parameters units, a standard scoring function (SSF) was used in order to normalize soil parameters by assigning scores ranging between 0 and 1 Andrews et al. (2002). Three types of indicators were separated according to their functional effect on soil quality, where the best soil functionality was joined with high, low or intermediate values and rated as: (1) “More is better” function was applied to OM and macro and micro nutrient elements for their roles in soil fertility because their high concentration was considered constructive for a good soil functionality of agricultural soil suitability; (2) “Less is better” function was applied to EC, $CaCO_3$, BD, sand and silt content, sodium degradation of soils. (3) “Optimal range” function was applied to pH ad clay content thus, scores were assigned using the more is better or the less is better function depending on whether the indicator value was below or above the optimal range.

2.2 Soil Quality Index and Weight Assignment

In order to determine agricultural requirements by taking into consideration soil physical and chemical properties, some literature sources were reviewed. Soil characteristic criteria together with weighting based on values normally was employed in assessment of agricultural usage. After indicators were scored and weighted, soil quality indices were calculated employing the Soil Quality Index using the following formula (1);

$$SQI= \sum_{i=1}^{n}(Wi.Xi) \quad (1).$$

Where; SQI: Soil quality index for agricultural usage, Wi: Weighting of parameter i, Xi: Sub-criterion score of parameter *i*. The above formula was applied to each soil sample.

A total of nineteen soil quality parameters were grouped into three sub-criteria such as land properties, soil physical, soil chemical, nutrient element and heavy metal pollution parameters, which means all the matrices in hierarchies A, B, and C were logically constructed. Each of sub-criteria has an importance level that differently affects the soil quality for agricultural usage. The weighting in soil quality is useful to assess the importance level of soil parameters for each sub-criterion. In this study, the AHP method (Saaty 1980) was selected and used for weighting the criteria and sub-criteria for the soil quality assessment of agricultural activities. The principles utilized in AHP to solve problems are to construct hierarchies. This pair-wise comparison allowed an independent evaluation of the contribution of each parameter, thereby simplifying the decision making process.The pair-wise comparisons of various criteria were organized into a square matrix. The diagonal elements of the matrix were 1. The principal eigenvalue and the corresponding normalized right eigenvector of the comparison matrix gave the relative importance of the criteria being compared. The elements of the normalized eigenvector were weighted with respect to the criteria or sub-criteria and rated with respect to the alternatives. The consistency of the matrix of order n was then evaluated. If this consistency index failed to reach a threshold level, then the answers from the comparisons were re-examined. The consistency index, CI, was calculated.In other words, the results indicated that all RIs for single and general hierarchy were lower than 0.1. Thus, homogeneity of indicators within each group, a smaller number of factors in the group, and better understanding of the decision problem improve the consistency index.

2.3 Interpolation Analyses

In the present study, three main interpolation methods (Inverse Distance Weighing-IDW, Radial Basis Function-RBF and Kriging) were performed for predicting the spatial distribution of SQI. Kriging is a geostatistical technique similar to IDW using a linear combination of weights at known points to estimate the value at an unknown point. The Root Mean Square Error (RMSE) was used to evaluate the interpolation techniques. The lowest RMSE indicate the most accurate prediction.

3. Results and Conclusion

3.1 Soil Physico-Chemical Properties

The descriptive statistical parameters such as mean, maximum, minimum, and coefficients of variation (CV) of the some basic physico-chemical properties and macro-micro nutrient elements related to 112 soil samples taken from surface (0-20 cm) and subsurface (20-40 cm) soils of the study area were done. In order to determine variability of some physico-chemical soil properties, many researchers offer to investigate coefficient of variation (CV). In this case, variables of clay, sand, silt, AvP, exCa and exMg have high CV. On the other hand, the variables of, BD, EC, pH, exNa, exK, AvZn, AvCu and AvFe of soils had a low level of variability. In addition to that, variability of HC, $CaCO_3$ and AvMn was found as medium CV in surface soil samples. The values of pH in soil samples ranged between 7.89 and 8.35 and classified as slightly alkaline, whereas electrical conductivity had a minimum value of 0.13 dS m^{-1} and a maximum value of 0.40 dS m^{-1}. The mean values of organic matter and $CaCO_3$ content (%) were 1.21 and 23.25.Table 1 shows also macronutrient status of the soil samples available AvP and exchangeable exCa showed high variation between minimum and maximum values. Total N varied between 0.06 and 0.19 and the average value of total N was 0.10. According to Table 1, exCa, exMg, AvMn, EC, pH, sand, clay and BD showed as normal distribution. Moreover, according to limit values reported by Lindsay and Norvell (1978) for micro nutrient elements, only available Zn was found insufficient amounts in most of the soil samples (about 94.6%) and their mean values are 1.24 mg kg^{-1}. As for subsurface soil samples (20-40), while variables of CaCO3 and AvCa have medium CV, most of the other parameters have a high level of variability. Range of the soil reaction and EC values showed similarity with surface soils' values. This case can be said for OM and $CaCO_3$ content; the mean values of OM and $CaCO_3$ content (%) were 0.91 and 23.78. In addition, micro and macro nutrient elements showed similar variability when compared to surface soil samples.

3.2 Soil Quality Evaluation and Spatial Variability of SQI

In this study, nineteen main indicators were selected for LQI by considering an extensive literature review. In order to assign the suitable score for each soil sample and point, it is composed of three main steps. In first step, AHP approach was carried out for evaluation of evaluate scores or eigenvector. In this step, the consistency ratio was determined if CR is far below the value of 0.1, which is the maximum limit, then the weighting is considered. Meanwhile, the results of the study by Wali et al. (2016) also stated that the method of AHP was successful in weighting values. Contribution weights of soil parameters to soil quality index estimated by the AHP are given in Table 1. The highest value (0.5396) was determined for Hierarchy B1 (physical parameters), whereas the lowest value (0.1634) was found for soil nutrient element concentration (Hierarchy B3). In addition, the highest contribution of the indicators in each Hierarchy B1, B2, and B3 were revealed as clay percentage (0.6491), OM (0.6089), and TN (0.2405), respectively.

Table 1. Contribution weight of soil parameters to soil quality calculated by the AHP

Hierarchy A				
Hierarchy C / Indicators	Hierarchy B			Combine weight $\sum B_i \times C_i$
	B1(Physical)	Chemical (B2)	Fertility (B3)	
	0,5396	0,297	0,1634	
Sand	0,1715			0,0925
Clay	0,4426			0,2388
Silt	0,2454			0,1324
Bulk Density	0,0875			0,0472
Hydraulic Conductivity	0,0530			0,0286
Organic Matter		0,6086		0,1808
Electrical Conductivity		0,1332		0,0396
pH		0,1871		0,0556
CaCO3		0,0711		0,0211
Phosphorous			0,1966	0,0321
Potassium			0,1466	0,0240
Total Nitrogen			0,2405	0,0393
Calcium			0,0841	0,0137
Magnesium			0,0494	0,0081
Natrium			0,022	0,0036
Iron			0,1206	0,0197
Cupper			0,0337	0,0055
Manganese			0,0269	0,0044
Zinc			0,0796	0,0130
	1,0000	1,0000	1,0000	1,0000

These results are also consistent and it can be expressed why the highest value is Hierarchy B1. This is because, textural (particularly clay content) properties of soil are one of the main limitation factors for cultivated area in terms of water and nutrient element retention capacity. In B2 hierarchy, OM content was found as the highest value due to its several important functions in soil as well as for its influence on the biological and physicochemical properties of soils. This indicator, in fact, is contained in development of the soil structure or aggregation, improvement of soil fertility, storage and supply of nutrient elements and also affects cation exchange capacity. On the other hand, this parameter can be affected by soil and plant cultivation practices. These two Hierarchies (B1and B2) can be defined as inherent or natural factors. On the other hand, Hierarchy B3, nutrient status of soils, can be defined as dynamic or artificial factor. Although soil fertility and yields were significantly improved by intensification of management practices, unfavourable environmental impacts can be observed in the catchment, such as soil acidification induced by enormous application of mineral fertilizers, especially nitrogen, and decreased use of organic fertilizers. Secondly, score values of all parameters determined by using the best soil functionality was associated with high, low or moderate (optimal range) values ranging between 0 and 1 based on their function on soil quality. Finally, after eigenvector for each indicator was assigned and scoring values determined, weighted linear combination technique was used to estimate SQI values for each soil sample. Interpolation analysis for SQI surface and subsurface layers were used to identify the best predictive model from among fifteen different semivariogram models tested. Variogram or function of each interpolation method yielding the best results was determined. Finally, it was chosen IDW-1 for surface layer and Gaussian model of Simple Kriging due to its lowest RMSE value to estimate SQI at unsampled locations.SQI of the study area is classified as five levels according to Table 2.According to obtained results, more than half of the study area' soils (35.3%) was classified as low and very low quality level whereas, about 23,5% of the total area belong to high and very high SQI class in terms of agricultural suitability in surface depth. Moreover, all study area study soils in subsurface were found in medium SQI class.

The SQI index was the best performing index and when calculated using the AHP and SSF approach could be applied as an efficient tool to assess soil quality and reduce the time and cost associated with sampling and analysis, because it took all soil parameters into consideration and gave the most consistent results. . In this study was performed about soil quality index in farm lands of Süleyman Demirel University with an area of 150 ha. Nineteen were grouped into 3 criteria (soil physical, chemical properties, micro- and macronutrient status of soils) by taking into consideration their effects on soil quality after taking 112 representative soil samples from the surface and subsurface layers in study area. According to soil quality assessment results, it was detected that less than the total study area is very highly and highly suitable for agricultural activity.

Table 2. SQI classes of surface soils (0-20 cm)

Class	Description	Index	Area	
			da	%
I	Very Low	0,0-0,19	14,9	1,9
II	Low	0,20-0,39	261,6	33,4
II	Medium	0,40-0,49	321,9	41,1
IV	High	0,50-0,69	178,9	22,8
V	Very High	0,70-1,00	5,8	0,7
Total			783,1	100,0

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Main Reasons and Results of the Land Degradation in Turkey

İbrahim ATALAY[1], Sevda ALTINBAŞ[2]

Abstract

Turkey is one of the countries subjected to the land degradation in the World. Main causes of the land degradation are the sloping lands in the mountainous areas, misuse of land, deforestation and over grazing in the meadows and rangelands, negative effects of physical and chemical properties of some geologic parent material and dispersed rural settlement in the mountainous areas.The slope inclination which is more than 40% in the mountainous areas and destruction of vegetation cover in the semiarid areas of Anatolia has led to the intense erosion process. Geologic parent material or bedrocks are exposed in places where native vegetation has been completely destroyed. That the misuse of lands especially on the mountainous areas, excess utilization forest products and over grazing are the main reason of the erosion and land degradation on the mountainous areas. For this reason, most of the land belonging to VI and VII class lands have been converted into class VIII. On the other hand, physical and chemical properties of the exposed parent material are played an important factor for the land degradation as well. In fact,the evaporitic sediments containing abundant chlorine, salty and gypsum materials considerably prevent the growth of the vegetation and these areas have been deeply dissected by the gullies that formed mostly chemical erosion. Typical examples of these lands are common betweenÇankırı-Sivas provinces and along the Kelkit river valley. The sandy materials which are found in the flysch formation in the western part of northern Anatolian mountains, volcanic sand and tuff in the Cappadocia region in the south-eastern part of Central Anatolia and sandy colluvial and fluvio-lacustrine deposits have been dissected deeply by gullies, some of these lands converted into badland topography, because sandy particles are easily carried away by the runoff.

Semi weathered and unweathered serpentine-peridotite masses that are exposed along the orogenic belts both Northern Anatolian and Taurus Mountains, Burdur-Gölhisar basin and around the Kırıkkale in Central Anatolia are generally devoid of vegetation due to cation exchange capacity is less than 10me/100g. Granite and gneiss producing sand soil is one of the vulnerable areas for the formation of gully erosion. Indeed, the thick sandy soil on the gneiss and granite has suffered to the gully erosion where native vegetation cover completely has been destroyed on the sloping areas nearPütürge and Baskil towns, East Anatolia.

One of the main reasons of internal migrationsoccurring from the rural areas to cities is mainly related to land degradation. Ecologically the forest areas covering the at least a half part of the total land of Turkey decreased as low as 27 % as the result of the forest destruction, most of which are unproductive. The agricultural fields have been abandoned as the result of erosion on the sloping area. One of leading important effects of the land degradation is to increase of bed material load of the streams especially flooding occurrence time. The accumulation of the sediments in the dam reservoirs has lead to the decrease the water holding capacity of dams such as Keban, Karakaya, Atatürk.

Keywords: Land degradation, sedimentation, gully erosion, Turkey

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Introduction

Land degradation which is the main reason of desertification and depletion of the natural potential of the land has mostly continued in the semiarid mountainous areas of Turkey and the world (Goudie 2006). The factors on the land degradation are not only to human impact on the mountainous areas but also physical and chemical properties of some parent materials such as salty and high alkaline evaporitic deposits and outcropped ultrabasic/ultramafic rocks in Turkey. Leading land degradation process has been continued on the sloping areas on the mountainous areas due to excess utilization of forest products, overgrazing and misuse of the lands. Gully erosion process continues on the low cohesive deposits composed of volcanic tuff, sand in the SE volcanic areas of Central Anatolia and gravelly and sandy colluvial and fluvio-lacustrine deposits occurring on the lower edges of mountains mostly in the Aegean Region. These areas are the mainland of badland topography of Turkey. The materials transported from the badland topography and/or gullies areas increases the sedimentation in the dam reservoir and flood plains (Atalay 1980). Slope inclination more than 40 % in the mountainous areas extending in the northern and in the southern parts Anatolian is the important factor the erosion and transportation process. In these areas erosion actively is continuing where natural equilibrium has been deteriorated.Some parts of the mountainous areas belonging to VI and VII land capability class have been converted to agricultural lands. 6 millions hectare agricultural land is found uncultivated areas of Turkey (Topraksu 1976). The cultivation to be carried out on the mountainous area is one of the erosion processes.

Deforestation depends on two factors. One is to obtain agricultural area and second is to over exploitation and/ or excess utilization. The natural forest areas covering 70-75 % of total land of Turkey has been decreased 27 % most of which is unproductive.Overgrazing having been continued all part of the meadows, rangelands have led to decrease of the herb productivity and spread bitter and spiny cushion plants that are not eat by animals.

Some parent materials such as salty and high alkaline evaporitic deposits and ultrabasic rocks, which are outcropped as the result of soil erosion and especially destruction of forest mostly prevents the growth of forest trees and agricultural production. These areas are found in bare appearance or desertificated areas. Degraded lands account for at least one-forth Turkey's total land (Atalay 2000).

In this article in order to assess some properties of land degradation only two subjects are taken into consideration: human impact and parent material.

Materials and Method

In order to introduce the main reasons and results of the land degradation field studies were carried out notably by Atalaysince 1970’s in Turkey. The main reasons of the erosion were examined and soil and parent materials samples were collected to determine general physical and chemical of properties parent materials. The analyses of these samples were determined at the laboratories of forest research institutes of Forest Ministry and Department of Soil Science of Atatürk University, Erzurum and Akdeniz University, Antalya.

The maps showing the active erosion and land degradation areas on parent materials were introduced. The data obtained citied references were used.

FINDINGS

1. Effects of Human Impact

In order to assess and illuminate the importance of the land degradation, the effects of the misuse of land, overgrazing, deforestation are taken into consideration.

1.1. Misuse of the land

As a general rule, according to land capability classification the suitable areas for agriculture cover the plain and plateau surfaces of Turkey. I, II, III and IV class lands account for 22 % of total land of Turkey, but this figure is about 36 % total land of Turkey (Atalay 2014, 2016; Topraksu 1976). Some parts of the mountainous areas are devoted to agricultural production. In fact, 6 million hectares agricultural land accounting for 8 % of the total land Turkey is found on VI and VII class lands that are unsuitable for cultivation (Topraksu 1976). In the sloping part of the plateaus surfaces and hilly areas in the Central Anatolia are also devoted to wheat and barley cultivation.

The people living in the mountainous areas have to engage in agriculture in order to obtain cereals from near-by areas.Agricultural fields on the sloping areas have led to soil erosion and then parent material erosion, mass movements and catastrophic floods in the rainy areas of eastern part of Black Sea Region.Here floods derived from the tea and hazelnut gardens have caused to destroy some houses of settlements. That is why, floods, mass movements and deaths occur frequently in the Black Sea region. For example a flood occurred in 1994, 100 houses were destroyed and 67 people died. In 2018, 7 people died as the result of landslides occurred in the Eastern Black Sea Subregion.

On the other hand, soil erosion on the agricultural land leads to the decrease of soil fertility so that many fields have been abandoned. This situation is one of the main causes of the internal migration.

1.2. Deforestation

Deforestation starting from the historical time continued up present time in Anatolia. First clearing of forest was occurred in the vicinity of Beyşehir Lake 3000-4000 years before present in the Lakes Region, SW of Anatolia. This clearance of the forests which is termed as "Occupation Phase of Beysehir"can be considered initial period of land degradation phase in Anatolia (Atalay 1992).Ecologically,the forestscovering 70-75 percent of total land of Turkey decreased as low as 27 % most of which belong to poor forest stands. Deforestation in these areasis the main spreading areas of land degradation in Anatolia.

There are two main reasons for deforestation: One of them is related to obtain firewood and constructional material and other is to obtain agricultural land. For that reason, forests in the vicinity of settlement areas have been generally completely destroyed and cleared. The natural regeneration also is prevented with grazing in the forest areas.

In the Mediterranean ecosystem clear-cutting of forest areas are occupied by garrique and over exploited and utilised red pine forest areas are replaced by maquis vegetation. For that reason, a great part of the *Pinus brutia* forests are covered with maquis and garrique communities. The forests which are found in upland part of the

Mediterranean region have been subjected to over utilisation by nomadic society. Approximately 1 million hectares cedar and black pine forest are completely destroyed in the uplands by the nomads (Fig. 1).

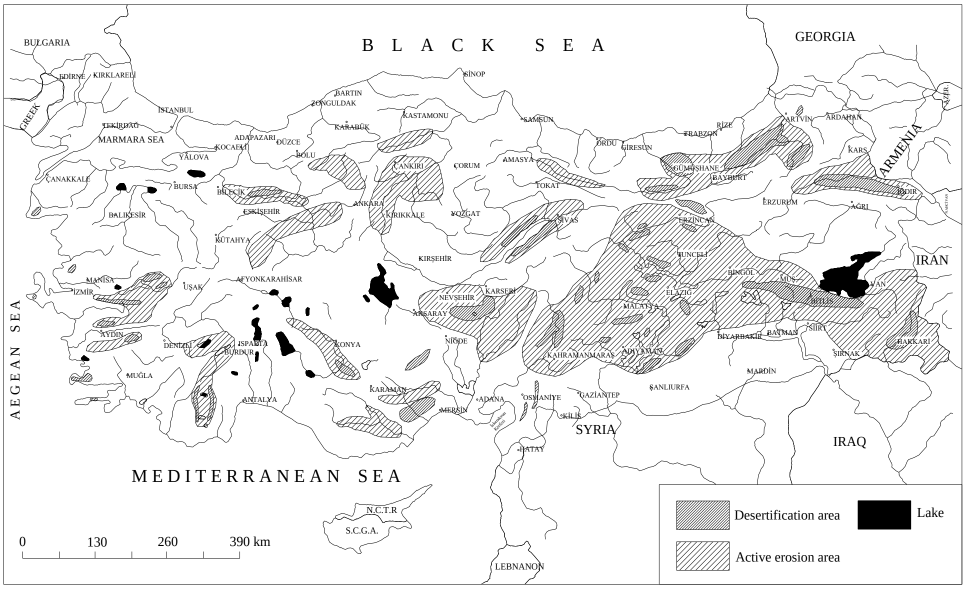

Figure 1. Main desertification and active erosion areas of Turkey

In the Black Sea ecosystem, forest areas along the coastal belt are replaced by pseudomaquis vegetation due to over cutting of forests. The destroyed forest area in upper part of this region is occupied by *Rhododendron* sp. which is the underground shrub of *Fagus* and *Picea* forests. The upper boundary of the forest has been shifted more than 200 m.

The continental part of the Anatolia has been suffered to extensive forest destruction. That is why, dry forest areas are occupied by anthropogenic steppe (Atalay 2014, 2015). The Eastern Anatolia containing mountainous and rugged topography is one of the regions to have been subjected to forest destruction. Most of oak forests have been disappeared in a great part of the SE Taurus Mountains. Soil and parent material erosion occurring on the rugged land in the Eastern Anatolia has led to severe sedimentation especially in the dam reservoir of Keban, Karakaya and Atatürk.

1.3. Overgrazing

One of the main livelihoods of the rural population living in the mountainous areas mostly depends on animal breeding. Goats and sheeps are grazed in the rangeland, grassland and forest. Most important problem relating to animal husbandry is to apply overgrazing, early-grazing and late-grazing system. In the overgrazed areas the natural herb composition of the meadows are degraded so that cosmopolite species composed of bitter and spiny herbs tend to be dominant. Other effect of the overgrazing is to decrease of the herb productivity and grazing capacity. In this case, the decrease of the herb productivity of the meadows has caused to decrease the income of peasants. Economic hardship in the rural areas is the main reason of internal migration.

2. Effects of Parent Material

Low cohesive deposit, ultrabasic rocks and evaporitic sediments are also leading factors in the land degradation where natural equilibrium has been deteriorated (Atalay 2000, 2014, Tetik and Yeşilsoy 1997). The negative effects of parent materials on the land degradation can be summarized as follows:

2.1. Physical properties of the parent material

The physical properties of parent material such astexture, cohesion, porosity and permeability play an important role in de mass movements on the sloping areas especially natural equilibrium deteriorated areas, in general. In Turkey, parent materials can be classified into two groups in terms of mass movements and erodobilityprocess: consolidated and unconsolidated.

Consolidated sediments like clay stone, marl deposit and clayey limestoneprevent a great extent water and air circulation and root development due to very low porosity and permeability. Marl deposits composed of clay and calcareous material also one of the gully erosion areas occurring on the steep slopes. This is related to the transportation of swollen surfaces of the marl deposit saturated with water are carried away by the overland flow (Atalay et al 2019).

The low cohesive or unconsolidated deposits composed of volcanic tuff, sand, agglomerate, colluvial material and flyschsubject to erosion easily on the sloping areas. Because, sand and silt particles are easily transported by runoff/overland flow; so deep gullies have been developed on the volcanic tuff, sand, flysch and thick colluvial deposits. For example, the volcanic tuff and sand deposits in the Cappadocia Region in the SE Anatolia have been dissected by the deep gullies. Sandy soil developed on the granite and gneiss also corresponds to gully erosion areas. For instance, the deep weathered gneiss in the Malatya Mountains and granitic areas in the vicinity of Elazığ in the East Anatolia are one of the gully erosion areas of Anatolia.

2.2. Chemical properties of the parent material

Chemical compound of the parent material affects the growth of the plant and its distribution and productivity and the erosion intensity and sediment yield. Chemical properties of the parent material generally depend on the content of soluble compounds in terms of erosion process and land degradation (Fig. 2). The effects of some parent material preventing plant growth are briefly explained below.

Evaporitic sediments

In the closed basins of the Anatolia the sediments containing alkaline, gypsum and salty materials were deposited under hot and arid climatic condition during the Oligo-miocene period. These evaporitic sediments appear along the tectonic basins extendingbetweenÇankırı andIğdır provinces, in the northern Anatolia, Narman-Oltu basin in the NE Anatolia. In the Narman-Oltu basin the chemical analysis of the evaporitic sediment on the 30 samples are as follows: pH 8,7-9,9, $CaCO_3$ 0,07-29,3 % soluble Cl 0,11-3,58 me/100 g, bicarbonates 0,05-0,70 me/100 g, sulphates 0,28-32,4 me/100 g, sodium exchange 2,3-75,1 me/ 100 g, exchangeable sodium percent (EPS) 7,3-44,1, sodium absorption rate (SAR) 0,53-55, electrical conductivity at 25^{o}C 0,27-36,7 milliohms /cm (Atalay 1982a and 1982b). These salty and alkaline deposits are very vulnerable for the chemical erosion due to the dissolutions of salts and carbonates. Besides the runoff occurring on these deposits has led to the formation of deep gullies as the result of the mainly chemical erosion.On the other hand, in these areas landslides, slope debris and slope slides are common because of the fact that these deposits dissolve when they are saturated with the atmospheric water (Fig.2). The dissolution of evaporitic sediments leads to the landslides in the steep slopes of the Aras river valley.

2.3. Ultrabasic/Ultramafic Rocks

The ultrabasic rocks which are mainly composed of peridotite-serpentine are widespread along subduction zone along the orogenic belt of Anatolia. Deep and good weathered ultrabasic rocks form a good habitat for the growth of the forest vegetation due to the abundant release of the plant nutriments. But unweathered and semi weathered rock surfaces are seen as a bare land because the released plant nutrient capacity is very low. For example, cation exchange capacity (CEC) of deep weathered serpentine-peridotite rises 50 me /100 g,while this figure is less than 10 me/100 g on the low and semi-weathered surfaces. For instance, the cation exchange capacity of 12 serpentine soil samples that are taken from the Malatya Mountains in the SE part of Anatolia ranges from 2 to 37 me/100 g and this figure changes between 2 and 50 me/100 g on the serpentine in the Burdur-Gölhisar Basin in SW Anatolia (Altunbaş 2019, Altunbaş et al 2019, Atalay et al 2019). Low weathered and unweathered serpentine-peridotite areas correspond to the desertification areas of Anatolia as are seen in the east of Gölbaşı, the some parts on the southern edge of SE Taurus Mountains, Datça peninsula, some part of Burdur-Gölhisar Basin, Karadağ Mountain nearNarman town, E of East Anatolia and northern part of Amanos Mountain, E of Iskenderun Gulf and so on.

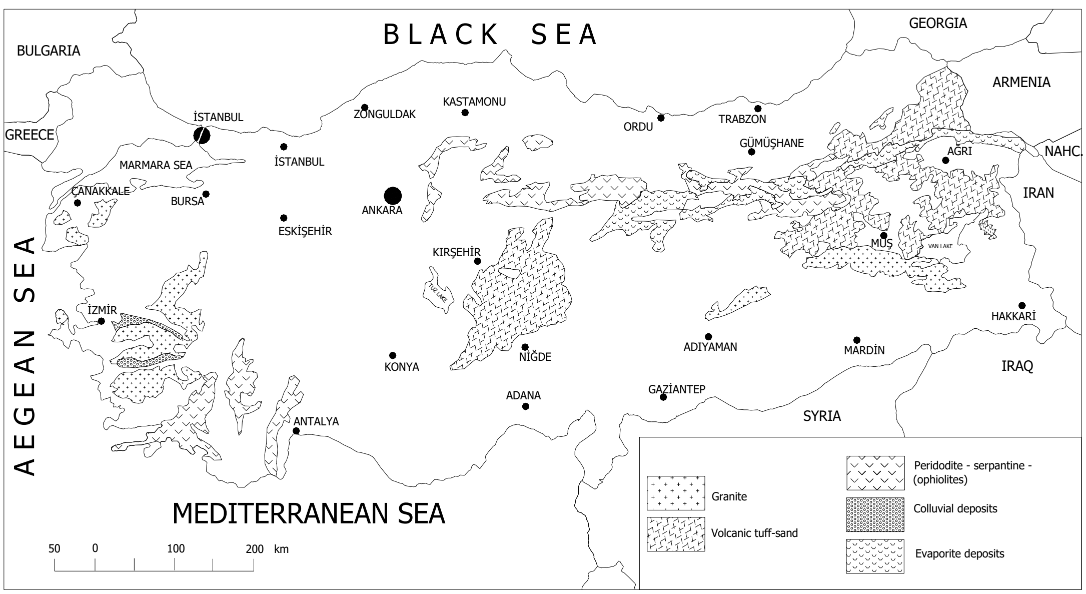

Figure 2. Parent materials affecting the land degradation and plant distribution in Turkey

On the other hand, swollen surfaces when saturated with water of peridotite-serpentine have subjected to gully erosion, because particles on the swollen surface are easily transported by runoff or overland flow.Shortly, the negative effects of some parent materials have increased the land degradation processes in Turkey (Fig.2).

3. Conclusions

We can reach some important conclusions are as follows:

Land degradation is the vital importance of Turkey in term of both economic and social aspects.Misuse of land in Turkey has caused the decrease of the forest cover and agricultural productivity and increasedthe desertification process. Bare lands appearing on the steep slopes are the result of typical desertification process. The low productive areas account for c. a half part of Turkey.The floods have caused the increase of modern sedimentation both in the flood plain and dam reservoir. Dam reservoir capacity is getting decreasing due to intense sedimentation. The dams constructed 40-50 year ago lost c. a half of the water carrying capacity.

Evaporitic sediment and low cohesive deposits that have been dissected by gully and rill are responsible for the formation of bed-land topography, mass movements and the increase of desertification process. Land degradation is one of the main reasons of the internal migration; a major part of urban population migratedfrom mostly degraded rural area. The increase of the unproductive or low productive areas caused the decrease of the food production and food security.Very rich biodiversity in the mountainous areas have been decreased due to the deforestation and soil erosion.

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The Importance of Marl Deposits on the Soil Formation, Land-Use and Land Degradation in Turkey

İbrahim ATALAY[1], Sevda ALTINBAŞ[2], Muzaffer SİLER[3]

Abstract

Turkey land which is located in the Alpine-Himalayan orogenic beltcontains all geological parent materials and they determine considerablyphysical and chemical properties of soil, land use and land capability classification notably on the sloping areas.Marl deposits containing c. 50 % clay and 50 % $CaCO_3$ have formed both on the lacustrine (lake) and shallow marine facies. Marldeposits may divide into four main groups containing clay content, geologic period and inclination of layer in terms of soil formation and land capability classification.Lower Tertiary marl deposit on the flat lands is the formation of red Mediterranean soil.Marl deposit containing rich clay on the flat lands are the main occurrence areas of Mollisol ordo, rendoll subordo (Rendzina) and clayey marl deposit corresponds to spreading areas of Vertisol as is in Thrace, bottom land of Muş Plain and southern part of Marmara Region.Young marl lake deposits belonging to Pliocene period have only thin A horizon, whileA horizonhas not developed on Pliocene and Quaternary marl deposits due to elapsed time is insufficient.As a general rule, almost all soft marl deposits on the flat land and slightly inclined slopes are partly suitable for agricultural production. Indeed, cereals are produced on marl deposit in the semiarid parts of Turkey.While marl deposits on the steep slopes havebeen subjected to the formation of gully erosion, because atmospheric water mostly flows as overland flow due to very low infiltration capacity. These areas have been dissected withgullies can be classified as VIII land capability class. Some of these areas are found in the eastern part of Lake Burdur and middle part of Göksu River basin in Mediterranean Region, and northeastern part of Central Anatolia. On the other hand, forest productivity is low on the hard and horizontal layered marl deposits, due to the fact that the vertical rootdevelopment of the trees mostly are hindered on the hard and compact horizontal layers some of which are common in the Taşeli Plateau and in the eastern part of Lake Burdur Basin.

Soft marl deposits on the flat land is one of the agricultural lands belonging to land capability class IV in the semiarid region of Turkey, but irrigation areas of the marl depositbelongs to land capability class III due to the high agricultural productivity as compared to the semiarid lands. CEC (Cation exchange capacity) of marl deposits changingbetween 20 and 40 $cmol_c\ kg^{-1}$ is enough for the production of cereal crops.

Keywords: Marl deposit, soil formation, agriculture, land classification, Turkey

1. Introduction

The parent materials on the sloping areas are one of the main decisive factors for the formation of soil, land capability classification and land degradation. This situation frequently changes depending on lithologic properties of the each parent material. For instance,deep weathered granite and gneiss producing sandy soil

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with c. 10 $cmol_c/kg^{-1}$create a suitable condition for the growth of stone pine (*Pinus pinea*) in the Mediterranean climate and scots pine (*Pinus sylvestris*) in the humid and subhumid-cold climate in Turkey. When the sandy soil transported by the surface flow the hard rocks mainly composed of granite and gneiss convert rocky lands belonging to land capability class VIII. Productive potato and grape and some trees such as stone pine (*Pinus pinea*) and scots pine (*Pinus sylvestris*) grow on the volcanic sand and tuff due to deep and large root development. Deeply weathered serpentine-peridotite producing clay and clayey loam texture and high nutriment capacity ranging from 20 to 50 $cmol_c kg^{-1}$ form a fertile agricultural land and highest productive black pine (*Pinus nigra*) forest is found on the deeply weathered serpentine-peridotite. While unweathered and/or low weathered serpentine with CEC is less than 10 $cmol_c/kg^{-1}$ form a poor habitat on which sparse and chaparralappearancetrees are found (Atalay et al 2010, 2014 and Atalay et al 2019, Altunbaş 2019). Limestone producing clayey soil with c. 30 and 40 $cmol_c/kg^{-1}$ that has developed on the cracks and bedding surfaces in the slopping areas contributes to productive forest lands due to the tree roots easily develop along the cracks and among the limestone layers. Red Mediterranean soil (Luvisol) is common on the limestone in the flat lands on which almost all vegetable and fruits are cultivated. Evaporitic sediments formed on the closed basin under the hot climatic conditions in the Anatolia containabundant salt, gypsum and alkaline materials. For this reason, exposed evaporitic sediments on the eroded sloping areas prevent the growth of vegetation. Marl deposits formed in the tectonic depressions and subsidence areas of Turkey arethe one of the main agricultural lands of Turkey.Clay content, inclination of layers and the geological period of marl deposits determine a great extent the soil formation, vegetation productivity, erodobility and land capability class in the given area. Marl deposit on the sloping area is vulnerable for land degradation. Gully and rill erosion that formed on the steep slopes of the marl deposit involves one of the land degradation areas of Turkey (Atalay 2014, 2016).

As to the soil classification on marl deposit, marl deposit-rich calcareous is the main occurrence areas of Calcisols. These soils widely occur especially on the marl deposit in the semiarid lands of Turkey (Akça et al 2018, Kapur et al 2018). Rendzic Leptosols are also found on the sloping and undulating topographies of the Aegean and Mediterranean parts of the Turkey. Erosion is the common threat process for these soils when they are under cultivation on the sloping areas (Kurucu et al 2018).Soil developed on the marl deposit and clayey limestone is rendzina and Rendoll subordo of Mollisol according to 1949 and 1975 soil taxonomy, respectively. Thesoils developed on the lowland parts of Central Anatolia, Thrace and SE Anatolia often reflect the physical and chemical properties of marl deposits (Driessen 1969, 1970, Cangir et al 1990, Dinç et al 1993, Atalay 2016b).

2. Method and Materials

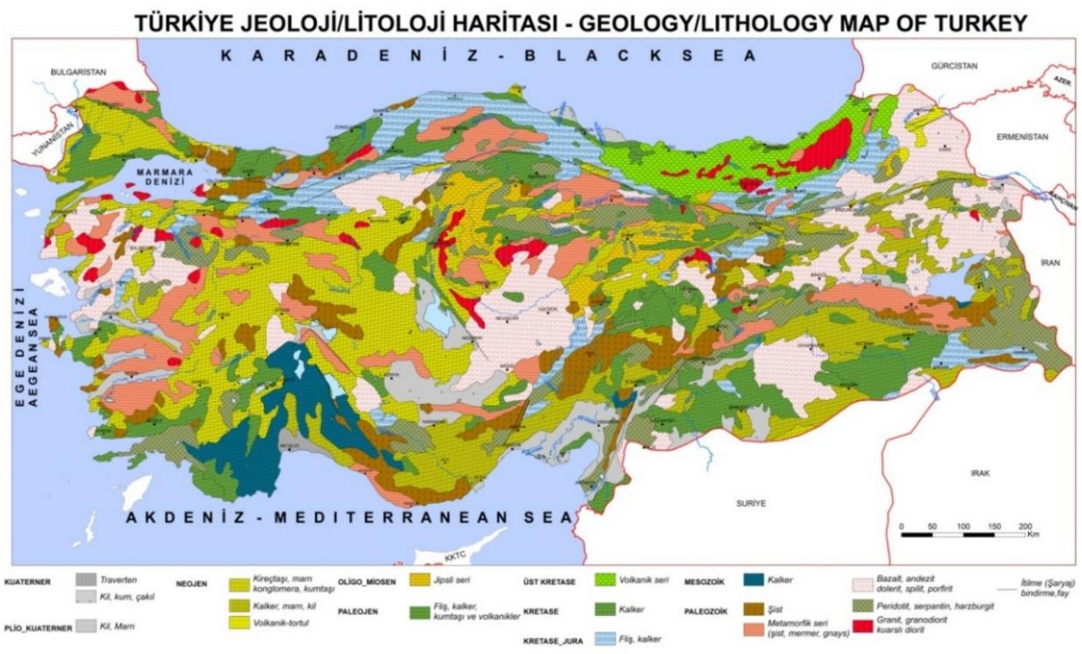
Firstly the geologic formation of marl deposit and its distribution in Turkey are explained (Fig. 1). Lithologic properties of the geological parent materials on the soil formation were examined during the field studies in some part of Turkey and soil and parent material samples were taken for analysing in laboratory. Characteristic examples that were taken from marl deposits that formed different periods of Neogene in the Burdur Basinwere analysed at the laboratory of the Soil Department and Plant Nutrition of Akdeniz University and the laboratory of Izmir Forest Research Institute of Agriculture and Forest Ministry. Texture of soil samples was determined based on Bouyoucos hydrometer method (Bouyoucos 1955), $CaCO_3$ (Jackson, 1967) and pH were determined based on Evliya (1964) and Jackson (1967) methods, respectively and CEC was determined Kacar's method (1995).

This study makes use ofsoil formation, soil geography of Turkey and geomorphology and pedogeomorphological studies (Atalay 1977, 2016c, 2017; Atalay et al. 2018, 2019 and Altunbaş2019, Altunbaş et al 2019). Geologic cross-section and profiles were drawn to show the soil formation relationship between the geological age of marl deposits and soil profile.

3. Findings

3.1. The Formation of Marl Deposit in Turkey

After the Alpine orogenic movements, vertical tectonic movements called "neotectonic movements" occurring between Middle-Upper Miocene and Last Pleistocene caused the formation of tectonic depressions that were formed along the faults lines. Thus, horst-graben structures especially on the rigid masse of Anatolia and subsidence areas in the Central Anatolia and middle part of Taurus Mountains were formed. These areas were occupied by the lake and sea in which sand, sandy clay and carbonates were accumulated. The regression of these lakes and seain the ends of Tertiary the marl deposits alternating marl, siltstone, sandstone and soft limestone layers were emerged in Anatolia and Thrace.Besides, marl depositswere also formed in the lakes occupied karstic-tectonic depressions especially in the western part of Taurus Mountains (Atalay 2017).



The yellow colour shows marl and soft clayey limestone and evaporitic sediments belonging to Tertiary Era.

Figure 1. Geologic and lithologic map of Turkey

3.2. Soils on the Marl Deposit on the Flat Lands

Soil thickness and horizon development on the marl deposit is mainly related to the geological period and clay, sand-silt content and alternating of sandy-gravelly layers in the marl deposit. The properties of marl deposit on the soil formation are explained below.

a. Geologic ageof marl deposit. Marl deposits and clayey limestones or soft limestones were formed on the shallow sea and lake facies occurred during the Tertiary Era. Generally, Lower Tertiary (Eocene) marl deposits belonging to sea facies are widespread in the depression of East Anatolia, northern and southern lowlands of the South-eastern Taurus Mountain range, Miocene marl deposits are common in the middle part of the Taurus Mountain. Neogene marl deposits occurring in the Aegean grabens and Central Anatolia lowlands were formed under the lake facies (Fig. 1). As a general rule, soil formation and soil type changes depending on the geologic period and/or age of the marl deposit on the flat lands. Red Mediterranean soils developed under the Mediterranean climatic conditions on the marl belonging to Lower and Middle Neogene. These soils are found on the marl deposit in the northern part of the Karacabey Plain, N of Aegean Region, partly in the Korkuteli depression in the western part of Taurus Mountains and northern part of Acıpayam depression in the SW Anatolia.Clayey marl depositsof Middle Neogene period correspond to the vertisol occurrence areas in the Ergene Basin (Thrace), Muş Basin (East Anatolia) and Karacabey Plain (NW of Anatolia), Harran depression (SE Anatolia) (Atalay 1983, 2016c). Here soil of A horizon with granular structure and high organic content, B horizon with accumulation of calcium carbonate and C horizon with semiweathered marl. Neogene deposits in the Karacabey Plain and Eastern Anatolian depressions and Kastamonu plateau, N of Anatolia are the main spreading areas of Mollisol belonging to the Rendoll subordo (Rendzina soil). Upper Neogene (Pliocene) marl deposits are generally devoid of soil horizon, only partly weathered C horizon is found. There is no horizon on re-deposited marl deposit of Quaternary in the southern part of Burdur Basin.

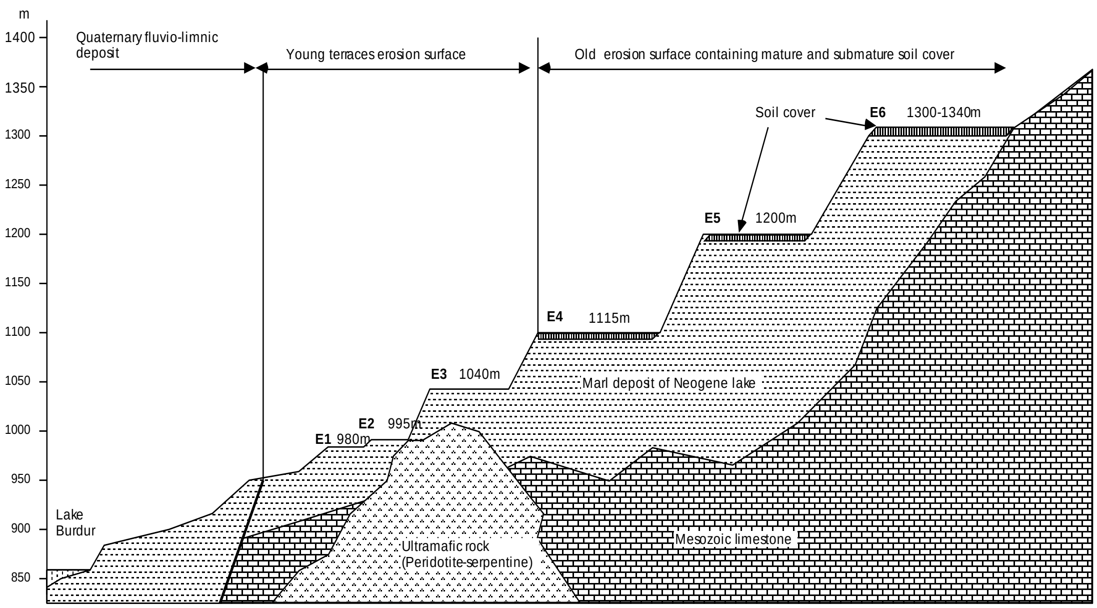
Soil formation beginning with Rendzina soil on the marl deposits converts to climatic soil type such as brown soil under the semiarid climatic conditions and red Mediterranean soil under the Mediterranean climatic conditions (Atalay 2016c).

Shortly, it can be said that there is no mature soil cover on the Pliocene and Early Quaternary marl deposits. Firstly, this is related to continual erosion on the steep slopes of marly areas. Secondly, enough time not elapsed for soil formation on the flat land in the lowlands of the basins. Furthermore, formation of soil on marl deposit takes a long time at least a few million years in age because weathering process is very low on marly materials. These deposits are widespread on the regressed lake basin at the end of Pleistocene due to capture of lake by river. These lands are found on the some parts of Central part of Anatolia and the Lake Burdur Basin, in general. Dry farming is applied on the exposed marl deposits on which wheat and barley are harvested.

b. Clay, sand-silt content of marl deposit. Marl deposits with high clay content more than 60% is very hardand water and air circulation is very limited. Here soil thickness is very thin due to weathering process is very low. For example, thin A horizon, 3-5 cm in thick, is developed on the neogene clayey marl deposit in the upper erosion level that developed on the Upper Neogene periodin the Burdur Basin (Atalay et al 2019, Altunbaş 2019, Altunbaş et al 2019). The presence of sandy and silty marl layer forms a soft ground not only for the deeply development of tree roots but also increase of the weathering process. Thus, soil development is faster on the silty-sand layers than that of clayey marl deposit.

The sandy and gravelly layers belonging to fluvial deposits that formed on the regression phase of the lake are responsible for the formation of sandy and gravelly soils. There is only A horizon on exposed sandy-gravelly layers due to the fact that the fine materials derived from A horizon easily transport to the deeper part via wide pores of sandy and gravelly materials.

Burdur and Gölhisar basins in the Lakes Region in Turkey bring about a good example to explain soil formation on the erosion surfaces developed on the Neogene marl deposit. The erosion surfaces that formed from the middle Miocene to Early Quaternary periods according to base level of the Burdur basin contain different physical and chemical properties of soil. The old erosion surfaces at an elevation of 1350 and 1200 m contain soil resembling rendzina soil. But almost all soils reflect physical and chemical properties of marl deposit. Indeed, pH of the soil changes between 7.4-7.8; $CaCO_3$ content varies between 18-23%, clay content is more than 20%. Texture is clay, clayey loam, and silty loam (Fig. 2, Table 1).



Soil formation not developed on the young erosion surfaces probably belonging to Pliocene-Upper Quaternary

Figure 2. Erosion surfaces formed on neogene marl depending on the base level of Burdur depression..

Table 1. Some physical and chemical analysis of marl depositon the erosion surfaces in the east of Burdur Basin

The location of samples and altitude	Lithology of Parent material	Sand (%)	Clay (%)	Silt (%)	Texture	pH	$CaCO_3$ (%)	Organic material (%)	CEC $cmol_c/kg^{-1}$
Erosion surface in the east of Burdur Basin, 1350 m	Marl deposit	17.03	26.82	56.14	SiL	7.5	53.71	1.57	23.3
Same place	Marl deposit	19.03	41.82	39.14	C	7.53	54.33	1.64	23.4
Kuruçay basin E of Burdur Basin, 1300 m	Sandy marl deposit	65.03	12.82	22.14	SL	7.32	17.65	2.13	15.4
Akyaka village agricultural field, 1300 m	Silty marl deposit	19.03	18.82	62.14	SiL	7.50	42.41	1.83	21.4
Bottom of Burdur, 950 m	Re-doposited marl	14.2	61.44	24.36	C	7.73	21.73	1.98	26.4
“	“	14.2	53.44	32.36	C	7.62	22.37	1.98	19.8
Kemer Marl	Marl dep.	1	69	30	C	7.66	31.6	0.6	22.1
Between Kemer-Kozluca village	Hard and white marl	43	9	48	L	7.64	56.2	0.7	11.4
Kemer-Kozluca, SE of Burdur	Swollen marl	21	23	56	SiL	7.64	40.6	0.4	10.5

On the lower level erosion surfaces on the marl deposit $CaCO_3$ content varies between 22% and 33 %, clay content changes between 10% and 32%, texture is clayey loam and loam. While re-deposited marl deposit that has been formed with transported materials from the upper part of neogene marl deposit on the lowland part of the Burdur basin is generally heavy texture due to the accumulation of clayey materials. Indeed, the amount of the clay changes between 53% and 61 %, indicating clay texture andcarbonate content is approximately 22 %.

Agricultural fields are found on the erosion surfaces on which mainly wheat and barley are produced for domestic requirement of the rural people and high productive agricultural fields are found on the upper erosion surfaces (Atalay et al 2019).

3.4. Land Degradation on Marl Deposits

Land degradation process occurs on the steep and/or inclined surface of the marl deposits. Because when marl deposit is saturated with water, infiltration capacity rapidly decreases, so overland flow occurs immediately after heavy rainfall. Rill erosion occurs on the steep slopes with the transporting of fine sandsand swollen materials notably clay on the marl deposit. With the merging of rills gully erosion formation develops, and in the further stage with the merging of gullies the deep and wide gullies dissecting of the steep slopes form. These landforms, called badland topography, can be assessed as a land capability class VIII. These landforms which are observed on the steep slopes of neogene marl deposits are one of the land degradation areas. Land degradation areas dissected by badlands are found in the eastern part of the Lake Burdur-Gölhisar Basin. Fault scarp,more than 100 m in height, extending eastern part of Lake Basin has been deeply dissected by the triangular shaped gullies (Atalay et al 2019, Altunbaş 2019). The floods coming from the gully areas transport mostly suspended load. In other words, gully areas that formed on the marl deposit is the main suspended load supplies areas. The accumulation of suspended materialson the lowlands of basin has led to the formation of clayey soil.

Other gullies areas on marl deposits are found in the vicinity of Beypazarı town in Central Anatolia, upper watershed areas of Ceyhan and Seyhan River basin, N of Çukurova (Cilician Plain), Upper Göksu watershed basin, middle part of Taurus mountain, Mediterranean Region, northern part of Muş Basin, some part of the inner part of west Anatolia and southern edges of SE Taurus Mountains**,**Natural slope equilibrium deteriorating on gully erosion areas has caused the mass wasting process especially debris flows. The plants seeds transporting with debris flows prevent growth and spreading of plans, for this reason the steep slopes of gullies are seen as bare land.

3.5. Land-Use on the Marl Deposits

As mentioned before, marl deposits on the flat land is one of the main spreading areas of agricultural land due to easily plough. For this reason, these agricultural fields are found on plateau and basin surfaces on marl deposits of Turkey. Dry farming which is carried out on the semiarid part of the Turkey are assessed as land capability class IV on which cereals mostly barley and wheat are harvested. While irrigated areas of marl deposits are the main vegetable and fruits especially apple production. These irrigated areas may be added land capability class III in semiarid parts of Turkey due to climatic limitations (Atalay 2016).

On the other hand, the important property of the marl deposit on the sloping and undulating areasis subjected to continual erosion.But agricultural practises go on these areas, because new and/or freshmarl deposit continually exposed beneath the eroded areas. For this reason, the steep slopes of marl deposit belonging to land capability class VII are also devoted to agricultural field in the many part of Anatolia (Atalay 2016a).

As to forest productivity on the marl deposit, generally speaking that marl deposit containing hard and compact layers considerably prevent to develop taproot structure of trees. For this reason, the forest productivity is less than that of other sedimentary parent materials such as conglomerate, sandstone and limestone. The growth rate of Calabrian pine (*Pinus brutia*) on the horizontal layered marl deposit is low due to the fact that the horizontal hard layer mostly prevent the development of the root toward the deeper part of marl deposits.

Reforestation and afforestation on the marl deposits. The seedlings planted on the marl deposit grow very slowly due to root developmentis very hard. For this reason, most of the planted seedlings dryon the compact and hard marly layer. During the field studies it is observed that majority the seedling are subjected to dry because the development of seedling roots is prevented by the compact marl layer at the depth of c. 10-15 cm (Atalay 2014).

4. Conclusions

Main properties of the marl deposit are summarized below:

1. Marl deposit creating a distinct environment and/or biomeis more different than that of other parent materials.2. There is no considerable difference between the physical and chemical properties of marl deposit and soils. 3. Mature soils like red Mediterranean soils are mostly found on the Lower Tertiary marl, while submature soils like rendzina and/or rendoll are widespread on the Upper Tertiary marl deposits. Cation exchange capacity is higher on the old deposit than the young ones.4. Marl andsubmature soil on the flat lands are devoted to agricultural field due to easily plough. Most of the agricultural lands belonging to land capability class IV are found on the neogene marl deposits. 5. Compact and horizontal layered marl layers often prevent the deep root development, while sandy marl and incline layered marl deposits support to formation a somewhat productive forest. 6. Marl deposits on the sloping areas are very vulnerable and/or sensitive for the land degradation. Clear-cutting vegetation areas on the sloping lands are the main occurrence areas of badland topography.

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Determination of Soil Erosion Risk for Samsun Province Using Multi Criteria Decision Analysis based on Fuzzy-AHP Approach

İnci DEMİRAĞ TURAN[1], Orhan DENGİZ[2], Barış ÖZKAN[3]

Abstract

Soil erosion is one of the leading environmental problems of the world. The erosion risk of soils can be evaluated directly carried out in the field, or laboratory by means of some experiments or indirectly based on developing and applying models. The main aim of this study is to determine erosion risk classes in Samsun province with the help of geographic information system (GIS), multi-criteria decision-making and statistical approaches. Samsun province covers about 957900 haand total 995 soil samples were taken from soil surface (0-20cm). In the study, it was created total data set (TDS) consisting of soil texture, soil depth, sandy, clay, silt, land use, vegetation, slope, erodibility and erozivity. In addition, in order to generate minimum data set (MDS), principal component analysis was done. MDS consists of sandy, erodibility, vegetation, land use and erosivity. Fuzzy Analytic Hierarchy Process was performed for determining the levels of importance of the criteria. Finally, Linear Combination Technique was used to estimate erosion sensitivity. Moreover, spherical semivariogram model of ordinary kriging was used to generate distribution map of the erosion risk classes in TDS. According to results, about 61% of the total area has severe and very severe risk of erosion whereas, about 10% is low. In addition to that, gaussian semivariogram model of ordinary kriging was used to create distribution map of the erosion risk classes in MDS. According to this analysis, about 57% total study area was found as severe and very severe erosion risk while, it was found that about 11% of it is low risk. Consequently, this present study showed that when used MDS, it was estimated soil erosion risk which is so close to TDS' results

Keywords: Fuzzy-AHP, Principal Components Analysis, Erosion risk

1. Introduction

Soil erosion is one of the leading environmental problems of the world. In many areas, loss of this valuable natural resource takes place almost imperceptibly and difficulty of detection since erosion is generally a gradual process and because of the long time spans involvedas well as significantly large area or large catchment scale (Dengiz, 2007).Today, along with the current techniques such as remote sensing and geographic information system (GIS) technologies, by using multi-criteria decision analysis (MCDA) approaches for making rational analyses and evaluations, these difficulties can be overcome. MCDA can be defined as choosing the one that is most suitable for at least a purpose or factor among a set of options.

The objective of this study is to characterize the spatial distribution of soil erosion risk in Samsun province help of MCDA and GIS. Ultimately, the assessment will help prioritize critical areas for adopting suitable soil erosion prevention measures.

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2. Materials and Methods

a. The Study Area

This study was carried out in Samsun province located in the Central Black Sea region of Turkey. The Samsun province is situated between 34° 51’ 59’’- 37° 06’ 21’’ west-east longitudes and 40° 49’ 54’’- 41° 43’ 06’’ north latitudes in the middle of Central Black Sea region (Figure 1).

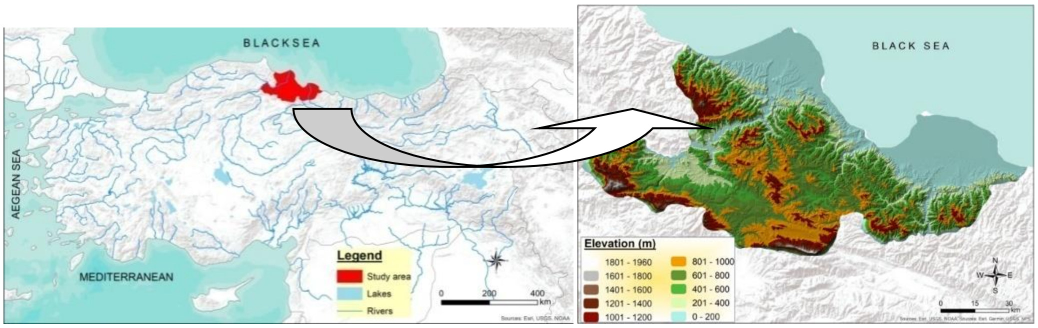

Figure 1. Location of study area.

b. Methodology

The sites weredivided into 2.5 x 2.5 km grid squares. Total 995 soil samples were collected from surface (0-20 cm) depth of each grid intersection point in cultivated fields of Samsun province.

The ten measured parameters were used in a total data set including erodobility, slope, land use, sand, clay, silt, soil depth, organic matter, erozivity and vegetation. All point soil erosion risk was calculated from the total data set obtained. The minimum data set was then created.The Minimum data set selection was determined to reduce dimensionality using principal component analysis (Doran and Parkin, 1994; Qi et al., 2009; Nabiollahi et al., 2017). As a result of factor analysis, groups with eigenvalues equal to 1 or greater than 1 were considered as factors and critical factor load was taken as 0.5 (Andrews et al., 2002, Wander and Bollero, 1999). For each factor, soil variables with high factor loadings were assumed to be the indicators that the best represent changes in soil erosion risk and were defined as having absolute values within 10% of the highest factor loading (Andrews et al., 2002; Govaerts et al., 2006; Sharma et al., 2005; Nabiollahi et al., 2017).

The Analytical Hierarchy Process (AHP) is one of the commonly used methods in multi-criteria decision making problems. The AHP is developed by Saaty (1980). AHP method does not reflect the humanistic way of thinking, even if it takes the knowledge of the expert. Fuzzy-AHP (FAHP) method has been proposed to overcome these deficiencies. In this study, the first step classes for each criteria was made and these classes takes value between 1 and 4. The least favour value of sub-criteria is 1 and the most beneficial value of sub-criteria is 4 for soil erosion risk (Table 1).

There are many FAHP approaches introduced by various authors in theliteratures (Buckley, 1985; Chang, 1996; Deng, 1999). In this studyerosion analysis, Buckley’s (1985) FAHP method was used in order to determine the criteria weights.

Table 1. Parameters and their weighting factor rates for soil erosion risk.

Erodibility		Slope %		Land use		Erozivite	
Class	Value	Class	Value	Class	Value	Class	Value
0.00-0.05	1	0-2	1	Forest	1	<60	1
0.05-0.10	2	2-6	2	Grassland	3	60-90	2
0.10-0.20	3	6-12	3	Agriculture	4	90-120	3
0.20+	4	12-20	4			>120	4
Organic matter		Texture (sand, silt, clay)		Soil depth		Vegetation	
Class	Value	Class	Value	Class	Value	Class	Value
< 1	4	Clay	4	90+	1	>70	1
1-2	3	L, SİC, SİCL, SİL	3	50-90	2	70-40	2
2-3	2	LS, S	2	20-50	3	40-10	3
3-4.4 <	1	CL, SL	1	0-20	4	< 10	4

In finally step, weighted linear combination formula was used to soil erosion risk for each sample point. Also various interpolation methods (Inverse Distance Weighing-IDW with the weights of 1, 2, 3 and radial basis function-RBF with thin plate spline (TPS), simple kriging (OK) with spherical, exponantial and gaussian variograms, ordinary kriging (OK) with spherical, exponantial and gaussian variograms, universal kriging (OK) with spherical, exponantial and gaussian variograms) were applied for predicting the spatial distribution of soil textural and climatic datawith ArcGIS 10.5v. In the present study, root mean square error (RMSE) was used to assess and figure out the most suitable interpolation model. That's why, the lowest RMSE indicates the most accurate prediction. In addition, in order to create the best arrangement of values in to the different soil erosion risk class, Natural Break method developed by Jenks (1967).

3. Results

In the study, FAHP method was used for the determinationof the relative weights of the criteria that will be considered for erosion.Among the total data set (10 criteria)and minimum data set (5 criteria)that were used, there is no hierarchical relationship. The pairwise comparisons that were made by the decision-makers were regulated according to the pairwise comparison scale in Gumus (2009).The pairwise comparison matrix for total and minimum data sets, which was created as a result of the evaluation of the decision-makers, is presented in Table 2 and Table 3.After pairwise comparisons were made, criteria weightswere obtained by following the FAHP steps.The highest value (0.214) was for vegetation criterion of erosion. Land use value was 0.193, slope value was 0.139, erozivity value was 0.123, organic matter value was0.108, soil dept value was 0.066, erodobility value was 0.059, clay value was 0.046, silt and sad value was 0.030, 0.021. The linear combination technique was used to calculate each soil sample. Comparison of interpolation methods for erosion is provided. Finally, spherical model of ordinary kriging function was used to estimate at unsampled locations and their distribution maps were presented in Figure 3 (A). Approximately 60.7% of the study area is high and very high erosion risk while approximately 9.9% is included in a low (Table 4).

Table 2. Pairwise comparison matrix for total data set soil erosion risk.

	Erodobility	Slope	Land use	Sand	Clay	Silt	Erozivity	Soil depth	Vegetation	Organic matter
Erodobility	1	1/4	1/4	5	2	3	1/3	1/2	1/3	1/2
Slope	4	1	1/2	3	3	3	2	3	1/3	3
Land use	4	2	1	6	3	4	3	3	1/2	3
Sand	1/5	1/3	1/6	1	1/3	1/3	1/3	1/5	1/7	1/5
Clay	1/2	1/3	1/3	3	1	3	1/3	1/3	1/3	1/5
Silt	1/3	1/3	1/4	3	1/3	1	1/5	1/3	1/5	1/5
Erozivity	3	1/2	1/3	3	3	5	1	6	1/3	2
Soil depth	2	1/3	1/3	5	3	3	1/6	1	1/3	1/3
Vegetation	3	3	2	7	3	5	3	3	1	2
Organic matter	2	1/3	1/3	5	5	5	1/2	3	1/2	1

Table 3. Pairwise comparison matrix for minimum data set soil erosion risk.

	Erodobility	Vegetation	Land use	Sand	Erosivity
Erodobility	1	1/5	1/5	2	1/5
Vegetation	5	1	2	5	3
Land use	5	1/2	1	3	2
Sand	1/2	1/5	1/3	1	1/3
Erosivity	5	1/3	1/2	3	1

The first five PCs explained 78.810% of the variance of the original data (Table 5). Sand had the highest loading value was selected as reflect PC1, erodobility had had the highest loading value was selected as reflect PC2, vegetation, land use and erosivity had the highest loading value for erosion reflect respectively PC3, PC4, PC5. Pairwise comparisons were made, criteria weights with minimum data setobtained by following the FAHP steps. The highest value (0.407) was for vegetation criterion of erosion. Land use, erozivity sand and erodobility value was respectively 0.270, 0.191, 0.066 and 0.066.

According to the minimum data set, the calculation was made to the soil erosion risk. Gaussian model of ordinary kriging function was used to estimate or predict erosion risk at unsampled locations and their distribution maps were presented Figure 3 (B). While more than half of the study area was determined to be high and very high for erosion risk, 10.9% of the total area has been identified low for erosion risk (Table 4).

Table 4. Total and minimum data set area and ratio (%) for soil erosion risk

	Total data set		Minimum data set	
	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)
Low	94924	9,9	104812	10,9
Moderate	281342	29,4	307588	32,1
High	345012	36,0	367860	38,4
Very high	236622	24,7	177640	18,5

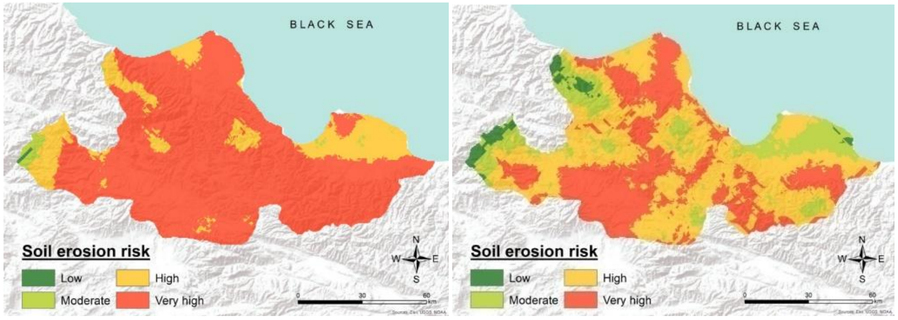

Figure 3. Map of total data set for erosion risk (A), map of minimum data set for erosion risk (B).

Table 5. Results of PCA for soil erosion risk in Samsun

Principal Component Analysis	Factor 1	2	3	4	5
Eigen value	1.88	1.70	1.49	1.24	1.14
Percent	38.13	15.45	14.54	23.34	11.36
Cumulative percent	28.13	45.58	58.13	69.47	78.81
Eigen vectors					
Erodobility	0.024	**0.785**	0.005	0.475	-0.009
Slope	0.054	0.057	0.146	-0.059	0.103
Clay	-0.021	0.495	0.075	-0.338	0.051
Sand	**-0.955**	0.007	0.095	-0.164	-0.094
Land use	0.733	0.246	-0.518	**0.906**	0.063
Silt	0.486	-0.329	0.567	-0.089	0.013
Organic matter	0.121	0.007	0.483	-0.174	0.271
Soil depth	0.604	-0.135	0.158	0.035	-0.169
Vegetation	-0.172	0.365	**0.941**	-0.045	0.671
Erosivity	0.051	-0.652	0.066	-0.109	**-0.749**

Underlined factor loadings are considered highly weighted.
Bold factor loadings selected as MDS.

4. Conclusions

In this study, it has been tried to determine total data set and minimum data set for erosion risk. The areas where especially the vegetation cover is poor, and slope is high the areas where the agricultural areas and poor pasture have been identified as too high erosion risk. MCDA technique is a powerful tool for resolving complexalternative choosing problems.Also, using GIS techniques, which is considered as one ofthe advanced technologies of today, allows obtaining, investigatingand/or analyzing, storing a large volume of data andinformation in a short time, and producing different maps. The soil erosion spatial distribution can provide local practitioners a basis for comprehensive management and sustainable land use in the study area.

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Land Degradation Trendsin Polandand Combatingits Negative Impact on the Food Production

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Abstract

Although land desertification and erosion resulting from global warming and climate change, but also from over-population or overconsumption in the EU to the greatest extent affects the Mediterranean region, some other Member States in Central and Eastern Europe, including Poland, are vulnerable to land degradation. According to Polish Central Statistical Office, in total area of the country (31268 thousand ha), agricultural land in 2017 accounted for 60. 16 % (18810 thousand ha).Of this,in 2017 in relation to 2016, a decrease of arable land, meadows and pastures by 64.5 thousand ha, and forest land by 202 thousand ha was reported. Agricultural land designated annually for non-agricultural purposes, mostly residential, since 2000 has been steadily growing, and in 2016 reached 4425 ha, of this agricultural land of I-III quality class accounted for 43% and forest land for 10%. Current agricultural production of Poland is dominated by grain growth (73 % of area), predominantly of wheat, rye and barley, and five other cereals. Average crop yield is relatively low (~3.1 T/ha) and variable, due to weak soils, low precipitation and unfavorable climatic conditions. The scenarios of climate change in Poland during the 21st century (from 1971-1980 to 2071-2090) consider increase of annual average temperature from 7.4 to 10.6 ^{0}C, number of days with T_{max}>25 ^{0}C from 27 to 52, and the longest dry period from 20 to 24 days. Therefore, a vital task for such prospects is to select cultivars resistant to the heat waves and droughts and well grown on the weak soil. For this, a pot experiment has been conducted in triplicate on 14 barley cultivars during hot and dry late spring/summer season of 2018 (day temperatures during vegetation were as high as 21-51^{0}C, at night 5-35,$^{\circ}$C) For the experiment, also the worst VI class soil was used, in addition in two sets highly polluted with Cd (15.2 and 16.9 mg Cd/kg, DW). All seeds were checked for germination showing 95-100% efficiency. The plants were fertilized entirely through leaves. All cultivars showed decreased growth of both roots and shoot, and weak development of ears and grains. Nevertheless, among studied cultivars, four showed 84-100 % survival in all repetitions, and the highest number of ears and formed grains. These cultivars create good prospects for further adaptation to extremely long droughts and heat waves, at relatively weak soil conditions. The study was performed within IEE-PAS statute activity, project No.1a-120.

Keywords: Droughts, Low-class soil, Resistant grain selection/adaptation

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The Importance of Flood and Landslide Control Works in Upper Watershed Basins for Land Degradation Neutrality (RIZE-IYIDERE Watershed Basin)

İsmail BULUT

Abstract

Turkey is extremely susceptible to soil erosion occurrence, due to climatic circumstances, soil condition and topography property. Therefore, soil conservation and watershed improvement works are needed to prevent land degradation.

Activities such as regulating water flow to restore the natural balance are considered within the scope of erosion control studies in the upper basins. It is aimed to mitigate or prevent the erosion and flood formation by delaying or preventing the surface flow in these studies. In this context, frequently occurring floods not only cause landslides with coastal carvings and coastal shifts but also increase the severity and destruction of floods in landslides in the Eastern Black Sea Region with a rugged topography. As a consequence of the deterioration of natural balance and destruction of agricultural lands, loss of life and property is experienced together with the loss of soil. It is necessary to know the basin well to prevent these losses and reduce the losses. The existence of natural resources in the basin and the determination of disturbance factors are evaluated together with the results of all the basin components and their effects.

By using landslide inventory maps, it is estimated that there are landslides around 60-70% in gully and along the creek in the East Black Sea as a result of topography and wrong land use, precipitation and human activities. Consequently, it has guided the projects to be done in order to provide the natural balance for the balancing of land destruction.

In this study, investigated basin-based flood and landslide control works are detailed for Eastern Black Sea (Rize Iyidere Basin).

Keywords: Landslide, Flood, Basin, Eastern Black Sea.

1. Introduction

1.1 Basin-Based Approach and the Importance of the Basin Management

Watershed Management should be provided or ensured by planning, projecting and implementing by using the following methods; water, soil, flora and fauna with assessing human resources, establishing new resources, establishing healthy relationships between natural resources and people, ensuring the sustainable use of existing resources and ensuring sustainable use. In the Eastern Black Sea region, which has a rugged topography, the floods that are frequently occurring in the East Black Sea Region cause landslides with coastal carvings and coastal shifts and increase the violence and destruction power of the landslides. The natural balance deteriorates, and the agricultural lands are destroyed, and loss of life and property, as well as untested land losses occur. In order to prevent these losses and reduce the losses, it is necessary to know the basin well. It is inevitable to determine the presence of natural resources in the basin and the determination of the disturbance factors and the relations of all watershed components with each other and the consequences of their effects. A large mass of water, called the FLOOD, which contains a large amount of solid material from the side streams as a result of heavy rains or rapid melting of snow. Significantly downward movement or movement of ground or rock masses is called LANDSLIDE.

1.2 State of the Landslide in Turkey

When the structures affected by natural disasters are considered in our country, the losses due to landslides are the second after the earthquakes with 27%. The reasons for the increase in damage caused by landslides are the increasing concentration of the population by unconscious concentration in landslide sensitive areas, changing climate conditions and unconscious destruction of forests.

2. Methodology

2.1 Slide and Slope Mechanism

The forces effective on the slope, sliding forces (actuating forces) and anti-slide forces (Resisting forces) are available. When the forces (water, weight) which facilitate sliding on the slopes exceed the anti-slide forces (friction, cohesion), downward mass movement occurs.

$$\sigma = (w \ x \ cosa)/A$$

$$\tau = c + \ \sigma \ x \tan \emptyset$$

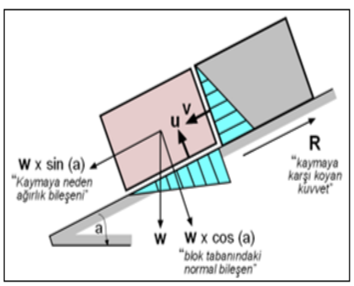
$$\tau = c + [(w \ x \ cosa)/A \ x \tan \emptyset$$

$$R = \tau \ x \ A$$

$$R = c \ x \ A + (w \ x \ cosa) \ x \tan \emptyset$$

$$w \ x \sin a = c \ x \ A + (w \ x \ cosa) \ x \tan \emptyset$$

$$w \ x \sin a + \ v = c \ x \ A + (w \ x \ cosa - u) \ x \tan \emptyset$$



What is the Factor of Safety;

$$\text{F or Gs} = \frac{\text{Sum Of Anti-Sliding Forces}}{\text{Sum of Sliding Forces}}$$

Factor of Safety (Gs, F): Anti-sliding Forces Sliding Forces

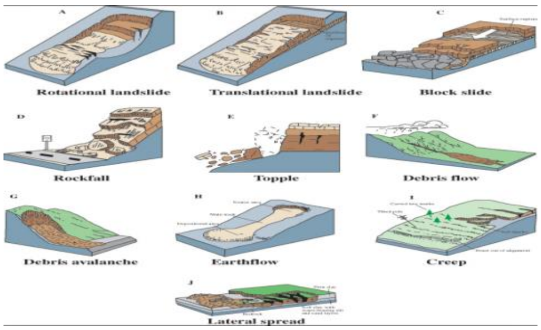
Cohesion of the soil – c, Internal friction angle-φ

Figure 1. Slide and Slope Mechanism

The factors of slide and slope mechanism (Figure1); structural measures (Ground Nails, etc.), to put a load on the heel (retaining wall, pile, etc.), load on head of slope, gravity and slope angle, groundwater and precipitation, pore water pressures, streams and marine erosion, seismic activity, carving the heel, shear strength of material decreases over time, it can cause instability on the ground because of degradation and vegetation change.

2.2 Types of Landslide and Classification

According to Varnes (1978) landslide classification (Figure 2), landslide was classified with morphology (shape and / or geometry of slope), how the movement occurs (mechanism), speed of movement, and type of material.



TYPE OF MOVEMENT		TYPE OF MATERIAL		
		BEDROCK	ENGINEERING SOILS	
			Predominantly coarse	Predominantly fine
FALLS		Rock fall	Debris fall	Earth fall
TOPPLES		Rock topple	Debris topple	Earth topple
SLIDES	ROTATIONAL	Rock slide	Debris slide	Earth slide
	TRANSLATIONAL			
LATERAL SPREADS		Rock spread	Debris spread	Earth spread
FLOWS		Rock flow (deep creep)	Debris flow (soil creep)	Earth flow (soil creep)
COMPLEX		Combination of two or more principal types of movement		

Figure 2. The classification system proposed by Varnes (1978) is taken into consideration as theclassification

2.3 Indicators of Slope Instability

The main signs of the movements in the slopes or natural slopes on the terrain and in the structures affected by these movements are as follows. The following slope instability indicators are cracks and splits in buildings and walls, jamming in doors and windows, pipe etc. breaks in the shallow substructure and leaks from the ponds, bending in trees and fences, stress cracks, rough topography (undulation), water leaks from slope heel.

2.4 General Factors of Landslides on Slopes

The general factors of landslides were analyzed in two parts (Gokceoglu and Ercanoglu, 2001). The first part is prepare factors like geology, topographic, environment, vegetation, using land, slope. The second part is initiator factors, which are called earthquake, rain and people (Gokceoglu and Ercanoglu, 2001).

2.4.1 Factors causing landslide: The behavior of each material with stress-deformation behavior and water varies. The type of material in a slope is directly related to the type of instability that may occur in that slope. Different lithology has different degree of sensitivity to potential shift or final renewal.

2.4.2 Geology-lithology: If the slope is composed of weak rocks such as material or pyroclastic rocks, these may be potential landslide areas (Figure 4 – (a)). The slopes made of solid rocks such as sandstone, granite and limestone are more stable in terms of landslide. High degradation in rocks, clays, serpentinization, etc. High rate of fracture and crack systems in rocks is a preparatory factor.

2.4.3 Climate: Has a significant impact on the landslide due to both precipitation and vegetation.

2.4.4 Water (underground and surface waters, heavy rain): Reduces friction force on the ground. Reduces cohesion and internal friction angle. It facilitates sliding of the slope material. Increased groundwater flow, leakage and increase in flow rates of the source water cause high pressures-pore water pressure and soil instability

2.4.5 Vegetation: It has positive and negative effects; Prevents slope erosion, increases stability against shallow landslides. Soil water balance is especially important in forest areas. This importance is understood by the start of landslides after the forest has been cut. The fact that the plant cover creates additional weight and the water flows through the slope and through the roots negatively affects the slope stability.

2.4.6 Human activities and / or improper land use: Excavation of the slope or heel, road excavation, house excavation, mining excavations (excavations without precautions taken), load on the hillside or on the top, lowering the pond water level, deforestation, incorrect agricultural activities, artificial vibration, water leaks from use, landslide sensitive areas to be opened, the necessary measures to be taken.

3. Results and Conclusion

The basin of Rize Iyidere is a very difficult basin due to its topographic structure. Since the general basin area is very large (30162.92 Ha), landslide inventory maps are taken into consideration and the parts where the terrain damage is intense is given priority. Erosion and landslides have also been observed due to the work from the construction of HES and Highways. Besides, 122 people died because of the disaster of flood and landslide in Rize between 1973 and 2010.In addition, the presence of too many tea areas, the wrong location of the site triggers the problem of drainage in the basin, disrupts the natural structure.With this project, transverse facilities have been proposed in areas suitable for working in the upper basin and thus it is aimed to contribute to the reduction of the damages of possible floods and landslides.

Land surveys were carried out by ÇEM and OGM officials in the study basin and the planned activities were decided together. In addition, DSI and AFAD provincial directorates were also informed about the studies. Land surveys were started from relevant institutions by obtaining data on the basin. The following statuses of Rize Iyidere;

Property Status: The points where the creeks and trenches to be implemented in the project basin are mainly composed of forests, agricultural lands and treasury lands. Tea areas are considered as agricultural areas because of intensive tea production in the basin (Figure 4).

Surface Flow status: The highest monthly surface flow value is 155 mm in February. The total annual surface flow value is 1120 mm. This value is more than 70% of Turkey's total annual rainfall.

Hydrology Status: There are 2 main streams in the study basin. These streams; İyidere and Kalkandere (Figure 3). Iyidere connect to downstream of Kalkandere. Apart from these streams, there are many big and small rivers (Figure 5 –(a)). However, due to the topographic structure of the study basin, these streams can reach the Black Sea directly without connecting to one another. Although the flow of these streams during the year is not very high, sudden and irregular precipitation causes floods and floods (Wild stream).

(a) **(b)**

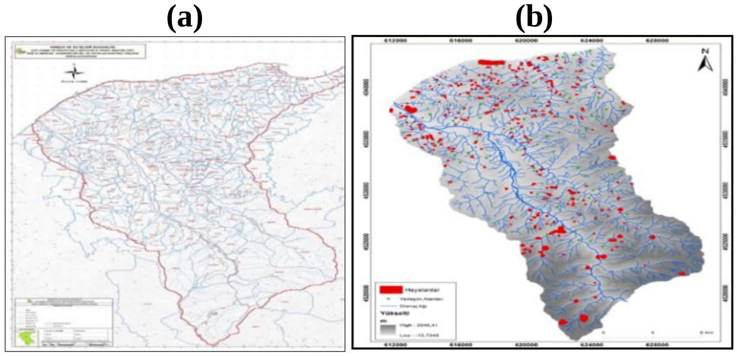


Figure 3. (a) Hydrology Map for Rize Iyidere and **(b)** the inventory of landslide and drainage network (Landslide Inventory Map: 87% of 315 landslides are surface and shallow landslides)

(a) (b)

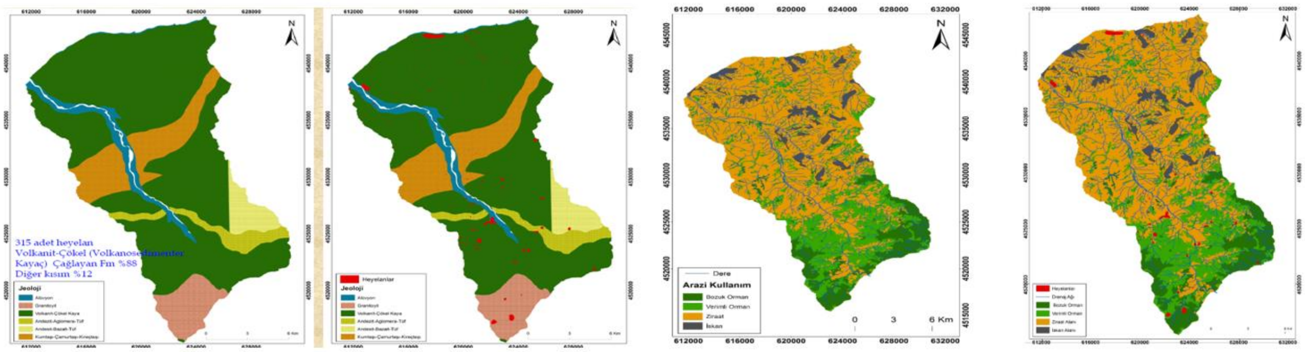


Figure 4. (a) Geology and landslide map (315 landslide volcanic sediment (volcano sedimentary rock) Çağlayan Fm %88 others %12and **(b)** Land use and landslide map.

(a) (b)

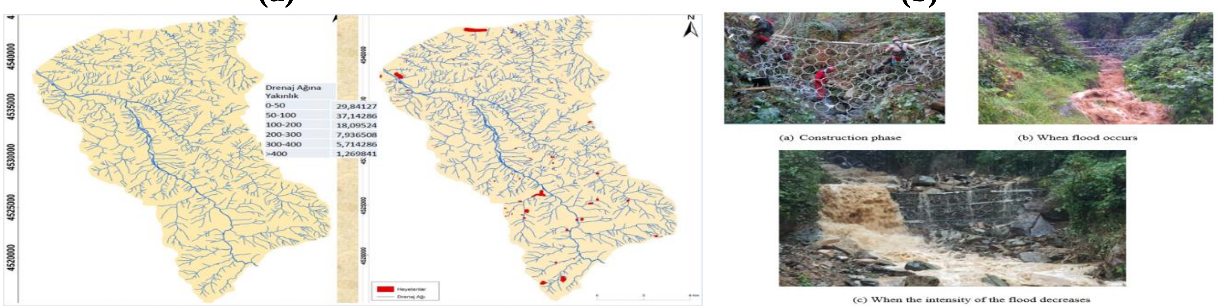


Figure 5. (a) Drainage Network Map(Proximity to the drainage network;0 m-50 m: 29.8417, 50 m-100 m: 37.14286, 100 m-200 m: 18.09524, 200 m-300 m: 7.936508, 300 m-400 m: 5.714286, and >400 m: 1.269841) and **(b)** the Example photographs a-construction phase, b-when flood occurs, and c-when the intensity of the flood decreases.

After the all analysis and studies, very high concentrations of rain can cause a high surface flow in less than an hour. This generally results in soil saturation, aquifer development and rapid rise in ground water level. Temporarily formed aquifers and high porewater pressure reduce the resistance of the soil, which causes slippage. Likewise, the rain that lasts for a few days at low intensity, raises the groundwater level and causes the soil's resistance to fall. The geological and geomorphological structure of Rize and its region, land use and climate characteristics (especially precipitation) provide a suitable environment for flood and landslide formation. By destroying the vegetation with high soil protection ability; the possibility of landslides is increased as a result of bringing the species with low soil protection ability to the field. A total of 315 landslides have been identified, of which 83% are in the agricultural area, 66.98% are in drainage lengths (up to 100 meters) and 55% are at a distance of up to 150 meters. The results of the analysis show that a large part of the landslides occurred in the agricultural areas where the forests were destroyed and turned into agricultural fields, however, as a result of heel abrasions and floor carvings, a high proportion of shallow and surface landslides occurred at the distances close to the roads and streams. Landslide inventory maps have been guiding in the flood and landslide control project to prevent the deterioration of the natural balance or to restore the deteriorated balance (Decision Support). It is expected that 66.98% of the landslides identified in the basin will minimize the effects of the transverse structures made in the side streams, dunes and trenches before they become catastrophic.

Acknowledgments

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Investigating the Multi Efficiency of the LDN Concept in Mediterranean Watersheds, Lebanon as a Case Study

Mario J. AL SAYAH[1,2,3], Chadi ABDALLAH[1], Michel KHOURI[2], Rachid NEDJAI[3], Talal DARWISH[1]

Abstract

This study aims to implement LDN through a simple data requirement methodology obtained by a compilation of several existing methods on two different settings in Lebanon: the agricultural Awali watershed and the Nahr Ibrahim watershed characterized by the typical unequal Mediterranean watershed land occupation distribution. By implementation of LDN to the Awali, an insight of LDN's effectiveness for land reclamation was obtained. When applied to the Nahr Ibrahim basin, LDN was tested as a tool for sustainability restoration through alternative LDN based land planning scenario. By combining land use dynamics tracked from remote sensing, the USDA's land capability classification and soil organic C built database, two outcomes of LDN were tested. Once applied based on its response hierarchy, in terms of LDN's curative angle, the 36% land degradation in the Awaliwas reduced to 2 %. The proposed LDN scenario for Nahr Ibrahim further served as an input to re-establish an LDN based sustainability map for comparison with those reflecting current conditions. The previous 66.2 to 33.8% of non-sustainable versus sustainable distribution in the basin was reversed to 35.6 to 64.4% respectively thus highlighting the importance of LDN as a land reclamation tool and as a key factor for sustainable development in the Mediterranean.

Keywords: Land Degradation Neutrality, Mediterranean, Lebanon, Land use planning

1. Introduction

Lebanon, as a Mediterranean country is particularly affected by the loss of healthy lands (Bou Kheir et al., 2008). Nearly one-fourth of its territory suffers from desertification, more than half of its lands are degraded (Darwish et al., 2012) and soil erosion has been progressing at unprecedented rates(Abdallah et al., 2018). To cope with the problem, integration of the United Nations Convention to Combat Desertification (UNCCD) Land Degradation Neutrality (LDN) concept is of crucial importance.Despite LDN's widespread acceptance, integration into several national and international policies, its implementation is still contested due to several multi-scale interdependent underlying reasons. A breakdown of LDN application constraints first shows general challenges resulting from fundamental gaps such as determining land degradation (LD) extent particularly in heterogeneous landscapes with complex orography such as those of the Mediterranean region. Furthermore, technical and operational challenges arising from site-specificity and study area particularities have complicated the task of unified guidelines or methods for a global LDN approach thus raising the need for a tailored site specific application based on adapted specific indicators reflecting local LD. For that purpose, this paper examines the multi-efficiency of LDN on two Lebanese test-basins as representative of the typical Mediterranean watersheds through a proposed simple data requirement methodology. The hypothesis of LDN concept multi-efficiency will be tested by revealing LDN use potential to neutralize degradation and to restore

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sustainability in the concerned areas by alternative scenario testing as a tool for fully comprehensive land use planning based on LDN's response hierarchy.

2. Methodology

2.1 Study areas description

The Awali and Nahr Ibrahim watersheds collectively accounting for nearly 5% of Lebanon's area, are chosen as the test-sites for LDN implementation given their importance at the national scale, their representitavity as an agricultural watershed (Awali) and a semi-natural mountainous watershed characterized by significant landslides and erosion risks (Nahr Ibrahim), and due to their significant LD state.

2.2 Materials and methods

Data inputs consist of a DEM layer provided by the CNRS-L at 10 m resolution, soil maps for the soil map of Lebanon 1:50 000 (Darwish et al., 2006) and LU/LC maps established from on-screen digitizing of multispectral satellite imagery with different resolutions and acquisition dates.

2.2.1 Implementation of the LDN concept by establishment of site-specific LDN indicators Land cover change

Multispectral time series satellite imagerywere used to establishthe LU/LC for baseline comparison with reference years. For the Awalibasin the year 1998 was set as baseline while for Nahr Ibrahim the year 2005 served as reference based on satellite imagery availability.

Land Capability Classification and sustainability distribution for LD mapping

Land capability classification (LCC) was undertaken to reveal the productive capacity of the study areas. This step was performed since the soil's suitability governs the choice of sought rehabilitation measures and reveals the nature and type of current mismanagements resulting from inadequate cover with respect to the soil's productive capacity (Al Sayah et al., 2019).For that purpose, the adapted LCC (USDA 1961)from Al Sayah et al., (2019) was used to classify soils of the study areas into a total of 5 groups, where classes I to IV represent arable lands in decreasing rank of productivity and class V represents the USDA's groups V to VIII under the non-arable lands. By intersecting the LU/LC and LCC layers, the adequacy or non-adequacy of the already present LU/LC distribution over the different land capability groups was revealed in turn allowing the categorization into sustainable and non-sustainable development zones. LDwas determined by the sum of non-sustainable development areas while the sum of sustainable development areas represent the land gains i.e areas needed to counterbalance those of loss.

Soil organic C

A soil organic C (SOC) inventory was built for both watersheds Obtained SOC maps for each basin were then in turnintersected with LU/LC maps in order to determine SOC changes as the 3rd indicator for the Awali and Nahr Ibrahim basins.

3. Results and Conclusion

3.1 LU/LC change

Figure1 presents LU/LC trends in the study basins at a simplified scale with respect to the defined areas. As observed increases in urban areas and declines of vegetated cover is observed in both study areas.

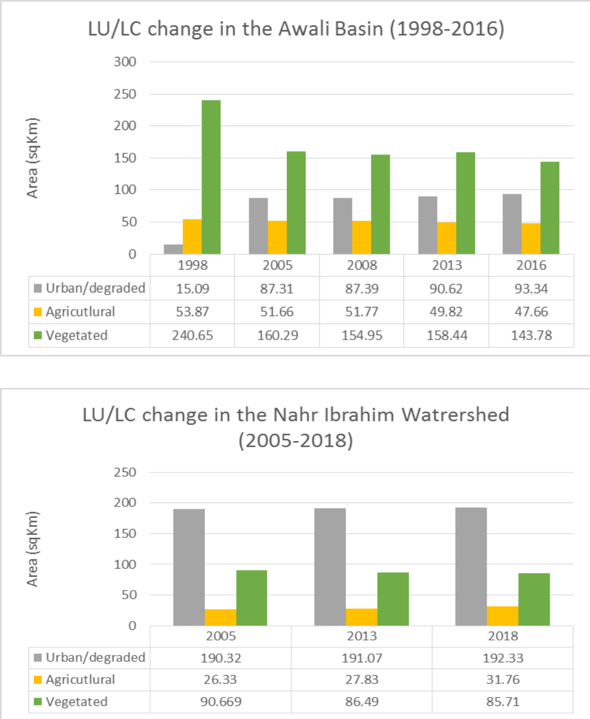

Figure 1. LU/LC change of the Awali basin

3.1.2. Sustainability distribution

LU/LC maps intersected with the land capability classification layer revealed sustainability distribution based on the adequacy or non-adequacy of soil cover with respect to its productive capacity (Figure 2).

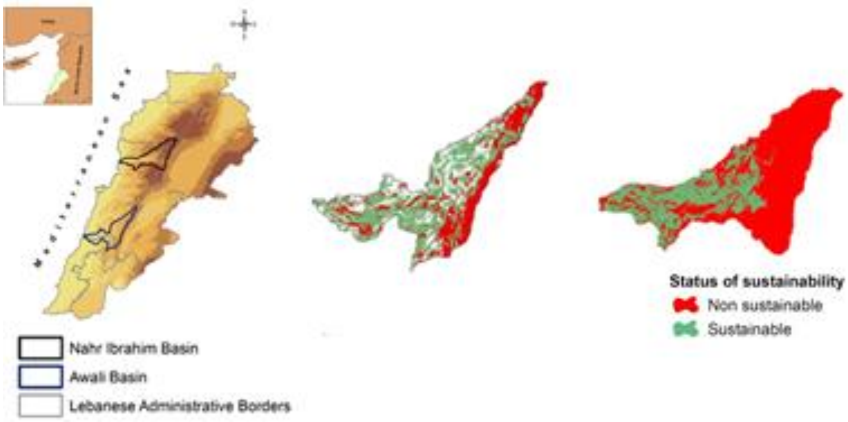

Figure 2. Sustainability distribution of the study areas

Based on computation of sustainable vs non sustainable development zones' areas, a 36% LD was observed in the Awali in contrast to the 66% observed in the Nahr Ibrahim basin.

3.1.3. Soil organic C change

SOC maps for both watersheds were crossed with their respective LU/LC transitions in order to quantify areas of SOC loss, these are naturally attributed to areas of natural cover regression and further aggravated by the presence of unsuitable LU/LC cover above areas of significant SOC.

a. Application of the LDN concept for land reclamation and promoting sustainability

Given the importance of land use planning in the implementation of LDN and based on the response strategy of the concept, two alternative LU/LC scenarios were proposed. The basis behind LU/LC planning was oriented from the consideration of the LCC. With respect to LDN targets, conversion of classes I, II and III to agricultural classes responds to increasing and or maintaining land productivity, conversion of classes IV and V towards grasslands and forestry replenishes SOC stocks (where possible by considering slopes), while consideration of classes IV and V for urban expansion (where possible) ensures a balanced trade-off between meeting populations needs and safeguarding natural resources. As a result, LD in the Awali watershed was reversed from 36 to 2%. The alternative LDN LU/LC scenario for Nahr Ibrahim was intersected again with the LCC model to reveal changes of sustainability distribution from 66.2 and 33.8% of non-sustainable vs sustainable distribution to 35.6 and 64.4% respectively highlighting the importance of LDN not only as a land reclamation but also as a decision making tool for land planning to anticipate LD, prevent where still possible and reverse its trends to combat desertification.

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Quantities of Organic Carbon According to the Land Use Class in Different Ecological Zones of Turkey's Soils

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Abstract

The amount of soil organic carbon varies according to land use classes and different ecological zones (ecozones) in the areas which are responsible for our Ministry within the scope of National Greenhouse Gas Emission Inventory Business Planincluding the Land use, Land use change and Forestry sectors.In this context, Soil Organic Carbon Map of Turkey is prepared to determine the amount of organic carbon in the soils. The data used for this map were obtained from 7743 coordinated soil samples collected for the "Creation of Geographical Database of Some Productivity and Soil Organic Carbon Content of Turkey Project" by regression kriging method.This obtained map and ecological zones (ECOZONES) are superposed. Then, using the CORNE-12, pasture, forest and agricultural areas within each ecological zone were determined and the soil organic carbon values in polygons showing each land use class were calculated as ton/ha.

Key words: Turkey's Soils, soil organic carbon, SOC, regression kriging, digital soil mapping, ecological zones

1. Introduction

Turkey, due to take place in the Mediterranean Belt where in the process of climate change is one of the sensitive zone is threatened by the effects of climate change significantly. Carbon emissions from soil are directly related to climate change and have an important relationship with soil organic carbon pool. Climate is one of the factors affecting the quantity and quality of soil organic matter. Therefore, carbon emissions occur at different rates under different interactions in soils.Annual precipitation and evaporation amount, atmospheric vapor pressure, day and night temperature difference,temperature difference between seasons,the quantity and quality of the radiation from sun and drought index are important factors that influence on the amount of organic matter in the region, the amount of organic matter that is added to the soil, the rate of oxidation of organic matter and consequently the amount and properties of TOC.Knowing the organic carbon content of our soils will be able to provide important base information about soil fertility and adaptation to climate change.The transition from natural ecosystems to agriculture has led to the impoverishment of soil organic carbon levels by decreasing the amount of plant roots and residues. This improves the dissolution when the soil is tillaged and erosion occurs. Therefore, some factors, such as existing soil management strategies, traditional soil use methods, climatic controls, and also topographic differences, affect the potential ground carbon sample exchange in the environment.Achieving carbon storage capacity of soils will improve the soil's productivity and resistance to erosion, and will also allow to recover of soil which has lost its agricultural value as a result of erosion.By preventing erosion, the amount of sediment transported to rivers will decrease and the quality of water will increase. The need for sustainable land and land management to be handled according to land use of soils for carbon storage in soil.

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2. Methodology

2.1 Soil sampling and Analyses

Soil Sampling strategy was established by interpreting spatially explicit a number of characteristics together such as soil properties, land use, land use capability classes, poorly drained alluvial soils with high water table, geothermal sites etc. using different base maps such as CORINE land use, geological maps, digital elevation models, 1/25 000 scale digital soil maps and Turkey's current road map where to find out optimal collecting routes. The soil sample data set is systematically collected taking into account the topographic, geological and agricultural characteristics of soils representing the whole country and contains 7742 soil samples (0-30 cm) in total provided from“Development of a Geographical Database of Some Productivity and Soil Organic Carbon Content of Turkey Project”.Ten teams of two persons collected 0-30 cm deep soil samples. The soil organic carbon content of these soil samples was analyzed in the TGSMAE soil laboratory system. In order to obtain an appropriate and harmonious data-set across the country, chemical and physical analytical methods have been compatible with ISO standards (or equivalents) were apllied to samples in laboratories of the institution (Soil Quality and Productivity Analysis Laboratory and Irrigation, Soil Physics and Salinity Laboratory) where TS EN ISO/IEC 17025: 2012 standards compatible. To obtain the geographic database of soil samples, analytical results were processed and controlled in the instutition GIS laboratory.

2.2 Auxiliary Dataset

In this study, in order to emphasize the important formations of soil organic carbon, 1 / 500 000 scale geological map of Turkey is divided into eight classes as metamorphic rocks, igneous rocks, limestones, sedimentary rocks, alluvial deposits, ophiolitic rocks, plutonic rocks and other rocks.CORINE Land Cover (CLC) was used to classify main land use types. Forty-four CLC classes were divided into seven new groups: urbanized, agricultural, forest / natural areas, arenosol, bare rocks / open areas / glaciers, wetlands and water bodies. Hydrated lime, clay and sand contents of soil samples were normalized and interpolation with Normal Kriging interpolation method to be used as base data in DSM.Climatic data sets (precipitation and temperature) covering the daily meteorological data derived from 265 meteorological stations were interpolated using ANUSPLINE method (Jarvis and Stuart, 2001). The annual minimum, maximum and average temperature and total rainfall values for each meteorological station were calculated from the 23-year daily data records between 1975 to 2002. Drought index was calculated from two climate parameters; Annual average of total annual precipitation and evapotranspiration. Drought index was calculated from two climate parameters; Annual average of total annual precipitation and evapotranspiration.The minimum, maximum and average data of NDVI vegetation indiceswere used to estimate soil organic carbon.

2.3 Data Preparation and Processing

All input data were prepared before executing geostatistical analysis; all input data were prepared using transformations for compliant projection and coordinate system and were resampled to the same resolution (50 m) for ensuring compatible data structure. All covariates were normalized before executing the model. Most of the continuous covariates (slope, temperature, precipitation, etc.) were normalized by using Z-score normalization technique. To reduce categorical information and the importance of a given variable, the number of classes was kept between 7 and 8. Categorical variables were normalized by reclassification of the selected main classes and then transfer of these classes to new layers. Reclassification resulted in binary data (0 and 1 class) for each layer.

2.4 Digital Soil Mapping

Digital soil mapping (DSM) is an approach to find out relations between known soil data and environmental parameters to produce soil maps. Regression kriging (RK) method as one of the widely used geostatistical techniques has been used for producing of soil property maps (Odeh et al., 1995; McBratney et al. 2000).

RK is a hybrid method that combines either a simple or a multiple-linear regression model with ordinary, or simple, kriging of the regression residuals.Multiple linear Regression-Kriging geostatistical technique was applied to estimate regression coefficients, calculate residuals and determine significant predictors for soil assessing and producing a continuous covers for soil organic carbon modelling in Turkey scale. After deriving significant predictors, regression model can be determined to predict target variable (soil organic carbon) with the help of those estimated regression coefficients. Residuals are interpolated by ordinary kriging technique. For final output, regression model of the significant predictors and interpolated residuals were summed up.Digital Organic Carbon map was created by using regression jacking model.Soil Organic Carbon Map of Turkey are shown in Figure 1.

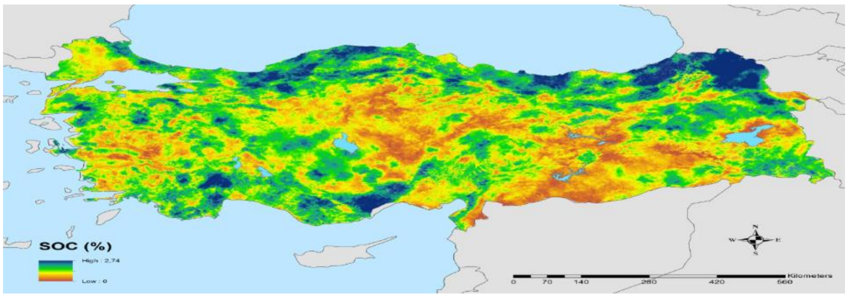
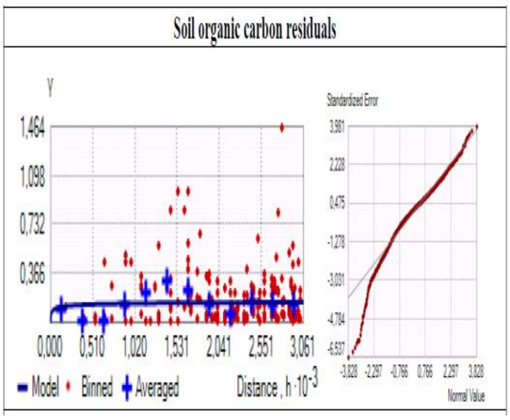


Figure 1. Soil Organic Carbon Map of Turkey (Aksoy, 2014)

The geostatistical analysis using regression kriging method has been performed to determine spatial variability of soil organic carbon content in Turkey. illustrates the regression coefficient, standard error (0,439) of regression (R2=0,324), and Root Mean Square Error (RMSE)(0,422) of regression kriging method. Table 2 demonstrates the regression equation and subsidiary parameters used to calculate soil organic carbon. Statistically significant predictors of the models that were best explained by these covariates were determined in the Table 1 for soil organic carbon. Semivariograms of the residuals and Q-Q Plots for soil organic carbon are shown in Figure2.

Table 1 and Figure 2. Regression equations for calculations of soil organic carbon (Aksoy, 2014) and Semivariogram of the residuals and Q-Q Plot for soil organic carbon (Aksoy, 2014)

Soil Organic Carbon =
(1.075 +(0.022 *"nkirec")- (0.136*"nkum") - (0.092* "nkil")+ (0.162 *"neto")+ (0.173 *"nkuraklik")+(0.119 *"nndviave")+ (0.941*"nmintemp")+ (0.594* "nmaxtemp")-(1.778*"navtemp")- (0.108* "navprec") + (0.011* "ncti")+ (0.026* "nslope") - (0.101*"cor5") - (0.083* "cor3") - (0.145 *"cor2") - (0.061*"geo5") - (0.084* "geo4") - (0.052* "geo2") -(0.062* "geo1") - (0.218 *"Lpe"))



The amount of soil organic carbon varies according to land use classes and different ecological zones (ecozones) in the areas which are responsible for our Ministry within the scope of National Greenhouse Gas Emission Inventory Business Plan including the Land use, Land use change and Forestry sectors. In this context, Soil Organic Carbon Map of Turkey is prepared to determine the amount of organic carbon in the soils. 8 different ecological zones have been identified in our country (Pamukcu et al., 2014).

Ecological zones with soil organic carbon maps obtained from "Creation of Geographical Database of Some Productivity and Soil Organic Carbon Content of Turkey Project" were overlaid.Then, using the CORNE-12, pasture, forest and agricultural areas within each ecological zone were determined and the soil organic carbon values in polygons showing each land use class were calculated as ton/ha.

3. Results

The result of this study, according to the different land use classes in different ecological zones of Turkey's soil organic carbon content (SOC) budget (Table 4) was determined and map was created (Figure 5).

Tablo 4. Soil Organic Carbon Budgets of Different Land Use Areas According to Different Ecological Zones

Corine 2012	Ecozones	SOC (tons/ha)
Grasslands	Mediterranean Mountain Belt	42.26
	Mediterranean Coastal Belt Leafy and Conifer Forest	33.99
	Eastern Anatolia Step	43.19
	Eastern Anatolian Leafy Forest Belt	37.17
	Euxine - Colchic Leafy Forest	44.69
	Central Anatolia Step	36.37
	Inner Aegean Leaf and Coniferous Forest	38.28
	Northern Anatolian Leaf, Coniferous and Mixed Forest	49.11
Forest Areas	Mediterranean Mountain Belt	51.53
	Mediterranean Coastal Belt Leafy and Conifer Forest	46.08
	Eastern Anatolia Step	48.41
	Eastern Anatolian Leafy Forest Belt	45.14
	Euxine - Colchic Leafy Forest	51.9
	Central Anatolia Step	49.92
	Inner Aegean Leaf and Coniferous Forest	50.88
	Northern Anatolian Leaf, Coniferous and Mixed Forest	55.05
Agricultural Areas	Mediterranean Mountain Belt	40.22
	Mediterranean Coastal Belt Leafy and Conifer Forest	29.62
	Eastern Anatolia Step	38.9
	Eastern Anatolian Leafy Forest Belt	30.44
	Euxine - Colchic Leafy Forest	38.68
	Central Anatolia Step	32.14
	Inner Aegean Leaf and Coniferous Forest	30.99
	Northern Anatolian Leaf, Coniferous and Mixed Forest	34.29

It was determined that the amount of soil organic carbon in the pastures of different ecozones ranged from 33,99 tons/ha to 49,11 tons/ha and the averages were 40,63 tons/ha. It was determined that the amount of soil organic carbon in the pasture areas was the highest in Euxive Colchic Leaf Forest Ecozone and the least in the Mediterranean Coastal Zone Leaf and Conifer Forest Ecozone.It was determined that the amount of soil organic carbon in agricultural areas in different ecozones ranged from 29.62 tons/ha to 40.22 tons/ha and the averages were 34.41 tons/ha. It has been determined that the amount of soil organic carbon in agricultural areas is the highest in Mediterranean Mountain Belt Ecozone and the least is in the Mediterranean Coastal Zone of Leaved and Conifer Forest Ecozone.The result of this study, an auxiliary dataset and a soil map was created for future climate change, greenhouse gases and sustainable land management research activities. The outcomes of this study will guide the decision-makers and save time and resources in national and international studies.

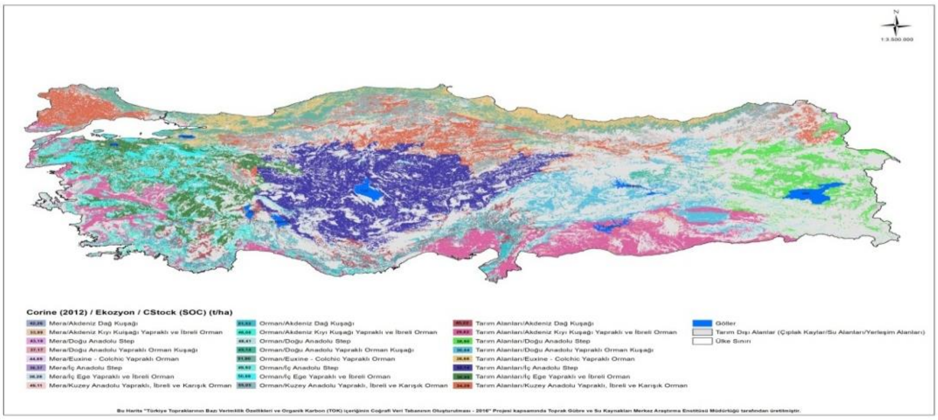


Figure 5. Soil Organic Carbon Budget Map According to Different Ecozons and Different Land Uses of Turkey

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The Role of Pressurized Irrigation Systems in Sustainable Use of Land and Soil Resources

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Abstract

Nowadays, as a result of reaching the final limit of the lands to be opened to agriculture, priority is given to the studies on increasing the yield from the unit area instead of areal extent. Irrigation is one of the most important inputs to increase agricultural yield.

It is a fact that land degradation (water erosion, fertilization of the upper part of the soil, surface flow, drainage, salinity, etc.) occurs in irrigation areas where water use efficiency is low.

Especially, when salt water is applied or there is an over-irrigation condition, a salty water table layer is formed and this layer rises, thereby, causing the soil to become salty.

For the Reason of reduced water resources, global warming and climate change, application of methods that use irrigation water effectively in agriculture has become inevitable for sustainable use of soil and water resources.

The use of pressurized irrigation systems is very important in terms of the sustainability of soil resources by eliminating the negative effects such as soil losses (erosion), surface flow and washing of plant nutrients which occur in surface irrigation methods. In addition, pressurized irrigation systems are more suitable for irrigation on slopes.

According to the publications of FAO (United Nations Food and Agriculture Organization), in many countries located in arid and semi-arctic zones, there has been successful transition from traditional open channel irrigation system to pressurized closed systems.

Turkey's land in the context of Land Use Capability Classification, 34.1 % (26.506.765) is suitable for cultivation of processed agriculture and long-lived plants. The irrigation area, which was built by DSİ and was put into operation, is 3.185.842 ha as of 2017. In other words, 12% of agricultural land is irrigated. In irrigation areas, irrigation rate and irrigation efficiency are 65,8 % and 47,5 % respectively. Increasing irrigation rate and irrigation efficiency are of great importance for optimum use of soil and water resources. In the current situation, the use of tools and techniques that provide efficient water use in agriculture has become one of the priority targets of our country.

Since 2003, General Directorate of State Hydraulic Works (DSI) has shifted its policy from open system to the construction of closed system irrigation network in order to enable irrigation in sloping land and prevent high water losses. Before 2003 while the proportion of closed (pipe) system as per irrigation network area was 6% reached 25% in 2017. It is aimed at soaring this ratio by 48 % by 2023.

Keywords: Land and soil resources, Sustainability, Pressurized Irrigation Systems

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The Role of Soil-Plant Interactions in Degraded Grassland Ecosystems

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Abstract

In the desertification process, soil-plant relations are important. When we consider the change inthe herbaceous taxa in the grassland areas within a vegetation period, it is important to considerwhen the determination of the effects of desertification in the pasture areas will be determined inthe most accurate way. Plants cover are used to determine the risk of desertification such asMediterranean Land Use and Desertification (MEDALUS) and Desertification Indicator System forMediterranean Europe (DIS4ME). In this study, the interaction between soil and plantcharacteristics and desertification were investigated in the grassland areas of Kavra village ofÇankırı province. The study area is composed of clay stone, limestone and gypsum rocks. In thestudy area, the sampling of plant sampling and plant cover was made from April to the end ofSeptember in the vegetation period of 2017. The soil sampling was done in September, the end ofthe vegetation period. In order to determine the physical and chemical properties (soil, pH,electrical conductivity (EC), lime content ($CaCO_3$), volume weight (HA) and soil organic mattercontent (TOM) of the study area soils, soil sampling was performed from 0-30 cm depth. Thedesertification survey form was filled in order to determine the desertification risk at each pointwhere soil and plant sampling was performed. In order to determine the desertification risk, theforms and algorithms in DIS4ME system for grassland areas were used. Following the calculationsusing the DIS4ME model, the risk of desertification in the study area is classified as the medium riskwith 4.91 and the highest risk with 6.49 and it is in the critical and fragile sensitivity class. Therelationship between plant cover values, soil properties and desertification risk investigated withcorrelation analysis. The relationship between plant cover and desertification risk measured forJune and July, and a moderately strong relationship was determined at the level of significance of 0,01 for June (r=-0.47, P<0.01) and a moderately strong relationship at the significance level of 0.05for July (r=-0.351, P<0.05) was determined. In this context, taking into account the plant coverwhich has a significant impact on desertification, it is thought that sampling in desertification willbe more appropriate in June and July.

Keywords: Degraded Land, Grassland, Desertification, Çankırı

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The Role of Biochar on Land Degradation Neutrality and Sustainable Land Management

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Abstract

As it is known, the organic matters are one of the most important components of agricultural soil for the purposes of sustainable use of soil and reducing all problems that take place regarding land degradation neutrality. The physical, chemical and biological properties of the soils, which are affected by lack of organic matters, get worse gradually and these mismanaged soil face desertification problems. Being able to overcome the already existing problems may only be possible through increasing the level of organic matters of the soils. One of the most important indicators regarding land degradation neutrality has been regarded as "soil carbon stocks." As the soil is the largest land carbon stock and its already existing amount changes alongside with the land management plans, various applications have been developed for the purpose of retaining carbon in the soils for the long term and minimizing the impacts of land degradation. The most outstanding of those applications is the "biochar" application which emerges through the pyrolysis of organic materials and which is rich in organic carbon. It is known that not only organic materials are added to the soil through the biochar applications, but also the land ecosystem fertility also increases through reduction of global warming by means of applying carbon to the soil persistently, waste management, soil quality and health. The use of "biochar" points out the attention for neutral of agricultural soil, which has been degraded over the years due to wrong applications, through sustainable land management planning and being an application which is consistent with the targets of sustainable development. Thus, the use of biochar materials in agricultural soil is inevitable allowing improvement of the deteriorating land conditions and sustainable combat against desertification.

Keywords: Land Degradation Neutrality, Sustainable Land Management, Biochar, Soil Organic Carbon

1. Introduction

Land degradation refers to the reduction or loss of the biological or economic productivity and complexity of land (UNCCD 2016a). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) recently provided a comprehensive assessment of land degradation, declaring it to be a 'pervasive and systematic phenomenon' that 'occurs in all parts of the terrestrial world' (IPBES 2018). Consequently, land degradation's impact upon people is vast. 1.3 billion people live on degrading agricultural land (UNCCD 2017b), and land degradation negatively impacts the well-being of at least 3.2 billion people globally (IPBES 2018). Land degradation may also increase food insecurity, by reducing production and increasing uncertainty, thereby leading to higher food prices (Davies 2016).

World population projected to reach 9.1 billion, 34 % higher than today at 2050 with the high rate growth is in developing countries such as Africa and Asia (Cohen 2002; Bruinsma 2011). To produce the increasing food demand, a considerable land area should be reserves, while the rest arable land areas is limited, at high risk for conversion, have unchangeable ecological functions, and have limited access.

Biochar may prove a key and accessible input for agriculture, it could help rehabilitate degraded land, and play a major role in sequestering atmospheric carbon dioxide. The UN Convention to Combat

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Desertification has been promoting biochar for countering land degradation and many other bodies have enthusiastically backed its use.

2. Soil Organic Carbon

Soil organic C (SOC) plays a key role in maintaining soil functions and quality, supporting the productivity of agroecosystems (Lal 2010). Although soils (to a depth of 1 m) contain almost 50% of the terrestrial C pool, previous research has reported that land use changes and human activities have reduced C stocks by ~133 Pg C in agricultural lands (Sanderman et al., 2017).

The atmospheric C levels are increasing by about 4.1 Gt/yr, with 7.2 Gt/yr being put into the atmosphere by fossil fuel combustion and cement production, and 3.1 Gt/yr being removed from the atmosphere by the ocean (2.2 Gt/yr) and terrestrial processes (0.9 Gt/yr) (Amonette et al., 2007). Agricultural farming practices during the past 150 years have resulted in a global loss of 78 gigatons of SOC, accounting for 66% of historic C storage; causes for SOC loss include clearing of native vegetation, cultivation of soils for annual cropping, and removal of crop residues for alternative uses (Lal 2004, 2009, 2010).The capacity for C storage in biochar-amended soils has been predicted to be up to 130 Pg over a century at a global level, a capacity based on the sustainable production of biochar and application rates of at least 50 Mg C ha^{-1} (Woolf et al., 2010).

Application of biochar may further enhance soil carbon stocks through “negative priming”, in which plant-derived carbon is stabilized through sorption of labile C on biochar, and formation of biochar-organo-mineral complexes (Keith et al., 2011; Weng et al., 2015). Conversely, turnover of native soil carbon may increase (“positive priming”) due to enhanced soil microbial activity induced by small amounts of labile C in biochar, but this effect is small and short-lived compared to the stabilization of biochar carbon and negative priming effects in the long-term (Singh and Cowie, 2014). Negative priming has been observed particularly in clay-dominated soils (Weng et al., 2015; Whitman et al., 2015).

3. The Properties of Biochar

Lehmann and Joseph (2009) define biochar as the carbon-rich product when biomass, such as wood, manure or leaves, is heated in a closed container with little or no available air. In more technical terms, biochar is produced by so-called thermal decomposition of organic material with limited supply of oxygen, and at relatively low temperatures (<700 ^{o}C) (Stockmann 2011).

The physicochemical properties and yield of biochar is mainly controlled by the feedstock species and thermochemical conditions (Tang et al., 2013; Ahmad et al., 2014).The biochar physicochemical properties can cause changes in the soil nutrient and C availability, and provide physical protection to microorganisms against predators and desiccation; this may alter the microbial diversity and taxonomy of the soil (Lehman et al., 2011).Some important properties of biochar are surface area and porosity, density, mechanical strength, elemental or nutrient content, pH, CEC.Studying the physicochemical characteristics of biochar is of great importance for its application. Taking the utilization of biochar in soil remediation as an example, the bulk density of biochar is an important factor impacting the gas exchange and pore size distribution of soil (Schjønning et al. 2011) porosity, determining the water-holding capacity and the surface area of soil; functional groups, affecting the cation exchange capacity and the nutrient retention ability of soil (Liang et al., 2006); total dissolved solids, determining the amounts of mobile charged ions traveling between the soil and plants; and pH, impacting the mobility of ions and microbial activity in the soil (Mayer et al., 2014).

The use of biochar as a carbon sequester assumes that stable carbon in biochar produced from biomass can persist in soil for hundreds or even thousands of years Biochar stability or biochar's resistance to biotic and abiotic degradations in soil can be used for the description of the carbon sequestration potential of a biochar.

4. The Role of Biochar on Land Degradation and Sustainable Land Management

Land degradation exacerbated by population growth, climate change, land use change, deforestation, overgrazing and over exploitation, and other new detrimental factors that challenging its management strategies. Food production and supply energy for 9.1 billion people by 2050 under climate change pressure while keeping the high environmental quality and protecting biodiversity loss is the serious challenge for managing land degradation. The United Nations Convention to Combat Desertification (UNCCD) supports biochar as a means for combating land degradation, improving farmland and combating climate change. There are two ways in which biochar use can counter land degradation: 1) biochar use to make farming more sustainable and productive with less harmful pollution. This would reduce pressure for clearing new land (Abend 2008). 2). Biochar use to rehabilitate degraded or naturally poor land e also helping to reduce pressures for clearing new areas.

Biochar system was designed to generate renewable and cheaper energy, amending soil and improving its productivity, managing waste and mitigating the climate change. Implementing and scaling up the biochar system should be significantly contribute to the land degradation management strategies. Biochar application in the fields helps in increasing the soil fertility, improved soil texture, improved sorption for nutrients which then helps in reducing the use of fertilizer which leads to the decrease in pollution through fertilizer run off. Biochar is highly efficient in increases in the crop production and yield. One of the major benefits of biochar is that it’s helping in combating with climate change by sequestering the carbon dioxide from the atmosphere. It can also be used for the rehabilitation of destructed landforms.

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Determination of the Land Cover Change Trends in Turkey by using Collect Earth

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Abstract

Turkey is a rapidly developing country. While developing, Turkey is in a process where natural resources are lost, land degradation is increasing and agriculture-forest-pasture-wetlands are rapidly transformedintoconstruction. Due to the technological development in the last seventy years, change in land cover and land use has become untraceable due to the increasing mechanization and construction. The negative effects of climate change on the world scale have accelerated the loss of natural resources and increased land degradation. In many areas, wetlands have decreased naturally or artificially, rivers have dried up, groundwater levels have decreased, and organic carbon amounts have decreased. Changes from agricultural, forest and pasture areas to artificial areas have increased. The natural balance that has been formed in millions of years is changing rapidly in the last seventy years, it is important to monitor the change and take necessary actions about the negative effects of change. Considering the diversity of geography of Turkey and the variations of land cover at short distances, monitoring of changes in land cover is very difficult in terms of time, cost and human resources. Detection of damaged natural resources, changes in land cover and studies to reduce land degradation should be accelerated by developing remote sensing methods. Nowadays, developing space technologies with Geographic Information Systems (GIS) integrated with Remote Sensing (RS) applications is increasing rapidly eventhough it is not sufficient. With the developing technology, faster monitoring and evaluation can be done in large areas. In this study, open source Collect Earth software has been used. Which software can determine the land cover / land use classes and the direction of change for the determination of greening trend from past to present. In this study, 61.685 plots were examined for the whole country. The land cover changes from 2002 to 2017 and as of 2017, the spatial distribution of the existing land cover was determined by the interpolation method. As a result of the evaluations, land degradation was detected in 715200 hectares of land while land improvement detected in 1730400hectares.

Keywords: Landuse, Landcover, Landdegradation, Collect Earth, Remote Sensing, Geographic Information Systems, GIS,RS

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Estimation of Carbon Footprint Equivalent of Soil Nitrogen Loss Due to the Sugar Beet Harvest in Turkey: A Review

Nazmi ORUÇ[1]

Abstract

This paper is aimed to create awareness on the amount of soil lost due to the sugar beet harvest and fertilizer value of harvested soil nitrogen in terms of carbon footprint equivalent as well. Soil erosion studies on cropland usually only consider water, wind and tillage erosion However, significant amounts of soil are also lost from the field during the harvest of root crops such as sugar beet *(Beta vulgaris L.)*. There are total of 33 sugar beet enterprise in Turkey, 25 of them run by the state (Türkşeker), eight of them belong to the private sector. According to the data of Türkşeker. It was given that average soil loss rate as 3.41 Mg ha-1 y-1,total loss of soil as≈716983 Mg y-1 and notably total amount of soil nitrogen loss as ≈2151 Mg y-1from sugar beet growing areas of Türkşeker from 1996 to 2016.Global warming due to greenhouse gas emissions (GHG) has become very important concern ofworldwide in 21th century. Production of nitrogenous fertilizer requires high energy consumption, emitting large amounts of CO_2 (carbon footprint equivalent) to atmosphere. The carbon footprint of the average N- fertilizer production in differentregions of world varies from 3.42 Mg to 8.43 Mg while the world average given as 5.66 Mg CO_2 eq/Mg Nitrogen. In this study total amount of soil nitrogen loss≈2151 Mg y-1 and world average of carbon footprint 5.66 Mg CO2-eq./Mg of mix nitrogen fertilizer production were used to estimate annual carbon footprint equivalent. Hence, the annual carbon footprint equivalent is calculated as 12045 Mg CO_2 eq. /Mg Nitrogen fertilizer.Loss of fertile layer of soil due to the root crops harvest should also be considered as an important reason of land degradation.To minimize the soil loss from the most fertile layer in terms of organic matter, microbiological activities and plant nutrients, growers have to be enlighten that soil moisture should be taken into account in sugar beet harvesting, harvested piles should be covered to ensure good drying and soils separated by cleaning machines at delivery points should be conveyed back to their agricultural lands.These precautions would mitigate not onlyland degradation but also environmental impacts of climate change due to global warming.

Key Words: Sugar Beet Harvest, Soil-N Losses, Carbon Footprint, Turkey

1. Introduction

Soil erosion studies on cropland usually only consider water, wind and tillage erosion However, significant amounts of soil are also lost from the field during the harvest of root crops such as sugar beet *(Beta vulgaris L.)*, potato *(Solanum tuberosum L.)*, carrot *(Caucus caroto L.)* chicory roots *(Cichorium intybus L.)*, cassava *(Manihot spp.)*, celery *(Apium graveolens L.)* Radish *(Raphanus sativus L.)* and sweet potato *(Ipomoea batatas (L.)*. Soil losses from the top and most fertile layer by harvesting sugar beet *(Beta vulgaris L.)* cause agricultural and environmental problems as well. During the harvest soil adhering to the crop, loose soil or soil clods and rock fragments are transported from the field (Figure 1).Main objective of this study is to assess (1) soil losses due to sugar beet harvest in Turkey, (2) fertilizer value of removed soil nitrogen in terms of carbon footprint equivalent of soil nitrogen lost due to the sugar beet harvest in Turkey and to create the public awareness of global warming and climate change in this contex as well.

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Figure 1. Soil adhering to sugar beet at harvest. Sugar Beet Factory Eskişehir, Turkey, Oct.2010 (Photo by N.Oruç)

2. Material and Method

Both, sugar beet and sugar industry have very significant place in Turkey's agriculture and agro-industry in terms of the technological, economic and social-economic development of rural areas. The sugar beet growing area is approximately 300.000 ha and about 15 million Mg of sugar beet processed annually in Turkey. The soil textures of sugar beet growing areas are generally clay and clay loam. Soils have pH values mostly medium alkaline, high lime content and low organic matter (Tuğrul et al. 2012). This study is fundamentally based on two reference (Saygın 2018),(Kool et al. 2012). Average value of soil loss as 3.41 Mg ha-1 y-1, total loss of soil as≈716983Mg y-1 and total amount of soil nitrogen loss≈2151 Mg y-1 was estimated due to sugar beet harvest between 1999 and 2016 from sugar beet growing areas of Türkşeker Enterprise (Saygın 2018). In the production of ammonia, which forms the basis of nitrogenous fertilizers, nitrogen is obtained from air and hydrogen from natural gas, both processes requires high amounts of energy. In the production of one Mg of nitrogen, the carbon footprint equivalent varies from 3.42Mg CO_2 to 8.43MgCO_2 while the world average is 5.6 Mg CO_2(Kool et al. 2012). Total amount of soil nitrogen loss≈2151 Mg y-1 and the world average ≈ 5.6 Mg CO_2 were used to calculate carbon footprint eq. of mix nitrogen fertilizers (such as urea, ammonium nitrate, ammonium sulfate etc..)

3. Results and Conclusion

3.1 Studies on Soil Losses Due to Sugar Beet Harvest in Turkey

Oruc and Gungor (2000) studied the soil loss due to the sugar beet harvest (SLCH) in Turkey about 20 years ago. It was estimated the soil tare values for the gross weight of harvested sugar beet as 10.24% and 11.20% for the period of 1989-1999 in Turkey and in Eskişehir Province, respectively. It meant that approximately 4.16 Mg ha-1 y-1 soil in Turkey and 4.8 Mg ha-1 y-1 soil in Eskisehir were transported from sugar beet fields annually. Oztas et.al.(2002) calculated that 3.48 Mg ha-1 of soil is removed due sugar beet harvest annually in Erzurum.Parlak et al.(2008) estimated that 5.22 Mg ha-1 y-1 soil exported from sugar beet fields in Ankara. Zengin et.al. (2001) assessed average soil tare as 3.42 Mg ha-1 y-1 in Konya and indicated that lower level of SLCH in Konya, than the SLCH values of Eskişehir and of Ankara that was related to less rainy months in beet harvesting period at Konya.Koc et al.(2012) carried a detailed research on the total soil amounts transported from the field for years from 2001 to 2008 that based on the 33 sugar factory data in Turkey. It was reported that the amount of soil transported from the field was calculated to be 3.86 Mg ha-1y-1from approximately 300,000 ha of sugar beet growing area in Turkey. Oruc (2012) assessed soil loss due to sugar beet harvest that based on annual reports of 33 sugar factories in Turkey for the years between 2000 and 2011. The study indicated that an average soil loss was as 4.65 Mg ha-1 with a Std= ±0.7. Since production of mineral fertilizers contributes to the global GHG emissions, Oruc(2013) estimated the fertilizer value of transported soil nitrogen in terms of carbon footprint equivalent due to the sugar beet harvest based on the data of 25 public and 8 private sugar factories in Turkey. Total soil N lost and total carbon footprint equivalent of ammonium nitrate (35%) were estimated as 20,157 Mg and 141,392 Mg, respectively. Saygın(2018) assessed soil loss due to sugar beet harvest and economic cost of the transported of plant nutrients based on the data of 25 state owned sugar beet factoriesfor the period of from 1999 to 2016in Turkey. Average value of soil loss as 3.41 Mg ha-1 y-1, total loss of soil as ≈ 716983Mg y-1 and total amount of soil nitrogen loss≈2151Mg y-1(Median:0.3% Std±0.11) were calculated in the study. This result indicated that harvest erosion represents only 0.9% of soil lost by water erosion in Turkey. However, the average 3.41 Mg ha-1y-1 soil loss value was considered to be higher than the tolerable soil loss value of 1 Mg ha-1 y-1 for each of the studied sugar beet factories. The amount of suspended soilcarried away by the rivers was measured by the General Directorate of State Hydraulic Works (DSİ).According to these measurements 154 million Mg of soil is transported by the streams in Turkey annually. This means that approximately 2 Mg of soil per hectare would be carried by rivers (Anonymous,2018).

Saygın (2018) also indicated that average soil loss rate was 3.41 Mg ha-1y-1 and US $419,433 investment which must be madeannually to recover N-P_2O_5-K_2O losses.Parlak (2019) assessed the carbon footprint eq. value of fertilizers to replace nutrients lost with soil due to potato, carrot, and celery harvesting areas in Turkey. It was indicated that about $40x10^3$ Mgy -1of soil was lost annually through potato, carrot and celery harvest from the studied regions, which resulted in 32.93 Mg of N, 3.21 Mg of P_2O_5, and 7.69 Mg of K_2O losses per year. Fertilizer value of transported plant nutrients in terms of carbon footprint equivalent was estimated as about 270 Mg CO_2 per year. It was pointed out that due the large nutrient losses and GHG emissions deserve consideration of soil management practices to reduce SLCH.An over view of some SLCH values related to sugar beet harvest in Turkey and some of the European Countries is given in Table 1.

Table 1. Soil losses due to sugar beet harvesting (SLCH)in Turkey and EU countries

Country/Region	SLCH Mg ha^{-1} (Min - max)	Measurement	Reference
Belgium	8.7 (4.4 - 9.5)	1968 - 1996	Poesen et al., (2001)
Belgium	9.3 (4.7 - 19.5)	1978 - 2000	Ruysschaert et al., (2005)
Belgium	8.5 (3.0 - 24.5)	1993 - 1995	Ruysschaert et al., (2007)
France	14.0 (2.0 - 44.3)	1984 - 1986	Ruysschaert et al., (2005)
Germany	5.2 (2.2 - 10.7)	1978 - 2000	Ruysschaert et al., (2005)
The Netherlands	6.2 (3.4 - 13.4)	1972 - 2001	Ruysschaert et al., (2005)
Croatia	1.3 - 2.3	2008	Jurisic et al., (2011)
Turkey (Eskisehir)	4.8	1999 - 2000	Oruc and Gungor (2000)
Turkey (Erzurum)	2.6	1990 - 2000	Oztas et al., (2002)
Turkey (Konya)	3.42	2000	Zengin et al., (2003)
Turkey (Ankara)	5.22	2006	Parlak et al., (2008)
Turkey (Ankara)	3.66	2004	Tugrul et al., (2012)
Turkey (Average)	4.54	2000 - 2008	Tugrul et al., (2012)
Turkey (Average)	4.65 (3.1 - 5.45)	2000 - 2001	Oruc (2012)
Turkey (Average)	3.41	1999 - 2016	Saygın (2018)

Note: SLCH values (except measurement for 2004 and 2008) based on factory data.

3.2 Studies on Soil Losses Due to Sugar Beet Harvest in European Countries

Severalresearchershave drawn attention to an often neglected, but apparently significantly soil erosion process, i.e., soil loss due to root crop harvests in last decades in European countries..Poesen et al.(2001) reported the average SLCH value as 8.7 Mg ha^{-1} for Belgium between 1986 and 1996. Mean SLCH values for sugar beet thatestimated from sugar factories data were 9.3 Mg ha^{-1} for Belgium, 14.0 Mg ha^{-1} for France,6.2 Mg ha^{-1} for the Netherlands and 5.2 Mg ha^{-1} for Germany(Ruysschaert et al.2005, 2007).It was indicated that average SLCH values were in the range from 1.3 Mg ha^{-1} to 2.3 Mg ha^{-1} in Croatia (Jurisic et al. 2011). It was concluded that soil moisture content at harvesting time was one of the most important factor explaining SLCH variability, besides soil texture and harvesting technique.Panagos et al.(2019) indicated that SLCH for sugar beet has decreased significantly in the EU-28 from 15 Mg y−1 in the period of 1986–1999 to 9.6 Mg y−1 in the period of 2000–2016 (−36%) due to a sharp decrease in sugar beet production driven by changes in diets and sugar policy after 2006.

3.3 Carbon Footprint Equivalant Of Soil N Lost

Global warming and climate change has become the most important challenge of the humanity in this century. Global climate change induced by global warming, triggers desertification, environmental degradation and migration.

Besides methane and nitrous oxides CO_2 is the most important greenhouse gas causing global warming.Among the factors that cause global warming and climate changes the amount of CO_2 released (carbon footprint equivalent) to the atmosphere during the production of nitrogenous chemical fertilizers is of great importance. Production of nitrogenous fertilizer requires high energy consumption, emitting large amounts of CO_2 to atmosphere. Annual carbon footprint equivalent calculated as CO_2 12174 Mg /Mg y-1 mix nitrogen fertilizer regarding to the total soil nitrogen loss≈2151 Mg y-1 and world average as 5.66 Mg CO_2 eq./Mg nitrogen production.This result seems rather small but it should not be ignored that many small make a great.

3.4 Conclusion

Loss of fertile layer of soil due to the root crops harvest should also be considered as an important reason of land degradation. To minimize the soil loss from the most fertile layer in terms of organic matter, microbiological activities and plant nutrients, growers have to be enlighten that soil moisture should be taken into account in timing of sugar beet harvesting, harvested piles should be covered to ensure good drying and soils separated by cleaning machines at delivery points should be conveyed back to their agricultural lands.These precautions would mitigate not only the land degradation but also socio-economic and environmental impacts in terms of global climate change as well.

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Participatory Planning Approach for Sustainable Natural Resource Management (Karanfilli Example)

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Abstract

Due to rapid population growth in the world, urbanization, increasing water demands, disruption of the ecological system, climate change and so on, conservation of natural resources and sustainable use of natural resources have become more important around the world agenda. In order to meet the demands of the communities and protect the ecological cycle in a sustainability way, it is necessary to manage and conserve natural sources we have. In this scope, performing integrated works are very important in natural resources management. After the 1990s, it has been noticed that works in watersheds come under the duties and authorization more than one government organization. Importance of participating of the public and non-governmental organizations for projects has been understood, and as a result of this, integrated watershed rehabilitation projects has been come in view. As a country of Turkey, we do have good examples related to project preparing and implementing.In this study, it will be conveyed the criteria of watershed selection, characteristics of the watershed and project activities for Batı Akdeniz Watershed, Karanfilli Stream Integrated Watershed Rehabilitation Projects which prepared in 2016 by ÇEM and participation of related organization, institution and local people, and OGM, Project implementing organization.

Key Words: Natural Resources, Rehabilitation, Watershed, Participation, Karanfilli Stream

1. Introduction

1.1 Rehabilitation in Watershed and Watershed Projects in Turkey

Rehabilitation has been described by National Academy of Science (1974) as reclaiming of a degraded area to make reproducible. Definition of the rehabilitation in 2015National Watershed Management Strategy (UHYS)has been expressed as rehabilitation works/activities conducted with field-specific species and feasible methods for nature in terms of solving problems that caused by human-being and natural factors .Watershed rehabilitation projects aim to improve the economic level of the people living in the basin along with the improvement of the forest, pasture and agricultural land in the basin and thus to restore the degraded natural balance. The rural areas have closed agricultural economies, have intense education and health problems and also in these areas natural resources are no subject to be used efficiently. For his reason, these regions are in great need of various infrastructure investments (Küçükkaya, 2013; Çetin, 2014; Çetin, 2015).As in study on 106 watershed carried out in 2005 by Postel and ThompsonJr, it was determined that almost one-third of watersheds land is converted into agricultural or urban-industrial land use.The activities related to watershed management problems have been started 1970s in public institutions. In Turkey in the years of 1970s, Forestry organization has prepared and implemented watershed-based projects in some regions. At the different time by various public organizations such as former General Directorate of Forestation (AGM), former General Directorate of Forest-Village Relations (ORKÖY), watershed-based projects prepared for the aim of erosion control, improving livelihood, generating incomes for the villagers. Particularly, between the years of 1974-1984, forest villagers development plans and forest villagers

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improvement plans were prepared for some period. Based on literature review, in Turkey 197 watershed projects has been noted.Table-1 summarizes these projects.

Table 1.Integrated Micro-Watershed (Catchment) Rehabilitation Project (1993-2018)

Project Name	Operator and Stakeholders Units	Number of Micro-catchment	Project Implementation Years (flexible)
Eastern Anatolia Watershed Rehabilitation Project	AGM *, KYGM *, TÜGEM *, ORKÖY * and World Bank	88	1993- 2001
Anatolia Watershed Rehabilitation Project	AGM*, ORKÖY*, TRGM, World Bank	28	2005- 2012
Çoruh River Watershed Rehabilitation Project	OGM, TAGEM, JICA	13	2012- 2019
Murat River Watershed Rehabilitation Project	OGM, ÇEM ve IFAD	26	2012- 2021
Watershed- Based Natural Resources Management Project	OGM	27	2012- 2013
Integrated Watershed Rehabilitation Projects	ÇEM, OGM, DSİ, Provincial Agriculture and Municipalities	13	2014- 2023
GEF6 - Upper Sakarya Watershed Rehabilitation Project	OGM, ÇEM, GEF	2	2019-2023
	# of Total Projects	**197**	

ÇEM: General Directorate of Combating Desertification and Erosion ;OGM: General Directorate of Forestry DSİ: Directorate General for state Hydraulic Works ;AGM: Former General Directorate of Forestation
ORKÖY: Former General Directorate of Forest-Village Relations ; KYGM General Directorate of Highways
TÜGEM: General Directorate of Agricultural Production;TRGM: General Directorate of AgriculturalReform
TAGEM: General Directorate of Agricultural Research and Policies;JICA: Japan International Cooperation Agency
IFAD: The International Fund for Agricultural Development;* Repealed Organizations

1.2 General Selection Criteria of Micro-Watershed/Catchment Projects

In general, Turkey have successful works after 1970 related to watershed-based field work and after 1990related to preparation and implementation of the watershed rehabilitation projects. These examples of best practice were carried out according to the experienced institutional and expert structure and besides selection of micro-catchments criteria. These criteria include;1-The severity of natural resource degradation,2-Potential of rehabilitation of natural resources,3-Natural disaster risk,4- Accessibility of the micro-tank,5- Rural poverty level,6-Human resource potential,7-Potential for the development of agriculture, livestock and other income generating activities,8-Inter-village and inter-village social cohesion ,9-The willingness of local people to participate in the project, 10-Potential for sustainable implementation of activities. These criteria are not only quantitative but also have been interpreted by experienced engineers. Alongside with the studies on Land Degradation Neutrality (rehabilitation, afforestation, erosion, soil conservation, flood and avalanche projects etc), income generating and welfare-enhancing studies, demonstration studies and educational research studies have been carried out.

2. Project Site and Methodology

2.1 Project aim and Site characteristic

In this project (Karanfilli Stream Integrated Micro-catchment Rehabilitation Project), it is aimed to usage of the forest, pasture, soil and water resources in a sustainable way, and purposed to reduce pressure on natural resources by generating incomes and increasing living conditions of local community, and also intended to take precaution to natural disasters occurred or likely to occur. This project was prepared in 2016 in cooperation with General Directorate of Combating Desertification and Erosion, Çameli District

Governorship, Çameli Municipality, Denizli Forestry Regional Directorate, ÇameliForestry District Directorate, other related stakeholders, organizations, institutions and local people. Karanfilli Stream Integrated Micro-catchment Rehabilitation Project was carried out within the border of Denizli Regional Directorate, Çameli Forest District Directorate. The area of the project was 28.216 ha.There were 8 villages within the scope of project which were; Akpınar, Cevizli, Elmalı, Emecik, Karabayır, Kirazlıyayla, Sarıkavak and Taşçılar.

Picture-1: Project Location

2.2 Methodology

In this project we focused Ask-Determine-Solve approach. Project and duration was divided to 4 work flows. At the level 1; we obtained general watershed data.At level 2; we applied farm and villager centered Ask-Determine-Solve method. At the level 3, activitieswere determined in field and at level 4 office works were done. With the help of Ask-Determine-Solve approach (hereinafter referred to as A-D-S), it was tried to provide an environment in which all villagers have equal rights regardless of their gender, ages and social conditions. During the meetings of each village, we gave small survey papers to all participants from village to learn the demands of local people, problems of the village, livestock and land existence, purpose of the forest and pasture usage etc. After local people wrote was asked, experts classified the problems by priority then project team wrote down the solutions of the problems.Table-2 shows an example of A-D-S method. After writing down problems and solutions based on obtained data from local people, approval of project voted. If everyone is agree, it means that project preparing stages would be started. In following steps, reconciliation meetings were hold to discuss and to finalize activities of project.

Table 2.A-S-D Example of Akpinar Village

AKPINAR VILLAGE (A-D-S) RESULTS		
PROBLEMS	PRIORITY LIST	PROPOSAL
Inadequate irrigation water	Inadequate irrigation water	Development of water resources (pool construction,channel improvement)
Village Road not enough	Flood Risk	Stream and slope reclamation
Flood Risk	Agricultural Education	Opening of required courses
Agricultural Education	Lack of electricity in the highland	Regional power administration

  

Picture 2. Ask-Determine-Solve and Reconciliation Meetings

3. Results and Conclusion

In the Karanfilli Stream Integrated Micro-Catchment Project, we identified the following necessary activities based on collected data, field works and meetings; RehabilitationActivities, Income Generating Activities, Welfare Enhancing Activities, Education and Capacity Building Activities, Demonstrations.

*a) **RehabilitationActivities** ;degraded forest lands (2.258 ha.), soil conservation(8.598 ha.), forest road building(30 km.), fire pond construction(4 ponds), honey forest planning(3 honey forest.), road afforestation(20 km.), public area afforestation(2000 various type saplings), recreation area(3 area)and participatory afforestation (8 ha.),have been planned.*

*b) **IncomeGeneratingActivities**; animal-barn improvement (85 barns),cattle dairy farming (175 units),milk sheep dairy farming(21 units),bee keeping (90 units),greenhouse building(105 greenhouses),irrigation pond(18 ponds) and pipeline construction(18 km.) have been noted for the project.*

*c) **WelfareEnhancingActivities**;solar waterheaters (140 solar power),roof covering(75 units), house insulation (75 houses), energy efficient stoves(65 stoves) and fertility management (17 storage area)have been projected for local community.*

*d)**Educationand CapacityBuilding Activities**; within scope of the rehabilitation works, Villager and farmer education, technical staff education, marketing research,medicinal and aromatic plants inventory education and fertility management education have been planned for entire watershed.*

*e) **Demonstrations**; in order to raise of the project awareness, within the context of this activities,strawberry cultivation (8 gardens),electro shock wire fence (8 units),alfalfa (3.200kg.), sainfoin (3.200 kg.) and vetch (800 kg.) have been planned.*

As a conclusion, this project was prepared by ÇEM in 2016 and OGM and other stakeholders are going to try to finish by 2021 .Within the concept of integrated watershed projects, it is important that participatory approach must be indigenized by all stakeholders including local people to have remarkable success. In addition to be successes, engineering works and projects should be based on quantifiable data and quantifiable indicators and general selection criteria of watershed management planning should not be ignored.

 

BEFORE ***AFTER***

 

Greenhouse incentive ***Reclamation***

 

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Determination of Land Degradation and Desertification Using Medalus Model Case Study; İnebolu Watershed

Orhan DENGİZ[1], Rukiye Başak AKSOY[1]

Abstract

Land degradation and desertification causes extinction of function of soil layer which is one of the most important terrestrial ecosystems and formed hundreds of years. Many studies were carried out and many kind of models have been developed. This study was performed in İnebolu Watershed and aimed to determine the zones that are sensitive for degradation by using MEDALUS Model. In first step, the indicators that are soil, climate, vegetation and management were calculated and mapped separately in this model. In second step, all indicator layers were combined to determine sensitive areas getting the geometrical average of those four index in GIS medium. According to results, environmental sensitive areas defined as critic and fragile in classification system were observed as fragile F3 and one of the important degradation C2. 35.65% of areas was classified as critic whereas, it was found that 18% of the total area wasfragile.

Keywords: Desertification, Land degradation, MEDALUS, İnebolu Watershed

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Desertification Risk, Erosion Risk Status, Soil Organic Carbon Stock and Land Degradation Neutrality in Sakarya Basin

Orhan DOĞAN[1], Ahmet İPEK[2] Özlem YAVUZ[3]

Abstract

Land degradation and desertification have reached significant dimensions in Turkey. This is not only due to edaphic and physiographic, but also anthropological factors. Therefore, in order to achieve the target of land degradation neutrality, it is necessary to improve, conserve and ensure rational use of land, to prevent rural migration, to reduce rural poverty, to ensure food safety and to produce safe and adequate food. So as to achieve these purposes, integrated basin management projects need to be undertaken. Moreover, with a view to identifying data necessary for these projects, a number of elements, including erosion risk status, amount of organic carbon stored in soil, desertification risk status, annual potential soil loss, and annual amount of sediment transported by Sakarya River were revealed in Sakarya Basin, with a total drainage area of 58.160 km². Furthermore, after comparing sediment amounts transported from 1982 to 2016, the contribution of rehabilitation activities to national economy was identified. These works will also contribute significantly to the Land Degradation Neutrality transformative GEF-6 project to be implemented in Upper Sakarya Basin by the General Directorate of Combating Desertification and Erosion of the Ministry of Agriculture and Forestry (MoAF).

Keywords: Sakarya Basin, Erosion Risk, Desertification Risk, SOC Stock, Sediment

Introduction

The total drainage area of basins constituting 8.1% of Turkey's surface area correspond to 6.329.415 hectares. Land use types in Sakarya Basin are provided below in Table 1.

Figure 1. Location of Sakarya Basin in Turkey

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Table 1. Land Use Types in Sakarya Basin

	Land Use Types in Sakarya Basin	
	ha	%
Agriculture	2.946.121	46,55
Forest	2.041.549	32,25
Pasture	1.125.642	17,78
Other	216.102	3,42

The classification of Great Soil Groups in Sakarya Basin was prepared by General Directorate of Soil-Water (TOPRAKSU – Turkish Acronym) according to US mapping system. Land works were conducted using topographic maps at 1:25,000 scale. As a result, provincial soil maps were produced at 1:100,000 and 1:200,000 scales.

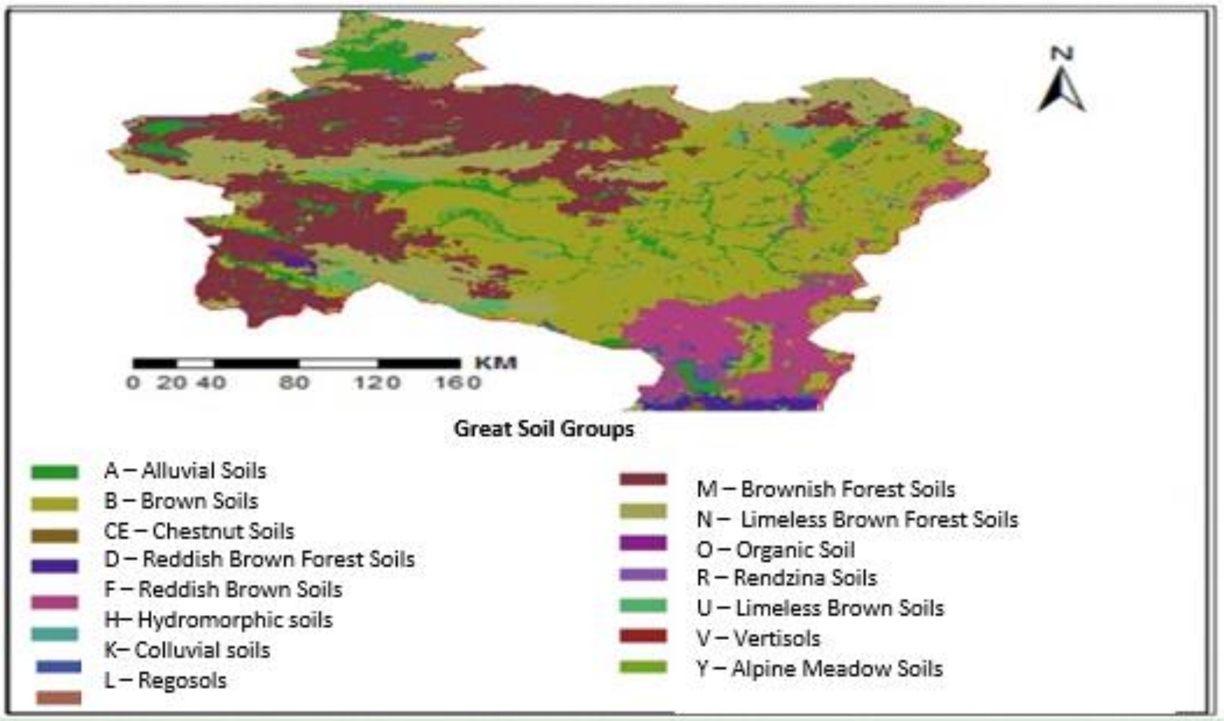


Figure 2. Great Soil Group Map prepared by TOPRAKSU

The Great Soil Group Map was prepared based on quality classification using data generated through soil survey and mapping studies undertaken by TOPRAKSU. Loss of soil horizon due to erosion was determined as criteria and categorized accordingly. The national-scale erosion map was issued at 1:1,250,000 scale.

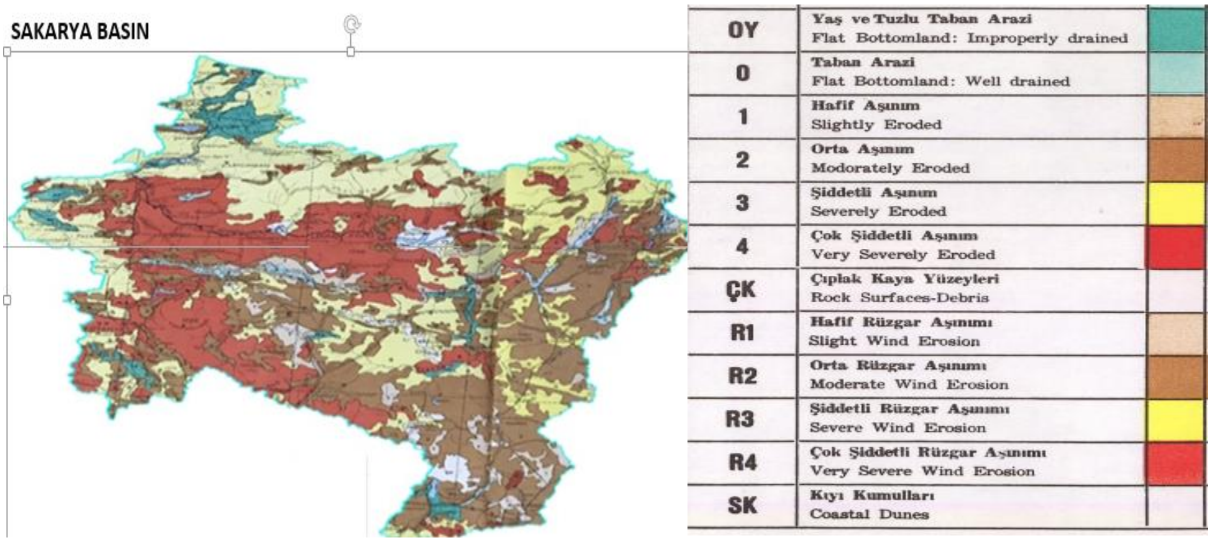
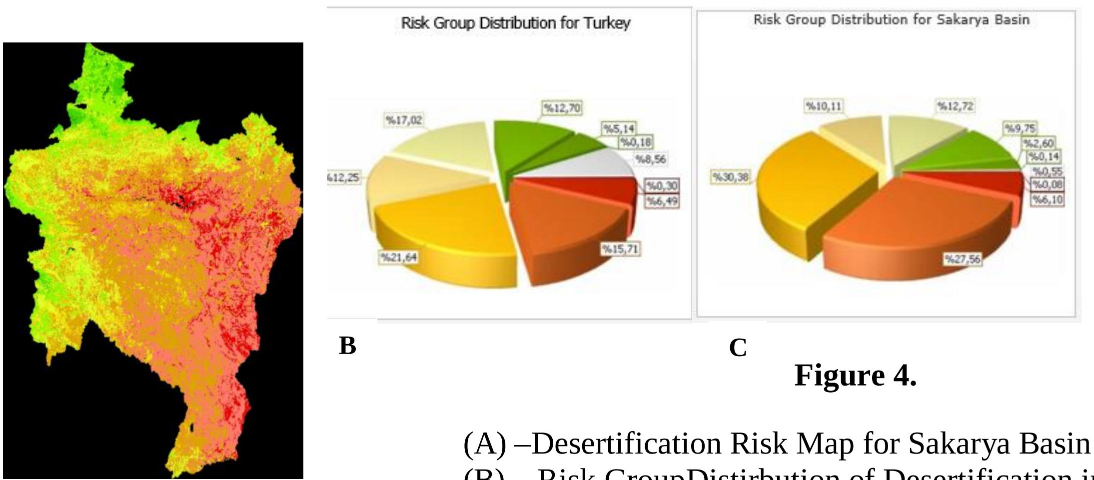


Figure 3. Erosion Risk Map for Sakarya Basin prepared by TOPRAKSU

Desertification Risk Map

The desertification risk model prepared under ÇEM and TUBITAK-BILGEM cooperation consists of 7 criteria, 48 indicators and 37 sub-indicators. The 7 main criteria include water, soil properties, land cover and land use, topography and geomorphology, socio-economy and management. Land degradation drivers in Turkey were concluded to be climate (35.6%), water (18.4%), soil (17.2%), land cover and land use (11.6%), topography and geomorphology (6.3%), socio-economy (6.2%) and management (4.7%).



B

C

A

Figure 4.

(A) –Desertification Risk Map for Sakarya Basin
(B) – Risk GroupDistirbution of Desertification in Turkey
(C) –Desertification Risk Group Map for Sakarya Basin

Erosion Risk Map

In Turkey, 26.5 million tons of soil are transported each year because of water erosion, with 5 million tons carried by rivers. In total, 4.2 tons of soil is translocated per hectare per year. It has been found that 63.02% of Sakarya Basin is exposed to very low erosion; 22.67% – low erosion; 7.54% – moderate erosion; 4.39% – severe erosion, and 2.38% – very severe erosion. Examining the independent effect of each equation parameter, it was concluded that rainfall (6.71%), soil (2.81%), topography (48.98%) and vegetation (41.5%) are respectively influential on total soil losses. According to land use evaluations; 54.95% of soil is translocated in agricultural; 7.71% in forest and 34.52% in pasture lands. A total 45.43% of agricultural lands is exposed to very low erosion, 34.97% – low erosion, 11.42% – moderate erosion, 6.03% – severe erosion and 2.15% – very severe erosion. Furthermore, a total 36.73% of pasture lands in Sakarya Basin is exposed to very low erosion; 35.39% – low erosion, 12.18% – moderate erosion, 8.52% – severe erosion and 7.18% – very severe erosion. The total forest area of Turkey is exposed to very low erosion.

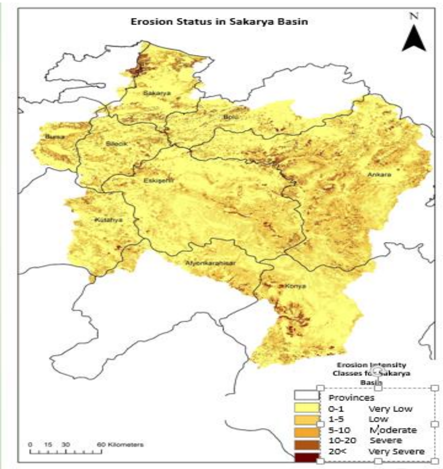


Figure 5. Erosion Map prepared by General Directorate of Combating Desertification and Erosion

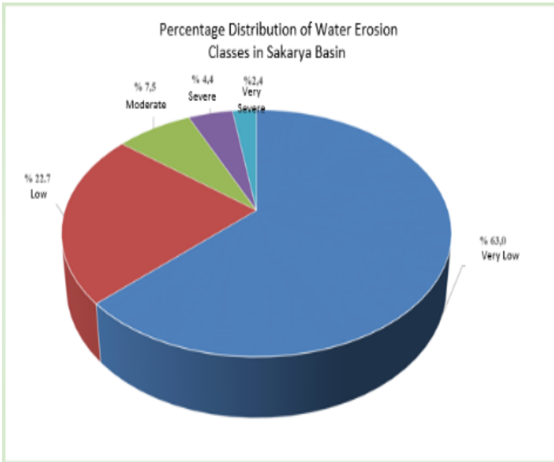


Figure 6. Water Erosion Classes for Sakarya Basin

Carbon Stock Map

Soil Organic Carbon (SOC) denotes the carbon content in the soil organic matter. The SOC content of Turkey's soils was determined analyzing 21.061 soil samples obtained from soil surfaces. These soil data were gathered by General Directorate of Agricultural Reform (TRGM), General Directorate of Agricultural Research and Policy (TAGEM), General Directorate of Forestry (OGM) and other concerned institutions. The SOC stock modeling for Turkey's soils was determined and mapped at basin scale under ÇEM and TUBITAK-BILGEM cooperation. SOC calculations were conducted based on 0-30 cm soil depth. SOC is one of the three important criteria used in achieving Land Degradation Neutrality. The total SOC stock amount of Turkey was estimated to be 3.51 billion tons. Of this, 38.3% are forests; 33.4% pastures and 26.9% agricultural lands.

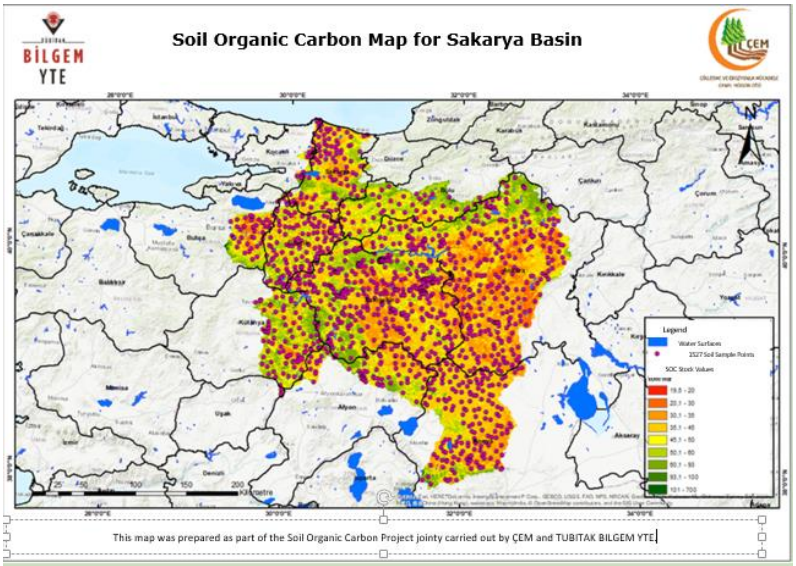


Figure 7. Soil Organic Carbon Map for Sakarya Basin

Land Use Types	SOC (T/Ha))
Forest	52.6
Pasture	44.4
Agriculture	35.2
Wetland	43.0
Artificial Land	12.0
Bare land	10.0
Average	32.9
Average SOC for Forest + Pasture + Agriculture	44.0

Table 2. Distribution of Soil Organic Carbon according to Land Use Types

Conclusion

The Land Degradation Neutrality transformative GEF-6 project to be implemented in Upper Sakarya Basin will help rehabilitate land cover, soil organic carbon and land productivity (three indicators of LDN) through Sustainable Land Management and Sustainable Forest Management activities to be conducted in forests, pastures and agricultural lands in Sakarya Basin. Rehabilitation practices were carried out on 602 thousand hectares, and up to 277 million tons of organic carbon stocks were determined in Sakarya Basin. As result of measures taken, 2.6 million tons of suspended sediment transport were prevented per year. This study will contribute to identifying priority activity areas within the Sakarya Basin.

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Soil Organic Carbon Project – ÇEM-TUBITAK-BILGEM, 2018, Ankara
Desertification Model of Turkey – ÇEM-TUBITAK-BILGEM, 2017, Ankara
Water Erosion Atlas of Turkey – ÇEM, 2018, Ankara

Combating Desertification in the Perspective of National Policies and Investments

Özlem YAVUZ[1,3] Pınar TOPÇU[2]

Abstract

Desertification is a critical global environmental issue and Turkey is one of the countries at risk of desertification in the world with its climate, hydrology, topographical structure, vegetation, land availability and population density.According to the World Atlas of Desertification (WAD), an important part of Turkey is shown as sensitive to desertification.This situation leads to the serious threat of natural and cultural resources. Therefore, the determination of the risk areas of desertification, especially on the basin scale, is important in terms of combating desertification.

It is very important to have knowledge of the current situation and trends of the desertification, to reverse the negative developments and to disseminate good practices about it. The first step towards desertification is the presence of an individual General Directorate in Turkey called "General Directorate of Combating Desertification and Erosion".In this way, policies and strategies have been prepared in cooperation with relevant institutions and organizations on combating desertification. The National Strategy and Action Plan to Combat Desertification (2015-2023) is the most significant development to improve the conditions of terrestrial ecosystems affected and likely to be affected from the desertification. An important contribution of this strategy is that leads to carry out many field studies.

This paper focuses specifically on the national policies and investments on the combating desertification in Turkey. Thus, several documents have been examined, from the National Development Plans to sectoral strategy documents, and projects carried out in this area have been taken under consideration. As a result of the focus, the paper also addresses the need to improvement areas in combating desertification and offers policy recommendations.

Keywords: Desertification, Policies, Investments.

1. Introduction

The desertification is the latest stage of the land degradation and is defined as a continuous decrease or loss of biological and economic efficiency of the land. Combating desertification is the prevention or mitigation of land degradation in order to improve the sustainability of land in the dry, semi-dry and sub-humid areas[3].

In addition to erosion, excessive grazing of natural resources, dispersed settlements, improper use of land, wrong agricultural techniques, inadequate water resources, wrong irrigation techniques, excessive use of fertilizers and pesticides, rural poverty, lack of education on the use of natural resources are among the reasons of desertification.

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[3] Orman ve Su İşleri Bakanlığı, 2015.

Turkey is among the countries that will be most affected by climate change and desertification due to its location on the world, geological structure, topography and climate[1]. According to the Desertification Risk Map; Turkey isin 25% higher-very high, 54% middle, 13% lower-very low risk group.

2. Combating Desertification in Turkey

2.1. Policies

- **National Development Plans**
    - ***The Tenth Development Plan (2014-2018):****"In forestry, capacity fight against fires, pest and diseases will be improved; afforestation and rehabilitation activities will be accelerated."*
    - ***The Ninth Development Plan (2007-2013):*** *"First of all, considering desertification and community health, it is important that industrial and soil conservation afforestation, rehabilitation studies, urban forestry and agricultural forestry are carried out in order to better assess the land, develop special afforestation and raise the awareness of society on these issues."*
- **Regional Action Plans**
    - ***DAP Action Plan (2014-2018):*** *"Activities aimed at enhancing soil conservation and forest presence will be expanded."*
    - ***DOKAP Action Plan (2014-2018):*** "*The sustainable management of forest resources will be provided."*
    - ***GAP Action Plan (2014-2018):*** "*Forest presence will be increased and protection of the dams from erosion will be ensured."*
    - ***KOP Action Plan (2014-2018):****"Soil conservation, desertification and erosion prevention forestation studies for control will be accelerated."*
- **Strategic and Action Plans, Sector Reports etc.**
    - **Action Plan of Combating Erosion (2013-2019):** In the framework of the action plan activities related to the erosion control, afforestation, rehabilitation, pasture improvement activities will be made with the aim of combating erosion.
    - **Action Plan of Dam Catchments Green Belt Afforestation (2013-2019):** Afforestation and erosion control works help to reduce sediment quantity transported by erosion which reach to dams that are constructed by great labor and money, to increase lifelong of dams and to provide protection of dams and watersheds.
    - **Upper Cathchment Flood Control Action Plan (2013-2019):** Action plan aim to take measures which will reestablish degraded natural environment in the catchment in order to reduce flood in catchment and regulate rainfall-water regime.
    - **Mine Site Rehabilitation Action Plan (2013-2019):** The main objective of the Action Plan isrehabilitation of degraded areas and restoration of the ecological and economic values of the damaged and affected by the mining activities.

[1]ÇEM, 2019.

- **National Strategy And Action Plan To Combat Desertification (2015-2023)**

The National Strategy and Action Plan to Combat Desertification outlines the key Strategy and Action Plan activities for combating desertification and land degradation in Turkey, for the period 2015 to 2023. It forms the underlying basis in how Turkey will ensure the effective implementation of planned practices and coordination between different institutions.

Turkey is a signatory to the United Nations Convention on Combating desertification (UNCCD), and National Strategy and Action Plan to Combat Desertification outlines how Turkey will implement the key strategic aims of the convention.

The National Strategy and Action Plan to Combat Desertification contains four sections and related Annexes. The Introduction summarizes the scope, and provides primary background information on the aim and basis of the Strategy and Action Plan. Section 2 starts with a world view on desertification and land degradation and focuses in detail on the current situation in Turkey, with related stakeholders, legislation and institutional structuring introduced. Implementation, results and experiences from the Turkish National Action Plan on Combating Desertification, enacted since 2005, are also briefly presented in section 2. The primary aims and objectives of the national action plan on combating desertification and indicators of success are described in the third section. The document concludes with a description of the necessary approach for the efficient implementation of the strategy and action plan. Monitoring and evaluation, institutional regulations, coordination and funding are further addressed in this section

2.2. Public Investments

Some of the public investments carried out by public institutions, especially the Ministry of Agriculture and Forestry, in the context of the combating desertification are presented below[1]:

- Combating Desertification and Erosion Project,
- Land Degradation Neutrality Project,
- Soil Organic Carbon Project,
- Forest Development Project,
- Combating Erosion Project,
- Çoruh River Basin Rehabilitation Project,
- Murat River Basin Rehabilitation Project.

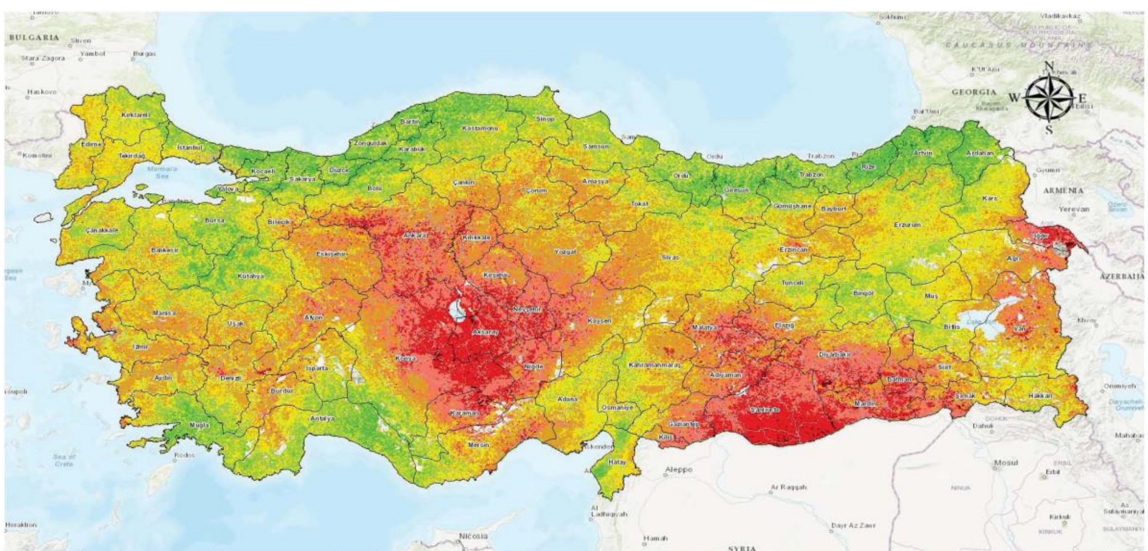
The aim of the Combating Desertification and Erosion Project, is to plan and implement integrated watershed rehabilitation plans and projects with the aim ofcombating desertification, avalanche, landslide, plantation and flood control, capacity building and dissemination activities in order to protect the soil and develop the natural resources.

[1] Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı, 2019.

Desertification Model of Turkey

Land degradation is a significant phenomenon in Turkey due to variety of factors such as through unsustainable land management, and through physical and climatic characteristics. Even it poses a huge threat under the current impacts of global warming and climate change in the country. Therefore, a national desertification map for effectively combating desertification has emerged as a prominent task. Under the umbrella project which is called the Watershed Monitoring and Evaluation System (HIDS), the General Directorate of Combating Desertification and Erosion in cooperation with the TÜBİTAK- BİLGEM, generated the Desertification Model of Turkey (DMT) that an original geographical and mathematical model specific to the country. The DMT is a tool used for estimating land degradation, assessing desertification vulnerability and risk, preparing watershed based risk maps and monitoring hot-spots for desertification. The DMT has been designed to consist of 48 indicators and 37 sub-indicators under 7 main criteria defined by the expertise group. Percentage distribution of desertification risk among watersheds was calculated in 9 classes based on the Desertification Risk Map of Turkey (DRMapT), and revised in accordance with the field surveys carried out in 2016-2017 within the scope of the DMT Verification and Calibration Project (DMT-VCP).

TURKEY DESERTIFICATION RISK MAP



Risk Sınıfı	Sınıf	Sınıf Aralığı	Tanımı	%
ZAYIF	1	1,00 - 1,28	Düşük	0,2
	2	1,29 - 1,35	Orta	5,1
	3	1,36 - 1,41	Yüksek	12,7
			TOPLAM	18
ORTA	1	1,42 - 1,46	Düşük	17
	2	1,47 - 1,49	Orta	12,3
	3	1,50 - 1,55	Yüksek	21,6
			TOPLAM	50,9
YÜKSEK	1	1,56 - 1,61	Düşük	15,7
	2	1,62 - 1,68	Orta	6,5
	3	1,69 - 2,00	Yüksek	0,3
			TOPLAM	22,5

Diğer Alanlar % 8,6

3. Results and Conclusion

The policy and strategy documents examined within the scope of this study and the implementation of the issues presented in the articles below within the framework of investments are important to reach the desired level in the combating desertification in Turkey:

- Number of project and activities of the combating desertification should be increased.
- Further monitoring of regional developments, including DAP, DOKAP, GAP and KOP, and the creation and implementation of the desertification projects in the areas needed should be ensured.

4. References

Action Plan of Combating Erosion (2013-2019)

Action Plan of Dam Catchments Green Belt Afforestation (2013-2019)

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ÇEM 2017, Desertification Model of Turkey, Technical Summary, Ankara, Turkey.

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DOKAP Bölge Kalkınma İdaresi Başkanlığı (2014). DOKAP Eylem Planı (2014-2018).

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Kalkınma Bakanlığı(2013). Onuncu Kalkınma Planı (2014-2018), Ankara.

KOP Bölge Kalkınma İdaresi Başkanlığı (2014). KOP Eylem Planı (2014-2018)

Mine Site Rehabilitation Action Plan (2013-2019)

National Strategy and Action Plan to Combat Desertification (2015-2023)

Orman ve Su İşleri Bakanlığı(2015). Çölleşme/Arazi Bozulumu ve Kuraklıkla Mücadele Terimler Sözlüğü, Çölleşme ve Erozyonla Mücadele Genel Müdürlüğü, Ankara, Ekim 2015.

Upper Cathchment Flood Control Action Plan (2013-2019)

Land Evaluation of Domanal Sub-Wateshed in Deccan Plateau Agro Ecoloical Sub Region (AESR 3) of India Using Remote Sensing and GIS for Watershed Development

PATIL[1], P.L. RAMACHANDRAIAH[1], H.C. Deepa KALAPPANAVAR[1], GEETHA[1], G.P. DASOG[1], G.S.

Abstract

Land evaluation studies such as land capability classification and land suitability for major crops are essential for planning appropriate measures to sustain productivity. An attempt was made to prepare land capability classification and land suitability studies for Domnal sub-watersheds located at North latitude 16^0 58' and 17^0 4'30" and East longitude 75^0 42' and 75^0 49"covering an area of about 4839 ha in Vijayapura district, under Northern dry zone of Karnataka using remote sensing and GIS techniques. The detailed soil characterization resulted in seventeen soil series which were evaluated for land capability classification and land suitability. The seventeen soil series were grouped into seventy three soil phases. Land capability classification was worked out for these seventy three soil phases which showed II, III, IV and VI classes. The land capability class II occupies1294 ha and having three subclass. The class IIs occupied 876 ha (18.12 %) of the study area. These soils had none to slight limitations ranging from slope, erosion, drainage, depth, texture, coarse fragments, $CaCO_3$, pH and organic carbon. The class III occupies 721 ha and having two subclass, IIIs occupied 581 ha (12.01 %). Soil site suitability evaluation for horticulture crops like mango, sapota, guava, pomegranate, grapes, amla showed that some of soil series were highly suitable (S1), moderately suitable (S2), marginally suitable (S3) and not suitable (N) for some soil phases. Major proportion of the study area belonged to land capability class VIs followed by IVs, IIs, IIIs, IIes, IIsw, IIIes respectively in the order of land capability rating. The land evaluation will help plan for most suited crops resulting the enhanced productivity.

Keywords: Land resources inventory, land suitability classification, horticulture crops

1. Introduction

Inappropriate land use leads to destruction of land resource, poverty and other social problems. The land is the ultimate source of wealth and the foundation on which many civilizations are constructed. Society must ensure that land is not degraded and that it is used according to its capacity to satisfy human needs for present and future generations while also maintaining the earth's ecosystems. Part of the solution to the land-use problem is land evaluation in support of rational land-use planning and appropriate and sustainable use of material and human resources.

Land evaluation is the process of assessment of a particular tract of land for specific purposes involving the execution and interpretation of data of natural resources, survey of soils, vegetation, climate and other related aspects of land in order to identify and make a comparison of the promising kinds of land uses. According to Van Wambeke and Rossiter (1987) land evaluation is the ranking of soil units on the basis of their capabilities to produce optimum returns per unit area. Several systems of land evaluation are used in

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soil survey programmes, the most important being land capability classification (Klingebiel and Montgomery 1961) and FAO framework for land evaluation (FAO1976).

The USDA land capability classification is a general purpose land evaluation system useful for farm planning with bias on conservation. The land suitability classification is a specified land assessment system suitable for qualitative and quantitative evaluations.

In the coastal agro-ecosystem, with the increasing human and animal population, the competition between various land uses has become intensive and otherwise unsuitable land is brought under cultivation and thereby causing physical and chemical degradation of land. Suitability of the area along the coast should be evaluated for crops grown on there and alternate land use options should be suggested for sustainable productivity.

The present study was carried out in Domanal Sub-watershedof Northern dry zone of Karnataka to find out the potential and constraints of these soils through land capability classification and soil suitability evaluation.

2. Methodology

Domanal sub-watershed of Northern dry zone of Karnataka lie between latitude of 16° 58' - 17° 4' 30" N and longitude of 75° 43' -75° 49" E near Vijayapura taluka of Vijayapura district. The study area has a hot arid climate with mean annual precipitation of 584; maximum and minimum temperature of 32.4 and 20.9°C respectively; relative humidity of 84 to 96 per cent. The length of growing period was 112 days.

Seventeen soil series with different phases were identified in the study area and mapped into seventy eight mapping units (Fig.2). Weighted average of each property was calculated and soil site characteristics of different soil units were obtained. These weighted average data were evaluated according to various interpretation systems such as land capability classification and soil site suitability evaluation. The mapped soils from the study area were matched with criteria for land capability classification and soil site suitability evaluation as suggested by Sehgal (1996). The kind and degree of limitations were evaluated. Land capability map and soil site suitability evaluation maps were prepared using Areview 3.2a GIS soft ware.

3. Results and Conclusion

Seventeen soil series with different phases were identified in the study area and mapped into seventy eight mapping units (Fig.1). In general soils were deep with more than 100 cm depth. Except Atharga, Dadamatti, Naihalla and Kalgurkiseries. Texture of the soil is clay, sandy clay and clay loam. The pH values of all the soil series were high and the base saturation was 100%. Organic carbon content varied from low to high in majority of the series.

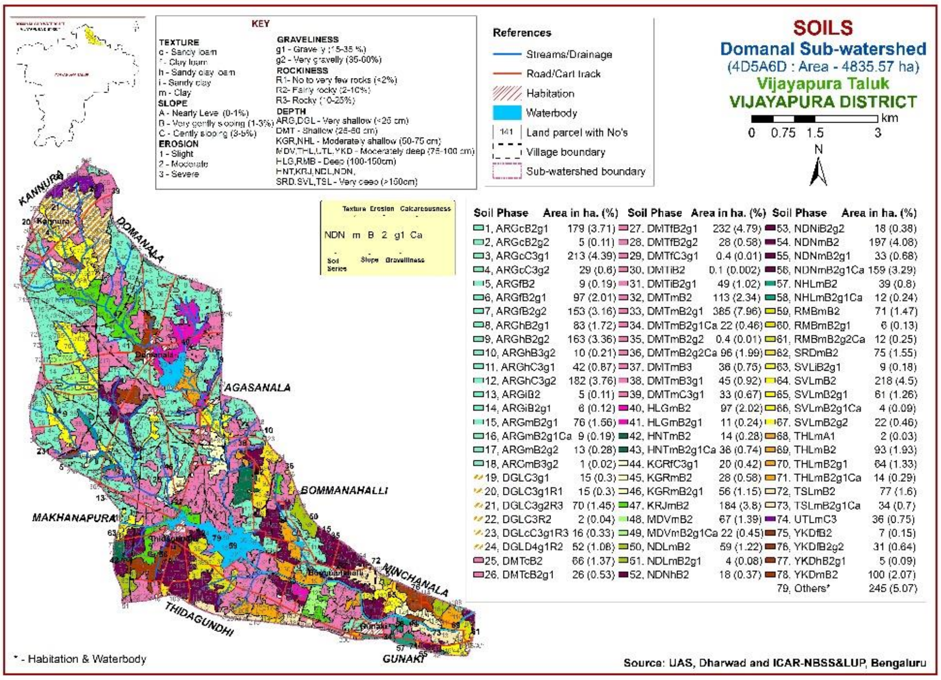

Figure 1. soil phase map of Domanal sub-watershed

3.1 Land Capability Classification

The classes and sub-classes pertaining to the land capability are presented in Table 2 and depicted in land capability map (Fig.2). The details and limitations are presented below.

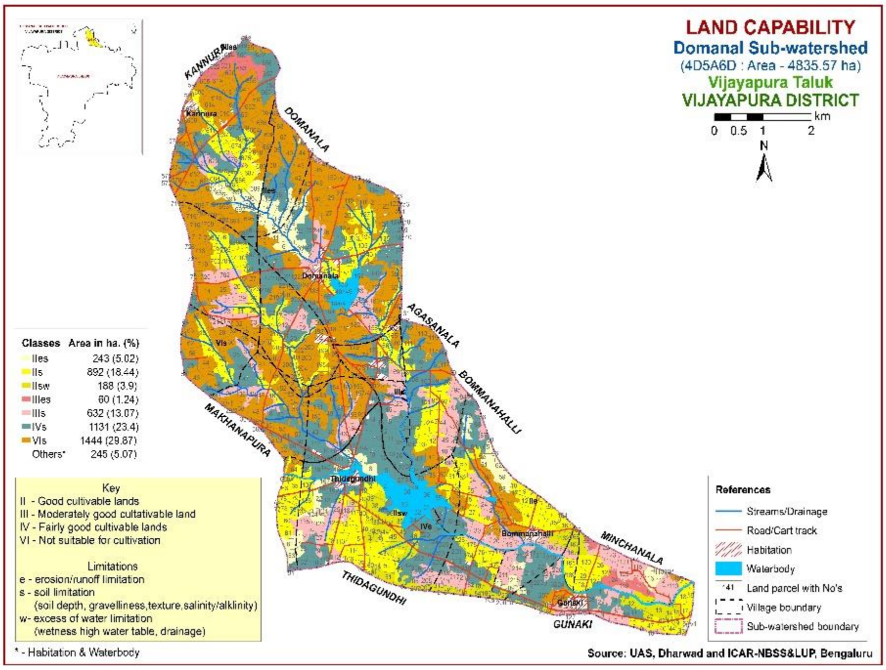

Figure 2. LCC map of Domanal sub-watershed

Land evaluation for land capability revealed that, the study area was differentiated into three land capability sub classes *viz.*, IIews, IIIes, IVs and Vs. Soil properties were the major limitations for grouping the soil mapping units into these sub classes. Soils of Karjol, Nandyal, Halagani, Honnutagi, Nidoni, Rambhapura, Tonshyal and Savanahalli series were evaluated to class IIs due to erosion, excess of water and soil limiations. It consists of good cultivable land on almost level plain or on moderate slope. Soils of Kalgurki, Nandyal, Madhabhavi, Naihalla, Yakkundi, Thenihalla, Sarwad and Utnal series were belonged to class IIIs. It consists of moderately good cultivable land in almost level plains or moderately steep slopes. Soils of Dadamatti series belonged to this class IVs with soil as the main limitation and it consists of fairly good land in almost level plains or moderately steep slopes. Soils of Atharga and Degraded land series belonged to non-arable category (Vs) due to very strong limitations of coarse fragments. Majority of the area was classified under non-arable category followed by IIs, IVs and then by IIIs category.

Table 2. Land capability sub classes for Domnal sub-watershed

Land capability class	Land capability sub class	Area (ha)
II	Erosion and soil condition (es)	243
	Soil condition (s)	892
	Soil condition and excess of water (sw)	188
III	Erosion and soil condition(es)	60
	Soil condition (s)	632
IV	Soil condition (s)	1131
VI	Soil condition (s)	1444

Suitability criteria for horticultural crops were compared with soil-site characteristics (Table 2) and arrived at different soil site suitability classes (Table 3) and soil site suitability maps were prepared.

Table 3: Area (ha) under different suitability classes for different crops

Class	Mango	Sapota	Guava	Pomegranate	Grapes	Amla
S1	9 (0.18 %)	14 (0.28 %)	14 (0.28 %)	22 (0.46 %)	14 (0.28 %)	22 (0.28 %)
S2	1196 (24.73 %)	1846 (38.19 %)	1431 (32.99 %)	1837 (38.01 %)	1846 (38.01 %)	1190 (24.62 %)
S3	656 (13.56 %)	153 (3.19)	405 (8.39 %)	153 (3.19 %)	153 (3.19 %)	810 (16.75 %)
N	2730 (56.46 %)	2576 (53.26 %)	2576 (53.26 %)	2576 (53.26 %)	2576 (53.26 %)	2576 (53.26 %)

3.1.1 Land Suitability for mango, Pomegranate,Sapota, Grape, Guavaand Amla: Soils of all series were moderately and marginally suitable for all horticultural crops. Soils limitations were major limitation in Atharga and Dadamatti series, which made it to be classified as not suitable. The suitability assessment for mango crop showed that 0.18 per cent is highly suitable, 24.73 per cent is moderately suitable 13.56 per cent is marginally suitable and 56.46 per cent is not suitable. The suitability assessment for pomegranate crop showed that 0.46 per cent is highly suitable, 38.01 per cent area is moderately suitable, 3.19 per cent is marginally suitable and 53.26 per cent is not suitable. The suitability assessment for these crops showed that 0.28 per cent is highly suitable, 38.19 per cent area is moderately suitable, 3.19 per cent is marginally suitable and 53.26 per cent is not suitable. The suitability assessment for guava crop showed that 0.28 per cent is highly suitable, 32.99 per cent area is moderately suitable, 8.39 per cent is marginally suitable and 53.26 per cent is not suitable. The suitability assessment for amla crop showed that 0.28 per cent is highly suitable, 24.62 per cent area is moderately suitable, 16.75 per cent is marginally suitable and 53.26 per cent is not suitable. The main constraints for both moderately and marginally suitable area are rooting condition, texture and soil limitations.

Land belonging to class II and III has varying suitability for different crops. According to suitability classification, these soils were found to be suitable for horticultural crops. Results of soil-site suitability evaluation indicated that maximum areas are for cultivation of sapota, pomegranate, grape and guava and mango and amla for moderately suitable and marginally suitable respectively.

3.3 Acknowledgments

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Gender and Land Degradation

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Abstract

The results of land degradation in arid ecosystems are more severe, but people living in these areas feel more of the results of the land degradation. Rural areas are more affected by land degradation as they provide livelihoods with more natural-related activities. This reduces the quality and quantity of products, and the deteriorating soil structure threatens future agricultural incomes.In addition to economic losses, the social structure is also affected negatively.

From this point, measures should be taken to improve the awareness and participation of local people, especially women, in efforts to mitigate the impact of the land degradation. Since, the women are mostly engaged in agricultural and forestry activities. On the other hand, women living in the countryside use natural resources to make traditional crafts. Considering the relationship between women and land degradation, the following areas stand out "land rights", "unequal labor", "poverty" and "women's organization". It is obvious that the women farmers rarely pay an hourly wage, and only if they sell their products have an income. Special support needs to be provided for the organization of women in rural areas. With the establishment of women's organizations, different and added value-added products are produced in the forests and rural areas and the pressure on natural resources is expected to decrease.

As highlighted in Sustainable Development Goals (SDGs) Number 5 (Gender Equality), ensuring the women's full and effective participation at all levels of decision-making in economic and public life and access to ownership and control over land, this paper not only sets up interest between SDG-5 (Gender Equality) and SDG-15 (Life on Land) but also concentrates specifically on the national policies and investments on the women in the rural in Turkey.Therefore, several documents have been examined, from the National Development Plans to sectoral strategy documents (such as Action Plan for Women Empowerment in Rural Areas) and projects carried out in this area have been taken under consideration.

Keywords: Land Degradation, Gender, Policy.

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Long-Term Soil and Crop Management Effects on Soil Physical Properties Related to Soil Erodibility

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Abstract

Long-term management systems cause changes to soil physical properties thatmay affect soil erosion and erodibility. A study was conducted to evaluate the effects of 125 years of continuous crop management on selected soil physical properties for Sanborn Field, Columbia, Missouri, USA.Intact soil cores(76 mm diam. by 76 mm long) were collected from continuous corn (Zea mays L.), continuous wheat (TriticumaestivumL.), continuous timothy (PhleumpratenseL.), and a rotation of corn–wheat–red clover (TrifoliumpratenseL.). Soil samples were collected from the surface horizon throughout 1 year (April, July, and November 2014 sampling dates). Aggregate stability, soil splash detachment, bulk density, and soil strength were measured. Significant differences in aggregate stability ($P < 0.01$), splash detachment ($P < 0.01$), soil shear strength ($P < 0.05$), and bulk density ($P < 0.05$) were found among the treatments. Continuous timothy had three to four times better aggregate stability and 50%to 75%less splash detachment compared with continuous wheat and corn, respectively. Lowest aggregate stability, lowest soil strength, highest bulk density, and highest soil splash detachment were found under continuous corn. Highest aggregate stability was found during July. Annual crops with tillage have a negative effect on soil quality and erodibility. Comparing results after 125 years with data collected after 105 years illustrates that properties have not changed dramatically during the past 20 years. Assessing the effects of long-term soil management on soil quality and erodibility is critical for society to determine the amount of soil erosion associated with selected soil management and to develop appropriate conservation practices to minimize this challenge and promote long-term sustainability.

Keywords: Aggregate stability, bulk density, soil shear strength, soil splash detachment

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Importance of Water Harvest in pasture management: A case study from Erzurum

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Abstract

One of the most important factors to neutrality land degradation is to control erosion.Active erosion was determined in 64% of pasture areas.The most important element of erosion control is good pasture management The pastures are known to be an indispensable element in terms of livestock breeding, as well as essential elements of the ecosystem, wildlife and erosion protection. Protecting and improving our pasture, which has a large portion of pasture areas (nearly %35) in our country, has become essential.

It was investigated the effects of moisture conservation and pasture hay yield of some water harvesting methods that will guide the other researcher. In the study, a total of 5 treatments were compared, including snow fence, open trench, open pit, contour stone bunds, and control. The herbal measurements of the experiment were applied as 3 replicates. When the moisture change was examined monthly, the highest moisture accumulation occurred in May at the snow fences with the effect of the snow melting, and in the following month measurement data were close each other and were obtained similar results snow fences, furrows, stone band, and rainwater collecting pit if the annual change was examined The application of water in the 0-60 cm soil profile of the trial area over the years of water has been the subject of the best soil moisture accumulation and resulted in 23.0% more moisture accumulation than the control. The highest dry grass yield was obtained from the application of snow fences forming the highest soil moisture accumulation. These applications were followed by the stone band, open trench and control applications, respectively. At the end of the trial (three years), the control plot showed an increase of 9.4% compared to the initial soil cover rate, while in practice 57.4 %.

As a result of the economic analysis, the main subject to be suggested is the open trench. Alternatively, open pit and stone bands can also be proposed because they have a positive net present value and a greater than 1 benefit-cost ratio. Snow fences are not economical due to high investment costs

Keywords: Water harvest, pasture management, land degradation, erosion control

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Meadows - Pastures in the Protectıon of Soıl, Water, and Vegetatıon

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Abstract

Meadow and pasture lands in our country have been considered just as the areas where animal owners live and animals graze.

However, 60.9% of Turkey's land is located on 5th and 7th class lands and the slope is over 15% in these areas. There is also severe and very severe erosion on these lands. The majority of meadows and pastures are located on these lands.

In countries where animal husbandry has been developed, meadows are utilized without any deterioration of fertility, as science suggests, unfortunately, in our country, meadows have been converted to poor meadows due to misuse and mismanagement.

As well as uncontrolled pasturing(early and late grazing, heavy grazing, etc.) also ecological conditions such as climate, vegetation cover, slope and soil characteristics can be effective in the transformation of well-qualified meadows into poor meadows, and consequently in the degradation of soil, water, and vegetation.

Technical and economic measures must defınıtely be taken to prevent erosion in meadows, together wıth increasing the yield and quality of animal fodderin the breeding activities to be carrıed out in pastures.

Pasture rehabilitation measures regarding firstly the maintenance of the soil, water, and vegetation equilibrium, then the production of fodder which is needed to boost animal production within the rangelands and ımprovement of the coarse fodder resources, will be described in this report by administrative, legal, and technical aspects. Besides, pasture rehabilitation activities which is carried out today will be presented as examples.

Keywords: Meadow, pasture, erosion, breeding/rehabilitation, uncontrolled grazing, water, soil/land/field and vegetation balance.

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The Effect of Vermicompost Obtained from Different Fabrication Wastes on the Growth of Bean Plant

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Abstract

In this study, vermicompost was obtained by using different factory wastes. By means of tests performed on vermicomposts, their effects were determined on the development of bean plants. For this purpose, 30% sugar factory, fruit juice factory and malt plant factory wastes were separated and after mixing with 70% animal manure, they were mineralized. After mineralization, vermicompost was obtained and a greenhouse experiment was set up. In this study, which was carried out as a greenhouse experiment, vermicompost obtained from different wastes at a rate of 20% was added to plastic pots with 2 kg soil. After Akman 98 bean seeds were surface sterilized, the seeds were planted in different vermicompost as inoculated and non-inoculated. Seeds were inoculated with *Rhizobium tropici* CIAT899 and the effect on some yield components was investigated. Some measurements were made in the upper and lower parts of the plant after the plants were harvested at the end of flowering period of the bean plant (Plant height, wet weight, dry weight, root length, wet weight, dry weight, number of nodules, diameter, weight, nitrogen in plant and root).

According to the results of the study; the effect of vermicompost obtained from different raw materials on some yield components of bean plant was different and this difference was found to be statistically significant ($p<0.05$). The effect of bean plant on different vermicompost was determined to be more effective in rhizobium inoculated seeds than in non-inoculated seeds. The maximum effect was determined in vermicompost obtained from malt factory wastes. Whereas no nodule formation was detected in control samples, it was observed in other applications. It was determined that the best nodulation was in the seeds planted with rhizobium in vermicompost obtained from different materials.

Keywords: Vermicompost, bean, rhizobium, yield component

1. Introduction

Vermicompost is the process of composting carried out by earthworms. In a more scientific way, it is a kind of biotechnological compost created with a specific type of earthworm to accelerate the process of waste transformation and to obtain a better end product. The motor power in composting all organic wastes is beneficial bacteria; earthworms simply add a high octane value to the mixture and accelerate the process. Earthworms blend compost, microorganisms and nutrients during digestion and make them a small and perfect soil-regulating package. The resulting earthworm excrement is left as organic fertilizer in the soil. Although thermophilic composts are more preferred as organic fertilizers, there is a trend towards vermicompost as a result of recent studies. Increased environmental pollution may be the reason for this trend. Because the increase of environmental pollution and the accumulation of waste adversely affect human and environmental health. Vermicompost process is carried out by adding specific types of worms to the domestic, industrial and

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animal wastes and the pollution becomes a benefit for the environment. Thus, both the environment and human health are protected and the sustainability of soil fertility increases (Boran 2015).

A large number of various organic waste can be used in the production of vermicompost. Examples of such wastes are urban sewage waste (Neuhauser et al., 1988), various industrial wastes such as beer, cork and paper industry (Butt, 1993), supermarket and restaurant waste (Edwards, 1995), processed potato waste, animals wastes resulting from poultry, cattle and sheep raising (Edwards, 1995) and organic wastes fromplant production. These organic wastes, which are released in many ways by vermicomposting, can be eliminated and fertilizer value can be obtained.In a study by Sönmez et al. (2011) in a winter season in the field conditions, the effects of different doses of vermicompost (VC1 = 100 kg / da; VC2 = 200 kg / da), stable manure (AG1 = 1500 kg / da AG2 = 3000 kg / da) and the control applications without any treatment on spinach (Spinaciaoleracea var. L.) plant development and soil fertility were investigated. In general, AG2 was more effective in plant growth, yield, mineral content and soil fertility parameters, while VC applications showed significant increases compared to control. Especially the Fe content of the plant and the application of VC2 on the soil Ca yielded the best results. Azarmi et al. (2008) stated that the physical structure of the soil changed positively and the amounts of organic carbon and N, P, K, Ca, Zn, Mn increased when 1.5 tons of vermicompost per decare was applied to the soils in which tomatoes grow.

This study was carried out to determine the effect of vermicompost and bacterial inoculation from different fabricated wastes on some yield components in bean plant.

2. Material and Method

In this study, Akman 98 bean varieties, which are a registered product of Anatolian Agricultural Research Institute, were used. *Rhizobium tropici* (CIAT899), obtained from biological laboratories of Ankara Soil, Fertilizer and Water Resources Central Research Institute, was vaccinated in bean seeds. The study was planned according to randomized block experimental design in greenhouse conditions and conducted in the computer- controlled greenhouse at Selçuk University, Faculty of Agriculture, Department of Soil Science and Plant Nutrition. For this purpose, vermicomposts obtained from different organic materials were mixed by 20% in plastic pots with 2 kg soil. After the cultivation medium was made ready for planting, bean seeds were kept in 0.5% sodium hypochlorite for 3–5 minutes and surface sterilized and then they were washed at least 6 times with sterile purified water. After the surface sterilization of the seeds was carried out, the experiment was performed with the bacteria being inoculated and non-inoculated. Inoculated seeds were planted in pots by taking into consideration the principles of rhizobium application. 5 seeds were planted in each pot and dilution was carried out after germination. After the plants were harvested at the end of flowering period, measurements were made in the upper and lower parts of the plant (Plant height, root length, plant weight, dry weight, number of nodules, nodule weight, nodule diameter, plant and root N).

The analysis of soil sample used in the experiment was performed according to texture Bouyocous 1951, pH Richards 1954, EC U.S. Pat. Salinity Lab. Staff 1954, organic matter Smith and Weldon 1941, lime Hızalan and Unal 1966, total nitrogen Bremner 1965, phosphorus Olsen et al. 1954 and the changeable cationsRichards 1954. Some physical and chemical properties of the soil used in the experiment are given in Table 1. Variance analysis of the data obtained as a result of the greenhouse experiment established in the trial plot of random plots was performed and the significance controls of the applications in the MSTAT-C computer program were grouped and evaluated with the DUNCAN test (Yurtsever 1984).

Table 1. Some Physical and Chemical Properties of soil used in the experiment

Property	Value	Property	Value
pH (1:2.5)	7.78	O.M. (%)	1.62
EC (1:5) µmhos/cm	349	N ($mgkg^{-1}$)	7.3
Tekstüre	Clay loam	P ($mgkg^{-1}$)	6.7
$CaCO_3$ (%)	30.2	K ($mgkg^{-1}$)	18.86

3. Results and Discussion

Vermicompost contains a high level of soil and symbiotic and asymbioticbacteria and it invigorates microflora and microfauna in the soil. It was revealed in the studies that plant yield and soil proporties (physical, chemical, biological), so soil productivity, increased when vermicompost is applied alone or in combination with other fertilizers (organic, inorganic). The effects of this organic material in the soil are primarily related to the properties of the soil and factors such as climate, but also the type and amount of vermicompost and its chemical and physical composition.

To determine the effect of vermicomposts obtained from different fabricated wastes as well as bacterial inoculation on some yield components of bean plant, the plants were harvested during flowering period and the necessary measurements were made. According to the results of the study, the effect of different vermicomposts and bacterial inoculation with vermicomposts on the length of the bean plant was different and this difference was statistically significant ($p < 0.01$). The length of the bean plant varies between 23.11 and 43.56 cm (Table 2). In the lowest plant length control application, the highest plant length was determined in the plant obtained by grafting bacteria in vermicompost obtained from malt plant. In general, plants with vermicompost and bacterial inoculation showed better development than plants obtained from other applications. The effect of bacterial inoculation and different vermicompost applications on the root length of the bean plant was not statistically significant. Root length values were determined between 30.22 - 32.22 (Table 2).

The effect of various vermicomposts and inoculation on the wet and dry weight of the bean plant was different. This difference was found to be statistically significant ($p < 0.01$), the highest plant wet weight (29.51 g) and dry weight (4.09 g) obtained from malt, bacteria inoculation were determined in vermicompost. The lowest plant wet weight was determined in the control application (6.46 g). Plant dry weights ranged from 1.22-4.09 g (Table 2). It was reported that the addition of organic materials to the soil in the form of compost regulates the physical properties of the soil positively and increases the nutrient values and uptake. (Alagöz et al., 2006).

According to the results of the study; the effects of various vermicomposts and bacterial inoculation on the root age and dry weight of the plant were different. This difference was found to be statistically significant ($p < 0.01$) and the root weights of bean plants were found to be between 4.94-9.55 g (Table 2). The root dry weight of the plant was determined as 0.37 and 1.53 g (Table 2). The highest root age and dry weight in the bean plant was determined in the plant obtained from the application of bacterial inoculation in the vermicompost obtained from the malt plant.

Table 2. The effect of some yield components of bean plant of bacteria inoculation and vermicompost from different fabricated wastes

	Plant height	Root length	Plant wet weight	Plant dry weight	Root wet weight	Root dry weight	Number of nodules	Nodule weight	Nodule diameter	N in plant	N in root
	cm		gr				number	gr	mm	%	
Control	23.11c	30.22	6.46d	1.22d	4.94c	0.37c	0.00e	0.00c	0.00b	1.80d	1.21c
+Rhizobium	26.22c	31.89	7.90d	1.32d	8.04abc	0.48c	14.78d	0.43ab	3.67a	2.23c	1.59b
F.J.F.V	32.67b	31.11	16.28bc	2.33e	6.57abc	0.83b	20.00d	0.27b	2.67a	2.63ab	2.15a
S.F.V	33.44b	31.33	11.73cd	2.07cd	6.69abc	0.83b	30.22bc	0.62a	3.00a	2.74a	2.19a
M.F.V	35.56b	31.00	20.72b	3.48ab	8.97ab	1.46a	33.11bc	0.54a	2.33a	2.79e	2.18a
R.M.V	35.67b	30.78	28.08a	3.63ab	5.81bc	0.90b	0.00e	0.00c	0.00b	2.39bc	1.98a
+ R M.S.F.V	36.89b	32.22	16.70bc	2.80bc	8.37ab	0.99b	33.89bc	0.60a	4.00a	2.77a	2.21a
+ R S.F.V	33,56b	31.00	14.97bc	2.88bc	7.64abc	1.03b	37.11b	0.53a	3.00a	2.79a	2.16a
+ R M.F.V	43.56a	31.67	29.51a	4.09a	9.55a	1.53a	44.45a	0.53a	3.00a	2.75a	2.13a
+ R R.M.V	35.89b	30.22	16.74bc	2.64bc	8.17abc	1.14b	29.11c	0.44ab	2.67a	2.50abc	2.02a
p<0.01 LSD	4.96	nd	6.09	0.91	2.98	0.31	6.92	0.23	1.85	0.27	0.24

M.S.F.V: Fruit juice factoryvermicompost; S.F.V: Sugar factory vermicompost; M.F.V: Malt factory vermicompost;
R.M.V: Ready mama vermicompost +R: With Rhizobium nd: not determined

In this study, the effect of bacterial inoculation and vermicomposts obtained from various wastes on the nodulation yield of bean plant root was statistically significant (p <0.01). In the experiment, nodule formation was observed in the pots treated with vermicompost without bacterial inoculation. It is understood from the nodulations that vermicomposts used in the study contain rhizobium bacteria and they are active. Vermicompost contains mycorrhizal fungi and bacteria (Azotobacter) performing nitrogen fixation from symbiotic bacteria (Rhizobium) and asymbiotic microorganisms (Sönmez et al. 2011). The nodules obtained from the experiment differed significantly and this difference was statistically significant (p <0.01). There was no nodulation in the plants grown in vermicompost application obtained from the control and ready-made food. Nodule numbers were determined between 0.00 and 44.45 (Table 2) units and the highest nodule weight (0.62 g) was determined in the plant grown in vermicompost obtained from sugar factory wastes. Nodule diameters varied between 0 and 4 mm and this difference was statistically significant (p <0.01).According to the results of the study; the effects of various vermicomposts and bacterial inoculation on the nitrogen content of the plant were different. This difference was statistically significant (p <0.01). The nitrogen values of the plant ranged from 1.80% to 2.80%, the highest nitrogen was obtained from the sugar factory and the bacteria were inoculated. The nitrogen values in the root of the bean plant range from 1.21 to 2.21% (Table 2). Vermicomposts contain microorganisms useful for soil and plant. In many studies, it is stated that the addition of organic material to soil has positive effects on soil nutrient and plant nutrition (Anonymous 1990). Parkin and Beery (1994) reported that vermicompost was richer in terms of mineral N than soil and also had a lower C / N ratio and pH than normal compost.

4. Conclusions

The aim of this study was to determine the effect of vermicomposts and bacterial inoculation on different yield components of bean plant obtained from different wastes. The use of macro and micro-organisms together gave more positive effects on some yield components of bean plant. Generally the organic matter content of our country is low. Vermicompost can be applied to all plants because it is rich in organic matter. It also has a healing effect on the physical, chemical and biological properties of soil. It is also effective in suppressing some plant pathogens. This study is primarily intended to enrich the organic matter of our soil with vermicompost and then to increase the biological activity in the soil and provide recycling of factory wastes in the region, reduce the costs of garbage disposal or garbage collection of factories and municipalities, contribute to the national economy, decrease the use of chemical fertilizers and allow the farmers to produe their own fertilizers. Vermicompost plays an important role in nature conservation and can contribute significantly to organic agriculture.

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How Agricultural Sector can Contribute to Land Degradation Neutrality in Pakistan; Perspective of Farmers' Participation and Integrated Land Use

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Abstract

Agriculture is vital for Pakistan's economy and plays major role in livelihood of majority of the population. The continuous rise in Country's population has put pressure on agriculture sector and demand for food is on the rise. In contrast, cultivable area is decreasing with the bulging issue of land degradation. Land degradation in the Country is caused by socio-economic factors, loss of soil fertility, grazing pressure, erosion, deforestation, water-logging, salinity and soil pollution. Besides, emerging problems include those of decreasing river and canal flow, utilization of agricultural area for housing and industries and irregular shifts in weather. Pakistan as land degradation neutrality (LDN) signatory needs to address such problems on immediate basis to attain the targets. A National Action Programme was initiated almost 17 years ago, yet not much has been achieved due to lack of implementation and non-participation of all stakeholders among other reasons. Therefore, quick education of all the stakeholders about the worth of soil and threats of land degradation is needed. The strategies and policies should include the farming community, and only through the participatory approach, land degradation can be decreased if not reversed. Also, cautious and integrated land use is advised to achieve LDN in Pakistan and other developing countries. The targets achieved locally would contribute globally leading towards the Sustainable Development Agenda.

Keywords: land degradation neutrality, Pakistan, farmer education, integrated land use

1. Introduction

Pakistan is predominantly agricultural country; with this sector contributing up to 18.9% in gross domestic product (GDP) and employing around 42.3% of the labor force (Ministry of Finance 2018). This contribution can be attributed to several natural resources including particularly those of arable land, fresh water availability and well-established irrigation system. The arable land of Pakistan is estimated 31.1 m ha constituting 39.1% of the total area, and is irrigated by more than 58000 kms of canals (Pakistan Bureau of Statistics 2017). Pakistan has long been successfully relying on these resources for food production with the exceptions of certain commodities. However, several factors are severely affecting the food self-sufficiency of the Country.

Pakistan has seen constant population bulge which is estimated at 2.4% per annum currently, thus there is increase in food requirement. Next biggest threat to food security in Pakistan is changing climate which has led to abrupt changes in rainfall and weather patterns; the most visible parameter accepted by masses. Severe rainfall and hailstorm, for instance, was very rare during wheat harvest and mango flowering season (mid-April), but happened this year and damaged large area throughout Pakistan. Similarly, Monsoon rainfall remained a blessing for both surface and groundwater reservoirs, but its increased intensity leads to flooding

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almost every year for the last two decades (Hunt et al. 2018; Khalid et al. 2018). The other extreme effect of climate change is the decrease in fresh water resources which is facing continuous decline and estimated at 9% lower in 2017-18 compared to previous year (Ministry of Finance 2018). It also leads to dry spells and severely affects cropping especially in rainfed areas. Next, cropping area is not utilized fully as cultivated area is only 22.7 m ha when compared with that of arable land (31.1 m ha) (Pakistan Bureau of Statistics 2017). Notably, energy crisis limiting the use of automated pumps for lifting groundwater, lack of agricultural mechanization, post-harvest losses, small and scattered land holding, supply and application problems with agricultural inputs, marginal ad subsistent land-use, yield gap issues, socioeconomic influences and depletion of soil resources are leading factors towards decreased crop yields asking for import of food instead of its export. The decreasing crop yield circumstances ask for efficient use of resources, especially that of the soil to fulfill increasing food needs. The extent of inefficient land use can be estimated as Pakistan stands 59th in yield per unit area of wheat (FAOSTAT 2017) among other countries. The case of other crops is also not different.

2. Land degradation in Pakistan

Estimated 85.4% of the soils of Pakistan are prone to degradation and desertification (Khan et al. 2012) through multitude of processes: 1) policy related 2) land managemental, 3) climatic, and 4) socioeconomic. Certain policy measures have been introduced for soil resource management including that of National Action Programme to Combat Desertification in Pakistan, 2002 following the ratification of Land Degradation Neutrality (LDN) initiative in 1997 by Pakistan. However, the implementation largely remains preemptive due to lack of specific organization, legislation and execution (Khan et al. 2012). Continuous change in administrative setups, lack of proactive application-targeted legislation, no or minimum participation of stakeholders, andlack of an authority for forcing the policies have been adding to the problem. This is also joined by meager extension activities, which have not incorporated the new problems. Similarly, soil is still considered personal resource rather than national which is one of the main reasons behind blunted execution of the policies.

Majority of farming community in Pakistan prefers conventional farming practices which have led to soil degradation throughout the country. For instance, flood irrigation, extensive tillage practices and incautious agricultural inputs application are common among the farmers. Similarly, unlined water channels and the incautious irrigation practices lead to soil loss. Besides, disposal of solid waste and effluent of industries to the soil, municipal waste dumping sites, and on-the-rise soil pollution add to the problem on managemental level causing damage to soil.There are certain land-use related issues too which have led to decline in soil resources. For example, marginal and subsistent land use is dominant which deteriorates the soil fertility.

Most parts of Pakistan receive minimal rainfall, and face high evapotranspiration, leading to soil salinity (Qureshi 2011). Similarly, irrigation using saline groundwater has also led to increase in saline soils throughout the country. This disturbed soil chemistry also leads to waterlogging problem in some areas.Further, the Monson rainfall has long been serving as source for water reservoirs, but recent trend has been drastic because of high intensity rainfall leading to flooding. The flooding and/or intense rainfall has often led to erosion particularly in the areas with more slope. The changing climate trends have started affecting the biodiversity and water availability which are having dire effects on soil.

Socioeconomic factors intermingled with those of policy, managemental and climatic issues are leading towards land degradation and depletion due toa) use of agricultural lands for housing, b) transportation of top layer for infrastructure, c) economic extremes leading to non-cultivation, d) dumping of domestic waste, e) family land division, and f) small and scattered land holding. Combined, all these factors have led to land degradation in Pakistan which is estimated 61% of the agricultural area (Hassan and Arshad 2006).

3. What can be done to achieve land degradation neutrality?

Very few localities in the world enjoy the luxury of vast agricultural land, but the realization of value of this resource is also very rare. The circumstances of ever-increasing food requirement and changing climate ask for efficient utilization of deteriorating soil resources and recovery of already degraded soils. The Land Degradation Neutrality (LDN) initiative under these circumstances is immediate need especially for the countries where soil loss has not yet been addressed. For Pakistan, few policy measures, management techniques and reclamation strategies have been devised for achieving LDN targets. First program set was The National Action Programme to Combat Desertification in Pakistan 2002 focuses on better crop and animal husbandry, soil and water conservation, reclamation of problem soils and afforestation. The progress on this and later programs has been slow and minimal, therefore immediate action is needed for the 2030 Agendafor Sustainable Development.

The reasons behind slow progress of such policies happen to be lack of participation of all the stakeholders especially that of the farming community who have to execute major part of the target. Therefore, the farming community needs to be educated about the worth of soil, and soil as national or global resource rather than personal. A survey of available resources, and periodic review of soil resources of each farmer can be started which can check the status of land degradation and suggest accordingly. Certain incentives can be coupled with achieving the targets. Furthermore, systemized knowledge dissemination regarding land degradation, soil conservation, links between climate change and soils, reasons behind soil fertility loss, and declining irrigation water dynamics can be done to the public. Similarly, farming community can be supported not only for the problem identification, but also for the solutions. Finally, awareness about soils as carbon sink rather than source, utilizing the soil's microbiological potential in reducing chemical inputs, and soil's importance for food security thus is a must and immediate need.

Another important aspect can be the integrated land-use which is quite the practice in rural farming communities, however, not being practiced up to its potential. The integrated farming encompassing all the three i.e. crop husbandry, animal husbandry and poultry farming, besides fisheries and agroforestry has the potential to address the problem of land degradation.There can be certain agronomic approaches under integrated land use: a) marginal lands can be utilized better through planting fodder crops incorporating legumes, b) crop residues or stubbles which are usually burnt can be used for housing or feed for the animals, c) utilization of animal and poultry manure as nutrient source, and d) grazing in agroforestry area will not only enhance biodiversity, but also can ensure security in case of environmental adversities damaging one crop, which can be applied. The agroforestry system besides, would not only prevent erosion, but also enhance soil nutrient status through nitrogen fixation trees and leaf litter. Finally, monsoon season receiving almost 70% of the annual rainfall within 2-3 months leading towards erosion, flooding, and sometimes crops lodging can be used for fisheries besides reservoir for water scarce periods. The integration although on smaller levels would be more secure than that of single crop stands, or sole rearing of animals. This system will also address the problem of deforestation in the Country. Another approach can be reclamation of problem soils initially through animal grazing. For example, a local palatable Kallar grass (*Leptochloafusca*) can grow well in saline and waterlogged areas, thus is an excellent candidate for reclamation of such soils. Similarly, microbe-assisted phytoremediation can be employed for recovering such soils which will also replenish the nutrients in the soil.

The soil loss is ultimately the loss of livelihood (Erfurth 2019) for the farming community throughout the world. The soils besides providing food to all the creatures are also potential carbon reservoirs, and under changing climate scenarios, their worth must be documented and understood. This realization on the part of public especially that of land owners thus is immediately needed besides policy formulation and implementation. The participatory approach and cautious land use in agricultural sector are the key to Land Degradation Neutrality which will help achieve Sustainable Development Goals (SDGs) locally as well as globally.

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THEME 2:
Soil Conservation

The Potential Use of Cover Crops for Controlling Soil Erosion Caused by Water

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Abstract

The soil is essential for many human activities. The soil is utilized by exploiting its functions such as for agricultural productivity, environmental quality, source of raw materials and base for buildings. The inappropriate soil exploitations can also cause damages especially soil erosion. Soil erosion can threaten agricultural productivity, food security, environmental sustainability and lead to the damage or even destruction of infrastructures. Soil erosion caused by water is the biggest soil erosion that occurs in the world, especially in the tropics and areas with high rainfall. The factors controlling soil erosion by water are the erosivity of rainfall, the erodibility of the soil, the slope of the land and plant cover. Plant cover is the most important factor that can affect other factors. The improvement of plant cover on the lands with high erosion risks become important to reduce those risks. The use of cover crops can be taken as a measure for soil plant cover improvement. Cover crops have dense with different depth root systems can help the soil to absorb more water and hold the soil surface. The density of the root system and soil cover of cover crops also can reduce the energy of runoff and the mass movement of soil surface. Previous studies show that some crops used as cover crops reduced the rate of soil erosion caused by water and high potential to be used for soil erosion control.

Keywords: Agricultural land, environment, plant cover, soil conservation, sustainability

1. Introduction

The soil is essential for many human activities and performs many functions including functions related to natural ecosystems, agricultural productivity, environmental quality, soil as a source of raw materials and a base for buildings. The soil is utilized by exploiting its functions. The exploitation of certain soil functions does not only create benefits but can also cause damages (Nortcliff et. al., 2006). Soil erosion is one of the major risks can be caused by inappropriate soil exploitations. Soil erosion threatens agricultural productivity, food security and environmental sustainability. Soil erosion can also lead to the damage or even destruction of infrastructures (IAEA, 2015). Soil erosion induced by both natural geomorphology and human activity occurs globally. The global average value of potential erosion in the 1980s is estimated to be 10.2 ton ha^{-1} $year^{-1}$ (Yang et al., 2003). The more recent data reported that the annual average of total global potential soil erosion in 2001 is 35 billion ton $year^{-1}$ and was estimated an overall increase of 2.5% in 2012 35.9 billion ton $year^{-1}$(Borelli et al., 2013).Soil erosion by water is a global major cause of soil loss. In the tropics, soil erosion by water can potentially reach dramatic levels because of the large amount and high intensity of rainfall (Labriere et al., 2015).Borelli et al. (2013) reported the highest changes of soil erosion by water from 2001 to 2012 with noticeable increases occurred in the tropics (South America, Sub-saharan Africa and Southeast Asia).

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The rate of soil erosion by water is controlled by factors such as the erosivity of rainfall, the erodibility of the soil, the slope of the land, plant cover and other soil disturbances such as tillage and constructions (Morgan, 2005; Ritter & Eng, 2012).Vegetation cover becomes the most important factor controlling soil erosion because can affect other factors (Morgan, 2005). The effectiveness of vegetation cover in controlling soil erosion is determined by vegetation type, the height of plants and the percentage of soil cover. Areas with various vegetation type and height and a higher percentage of soil cover can reduce the energy of raindrop and runoff. In order to control soil erosion effectively and efficiently, revegetation with the most suitable plants is needed. Cover crops can be used for this purpose considering their characteristics and advantages. Cover crop usually has a dense with a different depth root system and can cover the soil fast compared to other crop types. Cover crops can produce a high amount of biomass and increase soil organic matter, improve the physical, chemical and biological properties of the soil that contribute to improving the erodibility of the soil (Olson et al., 2010; Haruna & Nkongolo, 2015; Oktabriana & Syofiani, 2017; Nascente & Stone, 2018). This paper is trying to give general information about the potential use of various cover crops for controlling soil erosion caused by water.

2. The Use of Cover Crops for Controlling Soil Erosion Caused by Water

Cover crops are defined as the crops which are planted to be used to cover the ground surface (Sharma et al., 2018). Cover crops are used to cover the soil surface to mainly protect the soil from erosion and loss of nutrients through leaching and runoff. The effects of cover crops on soil erosion can be direct and indirect. The direct effects of cover crops are the height and canopy of cover crops can reduce the energy of raindrops, the morphology and dense cover reduce the runoff and the deep and dense root system hold the soil and prevent soil mass movement. The indirect effects are the cover crops can improve the erodibility of the soil with improving the physical and chemical properties of the soil (Morgan, 2005).

Some studies about the direct effects of cover crops especially the percentage of cover on soil erosion have been reported. Dong et al. (2015) studied the effects of ryegrass coverage on soil loss. The study used 25, 50 and 75% ryegrass coverage in different slope gradients and rainfall intensities. In the highest gradient used (25o) with rainfall intensity of 90 mm h^{-1}, ryegrass coverage 25, 50 and 75% resulted 63.90, 69.52 and 75.06% soil erosion reduction respectively. Parlak et al. (2015) used different cover crops that resulted different soil coverage at the time when the soil observation was done. The used cover crops are horse bean with 23.75, field pea with 31.25, vetch with 37.50, vetch+wheat with 46.25 and field pea+wheat with 63.75% of soil cover resulted 302.80, 259.20, 370.20, 147.10, and 47.20 g m^{-2} of total soil loss respectively. Previous studies on the indirect effects of cover crops on soil erosion were related to their effects on the physical and chemical properties of the soil. Haruna and Nkongolo (2015) studied the use of cereal rye (*Secale cereale*) as a cover crop in a corn-soybean rotation. The results showed that a 3.5% decrease of soil bulk density was observed in cover crop plots as compared with no-cover crop plots.The use of *Mucuna conchichinensis*, *Colopogonium mucunoides*, *Centrocoma pubescens* and *Mucuna bracteata* as cover crops was reported by Oktabriana and Syofiani (2017). The results of this study showed that these cover crops significantly increased available P, available K, organic C and total N contents of the soil compared to control ones.

The effectiveness of soil erosion reduction by cover crops is varies depending on cover crop species and management, percentage of crop cover, the gradient of slope and other related factors. Table 1 presents several reports of previous studies on the effectiveness of some cover crops in reducing soil erosion. In these tablescan be seen that most crops used as cover crops for erosion studies are forage crops. This is because forage crops have suitable characteristics as cover crops. These crops improve the forage qualities and quantities (rehabilitation) and can be used for controlling soil erosion in rangeland, pasture or grassland areas at the same time (Altin et al., 2005).

Table 1. Several previous studies on the use of annual and perrenial forage crops as cover crops for reducing soil erosion

Authors	Cover Crops	Reduction of soil loss (%)
Manipura, 1972	*Eragrostis curvula* *Stylosanthes gracilis*	100.00 91.30
Zhu et al., 1989	Chickweed (*Stellaria media* L.) Downy brome (*Bromus tectorum* L.) Canada bluegrass (*Poa compressa* L.)	87.00 96.00 95.00
Wall et al., 1991	Red clover (*Trifolium pratense*)	78.00
Malik et al., 2000	Annual ryegrass (*Lolium multiflorum* L.) Crimson clover (*Trifolium incarnatum* L.) Tall fescue (*Festuca arundinacea* L.) Sericea lespedeza (*Lespedeza cuneata* (Dumont) G. Don.)	36.07 39.08 62.60 49.07
Le Bissonnais et al., 2004	Ryegrass (*Lolium perenne*)	98.00
Babalola et al., 2007	Vetiver grass (*Vetiveria nigritana*)	65.55
Gomez et al., 2009	Ryegrass (*Lolium* sp.)	97.94
Parlak & Ozaslan Parlak, 2010	Vetch (*Vicia sativa* L.) Barley (*Hordeum vulgare*) Ryegrass (*Lolium* ssp.)	87.07 91.73 73.94
Ryu et al., 2010	Rye (*Secale cereale* L.) Hairy vetch (*Vicia villosa* Roth.)	75.00 56.25
Garcia-Estringana et al., 2013	*Colutea arborescens* *Dorycnium pentaphylium* *Medicago strasseri*	94.87 96.77 99.09
Ruiz-Colmenero et al., 2013	*Brachypodium distachyon* *Secale cereale*	86.73 72.79
Chen et al., 2015	Bermudagrass (*Cynodon dactylon*)	32.00
Dong et al., 2015	Ryegrass (*Lolium perenne*)	92.75
Simatupang, 2015	*Brachiaria decumbens* *Centrocema pubescens*	80.77 67.68
Asbur et al., 2016	*Asystasia gangetica*	47.10
Mancini et al., 2017	*Lolium multiflorum*	57.14
Safriani et al., 2017	*Axonopus compressus* *Imperata cilindrica*	69.79 62.79
Murtilaksono et al., 2018	*Nephrolepis biserrata*	95.90
Sumiahadi et al., 2018	*Arachis pintoi* Karp. & Greg.	71.65

3. Conclusion

Soil erosion caused by water is a global major cause of soil loss. Cover crops are used to cover the soil surface that has a major purpose to protect the soil from erosion and loss of nutrients through leaching and runoff. The use of cover crops have direct and indirect effects on soil erosion. Previous studies reported that cover crops significantly affected soil erosion both directly and indirectly and indicated that cover crops have high potential to be taken as a measure to control soil erosion.

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Impacts of Pre - And Post- Biochar Application on Soil Quality in Field Conditions

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Abstract

Recently Biochar has received a significant attention due to its high carbon content, porous structure and low bulk density. Its impacts on various soil parameters have been intensively investigated in tropic and subtropic areas under controlled conditions however its effects on soil quality variables under semi arid contidions with field studies are less known. In this study, the impacts of pre- and post- biochar application on the soil quality were compared with a field experiment using Soil Quality Indexes (SQI). Biochars were produced from locally grown crops residues and incorporated into parcels at three different doses (0, 0.2 and 0.4 % as weight bases).Disturbed and undisturbed soil samples were collected at 0-30 cm depth of parcels both before biochar application and also after biochar application. Soil quality parameters such as bulk density, available water content, agregate stability, porosity, soil organic matter and hydraulic conductivity were determined and soil quality indexes of each parcels were obtained using linear and nonlinear scoring functions. Overall compare to before biochar application parcels, the parcels treated with various amount of biochar provided 15 to 34 % increases in soil quality indexes showing the potential of biochar in imrovement of soil qualities of degraded lands.

Keywords: Soil quality, biochar, field experiment

1. Introduction

The use of biochar has recently become very common because its high stable carbon content and porous structure. Its carbon content may change between 41 and 85 % depending upon the materials from which it is produced (Ding et al. 2016). Earlier researchers have generally reported the benefits of biochar incorporation into soils alone or combined with fertilizer and manure. The researchers reported that incorporation of biochar into soils alone or combined with fertilizer or manure improved carbon sequestration, productivity of soils and plants, soil microbial activity, availability of soil nutrients, soil drainage, soil organic matter and and reduced soil degredation, greenhouse gase emissions, environmental pollution, crop diseases, soil salinity, soil crusting and sealing etc (Lehmann et al. 2009; Laird et al. 2010). The positive impacts of biochars on soils have been attributed into improvements in soil water holding capacity, soil aggregation, soil porosity and microbial activity after it has been incorporated into soils in variant amounts. Bioachar achive all these because of its high stable slowly decaying, highly porous structure, low bulk density and large surface area (Herath et al. 2013; Laird et al. 2017).

With biochar application, soil moisture, soil aggregate stability, hydraulic conductivity, available water content, soil organic matter, soil carbon, total nitrogen, available nutrients in soil, CEC, microbial biomass carbon, microbial dynamics, and enzymes have increased but soil bulk density has decreased (Kimetu and Lehmann, 2010; Herath et al. 2013).

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On the other hand, some negative impacts of biochar incorporation into soils have been reported such as increases in pH and EC (Li-li et al. 2017). In addition, it may cause yield reductions especially in soils rich in nutrients. Adverse impact of biochars in the soil are due to its high C/ N ratio. Influence of biochar can depend upon various factors such as types of biochar, size of biochar, biochar application rates and also the type of soil into which biochar was applied (Lim et al. 2016; Laird et al. 2017).

Million hectares area across the world suffer from problems such as soil degradation, low soil quality, erosion and runoff because of mostly low amount of soil organic matter. Similarly, the soils of the Harran plain are mostly poor in soil organic matter (< 1 %; Sayğan, 2007). More than 80 % of the quality of the Harran plain soils are low or very low (Bilgili et al. 2017), which is mostly intensive agriculture, unsuitable irrigation and soil tillage applications and unsustainable cropping design with less amount of residue (Bilgili et al. 2018).

Soil organic matter is the center of soil quality, which is the capability of soils to function well. Soil quality is assessed generally with soil quality indexes which are obtained from the combination of soil physical, chemical and biological quality variables. The qualities of soils should be increased or maintained by activities that may increase the organic matter levels of soils such as application of biochar rich in carbon (Zhang et al. 2017).

The impact of biochar on individual soil quality parameters have been intensively evaluated mostly in tropic and subtropics lands and under controlled conditions. However its impact on soil quality which are directly determine using soil quality indexes in arid and semi arid conditions are less known. More studies are needed for a better evaluation the impact of biochar amendment on soil quality with field experiments under semi arid conditions. Therefore the aim of this study was to evaluate the changes in soil quality indexes of the each parcels treated with different types and doses of biochar before and after biochar application in field conditions under a semi arid climate.

2. Materials and Methods

2.1. Field site and treatments

The research has been performed as field experiment in Agricultural Research Experimental area of the Harran University located in the Harran plain, Şanlıurfa with average temperature, rainfall and evaporation rates of 17.2 °C, 365 mm and 1848 mm. Soils of the experimental area is classified as Vertic Torrifluvent according to Soil Taxonomy (Soil Survey Staff, 2010). Soils are high in clay and CaCO3 but low in soil organic matter (Aydemir, 2001). Split-split plot design was used in the experiment with a total of 108 parcels (3 different biochar materials x 3 different biochar doses x 2 different irrigation rates (65 % and 100 % of field capacity) x 2 different nitrogen doses (N0 and N1) x 3 replications). Two different irrigation application formed main blocks which were divided into subplots for different nitrogen doses; NO and N1. Soil samples were obtained from sub-subplots which received three different biochars doses (0, 0.2 and 0.4 % weight based) as three replicates. Four rows of maize were planted in each plot with the size of 5 m x 3.1 m. Drip irrigation was used for irrigation. In this paper, only parcels underN1 and FC 100 applications were used.

2.2. Methods

2.2.1. Biochars and Biochar Treatment

Biochars were produced from residues of locally grown crops; pistachio shells (PS), corn corbs (CC) and cotton steaks (CS). Biochars were obtained with pyrolysis technique with a final temperature of 550 °C during 24 hours. Crushed and 2 mm sieved biochar were applied into top 20 cm of soils at three different doses at weight bases (0, 0.2. and 0.4 % weight based). Irrigation was performed as drip irrigation system as two different irrigation treatments; full (100 % of field capacity water demand) and limited (65 % of field capacity water demand).

2.2.2. Soil Sampling and Analyses

Disturbed and undisturbed soil samples were taken at 0-30 cm soil depth when soils are at field capacity level and closer to harvest. Samples taken were analyzed for bulk density (Bluke and Hartge, 1986), hydraulic conductivity (Klute and Dirksen, 1986), soil organic matter (Nelson and Sommers, 1982), total nitrogen, soil aggregate stability (Murer et al. 1993), plant available water content (Richards, 1948) and porosity according to Hao et al. (2008) by taking ratio of bulk density to particle density.

2.2.3. Soil Quality Indexes

Soil quality indexes of each parcel was obtained by scoring each soil quality variable on a scale between 0 and 1 using linear and nonlinear scoring functions. after soil parameters were grouped as "more is better" and " less is better "variables. More is better group included all variables except bulk density which was involved in "less is better" group. The NORMDIST function in Excel (Microsoft Office, 2007) was used for scoring soil quality variables according to nonlinear scoring approach. More detailed information about scoring of soil quality parameters and calculation of the final soil quality indexes can be found in the studies by Bilgili et al. (2017) and Bilgili et al. (2019).

Statistical analyses were performed using SPSS software package (SPSS Inc Chicago, USA).

3. Results and Conclusion

In order to compare averages of soil quality parameters and indexes measured in each parcels before and after different types of biochar appplication at different doses, dependent groups t statistics analyses were used. Minimum, Maximum, Mean and Standard deviation, t statistics and corresponding p values of combined effects of differenty types and doses of biochar application on each parcels before and after biochar applications were given in Table 1.

Table 1. Combined effects of different biochar types and doses at soil quality parameters and indexes measured at each parcel before and after biochar application

	n	Minimum	Maximum	Mean	Standard Deviation	Standard Error of Mean	df	t-value	p-value
SOM_BBA	27	1,30	1,56	1,43	0,08	0,01	26	-10,910	0,000***
SOM_ABA	27	1,40	1,65	1,53	0,07	0,01			
AS_BBA	27	33,28	67,71	47,83	6,22	1,20	26	-15,759	0,000***
AS_ABA	27	58,97	73,94	68,29	2,98	0,57			
BD_BBA	27	1,21	1,27	1,24	0,02	0,00	26	2,437	0,022***
BD_ABA	27	1,19	1,25	1,23	0,02	0,00			
AWC_BBA	27	1,35	3,15	2,32	0,50	0,10	26	-35,474	0,000***
AWC_ABA	27	10,69	16,57	13,85	1,77	0,34			
HC_BBA	27	3,28	3,45	3,35	0,04	0,01	26	-1,549	0,133ns
HC_ABA	27	3,18	4,06	3,41	0,20	0,04			
POR_BBA	27	39,24	60,03	53,55	3,55	0,68	26	-4,291	0,000***
POR_ABA	27	51,05	60,92	56,94	2,62	0,50			
SQINL_BBA	27	26,07	53,49	36,67	6,57	1,26	26	-16,277	0,000***
SQINL_ABA	27	50,92	89,15	70,98	8,83	1,70			
SQILN_BBA	27	68,36	75,05	71,54	1,76	0,34	26	-33,218	0,000***
SQILN_ABA	27	84,51	94,15	90,03	2,59	0,50			

SOM_BBA: Soil Organic matter before biochar application; SOM_ABA: Soil organic matter after biochar application; AS_BBA: Agregate stability before biochar application; AS_ABA: Agregate stability after biochar application; AS_ABA: Agregate stability after biochar application; BD_BBA: Bulk density before biochar application; BD_ABA: Bulk density after biochar application; AWC_BBA: Available Water Content before biochar application; AWC_ABA: Availavle water content after biochar application; HC_BBA: Hydraulic conductivty before biochar application; HC_ABA: Hydraulic conductivity after biochar application; POR_BBA: Porosity before biochar application; POR_ABA: Porosity after biochar application; SQINL_BBA: Soil quality Indexes calculated using nonlinear scoring function before biochar application; SQINL_ABA: Soil quality Indexes calculated using nonlinear scoring function after biochar application; SQILN_BBA: Soil quality Indexes calculated using linear scoring function before biochar application; SQILN_ABA: Soil quality Indexes calculated using linear scoring function after biochar application; ** significance level at level of $p < 0.01$; ns: statistically non significant ($p<0.05$); n: number of parcels.

For soil quality parameters such as SOM, AS, BD, AWC and POR measured in the parcels treated with different types and doses of biochars, the differences between before bioachar application and after biochar application were found statistically significant ($p< 0.05$).On the other hand, for HC parameter measured in parcels treated with different types and doses of biochar, the difference between biochar application and after biochar application was not found statistically significant ($p>0.05$).Similarly for soil quality indexes (SQILN and SQINL) that show the combined effects of individual soil quality parameters in each parcels and that were obtained using both linear and nonlinear scoring functions, the differences before and after biochar application were statistically significant ($p<0.01$) (Table 1).

Per cent improvements which were calculated based on mean values of soil quality variables and indexes measured in each parcels before and after biochar application were around 7, 43, 1, 496, 2, 6, 94 and 26 % for SOM, AS, BD, AWC, HC, POR, SQINL and SQILN, respectivelly.

Overall, the differences in all soil quality variables except HC and indexes measured in field experimental parcels treated with different types and doses of biochars before and after biochar application were found statistically significant showing the positive impact of the use of biochar in low soil quality and degraded soils. Up to 94 % of improvements were achieved in soil quality indexes in the parcels after biochar application.

3.2 Acknowledgements

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Rockfall Mappingthrough Kinematic Analysis: The Sample of Kargabedir Tepesi in Ballıkuyumcu, Ankara

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Abstract

Rockfallincidents lead to loss of life and property destruction and are observed in many mountainous regions across the globe.The subject of this paper is to investigate the stability of rock slopes covering an area of 29 hectares in Ballıkuyumcu District, Kargabedir Hill, Ankara.For this purpose, discontinuity properties of relatively fractured and fissured slope-forming rockswere determined and their stability was examinedthrough kinematic analysis in the study area.Unmanned Aerial Vehicle (UAV) derived Digital Terrain Model (DTM) was produced and unstable limits were determined usingRockscience Dips software. As a result, it was observed that planar sliding, wedge sliding, and toppling failure could possiblyoccur in slopes of the region.

Keywords: Landslide, Kinematic Analysis, Discontinuity, Rock Slope

1. Introduction

Landslide denotesa downward movement of slope-forming soil, rock or other materialat a certain depth due to gravity and continues untilreaching a new state of equilibrium(Cruden, 1991).Landslides are among themostcommon types of disasters observed after long-term heavy rainfall insteep topography regions under humid climate conditions (Kaba, 2017). Landslides are also one of the most frequently occurring natural disasters worldwide (He and Beighley, 2008). In context of Turkey, landslides often occur due to climatic characteristics and topographic features and lead to great loss of life and property destruction. Over 95% of all deaths caused by natural disasters do typically result from landslides (Hansen, 1984; Chung at all., 1995). After earthquakes, landslides are the most prevalent and destructive type of disaster; whilst contributing to the formation of floods, they cause a considerable loss of life and property destruction (Kaba, 2017). Amongst the most relevant global factors causing an increase in landslide incidentsare urbanization, improper land use, destruction of forests, effects of climate change and desertification, lack of legislation and supervision (Kaba, 2017).

1.1 Landslide Classification

Many landslide classification systems were developed previously; however, Classification of Varnes (1978) is nowadays the most widely used classification. While classifying landslides, Varnes (1978)put focus on a number of factors, including morphology of slope movements, mechanism of stability, type of sliding material, length of grain, and movement velocity to classify total instabilities.Landslides are generally classified by type of material as rock, debris and soil; and rockfallwasexamined as part of this study.

1.2 Rockfalls in Turkey

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Rockfallsareobserved in East Anatolia, and some parts of Central Anatolia in Turkey. Data obtained by Directorate General of Disaster Affairs (DGDA) Archive displays that 750 rockfallincidents have taken place since 1958. As result of these incidents, 34 people lost their lives and 26.500 houses werenegatively affected andforced to eventually change their places.Table 1 provides an overview of the 15 provinces revealing the highest risk and danger to rockfallsin Turkey.

Table 1. Provinces most exposed to rockfalls (Ergünay, 2007)

#	Province	Number of Incidents	Population at Risk
1	Kayseri	34	10000
2	Niğde	28	8400
3	Erzincan	20	6000
4	Aksaray	18	5400
5	Karaman	17	5100
6	K.Maraş	16	4800
7	Adıyaman	16	4800
8	Sivas	14	4200
9	Bitlis	13	3900
10	Diyarbakır	12	3600
11	Nevşehir	12	3600
12	Mardin	10	3000
13	Malatya	9	2700
14	Hakkari	9	2700
15	Kars	7	2100
Total		235	70300

2. Methodology

2.1 Creating a Digital Elevation Model (DEM)

In order to create a high-resolution Digital Elevation Model and orthophoto of the study area, an autonomous flight was performedthrough Drone Harmony and UAV flew at an altitude of 50 m, with atransversal and longitudinal overlap of 80%.A total of 739 images with an orthophoto resolution of 2.197 cm were produced in office environment with the help of Pix4D software. A digital elevation model with a resolution of 50 cm x 50 cm was createdbased on the generated point cloud.

2.2 Conducting Kinematic Analysis

During the field study, 98 discontinuity measurements were conducted for kinematic analysis. Discontinuity sets were determined using Rocscience Dips software from discontinuity measurements. Considering current discontinuity sets, slope dip and dip directionranges within which planar sliding, wedge sliding and toppling (three different instability problems) could occur were determined.Dip and dip directionswere produced based on DEM using neighboring-cell method. Slope dip and dip directionwere classified as “1 (yes)” or “0 (no)” so that three different instability types couldbe obtained. As discontinuity occurs only whendip and dip direction classes have a value of “1”, source areas were generated for each stability type by multiplying mathematically the dip and dip directions (Table 2).

Table 2. Instability conditions due to dip and dip direction

Dip	Dip Direction	Instability Conditions
0	0	0 – not expected
0	1	0 – not expected
1	0	0 – not expected
1	1	1 – expected

2.3 Preparing a RockfallSusceptiblityMap

As result of kinematic analysis, engineering parameters were produced. Included in these are trajectories followed by rocks, splash heights and flow velocities that will be detached from determined welding regions. The final version of rockfall **susceptiblity** maps were prepared based on these data.

3. Results and Conclusion

In this thesis, Kinematic Analysis Method was used to examine the types of unstable occurrences that might occur in the rocky area of Ballıkuyumcu District, Kargabedir Hill, Ankara. The Kinematic Analysis Method was firstly described by Hoek and Bray (1981), developed by Goodman (1989) and reconstructed by Wyllie and Mah (2004). This method is usedto investigateplanar sliding, wedge sliding, and toppling failure of rock slopes (Karaman, 2013). As such, planar sliding, wedge sliding, and toppling failurewere investigated in the study area. Furthermore, slope dip and dip directionof discontinuity properties thatpossibly lead to instability, and internal friction angle (Φ) of discontinuity surface were used as input parameters in the analysis. Input parameters necessary for kinematic analysis were providedthrough measuring discontinuities in rock slopes in the region. Dip and dip directions of measured discontinuities were then processed in stereonets using Rocscience Dips; and large circles and poles of sets were obtained (Figure 1).

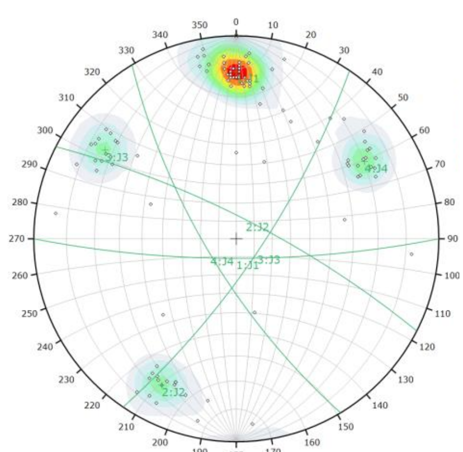

Figure 1. Representation of discontinuities of the study area on an equal-angle stereonet

After drawing a large circle for slope on the same stereonet and plotting the internal friction angles of the discontinuities on the stereonet, an evaluation was madewith regard to theidentification of instability condition. The limit slope parametersconstituting the kinematic discontinuity conditionsfor existing discontinuity setswere evaluated separately for each failure type; namely planar sliding, wedge sliding and toppling failure. As a results of the analysis, it was determined that planar sliding failure tend to occur when the following conditions are encountered: (i) slope dip direction is between 160° and 200°, slope dipis higher than 79°;(ii) slope dip direction is between 7° and 47°, slope dip is higher than 78°; (iii) slope dip directionis between 104° and 144°, slope dip is higher than 77°; (iiii) and slope dip direction is between 219°and 259° and slope dip is higher than 73°.

Slope parameters for the4 discontinuity sets causing wedge sliding were determined. According to these parameters; it was observed that no wedge-sliding failure occurred in cases where the slope dip ranges between 0° and 46°.If the slope dip direction ranges between 47° and77°, then wedge-sliding occursbased on different slopedip directions. If the slopedip direction is 78° and above, then wedge-sliding occurs regardless of theslope dip direction.

Toppling failure, on the other hand, tends to occur when the following conditions are encountered: (i) the slope dip direction is between 340° and 020° and slope dip is higher than 41°; (ii) slope dip direction is between 187°and 227° and slope dip is higher than 42°; (iii) slope dip direction is between 284°and 324° and slope dip is higher than 44; (iii) and slopedip direction is between 039°and 079° and slope dip is higher than 47°.

In the context of thisstudy, Unmanned Aerial Vehicle (UAV) derived Digital Terrain Model (DTM) was processed, andsource region maps wereproduced for cases providing deflection conditionsfor planar sliding (Fig. 2-a), wedge sliding (Fig. 2-b) and toppling failure (Fig. 2-c).

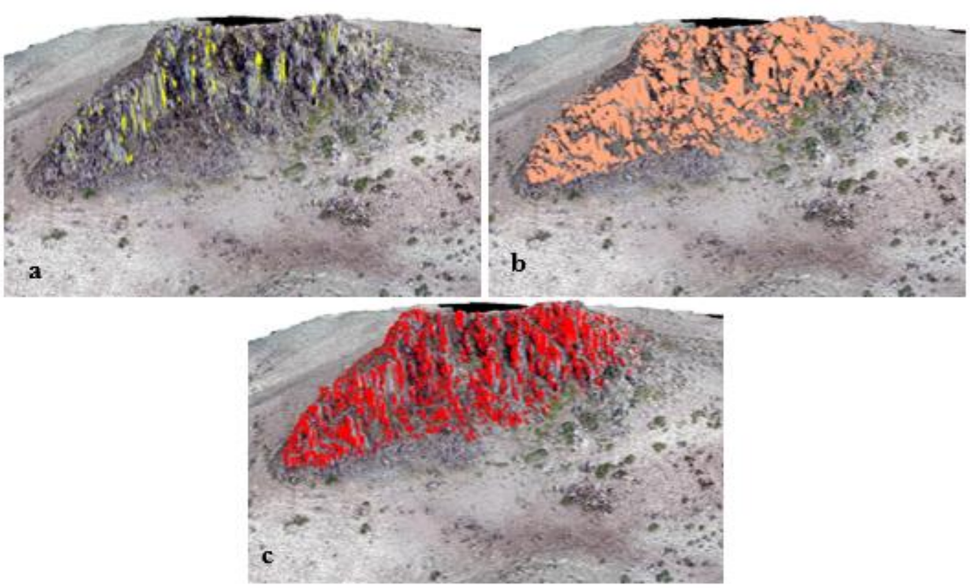

Figure 2. Rockfall Starting Zone Map
(a) Planar Sliding (b) Wedge Sliding (c) Toppling Failure

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Model-Based System Foranalysing Wind Erosion Risk in Turkey

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Abstract

Land degradation closely correlated with the current trend of climate change is one of the most important environmental problems in the world. The most sensitive areas to land degradation are primarily arid, semi-arid and semi-humid regions, and along with drought,wind erosion is one of the dominant degradation processes in these areas. The geographical location of Turkey makes the country quite prone to both drought and wind erosion, indicatingan urgent need for assessing their interactive risk at national scale considering all relevant factors of climate, soil, topography and vegetation.Especially during the dry periods of year,lack of sufficient vegetative coverto protect soil surface in semi-arid pastures and rain-fed agricultural lands,poses a great threat resulting from wind erosion. As a consequence of global warming, untimely rains and droughts are occurring in Turkey, which will further exacerbate the risk of erosion processes by wind and water. Because of this high expectation, the conceptual framework of land degradation neutralization (LDN) signifies aridificationand wind erosion as key degradative processes that need to be counterbalanced.For this reason, estimating soil loss occurring from wind erosion at the national level has been targeted, and the built system is named as UDREMIS acronymically in Turkish was created byGeneral Directorate of Combating Desertification and Erosion (GDCDE). This will help develop effective protection methods in the arid and semi-arid areas of Turkey and sustainable resource utilization can be promoted, too. Keeping these goals in mind, dynamic, up-to-date data sets werecollected to estimate the total land area exposed to wind erosion in Turkey using the Revised Wind Erosion Equation (RWEQ) as a prediction model. Eventually, model-based risk assessment was achieved and a map of this was successfully generated at the national scale depicting class boundaries defined by quantitative soil losses from wind erosion.Information onthe RWEQ model structure and national predictive system used to determine the temporal and spatial extentof wind erosion risks are briefly given in this paper.

Keywords: Wind Erosion, RWEQ Model, National Prediction System

1. Introduction and Objectives

Previous areal statistics reports that wind erosion susceptible land covers an area of 465, 913 ha in Turkey, being affected by varying extents of soil losses from wild to very severe, Approximately 70% (322,474 ha) of this area is located within the provincial boundaries of Konya and Karapinar districts (Ozdogan, 1976; Abali et al., 1986). According to Ozden et al., (1998) 330,000 ha land in Turkey is affected by wind erosion and Okur (2010) argues that almost one-third of the affected area (103,000 ha) is in the Karapinar district. In addition, there is no yearly statistical data on variation of wind erosion effects with time.

Recently, physical and mathematical models successfully applicable from plotsize to basin scale have been used in Turkey. In order to effectively combat wind erosion and to minimize its damages by effective future sustainable planning approaches, it is necessary to predict possible erosion threats under the evaluative

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scenarios on a regional or national scales. Moreover, model-based erosion studies havebecome a necessity in Turkey to plan erosion control measuresat different spatial scalesas technologies of Sustainable Land Management (SLM) and Sustainable Soil Management (SSM) are increasingly gaining more weightin land use planning (Erpul et al., 2016).Over the past couple of decades, the area affected by climate change-induced drought and intensity of wind erosion observantly tends to increase especially in both agricultural and grazing areas of Turkey. Therefore, a project has been initiated by the General Directorate of Combating Desertification and Erosion (GDCDE) to assess the degree of wind erosion risk and its countrywide spatial interactions to proactively contain possible forthcoming threats. This study outlines the structure of the national RWEQ-based predictive system along with its spatial and temporal assessments on wind erosion distribution over catchments as map surfaces.

2. Materials and Methods

The national wind erosion estimation system of the GDCDE is based on the Revised Wind Erosion Equation [RWEQ], Fryrear vd., 2000). It is a dynamically updateable system fed by natural resource data sets of relevant state institutions and integrated by Remote Sensing and GIS to a certain extent. Given the fact that, relying strongly upon the past studies of the wind erosion assessments, it extensively occurs distributively in the flat and bare areas having sandy soils during poor vegetation cover in dry seasons, the system physiographically delineates the plains of Turkey using slope classes ≤ 6% for estimating soil losses by wind erosion processes (Figure 1).

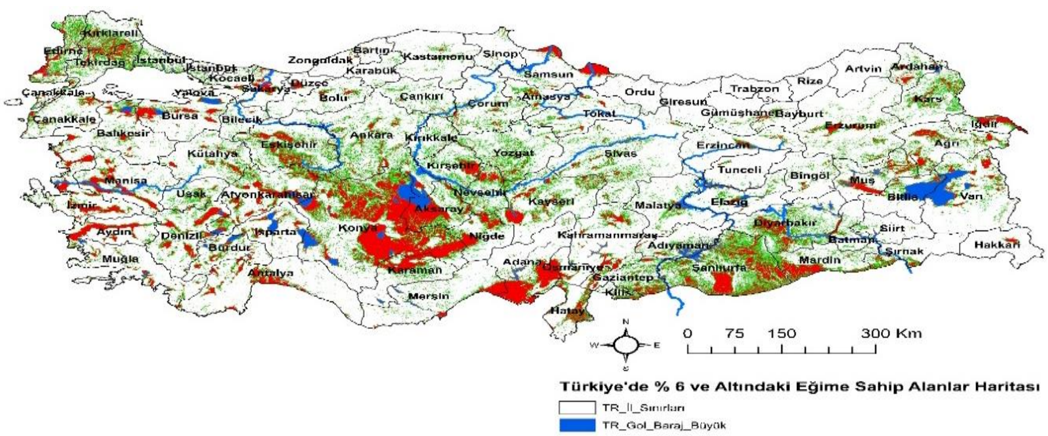

Figure 1. The Map of Potential Wind Erosion Risk Areas in Turkey in terms of topography (Slope Map of Turkey - sloping fields of ≤ 6%)

Figure 2 shows the user interface of the UDREMIS in whichthe necessary calculations areconductedfor all Turkey and when needed, the requireddata set can be produced for anydesired specific location, especially for the province and basin scales. In addition to optional spatial analysis, temporal analysis is performed within certain time intervals, as well.

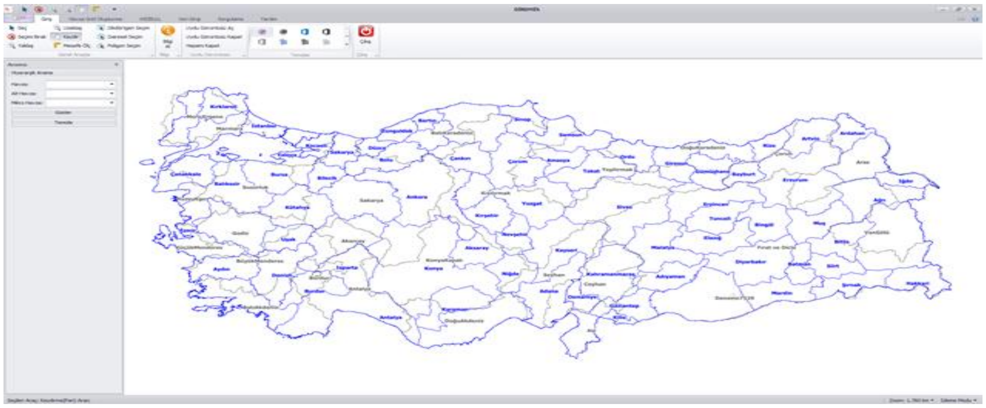

Figure 2. User Interface of the UDREMISsoftware

2.1. Revised Wind Erosion Equation Model (RWEQ)

The 'Wind Erosion Equation' (WEQ) was developed by Woodruff and Siddoway (1965) as first of all pioneering large-scale wind erosion models. Afterwards, the WEQ model was revised in 1998 as RWEQ, which is a combination of experimental and process-based modeling tools to predict soil loss in agricultural areas (Fryrear et al., 1998; Fryrear et al., 2000) and estimates wind-blown sediment flows at the heights from the soil surface up to 2 m in the field scale. Four main factors and associated sub-parameters of the RWEQ together with source databases arein extensortabulated in Table 1 and its structure is schematically portrayed by Figure 2.

Table 1. Main factors and sub-Variables of the RWEQ model along with their relevant databases

RWEQ FACTOR	SOURCEDATABASES	SUB-VARIABLES
Climate	Data recorded by OMGI of MGM	Station number, station name, province, latitude, longitude, altitude, year, month, day, hour, minute, direction data number, speed data number, half hour average wind direction in degrees, half hour average wind direction, half hour average wind speed and threshold wind speed
Soil	Results from soil samples analysis	Sand, silt, clay, organic matter, amount of $CaCO_3$ (%)
Vegetation	Satellite images (USGS Landsat_8 satellite images, 30*30m resolution)	Vegetation and vegetation-related soil loss rate (%)
Topography and Roughness	CORINE 2012 and Numerical Elevation Model (1/25.000)	Fields with slope equal and less than 6%, roughness coefficients

*OMGI: Automatic Meteorological Monitoring System; MGM:General Directorate of Meteorology

In order to determine the potential erosion risk, the RWEQ uses the cube of either wind friction speed or wind speed at reference height, as in the other transport equations as well. In our RWEQ calculations at larger scales, we used an overall threshold wind speed of 5 ms^{-1} at the reference height of 2 m since describing the threshold wind speeds requires in-situ detail measurements of wind velocity profiles variable with all kinds of surface roughness elements such as those that could stem from vegetative growth stages, regular soil tillage operations and aggregate and particle size distribution.The RWEQ model estimates the average of the soil lossfrom a described land unit using the equations given by Eq. [1], [2], [3] and 4 (Borelli et al., 2016):

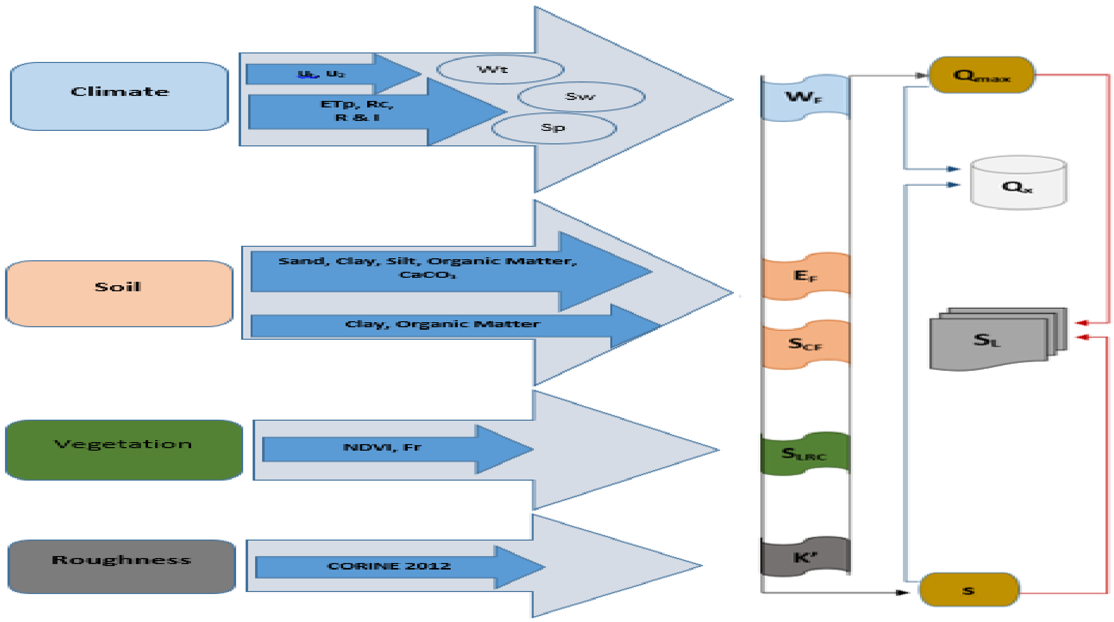

Figure 3. The flow chart to calculate soil loss by theRWEQ model (Fryrear vd., 1998; Youssef vd., 2012)

$Q_x = Q_{max}[1 - e^{-\left(\frac{x}{s}\right)^2}]$ (1)

Where Q_x (kg m^{-1}), mass transport at a specific downwind distance (x, m); Q_{max}, maximum transportcapacity (kg m^{-1}); ands is the critical field length (m) at which the 63% maximum transport capacity Q_{max}(kg m^{-1}) is reached.

$SL = \frac{2x}{s^2} Q_{max}\, e^{-\left(\frac{x}{s}\right)^2}$ (2)

Here, SL, Soil Loss (kg m^{-2}) . $Q_{max}$and s are calculated by Eq. [3] and Eq. [4], respectively:

$Q_{max} = 109{,}8\ (W_F * E_F * S_{CF} * K' * S_{LRC})$(3)

$s = 150{,}71\ (W_F * E_F * S_{CF} * K' * S_{LRC})^{-0{,}3711}$(4)

Where W_F, Weather Factor; E_F, Soil Erodible Fraction; S_{CF}, Soil Crust Factor; K ', Soil Roughness and S_{LRC} refers to the Combined CropFactor.

*The W_F of Eq. [3] was obtained from wind database of GDCDE UDREMIS that generates min, max and mean velocities in 16 wind directions using Weibull Probability Distribution Function (WPDF) at different temporal scales based on long-term data of OMGI scattered throughout our country.

*The data set of 14 801 GPS-coordinated soil surface samples collected and recorded by different institutions and organizations were used for calculating both Wind Erosion Soil Crust Index (S_{CF}) and Wind-ErodibleFraction (E_F) as soil factors (Eq. [3]).

*Landsat_8 Satellite Images produced by the USGS (United States Geological Survey) with a resolution of 30m x 30m, was used todetermine the Wind Erosion Vegetation Factor (S_{LRC}), which proportionally indicates the effect of vegetative cover on the rate of soil loss.

*CORINE (COoRdinate INformation on the Environment) 2012 data was made use of defining soil roughness factor (K') and accordingly 14 different terrain roughness coefficients were assigned for relevant 44 land use classes on pre-delineated hexagonal area of 25 ha of CORINE map.

3. Results and Conclusion

As shown in Figure 4, as a result of calculations and evaluations created using the corresponding equation in theNational Dynamic Wind Erosion Model and Monitoring System software, Map of the Amount of Sediment Transported by Wind Erosion in Turkey (kg m^{-2} yr^{-1}) was obtained.

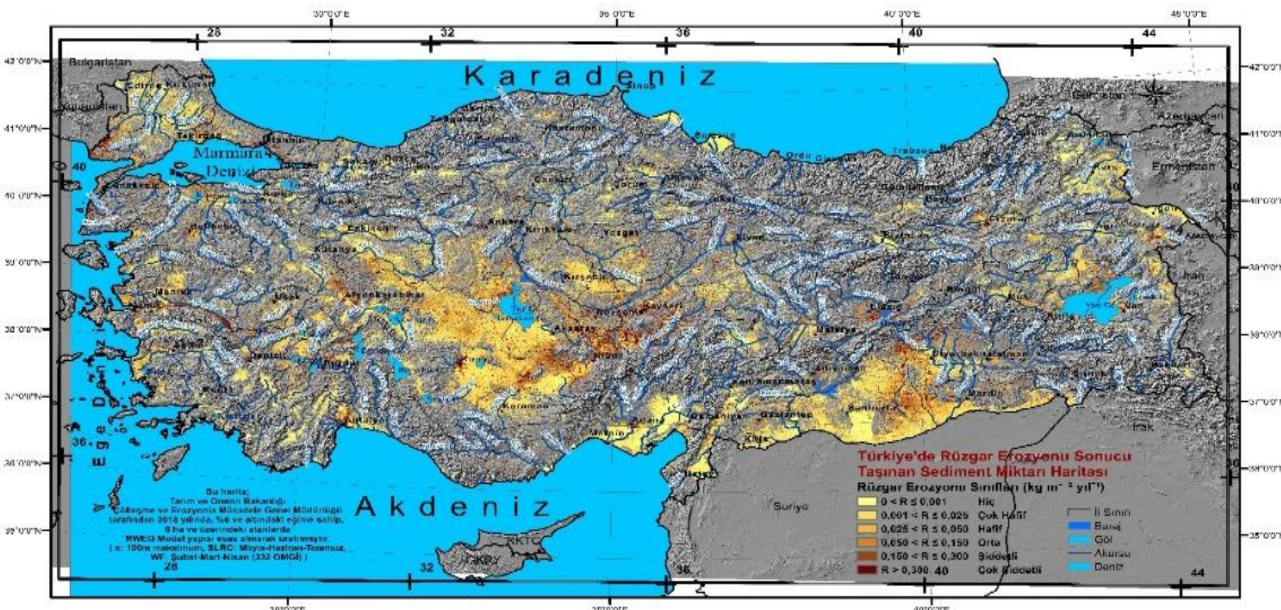

Figure 4. National wind erosion map of Turkey generated by the RWEQ model

A wind erosion map produced by the RWEQ model-based UDREMIS is picturedin Figure 4 and its results showed that approximately 1.3 million ha areas in Turkey have been extremelyaffected by the wind erosion (Table 2). Table 2 additionally tabulates that Dicle-Firat, Kizilirmak and Konya basins, respectively, are the highest three basins that were spatially affected by wind erosion because of their drought conditions among great basins in Turkey. On the other hand, Western Black-Sea, Eastern Black-Sea and Coruh basins that were under wind exposure areas but not extremely wind erosion occurred because they have enough vegetation cover beside adequate rainfall and soil moisture.

The wind erosion map of Turkey generated by the RWEQ model (Figure 4) using RS and GIS along with limited data sets of soil and vegetation might be considered as the first approximative layer at national and basinal scales, the values of which on wind erosion severity classes should be validated and verified by studies at smaller scales with detailed data entries.UDREMIS software has been dynamically designed in accordance with continuous data entry, and the sensitivity of the model results is expected to increase when OMGI data areintegrated into the system more regularly and as new soil sampling information and data sets starts feeding back into the system to reduce possible statistical variations and errors.

Table 2. Spatial distribution of potential wind erosion risk classes specified by the 25 principal river basins of TurkeyTable of Wind Erosion in Main River Basins

Basin Name / Wind Erosion Intensity (kg m^{-2} yr^{-1})	No (0 – 0.001)	Very Sight (0.001 – 0.025)	Slight (0.025 – 0.05)	Moderate (0.05 – 0.15)	Severe (0.15 – 0.30)	Extreme (0.30 - +)
Akarcay	68.266,80	121.317,03	30.343,95	37.222,47	16.156,98	19.947,24
Antalya	84.555,09	110.873,52	21.367,62	34.190,55	19.530,54	30.492,81
Aras	282.292,83	310.321,62	33.328,44	25.675,56	11.195,28	11.564,46
Asi	72.027,54	114.180,30	12.955,77	20.978,73	8.092,62	8.046,99
Western Mediterranean	124.530,75	103.720,05	11.886,84	13.719,33	5.256,99	7.780,32
Western Black Sea	104.090,58	49.474,80	8.444,88	7.760,97	2.899,35	3.701,34
Burdur	15.162,84	73.513,17	24.251,31	30.316,23	10.622,61	21.346,29
Buyuk Menderes	121.550,49	253.623,78	89.717,67	85.369,41	36.060,03	51.569,28
Ceyhan	295.133,22	202.724,19	26.056,53	22.473,63	9.762,30	9.432,90
Coruh	20.943,72	33.822,99	4.844,88	3.700,71	1.400,49	1.808,37
Dicle-Firat	635.495,22	1.740.632,94	448.925,67	495.919,53	188.067,51	**265.259,88**
Eastern Mediterranean	61.122,06	50.856,75	13.160,70	19.809,90	6.469,02	6.980,22
Eastern Black Sea	5.476,50	4.560,84	1.097,19	1.578,06	1.063,08	3.658,59
Gediz	52.803,45	110.979,63	37.836,99	51.864,75	32.182,74	62.650,26
Kizilirmak	296.928,09	668.650,14	239.262,57	290.850,21	115.795,44	**198.444,78**
Konya	332.864,73	1.108.820,52	416.047,59	458.985,33	151.930,71	**156.253,95**
North Aegean	15.561,09	75.049,83	18.799,02	31.400,37	20.692,08	35.644,32
Kucuk Menderes	43.721,82	50.480,64	14.429,43	23.069,97	10.876,05	25.688,43
Marmara	59.399,46	122.376,15	37.828,80	62.763,30	37.945,71	82.496,61
Meric	210.017,34	343.916,46	69.441,66	74.307,78	34.011,72	47.316,51
Sakarya	414.099,81	803.453,58	243.538,38	301.827,33	56.324,52	70.827,30
Seyhan	133.903,71	119.345,76	30.109,05	48.770,10	32.358,51	72.347,13

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Assessing Erosion Control Ecosystem Service of Olur State Forest Enterprise

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Abstract

Forests offer a myriad of benefits to people including cultural, provisioning, and regulatingecosystem services (ES). Erosion control, as a regulating ES, is of crucial importance to sustainable use of soil and land resources toward land degradation neutrality (LDN) vision, especially for countries suffering from severe erosion rates such as Turkey. In this context, future-capable forest management needs to assess this ES in a spatially explicit manner to integrate it into planning processes, since forest ecosystems are very effective for combatting soil erosion when properly managed. The present study, therefore, aims to develop useful indicators for assessingerosion control service of forests located in Olur District of Erzurum, Turkey. To this end, 146 systematically selected sampling plots were visited in OlurState Forest Enterprise. Measured variables were tree height, diameter at breast height, stand age, increment, canopy closure, and dead trees for forest inventory purpose. In addition to standard inventory, measurements for erosion-related variables were also performed including surface stoniness, surface roughness,the thickness of litter layer, height and closure of understory, basal area, number of snags,slope degree and its length, soil moisture, and any observed erosion type during the field surveys. Finally, disturbed topsoil samples were collected in each plot at a 0-15 cm depth and taken to the soil lab for analysis. The study results revealed several relationships between biophysical and soil-related variables. Pearson's r coefficient showed that there was a positive relationship between soil erodibility (K-factor) and closure of understory within forest (r=0.39). Soil OM content, on the other hand, showed stronger correlation both with canopy closure (r=0.66), and thickness of litter layer (r=0.46)as well as stand height (r=0.43). Furthermore, ANOVA results showed that the soils of conifer forests contained more OM than the mixed as well as the deciduous ones. Aside from forests, environmental variables such as surface roughness, surface stoniness, slope, and elevation were key indicators in other land cover types, too. Taken together, all these indicators can be used for a quick assessment of erosion control ES within OlurState Forest Enterprise. Thus, soil loss could be controlled by appropriate forest management. A high canopy closure, for instance, could easily be achieved by reducing the thinning intensity or extending the rotation periods. Alternatively, rehabilitation activities could be another short-term strategy for both degraded and sparsely-closed stands. However, these are site-specific recommendations and need to be tested in other regions of the country. By doing so, the forestry sector in Turkeywill be able to integrate the key ESs into management plans and help to achieving the national LDN targets up to 2030.

Keywords: Soil protection, Erosion prevention function, Soil loss, Forest management planning

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Organic Matter Distribution in Aggregate Fractions and Affecting Soil Structural Parameters

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Abstract

In this study, eighteen soil samples were classified according to their organic matter (OM) contentswithin the 6 different classes as follows; <1% OM, 1 to 2% OM, 2 to 3% OM, 3 to 4% OM, 4 to 5% OMand >5% OM. Five different size of aggregate fractions (<0.25 mm,0.25-0.50 mm, 0.50-1.00 mm,1.00-1.40 mm and >1.40 mm) were obtained with dry sieving of the soil samples. Organic mattercontent in each size of the aggregate fraction was determined.Mean weight diameter (MWD) andaggregate stability (AS) of each soil samples were also determined as soil structural parameters. Ineach soil class, the highest OM content was generally determined in the smallest size (<0.25 mm) group of aggregates. OM contents in the aggregates decreased with increasing the aggregate size.While the highest mean OM content (4.81%) was determined in <0.25 mm aggregate size, the lowestOM content (2.36%) was determined in >1.4 mm aggregate size. Mean weight diameter of the soilsamples significantly increased from 0.663 mm to 0.903 mm with increasing mean OM content of thesoil samples from 0.53% to 6.81%. Also, AS values significantly increased from 60.01 % to 86.89%with increasing soil OM content. Soil OM content gave significant correlations with MWD (0.769**) andAS (0.736**) at 1% level. MWD values also significantly correlated with AS (0.748**). According tothese results, it can be concluded that humus distribution in aggregates is generally abundant insmaller size of aggregate fractions and play important role on soil structural development.

Keywords: Humus, mean weight diameter, aggregate stability, aggregate fractions

1. Introduction

Soil quality is important for sustainablecrop production on agriculturallands. Dry and water-stable aggregate contents and their size distributions in soil affect the soil quality.The aggregation of soil particles not only increases soil quality and fertility, but also increases the efficiency of nutrients and water use (Byung et al., 2007). The aggregates are mainly formed by physical processes; afterward, biological and chemical processes are principally responsible for their stabilization (Allison 1968; Lynch and Bragg 1985). Soil aggregation is related to soil properties such as amount of soil organic matter, biological activity, infiltration of water, water holding capacity, aeration and availability of nutrients (Six et al., 2004; Pirmoradian et al., 2005). There is a close linear relationship between organic carbon content and water stable aggregates in various soils (Angers, 1992; Carter, 1992). Soil organic matter (OM) is one of the main aggregating agents of soil particles (Nunes et al., 2010).Organic matter also influences soil structure and stability by binding soil mineral particles, reducing aggregate wettability, and influencing the mechanical strength of soil aggregates, which is the measure for the coherence of inter-particle bonds (Tisdall and Oades 1982; Onweremadu et al., 2007). Albiachet al. (2001) showed that five different organic waste applications increased aggregate stability of soils. Gülser (2006) found that six different forage cropping treatments increased organic matter content, aggregate stability and mean weight diameter in the clay soil.It has been demonstrated by many researchers that the organic matter addition to the soil improves soil structural parameters(Karamiet al., 2012; Sun and Lu, 2014; Gülseret al., 2015).There arefew studies about properties and

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functions of physically separated soil organic matter fractions changing with aggregate size (Six et al. 2001; Puget et al. 2000).

The objective of this study was to determine the distribution of soil organic matter in different aggregate size fractions and to investigate relationshipsamong soil organic matter content and structural parameters.

2. Material and Method

In this study, eighteen different surface soil samples (0-20 cm) were used. The samples were air-dried,crushed, and passed through a 2-mm sieve.Particle size distribution was determined by hydrometer method (Day, 1965), soil reaction (pH, 1:1 (w:v) soil:water suspension) by pH meter, electrical conductivity (EC25ºC) in the same soil suspension by EC meter, organic matter in the soil samples by Walkley-Black method (Kacar, 1994). Aggregate stability (AS) was determined for soil samples using a wet sieving method (Kemper and Rosenau, 1986).In the dry sieving, 100 g of air dry soil sample was sieved using a nest of sieves with mesh openings of 2.00, 1.40, 1.20, 1.00, 0.50, 0.425 and 0.25 mm respectively, and a shaking at 200 rpm for 1 min.Organic matter content in each fraction size was also determined. Mean weight diameter (MWD) was calculated from weights of aggregates retained in each size class with the equations (Hillel, 1982):$MWD=\sum W_{(i)}X_i$. Where W(i) is the proportion of the total dry sample weight, X_i is the mean diameter of any particular size range of aggregates separated by sieving and equal to $(X_i + X_{i-1})/2$.The variance analyses of the data and correlations amongthe soil propertieswere completed by using SPSSprogramme.

3. Results and Conclusion

Some physical and chemical properties of the soil samples are given in Table 1. The clay content of the soil samples varied between 5.63% and 28.72% with a mean of 16.06%. Soil samples varied between ultra-acid and neutral in pH (1:1), and non-saline according to the EC values (Soil Survey Staff., 1993). Soil OM contents varied between 0.34% and 8.41% with a mean of 3.31%.

Table 1. Descriptive statistics of the soil properties

	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Clay, %	5.63	28.72	16.06	6.23	0.134	-0.481
Silt, %	8.69	31.57	23.04	4.78	-1.332	4.412
Sand, %	44.09	74.94	60.89	9.46	-0.291	-0.867
pH(1:1)	4.25	6.66	5.45	0.71	0.396	-0.411
EC, dS/m	0.047	0.34	0.14	0.08	1.139	0.865
OM, %	0.34	8.41	3.31	2.12	0.729	0.487
AS, %	52.84	91.85	72.80	10.35	-0.143	0.059
MWD, %	0.61	0.93	0.78	0.10	0.160	-1.412

Descriptive statistics of the organic matter content of each fraction size is given in Table 2. Soil OM content in the small fractions was higher than that in the big fractions. While the highest OM (12.92%) was determined in the smallest fraction size (<0.25mm), the lowest OM (0.10%) was in the biggest fraction size (2.0-1.4 mm). It was determined that mean OM content significantly decreased from 4.81% to 2.36% with increasing mean aggregate fraction size from 0.25 mm to 1.70 mm (Table 2).Soil samples were classified within 6 groups according to their

OM contentsas follows; <1% OM, 1-2% OM, 2-3% OM, 3-4% OM, 4-5% OM and >5% OM. In each soil group according to OM, the highest OM content generally found in the smallest size fraction (<0.25 mm) and OM content reduced with increasing the fraction size of aggregates (Figure 1). Total organic matter content of the soil samples did not show an effect on the distribution gradient of OM in different fraction size. Although the amount of OM content in each fraction size increased with increasing soil OM content, the decreasing gradient in OM content was determined with increasing the fraction size in each soil group. However, some researchers reported that soil organic C was strongly correlated with macroaggregats, and the amount of organic C in macroaggregates were greater than in microaggregates (Kushwaha et al., 2001; Gülser et al., 2015).

Table 2. Organic matter content (%) distribution in different fraction sizes of the soil samples (n=18)

Fraction size, mm	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
<0.25	0.84	12.92	4.81 a*	2.89	1.48	2.67
0.25-0.50	1.05	11.27	4.40 ab	2.63	1.19	1.75
0.50-1.00	0.55	8.02	3.37 ab	2.09	0.87	0.35
1.00-1.40	0.49	8.04	3.10 ab	2.30	0.93	-0.41
2.00-1.40	0.10	6.39	2.36 b	1.85	1.01	-0.18

*significant at 0.01 level.

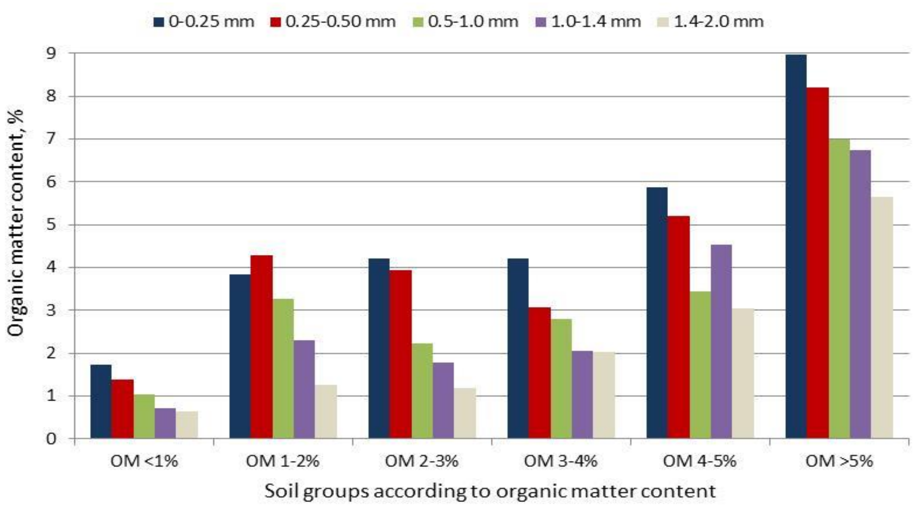

Figure 1. Distribution of organic matter (OM) content in different aggregate size fractions according to soil groups including different total OM levels

Mean weight diameter (MWD) of the soil samples varied between 0.61 mm and 0.93 mm with a mean of 0.78 mm (Table 1). MWD values of soil groups significantly increased from 0.66 mm to 0.91 mm with increasing mean OM content of soil groups from 0.53% to 6.82% (Figure 2). A significant positive correlation (0.632**)was determined between soil OM content and MWD. Gülser (2006) determined that increasing soil OM content by the different forage cropping increased the MWD of clay soil, and there was a significant positive relation between organic C and MWD. Kushwaha et al. (2001) reported that increasing soil organic carbon in macroaggregateswith tillage reduction increased theMWD of aggregates over control treatment.

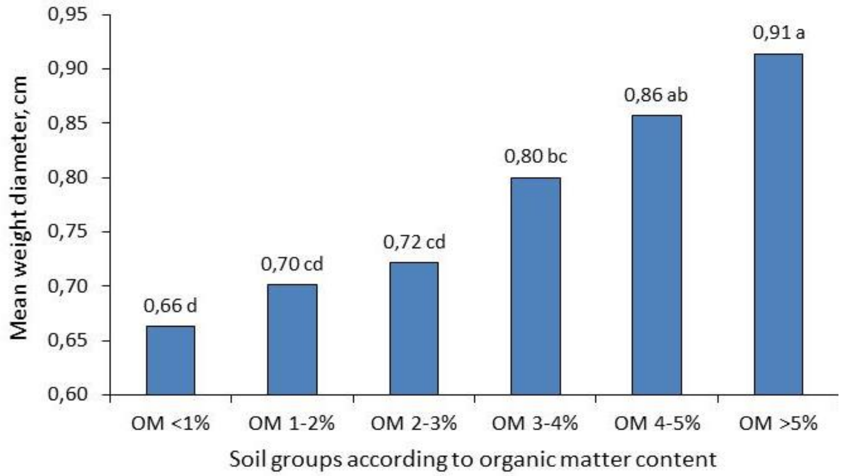

Figure 2. Changes in mean weight diameter of different soil groups including different total OM contents

Aggregate stability (AS) values of the soil samples varied between 52.84% and 91.85% with a mean of 72.80% (Table 1). Mean AS values of soil groups also significantly increased from 60.0% to 86.90% with increasing mean OM content of soil groups (Figure 3). Mean AS values had significant positive correlations with soil OM content (0.709**) and MWD (0.819**). The positiverelationship between organic matter and aggregate stability hasbeen given in numerous studies (Tisdall and Oades,1982;Gülser 2006; Candemir and Gülser 2007; Gülser and Candemir 2015; Gülser 2018). Haynes and Beare (1997) reported that the positive effect of forages on soil structural stability was related to increasing levels of soil organic C, microbial biomass, carbohydrates, fine roots and fungal hyphae.Gülser (2006) found that increasing organic C content of clay soil by forage cropping improved soil structural stability, and there was a significant positive relation between MWD and AS.

As a conclusion, total organic C content in soil is very important to improve soil structural parameters. Increasing total soil OM content of soils increased MWD and AS values of soils classified in different OM levels. It was determined that humus or soil OM distribution in aggregates is generally abundant in smaller size of aggregate fractions compared with the bigger size of aggregates. Soil OM content plays an important role on soil structural development, and should be enhanced with agricultural practices for sustainable soil management.

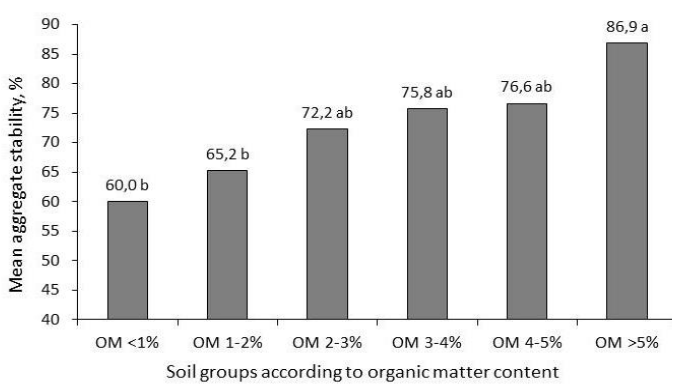

Figure 3. Changes in mean aggregate stability of different soil groups including different total OM contents

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Importance of Soil Quality Parameters in Land Use Planning, Case Study: Kösrelik Pond Recreation Area

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Abstract

In order to ensure sustainable development, land should be planned in line with the potentials of the land and should be used by considering the quality parameters of the soils. Thisshould not be overlooked in all types of land use planning and agricultural activities. In this context, as a sample study, AnkaraKösrelik Pond Recreational Area is selected. 10 surface soil samples were collected from the study area,4 soil profiles were opened and all necessary quality parameters were analyzed. Erosion risk maps were prepared according to CORINE Methodology. 62% of the study area was found to have a high risk of actual erosion. In terms of soil quality, 83% of the total area has low quality soils. In the planning of the land use which was carried out by trying not to deteriorate the natural structure, 41 da is planned asagricultural field, 10.7 da is planned as the picnic area, 100 da as the green field in, 28 da as the rocky garden, 13.6 da as the organic horticulture and 5.7 da is planned as organic vegetable field. Natural plant species that are Astragalus microcephalus, Nepetaitalica, Ferulago sp., Salvia verticillatamust be protected. It is recommended to cultivate barley, wheat, fruits and vegetables in areas planned as agricultural land; larch, cedar, almond, spindle, mahaleb suitable for the region in areas planned as afforestation area.

Keywords: Land use planning, Soil quality parameters, Kösrelik Pond

1. Introduction

In order to sustain life, the importance of dependence on natural systems is inevitable. This situation can often disrupt the ecological balance and damage natural resources. Land use plans must be carried out in order to protect natural sources that are gradually decreasing and being disrupted in parallel with the increasing population and developing technology and to use them in the most efficient way. The land should be plannedaccording to their talents and potentials, the characteristics they carry and the potentials in areas of usage.

In this study, the necessary soil quality parameters were analyzed and planning of the study area was made according to the CORINE Method, from different maps with the logic of layer overlap. By determining the positive and negative characteristics of the land, soil quality parameters were investigated and the properties of the plants that were intended to be cultivated were investigated and appropriate planning and plant selection was made.

2. Materials and Methods

As an exemplary study area, the Ankara Province Kösrelik Pond recreation area which covers an area of 65 ha was selected. The climate data of the last 30 years have been taken from Ankara Meteorological Station, which

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has been measuring since 1926.In this region that is ruled by typical continental climate conditions, it is determined that the average annual precipitation is 402.6 mm, the highest average temperature is 40.8ºC and the lowest average temperature is-21.5ºC. The periods when the temperature drops below +8 degrees are considered to be the end of the vegetation period. The planting period in Ankara starts on 20 April and ends on 4 November (Özbek 1993).The rocks in the study area are; in the forms of high claystone, konglemerabrecci, sandstone, silicified veined rocks. Natural vegetation are Artemisia (Pelin), Thymus (Thyme), Gramineae (Grain), Peganumharmala (Onlik), Astragalus, Acantholimon (Hedgehog), FestucaValesiaca (Sagebrell), Onobrorychis-cheiranthifolium (Sainfoin), Varbascum- cheiranthifolium (beef tail), Pinusnigra (Black pine-larch), quercuspubescens (Hairy oak), Juniperusoxycedrus (Juniper-thrush), CedrusLibani (Lebanese cedar) and natural bushes (Anonymous 2012).

Ten soil samples were collected from the study area and from foursoil profiles that were opened. % Lime ($CaCO_3$), Total Nitrogen (N), AvailablePhosphorus (P_2O_5), Extractable Potassium (K_2O), Water Soluble Boron (B), Sodium (Na), Organic Carbon, Texture, Soil Reaction (pH), Electrical Conductivity (EC), Field Capacity (FC), Wilting Point (WP), Available Water Content(AWC), Hydraulic Conductivity, Bulk Density, Cation Exchange Capacity, Water Resistant Aggregate Percentage were analyzed.The results of the analysis are given in Table1.

Based on the current maps, satellite images and laboratory analysis results of the region erosion risk maps and land quality maps have been created by using CORINE methodology (Anonymous 1992).According to the actual erosion risk map, it is observed that there was no erosion in 10%, low erosion risk in 2%, moderate erosion risk in 24% and high erosion risk in 62% of the study area. Besides, in compliance withthe actual land quality map, study area consists of 2% of high quality, 5% of medium quality, 83% of low quality soils and 10% of bare rocky areas.Using these generated maps and analyzes, the study area land suitabilty map has been prepared. According to the land suitability map, 20446m^2 of the working area is planned as natural habitat, 41078 m^2 as field, 10745 m^{2}as picnic area, 28307 m^{2}as rock gardens, 100833 m^{2}as green area, 13625 m^{2}as organic gardening, 5738 m^{2}as organic vegetable growingand 18624 m^{2}as tree corridors (Figure 1).

Table 1. Some physical and chemical analysis of surface soil samples.

Sample No.	pH	EC (dS/m)	Lime (%)	Organic Carbon (%)	Water Stable Agregate (%)	B (ppm)	Total N (%)	P (kg/da)	K (kg/da)
1	7,80	0,221	16,37	0,78	38	0	0,069	11,1	364
2	7,67	0,150	12,72	0,26	40	0,59	0,040	11,4	345
3	7,50	0,163	45,44	1,67	58	0	0,080	12,3	411
4	7,35	0,126	0,45	0,90	47	0,47	0,032	10,6	470
5	7,39	0,167	10,00	1,00	43	0,72	0,100	12,2	375
6	7,63	0,226	10,70	1,10	36	0,53	0,061	14,1	391
7	7,65	0,178	4,50	0,63	60	0,58	0,091	10,7	541
8	7,65	0,136	2,14	0,81	62	0,49	0,081	11,5	510
9	7,13	0,063	0,90	1,08	29	0,5	0,078	13,1	481
10	7,35	0,354	0,90	1,00	26	0,49	0,098	12,4	476

Table 1. Some physical and chemical analysis of surface soil samples (continued)

Sample No.	Texture (%)				Field Capacity (%)	Wilting Point (%)	Available Water (%)	Hyraulic Conductivty (cm/hour)	Bulk Density (g/cm^3)	Ca+Mg (me/lt)	Na (me/lt)	CEC me/100g
	Clay	Silt	Sand	Texture								
1	42	29	29	C	32,10	21,63	10,47	0,23	1,18	1,20	0,83	24,48
2	48	29	23	C	36,40	25,32	11,08	0,16	1,12	2,40	1,06	23,77
3	53	30	17	C	38,24	28,11	10,13	0,14	1,10	3,20	0,73	23,59
4	25	17	58	SCL	22,39	13,64	8,75	0,51	1,30	2,80	1,14	25,77
5	62	10	28	C	41,72	30,58	11,14	0,12	1,08	2,80	1,14	22,86
6	33	23	44	L	29,07	18,71	10,36	0,28	1,21	1,40	0,95	32,43
7	41	26	33	C	33,15	21,37	11,78	0,13	1,16	1,60	0,95	38,93
8	28	17	55	SCL	25,84	15,63	10,21	0,34	1,22	1,20	1,08	36,56
9	26	16	58	SiL	24,07	14,12	9,95	0,31	1,29	1,80	1,30	38,55
10	33	28	39	CL	27,42	16,35	11,07	0,26	1,20	1,60	1,06	22,70

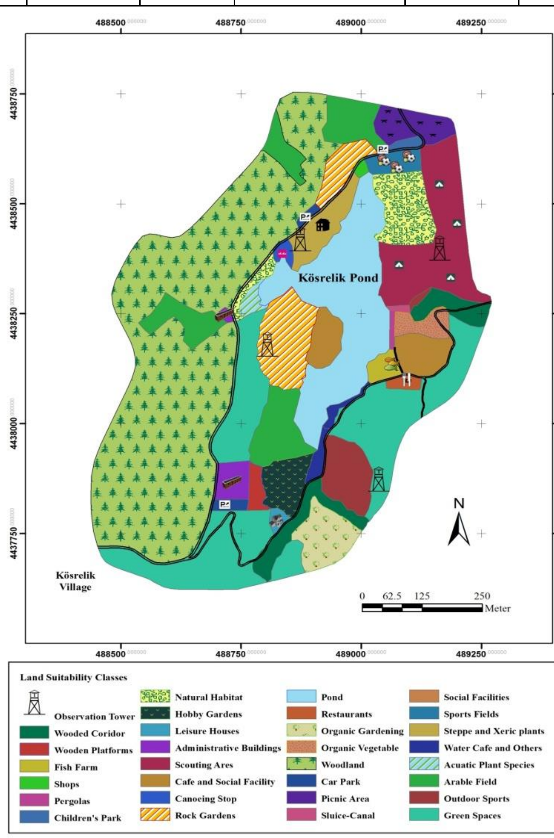

Figure 1. Kösrelik Pond land suitability map

3. Results and Conclusion

Recreation area planning is usually carried out according to the personal wishes and opinions of the authorities and planners. The projects produced according to urban requirements without the necessary analysis and studies cause ecological deterioration and reduce the quality of life environment in the long term. In the land planning of Kösrelik Pond Recreation area that is present as a natural beauty, the necessary soil quality parameters for land use planning were examined and land ownership status was paid attention.For plants to be used for planning, plants suitable for the region and supporting natural vegetation are recommended. It is recommended to plant barley, wheat, fruits and vegetables suitable for the region and plantation of larch, cedar, mahaleb, spindle and almond trees for afforestation areas (Yalçın and Baran 2014).

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A Method of Combating Urban Desertification:

Water Harvesting and Water Retention Practices

Enis BALTACI[1], Ahmet DOĞAN[2]

Abstract

Due to global warming, climate change and rapid increase in population, increasing flood events and lack of sustainability of water resources affect the social life and cause loss of life and property in Turkey in recent years. On the other hand, the needs of Turkey's growing population with the unplanned urbanization is in increasing pressure on the natural resources with converting Turkey's land from forest,agricultural land and wetland to urban areas can lead to irrevocably and permanent desertification problem.In addition, since Turkey is located in the arid and semi-arid climate zone is situated in the most sensitive areas in terms of water scarcity categories. As a result of the reduction in the presence of water inevitably triggers desertification. It is of great importance to protect and develop water resources in order to meet future drinking water needs in cities and to reduce soil loss as a result of uncontrolled and distorted urbanization. Therefore, the effective use of water harvesting and water retention practices in urban areas is one of the most important ways of combating urban desertification. Among these, water harvesting practices should be applied in the form of keeping rain water and controlling the rain in the place where it falls and storing it in the soil.When the daily water consumption requirement is assumed to be about 200 liters per person, a large part of this need can be easily met by water retention practices such as rain barrels, permeable pavement and rain gardens.

Construction in the settlement areas increases the impervious surfaces and prevents the rain water infiltrate to the soil. The rain barrels are used in the residential areas will be able to store rain water falling on the roofs of the houses and then the stored water can be used in many areas such as garden irrigation, toilet cleaning, car-building washing and pool or pond filling. The rain barrels are also a great tool to fight water scarce. With the use ofpermeable pavement,it will be ensured that the rain water can be leaked to the soil.With rain gardens, rain water will be stored and infiltrated into the soil, and planting with native species can be gained an aesthetic view. In this way, the use of rain water will increase the efficiency of use, protection of ground water resources, reduction of flood and flood risk and saving on budget. Furthermore, the heavy metals which comes with rainfall can be prevented to reach the stream and groundwater using rain barrel and hence it will help to remediation of water quality.As a result, rainwater harvesting andwater retention practices can provide the rational solution as well as ecological and economic advantages.

Keywords: Urban Desertification, Water Scarce, Water Harvesting, Sustainability of Water Resources, Land Use Planning

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Investigation and Comparison on Past and Present Erosion Riskin the ÇınarcıkDam Basin by Corine Erosion Model

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Abstract

The Çınarcık Dam was constructed between 1996 and 2002 for several purposes including power, irrigation, flood control and water supply to the city of Bursa. The dam is located 55 km from Bursa city center at 40°00′59.39″ N, 28°46′21.44″ E coordinates and it is settled on Orhaneli river in Mustafakemalpasa, Bursa. In this study, the basin of the dam was generated from a DEM using hydrology tools of ArcGIS software, and it covers an area of 439525 hectares, and its altitudes range between 37 m and 2047 m. Soil erosion is the most critical reason for sedimentation load of dam reservoirs in Turkey as well as in most parts of the World. The sedimentation increasingly threatened the economic life span and capacity of the dam reservoirs.Due to sedimentation in the near future, most of the dam reservoirs in the world and also in Turkey probably will be lost their storage capacity before their planned lifetime capacity.The deforestation, rainfed cultivation, excess grazing, and extensive excavations for mining are all the essential human-made effects on land caused soil erosion of the entire basin.In this study, past and present human effects on soil erosion in Çınarcık Dam basin were investigated and compared by using GIS aided Corine erosion model based on 1990-2012 Corine LC/LU maps. To determine actual and potential erosion throughout the basin, Corine model was run within the framework of a GIS which contained all layers of parameters required by the model and the related database. The use of GIS allowed mapping of the actual and potential erosion contribution of every part of the Çınarcık Dam basin so that it was possible to get information on the type and location of measures to be taken against soil erosion. In addition, the use of GIS made it possible to compare soil erosion risk of past and present time of the study area to show seriousness to land degradation situation of the Çınarcık Dam basin.

Key Words: Erosion risk, CORINE, GIS, Çınarcık Dam

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Impact of Organic and Inorganic Fertilizers on Carbon Budget (CO_2 Flux and Carbon Fixation) Under Wheat-Maize Agricultural System

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Abstract

Effects of organic and inorganic fertilizers application on carbon budget was determined in a long-term field experiment with wheat-maize rotation. Plant photosynthesis productivity and CO_2 flux form plant root surface on plants were measured. Experiment was set up since 1996 with treatments of control, NPK mineral fertilizer, 25 t ha^{-1} compost with animal manure and 10 t ha^{-1} compost + mycorrhizal inoculum. These organic/inorganic fertilizer applications were applied regularly for each crop (wheat-maize-wheat). During the successive research work, shoot and root biomass, grain yield, root length, root volume, mycorrhizal root infection, carbon (C), nitrogen (N) and other macro and micro nutrients in plant tissues were analyzed. During plant growth, photosynthesis, CO_2 released from rhizosphere to the atmosphere were measured with regular interval.

It was observed that under field conditions, organic and inorganic fertilizers application significantly increased plant growth compared to control treatment. The effects of organic and inorganic fertilizers application on the yield of both maize and wheat crops were differentiated according to following order from highest to lowest yield of animal manure (25 t ha^{-1}) > inorganic fertilizer > compost (25 t ha^{-1}) > compost + mycorrhiza (10 t ha^{-1}) > control treatment. The amount of CO_2 flux from soil to atmosphere was measured. It was determined that more CO_2 was released into atmosphere in order of animal manure > compost > mineral fertilizer > compost + mycorrhizae > control.

Research findings showed that it is possible to calculate and estimate soil organic carbon budget. Under long period of time, soil and crop management system, organic and inorganic fertilizer application, especially organic fertilizer application to the soil increased amount of soil carbon content. Our findings showed that organic fertilizer treatments have higher soil organic carbon pool and carbon sequestration than control even than mineral fertilizers. Also, under organic fertilizer there was high CO_2 emission and flux than control treatment.

This work was supported and prepared with in cooperation between Cukurova University and TAGEM (TAGEM/16/AR-GE/59 Project).

Keywords: Soil carbon budget, carbon sequestration, long term field experiment, climate change

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Introduction

In the present era of globalization, relation between soil/environmental scarcity and human conflict is complex. At the same time, it is obvious, human impact has effects on soil and directly/indirectly on climate change. There is a strong need to work together globally, rather than locally or regionally. Economic development and environmental enhancement must go hand in hand. In order to reduce impact of CO_2 on climate change, economic development and environmental enhancement must go hand in hand, and the highest priority must be given to development of the ecosphere (Lal 2015). Estimating the field conditions, carbon cycle is the key to predict Earth's climate change. Also, actual measurement in field is of vital importance for accurate estimations. Land use change, soil and crop management also play a critical role in influencing losses of the soil C by respiration.

Soil and crop management may affect many soil properties, such as enhancing the soil organic carbon (SOC) pool, the development of soil structure and the transfer of atmospheric CO_2 to soil through photosynthesis is very important. It is also important to manage soil organisms especially mycorrhizal fungi which is a powerful tool to fix more CO_2 from atmosphere to soil through plant leaves and roots. Many studies showed that chemical fertilization had marginal effects on soil organic matter (SOM) and its C and N fractions (Rudrappa et al. 2006). However, in the North China Plain, Gong et al. (2009) reported that the NPK treatment was important for increasing crop yields and increased soil organic C fractions.

Methods and Materials

The field experiment was conducted at Research Farm of the Çukurova University which is located in the eastern part of the Mediterranean region of Adana, Turkey from 1996 to 2019. The soil is a Menzilat clay loam (Typic Xerofluvents) with pH 7.6±0.7, salt 0.05%, effective cation exchange capacity 20.5±2 $cmol_+$ kg^{-1}, available phosphorus 14.5±2 mg kg^{-1}, and contains 319±31, 361±87, and 320±23 g of clay, silt and sand kg^{-1} of soil, respectively (Ortas 2012). The experiment was laid-out in a randomized complete block design with five treatments and replicated three times in 10 m x 20 m plots. The treatments were (1) control, (2) chemical fertilizer (N-P-K applied at 160 kg $(NH_4)_2SO_4$, 83 kg K ha^{-1} as K_2SO_4, and 26 kg P ha^{-1} as $3Ca(H_2PO_4)_2.H_2O$), (3) manure (cow manure applied at 25 Mg ha-1 yr^{-1}), (4) compost (25 Mg ha^{-1} yr^{-1}), and (5) mycorrhizae (mycorrhizae-inoculated compost at 10 Mg ha^{-1} yr^{-1}), respectively. The treatments were applied annually from 1996 to 2019 in corn and wheat rotation moldboard plowing after each harvest. While corn was irrigated, the wheat was grown under rain fed.

Soil Collection, Processing and Analysis

Composite soil samples were randomly collected after wheat (*Triticum aestivum* L.) harvest from each replicated plot at 0 to 15 cm and 15 to 30 cm depths followed by sieving with 2 mm mesh. Total C (TC) was determined on finely-ground oven-dried soil using automated CN dry combustion analyzer by Fisher-2000 equipment. Organic carbon was determined by reducing inorganic carbon from organic carbon.

Greenhouse Gas Emission

As seen in Figure 6, CO_2 gas storage circles were placed according to the experimental design determined in different areas. PVC land gas collection circles were used in each application units. During the trials,

CO_2 analysis was carried out in open terrain at two-week intervals.

Figure 6, Under field conditions CO_2 measurements and equipment's

In each parcel, CO_2 emission from the soil was measured by using LICOR LI-8100 automatic soil carbon dioxide flow system from the root zones. After the plant began to form three leaves, the total number of days over the days between the measurements made with the intervals of 15 days.

Results and Discussion

Soil Organic Carbon Concentration and Carbon Pool

Under the Mediterranean climate, the ambient temperature raises up to 40 ^oC during summer months. Thus, it may take long time for SOM to accumulate in the surface layer with supre-optimal soil temperatures (Ortas et al. 2012). Since soil organic carbon (SOC) is the main sink for atmospheric C through coil-crop management practices SOC stocks is receiving attention. In present work, under a long term experiment, the effect of several organic and inorganic fertilizers on SOC concentration was determined with maize and maize rotations. There were significant differences in SOC concentrations among treatments in 0-15 cm and 15-30 cm depths over 20 year of crop cultivation. In the present experiment different soil depth SOC content combined for general cooperation. There was a noticeable trend of higher SOC in the plots receiving organic than inorganic fertilizers.

The SOC pools in the bulk soils were significantly affected by organic and partially by chemical fertilizer treatments (P <0.001) (Table 1). These data indicate that organic fertilizer including mycorrhizal application increased SOC pool in 0-30 cm depth compared to control treatment. Soil receiving animal manure had the highest SOC pool (58.20 Mg C ha^{-1}) in the rhizosphere 0-30 cm depth relative to the control treatment (30.68 Mg C ha^{-1}) which contained the least.

Table 1. Carbon budget analysis. In 2016 maize was cultivated and the calculation of the amount of soil organic carbon under different organic and inorganic fertilizer application

Treatments	Bulk density	Rhizosphere		Non-Rhizosphere (0-30cm)		Mean of R and Non-R soil	
	g cm^{-3}	Mg Ha^{-1}					
Control	1.38	30.68	±5.79	28.58	±8.74	29.63	±7.26
Mineral Fertilizer	1.42	35.33	±4.34	37.29	±13.46	36.31	±8.90
Animal Manure	1.18	58.20	±15.32	65.72	±13.84	61.96	±14.58
Compost	1.13	45.19	±13.49	42.25	±8.57	43.72	±11.03
Com. + Mycorrhizae	1.29	34.11	±5.91	35.44	±4.19	34.78	±5.05
Mean		40.70	±8.97	41.86	±9.76	41.28	±9.37

Mg = mega gram (ton), ha= hectare

When soil received mineral fertilizer, compost and compost +mycorrhizae treatments contained 35.33, 45.19 and 34.11 Mg C ha^{-1}, respectively. In non-rhizosphere soil with 28.58 Mg C ha^{-1} in the control treatment and animal manure treated plots have the highest SOC 65.72 Mg C ha^{-1}. In general, there is not significant relationship in between rhizosphere and non-rhizosphere soil SOC concentration.

The trend of a higher SOC pool in organic fertilizer compare to mineral fertilizer may be attributed to every year organic matter addition. Also, other organic matter addition has significant effects on aggregation as a results well developed soil structure have lower rate of SOM decomposition and on other hand, in control and mineral fertilizer have higher breakdown of soil aggregates (Singh et al. 2009). Previously, Ortas et al. (2012) in the same area they found similar results. In the same field experiment, in previous years under maize and wheat rotation, C_4 plants, such as maize, provide more soil organic carbon than C_3 such as wheat plants in terms of contributing to soil organic carbon budget. For future soil organic carbon pool it is important to manage the plant and soil managements

Carbon sequestration

Under long term field conditions yearly fertilizer application have significant effects on C sequestration (CSQ) when calculated from the data between 1996 and 2016 by using initial soil organic carbon content (Table 2). Total CSQ ranged from -0.21 to 1.41 Mg ha^{-1} for 0-30 cm depth (Table 3). The difference in CSQ between control and animal manure treatments was 1.60 Mg C ha^{-1}. Compost applied plot have 0. 49 Mg ha^{-1} which is the highest sequestration after animal manure application. After 20 years of regular organic fertilizers application, there was a higher CSQ in animal manure and compost application. In the year 2010 CSQ was calculated an it was higher (Ortas et al. 2012) than in the year of 2016. Ussiri and Lal (2005) observed that the rates of CSQ in reclaimed mine lands in Ohio ranged from 0.3 to 1.85 Mg C ha^{-1} yr^{-1} for pastures and rangelands, and 0.2 to 1.64 Mg C ha^{-1} yr^{-1} for forest land use.

Since majority of plant root are in 30 cm depth SOC content was calculated for 30 cm soil depth. Katterer et al. (2011) reported that root-derived carbon was about 2.3 times higher than that for above-ground plant residues incorporated with soil. In the North China Plain, Liang et al. (2012) reported that application of manure is important to soil C sequestration and improving soil quality.

Table 2. Effects of long term fertilizer application on carbon sequestration

	1996 SOC	2016 SOC	Carbon Sequestration 1996-2016	
Treatments		SOC Mg ha^{-1}	SOC 2016- SOC 1996	Mg ha^{-1} SOC year
Control	33.8#	29.6	-4.2	-0.21
Mineral Fertilizer		36.3	2.5	0.12
Organic Manure		62.0	28.1	1.41
Compost		43.7	9.9	0.49
Compost + Mycorrhiza		34.8	0.9	0.05
Mean		41.3	7.5	0.37

= 1996 initial SOC, Mg = mega gram (ton), ha= hectare

Effects of Treatments on CO_2 Flux

Carbon fluxes as an uncertain source of CO_2 emissions in between the soil and atmosphere is responsible to rising global temperatures and causing the land degradation. CO_2 flux under maize filed conditions in 2016. Usually lower CO_2 emissions were observed in the bare area (without plant). With time for all treatments CO_2 flux decreased. Since at the beginning of plant growth rhizosphere developed possibly microbial activity was higher. Organic manure, compost and compost + mycorrhizae application plot have higher flux than control treatment (Figure 2).

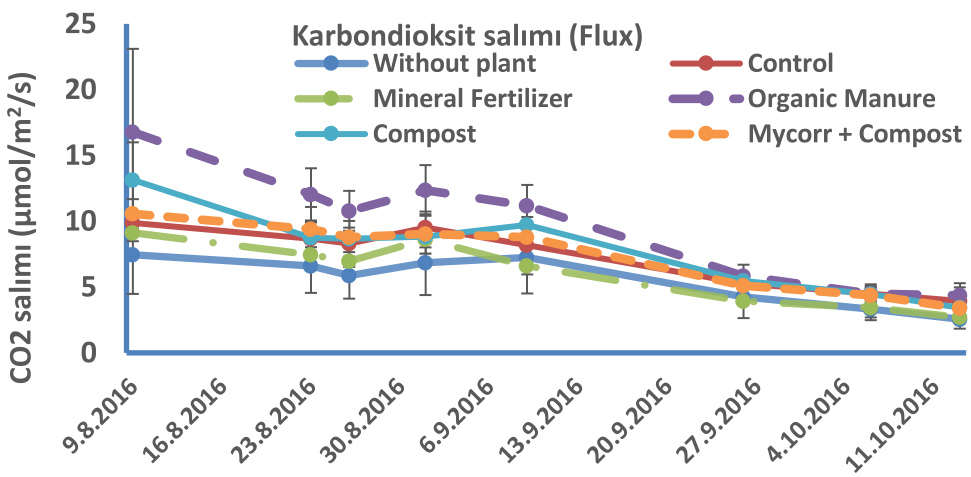

Figure 2. Carbon flux measurement with time.

Finally, organic fertilizer applied plot have higher C flux and the same time have higher SOC accumulation. Following the animal manure, compost and compost + mycorrhizae treated plots have high flux and SOC content than control and mineral fertilizer treatments. For sustainable agriculture and life, it is very important to have sufficient C and C flux rate for better predicted the effects of climate change on agriculture.

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Plant Root Development and Their Relation with Carbon Sequestration Influenced by Organic and Inorganic Fertilizers Under Long Term Field Study*

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Abstract

Organic fertilizers are very important for sustainable agriculture and soil quality. As a key nutrient supplier, soil organic matter (SOM) is an important component of soil fertility and soil quality. It is possible to increase SOM with addition of organic fertilizers. It is estimated that 80% of all plant problems related with soil-root relationship through rhizospheric organisms. Good root system development is also essential for optimum plant development especially under water-limiting conditions. Since hidden half of the plant material is underground, it is important to search hidden section of plants. Root development is significantly affected by environmental factors such as soil-crop management, irrigation and fertilizer treatments. Soil-crop management is directly related with rhizosphere management. Soil-crop management is very important for reducing soil degradation and soil erosion

The aim of study was to evaluate impact of long-term mineral and organic fertilizer including mycorrhizal inoculum on maize root development such as root growth, root length, surface area, specific root length, root volume and mycorrhizal root colonization relation with soil organic carbon.

A long term field experiment was established in 1996 and since then each year, 25 t ha^{-1} compost + animal manure, 10 t ha^{-1} for compost + mycorrhizal inoculum and NPK mineral fertilizers are applied on regular interval. Under rain fed conditions, wheat-maize rotation was applied for several years. At harvest, plants total root biomass was taken and root parameters were determined. Wheat and maize root biomass and other parameters differed with organic and inorganic fertilizers treatments. Control treatment has lowest root biomass, animal manure treated plots had the highest root biomass. Root colonization was different with fertilizer treatments. The effects of residual root material, carbon contribution to the soil was calculated. Fertilizer treated plots have higher carbon input and soil had high SOC content. Under long term organic and inorganic fertilizer application compared to control treatment. Fertilizer application had significant effect on root biomass production that contribute on soil quality parameter.

Keywords: Soil organic carbon, carbon sequestration, root growth, organic and inorganic fertilizer

Introduction

Soil is most important natural resource. It is crucial to save and protect soil for the sustainability and food security. For better health and food security, plant root development is considered as an important factor. Worldwide, research increasingly value to root health as the key for future crop productivity improvements. Only root biomass measurements are not necessarily indicative of the total nutrient and water absorptive area

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of the root system. Root biomass is important to estimate shoot/root ratio however it is not enough for surface estimation. Because they are out of sight, naturally the roots are often out of human mind.

Root length, surface area and specific root area may be controlling variables for nutrient uptake. it is important to be able to quantify property of root parameters. Besides their role in nutrient uptake, roots constitute a major source of C for soil (Rasse et al., 2005) and root biomass might be a good indicator of crop C input to soil (Monti and Zatta, 2009). Some researchers suggest that root C pool and soil organic C have a direct relationship and most soil organic matter is derived from roots (Rasse et al., 2005; Kong and Six, 2010). It shows that a change in agricultural system would have direct impact on soil organic matter in soil profile by root C inputs. Root system providing a C input to the soil C pool through root turnover and deposing in soil profile (Farrar et al. 2003). Root turnover considered to be a key component of C sequestration in soils (Matamala et al. 2003; Norby et al. 2004). The study was conducted to search the impact of long term organic (including mycorrhizal inoculum) and mineral fertilizer on maize root development such as root growth, root length, surface area, specific root length, root volume and mycorrhizal root colonization relation with soil organic C.

Material and Method

The aim of work was to search effects of organic fertilizers including mycorrhizal inoculation on mineral fertilizer on plant root growth and relation with C sequestration.

Picture 2.1. Satellite image of the experimental area. The experimental parcels were established in 1996 in Ç.U. Research Application Farm, Soil Science and Plant Nutrition Department. It was with 5 different applications (Control, full mineral (NPK) fertilization, animal manure, compost and compost + mycorrhizal fungi application).

The experiment initiated in 1996, comprised of five treatments were: (1) control, (2) traditional N-P-K fertilizers [160 kg N ha^{-1} as $(NH_4)_2SO_4$, 83 kg K ha^{-1} as K_2SO_4, and 26 kg P ha^{-1} as $3Ca\ (H_2PO_4)_{2.H2O}$], (3) compost at 25 Mg ha^{-1}, (4) animal manure at 25 Mg ha^{-1} and (5) mycorrhiza-inoculated compost at 10 Mg ha^{-1}. It was established with three replicates = 15 plots, each of 10 X 20 m (200 m^2) dimensions.

Soil Analyses

Routine analyses were performed and soil samples were taken from field before the experiment was established. Soil analyses were done according to (Güzel et al., 1990). Soil analysis results are given in Table 2. The pH of the bulk soil was determined in deionized water using a soil-to-solution ratio of 1:5. Total C of the bulk soil samples concentrations determined by the dry combustion method at 900°C using a C and N elemental analyzer (LECO Corporation, St. Joseph, MI, USA). The SOC concentration was obtained by subtracting soil inorganic Carbon (SIC) from total C. The Olsen method with 0.5 M $NaHCO_3$ available P of the bulk soil was determined by spectrophotometer at a wavelength of 890 nm.

Morphological analysis of roots

After separation of roots from the shoots, roots were washed 3-4 times with deionized water. Sub root samples were scanned by a root-system scanner. Root length was measured using the software WinRHIZO image analysis system. Plant roots were separated from the soil by method of (Ortas et al., 1996). Separated roots from the soil by washing with running tap water and distilled water. Roots were then cut into 1 cm segments and stored in 70% ethanol at 4°C for further analysis of mycorrhizal colonization and morphological analysis of roots. The small proportion of the sub roots were stained as described by (Koske and Gemma, 1989), to examine the presence and degree of mycorrhizal colonization according to (Giovannetti and Mosse, 1980). Statistical analysis was done by analysis of variance (ANOVA) using SAS.

Results and Discussion

Plant Root Development

Root diameter and length of plants were determined after harvesting (Table 1). Root surface area, root volume and specific root length were also determined. The root length of the parcels with organic fertilizer application was higher than mineral fertilizer application. According to the research findings, average root diameter of control plants was 0.41 mm, while in the animal manure, it was 0.40 mm and in the compost plots were 0.37 mm.

Root surface area and root volume values were also calculated. In general, animal manure applied parcels in the root length is higher than other treatments. In terms of root volume values, with animal manure application highest root volume production was obtained (2.15 m^3). The root length of per unit root dry matter weight on the basis of the research data was calculated as a specific root length. In control and mineral fertilizer application specific root length was 50.09 km kg^{-1},50.07 km kg^{-1} respectively. While in the parcels of animal manure, compost and compost + mycorrhiza were 56.1, 59.4 and 56.6 km respectively.

Table 1. The effect of organic and inorganic fertilizers on the root parameters of maize plant (Ortas et al. 2018).

Treatments	Root diameter		Root length		Root surface		Root Volume		Specific root length	
	(mm)		Km da^{-1}		m^2 da		m^3		(km kg^{-1})	
Control	0.41#	±0.02 †	15050	±1837	18974	±1478	1.92	±0.13	50.9	±8.0
Mineral Fertilizer	0.39	±0.03	14602	±3927	17368	±3413	1.66	±0.20	50.7	±11.8
Animal Manure	0.40	±0.00	16978	±4664	21368	±5670	2.15	±0.55	56.1	±10.7
Compost	0.37	±0.00	16973	±3901	19840	±4272	1.86	±0.37	59.4	±12.9
Com. + Mycorrhizae	0.38	±0.01	15591	±1377	18610	±1796	1.78	±0.19	56.6	±6.1
	P<0.2282		P<0.9281		P<0.8528		P<0.6428		P<0.8857	

#: mean of three replicate, †: standard Davion.

Specific root length data were found to be more consistent with yield values than root length and root surface area values. There is also a significant relationship between the use of plants in nutrients and harvest index. Root and root parameters are very important for water uptake and nutrients which is determined by assimilate allocated to root (Ahmadi et al., 2018).

Root colonization analysis was performed in sub-samples taken from plant roots. In control treatments 51% of root infection was determined and 81% root infection was detected in compost + mycorrhiza applied treatments. Due to the relationship between organic C and mycorrhizae, it is expected that high root infection will occur in the environment where organic fertilization is performed. Animal manure and compost treated root have similar root colonization with compost + mycorrhiza treated data. Linderman and Davis (2004) reported that since root exudates are organic compound which can prefer mycorrhizal fungi.

Soil Organic Carbon Concentration

After the harvest, soil organic C analyzes were performed in rhizosphere and non-rhizosphere in soil depths of 0-15 cm and 15-30 cm. The highest organic C content was measured in animal manure 1.60% of followed by compost with 1.26%, compost + mycorrhiza with 0.83%, mineral fertilizer with 0.79 % 0.71 % in control of rhizosphere soil 0-15 cm depth (Table 2). In the 15 - 30 cm depth of rhizosphere, highest SOC was measured as 1.66% in animal manure, 1.38% in compost application followed by 0.96% in compost +mycorrhiza application, and the lowest % C content in control plots was 0.76%.

Generally, for both soil depths SOC concentrations of rhizosphere and non-rhizosphere were listed as animal manure > compost > compost mycorrhiza > mineral fertilizer > control. Akala and Lal (2001) reported that under long term field conditions organic fertilizer application increase soil SOC concentration. Improvement in soil fertility through nutrient management is also important to SOC sequestration (Lal 2005) because concentrations of SOC

Table 2. Mineral and organic fertilizer applications were made under field conditions and % inorganic and organic C concentrations (Ortas et al. 2018).

Treatments	**Rhizosphere (0-15cm)**	**Rhizosphere (15-30cm)**	**Non-Rhizosphere (0-15 cm)**	**Non-Rhizosphere (15-30 cm)**
	Organic Carbon		**Organic Carbon**	
Control	0.71 ±0.14b	0.76 ±0.12c	0.65 ±0.28b	0.73 ±0.13b
Mineral Fertilizer	0.79 ±0.14ab	0.88 ±0.08bc	0.81 ±0.51b	0.94 ±0.12b
Animal Manure	1.60 ±0.56a	1.66 ±0.26a	2.30 ±0.50a	1.41 ±0.27a
Compost	1.26 ±0.40ab	1.38 ±0.38ab	1.34 ±0.33b	1.16 ±0.21ab
Com. + Mycorrhizae	0.83 ±0.31ab	0.94 ±0.07bc	0.96 ±0.02b	0.86 ±0.19b
	P<0.1229	P<0.0120	P<0.0091	P<0.0377

#: mean of three replicate, †: standard Davion.

In the same soil our previous results were similar (Celik et al., 2004; Ortas et al., 2012; Ortas and Lal, 2014). Zhang et al. (2018) speculated that under field conditions, yearly 0.52 Mg C ha^{-1} $year^{-1}$ accumulated. The effects of different organic sources have different effects on organic C which is supported by data of Chaudhary et al. (2017).

Data are shown that there is a stong correalation between plant root parameters and soil organic C data. Since organic C directly affects palant growth manily root growth realtionship is very singificant. Espeacilay, spesific root lenght is significantly coorealted with soil oganic C concentration. Also it is important to mesure the root hair and to look at the corelation in between root hair and organic carbon cocntration.

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Short-Term Impact of Vermicompost on Physical Properties of a Calcareous Soil Subjected to Wind Erosion; Incubation Study

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Abstract

In recent years, composting of organic materials originated from agricultural and industrial wastes with regard to their use as soil amendments and fertilizers has been increased. During biological processes, vermicompost which is the prime product of different organic wastes' decomposition through various species of worms and other earthworms plays an important role in soil remediation and fertility improvements. In semi-arid and arid region, vermicompost will likely improve limited sustainability and fertility of a calcareous soil subjected to a wind erosion. In this regard, soil sample from wind erosion affected region located in Konya-Karapınar region, Turkey, was used during this study. A pot trial was conducted and vermicompost at the application rates of 0, 1, 2 and 4% (w/w) were thoroughly mixed with experimental soil, then poted in a pot with a diameter and height of 13.5 and 17 cm respectively, and subsequently incubated for 30 days. At the end of incubation period, obtained results revealed that applied vermicompost (V) to a calcareous soil subjected to a wind erosion significantly ($P<0.05$) affected soil aggregates stability (*AS*), field capacity (*FC*), permanent wilting point (*PWP*), plant available content (*AWC*), electric conductivity (*EC*), organic matter (*OM*) and total nitrogen content (*TN*), yet *pH* and lime content ($CaCO_3$) responses to vermicompost application were found insignificant. The improvement of aforementioned soil properties was proportional to the application rates. Consequently, application of vermicompost was significantly found to have a pronounced effect on improving physical and some chemical properties of a calcareous soil subjected to wind erosion under short-term period.

Keywords: Calcareous soil, soil remediation, vermicompost, wind erosion

1. Introduction

Land degradation is one of the major environmental concerns, since there is an increasing awareness that soil is a critical component of the biosphere, not only by the production of food but also by the maintenance of environmental quality (Marcotea et al., 2001). Inappropriate production technologies have resulted in soil quality deterioration, and thereby leading to soil organic matter losses and structure degradation, affecting movement of water, air and nutrient, as well as negatively affecting plant growth (Golchin et al., 1995). Organic matter reduction is, in turn, associated with the soil structure degradation (Albiach et al., 2001). Soil degradation is particularly a serious problem in Mediterranean areas where the effects of anthropogenic activities are compounded by the problems caused by prolonged periods of drought, as well as intense and irregular rainfall (Hueso-González et al., 2014). Soil physical degradation in agricultural areas occurs mostly as a consequence of a decrease in soil organic matter caused by excessive soil cultivation (Grandy et al., 2002). Soil application of composted organic residues, such as animal manures, sewage sludge and household wastes represent a management strategy that could counteract depletion of organic matter in soils. In today's sustainability concept, methods for the use of organic wastes as soil conditioners have started to become popular. One of them is the wastes of worms and the conversion of these wastes into a high quality product

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under a short period of time is defined as vermiculture (Erşahin, 2007). In practice, vermicompost (worm manure), which has gained popularity in recent years, is obtained by converting organic materials into humus-like materials using worms (Garg et al., 2010).

The objectives of this study was to determine the effects of vermicompost application on soil physical and some chemical properties of a calcareous soil subjected to a wind erosion under laboratory condition.

2. Methodology

2.1 Site Description and Experimental Set Up

Vermicompost (trade name Rivo) was supplied from a company. Soil sample from wind erosion affected region located in Konya-Karapınar, Turkey. The climate is semi-arid, with an annual precipitation of 279.5 mm and an annual mean temperature of 10.9 ˚C. The experiment was triplicate, designed in accordance with a complete randomized plot design and carried out in the laboratory environment (22-23˚C±3) by using a pot trial. The soil specimens taken at the surface (0-20 cm) were dried at room temperature, ground and sieved by 2-mm sieve, and thereafter mixed homogeneously. Four pots with dimensions of 13.5 cm x 17 cm were used during the experiemt and packed with 2000 g of soil for each, and applied four level of vermicompost (control (0), 1, 2 and 4 % by weight) were homogenously blended with the soil and incubated for 30 days. In the course of incubation, soil moisture was brought to field capacity and regular check up was made to maintain the water at this level. Some physical and chemical properties of the soil and V are given Table 1 and 2. The soil was characterized by having a sandy clay loam texture, a alkaline soil pH (8.43) and organic matter and $CaCO_3$ contents of 0.98 % and 70 %, respectively

Table 1. Properties of the soil and vermicompost used in the experiment

Properties	Soil	V
Sand (2-0.05 mm)(%)	68.50	
Silt (0.05-0.002 mm)(%)	8.00	
Clay (<0.002 mm)(%)	23.50	
Textural class	SCL	
pH (H_2O, 1:2.5)	8.43	6.7
EC (H_2O, 1:2.5) dS m^{-1}	0.393	5
Organic matter (%)	0.98	46.7
Carbonates (%)	70	
Toplam N (%)	0.07	2.64
Field capacity (%)	12.91	
Wilting point (%)	9.76	
Aggregate stability (%)	22.42	

2.2 Soil Analyis

Particle-size distribution was determined by the hydrometer method (Gee&Bauder, 1986). The moisture contents at field capacity and wilting point were determined with a pressure plate apparatus (Cassel&Nielsen,

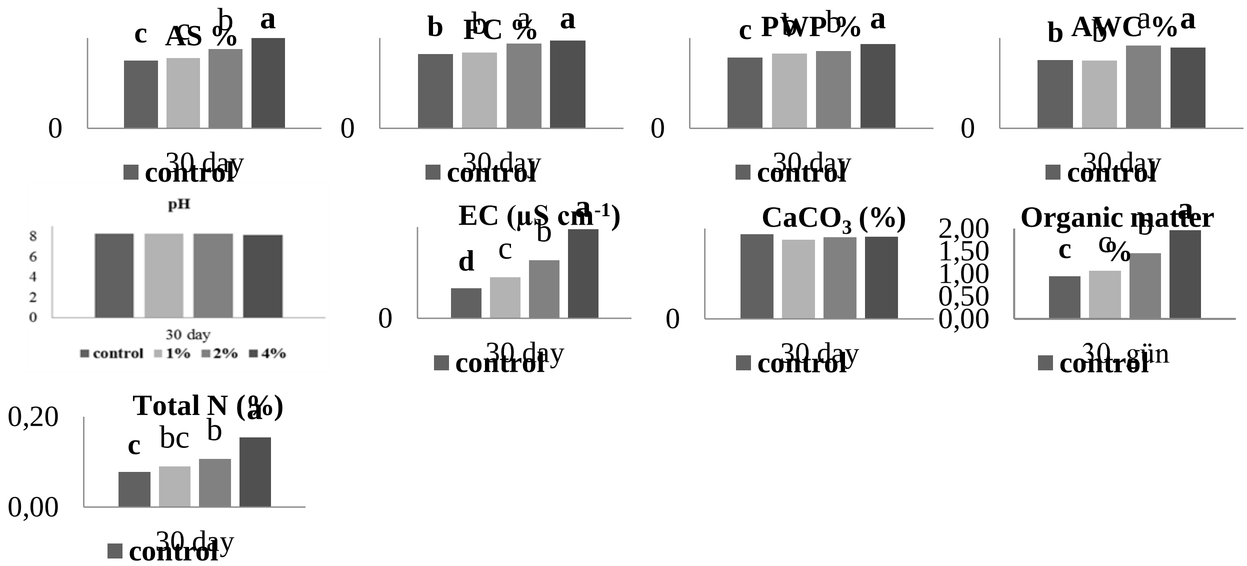
1986). Soil pH and EC values were determined using a glass-calomel electrode in a 1:2.5 mixture (w/v) of soil and water (Thomas, 1996; Rhoades, 1996). Soil organic matter was determined using the Smith-Weldon method (Smith and Weldon, 1941). Total N was determined by the using the TruSpec CN Carbon/Nitrogen Determinator (LECO Corporation 2006). Aggregate stability was determined by immersing the sieves containing the aggregate samples (between 1-2mm size) in a distilled water with up and down oscillation on screens through 55 mm at 30 strokes min-1 for 5 min (Kemper, 1965).

2.3 Statistical Analysis

Statistical analysis of the data was performed by using software program Minitab-16. The experimental design was a completely randomized and the data were subjected to one way -ANOVA as variance analysis technique and differences between amendment means were considered statistically to be significant at $P< 0.05$ through Tukey's test.

3. Results and Conclusion

The effects of V on soil aggregate stability values are given in Fig. 1. Aggregate stability values of the soil treated with different doses of V application were measured after 30 days of incubation period. The effects of V application on soil aggregate stability values were significant ($P<0.05$). Generally, aggregate stability increased with V applications. This effect of V can be elucidated by the V's OM content which probably enhanced the structure of soil in mechanical ways (Seker, 2003; Gümüs and Seker, 2015, 2017). The positive effect of V application on the formation of macro-aggregates (2-1 mm) can be caused by different structure of enzymes and hydrolysis' substances that passes through the digestion system of worms during the formation of V, and thus bind micro-aggregates into macro-aggregates (Turchenek and Oades 1979). Fig. 2, 3 and 4 presents the effects of applied V on FC, PWP and AWC. The results of experiment indicated that applying of V to the soil was markedly effective ($P<0.05$) in improving soil water holding capacity and V doses scaled up with rising water holding capacity at large. The positive effects of V application on improving soil moisture retention properties due to organic matter addition are consistent with the literature (Alaboz et al., 2017). Abadi et al. (2012) reported that field capacity and wilting point were positively impacted by the different V applications. The effects of V on the pH and EC values of the soil are shown in Fig. 5 and 6. The effects of V applications on pH values were insignificant ($P<0.05$). After the incubation of 30 days, the experimental results showed that EC values was significantly increased in all V application rates and EC scaled down with increasing doses of V. The reduction of pH and EC of the soil were also observed in V by Wahid et al. (1998). The electrical conductivity of V depends on the raw materials used for producing V and their ion concentration (Atiyeh et al., 2002). Fig. 7, 8 and 9 presents the effects of applied V on $CaCO_3$, OM and total N. The effects of V applications on $CaCO_3$ values were insignificant ($P<0.05$). Özkan et al. (2016) found that V applied to soils did not have statistically significant effect on lime content. The effects of V application on OM were significant ($P<0.05$). Generally, OM increased with V applications. In general, soil OM content values increase with larger amendment rates of organic materials. These increases were attributed to high organic matter content of V (Uz et al., 2016). The effects of V applications on total N values were significant ($P<0.05$). Generally, total N increased with V applications. The addition of organic matter in the form of mulch, V and the addition of earthworm casts cause the increase of the bioavailability of these elements (Germida and Siciliano, 2000).



In conclusion, the results of this laboratory study indicated that V applications can improve physical and some chemical properties of calcareous soil subjected to wind erosion under laboratory conditions. Physical and chemical properties of soil aggregate stability, field capacity, permanent wilting point, plant available nutrients content, electric conductivity, organic matter and total nitrogen content were improved by V amendment. According to the results, application of V was significantly found to have a pronounced effect on improving physical and chemical properties of calcareous soil subjected to wind erosion under short-term period.

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Determination of Soil Erosion Risk for Samsun Province Using Multi Criteria Decision Analysis based on Fuzzy-AHP Approach

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Abstract

Soil erosion is one of the leading environmental problems of the world. The erosion risk of soils can be evaluated directly carried out in the field, or laboratory by means of some experiments or indirectly based on developing and applying models. The main aim of this study is to determine erosion risk classes in Samsun province with the help of geographic information system (GIS), multi-criteria decision-making and statistical approaches. Samsun province covers about 957900 ha and total 995 soil samples were taken from soil surface (0-20cm). In the study, it was created total data set (TDS) consisting of soil texture, soil depth, sandy, clay, silt, land use, vegetation, slope, erodibility and erozivity. In addition, in order to generate minimum data set (MDS), principal component analysis was done. MDS consists of sandy, erodibility, vegetation, land use and erosivity. Fuzzy Analytic Hierarchy Process was performed for determining the levels of importance of the criteria. Finally, Linear Combination Technique was used to estimate erosion sensitivity. Moreover, spherical semivariogram model of ordinary kriging was used to generate distribution map of the erosion risk classes in TDS. According to results, about 61% of the total area has severe and very severe risk of erosion whereas, about 10% is low. In addition to that, gaussian semivariogram model of ordinary kriging was used to create distribution map of the erosion risk classes in MDS. According to this analysis, about 57% total study area was found as severe and very severe erosion risk while, it was found that about 11% of it is low risk. Consequently, this present study showed that when used MDS, it was estimated soil erosion risk which is so close to TDS' results

Keywords: Fuzzy-AHP, Principal Components Analysis, Erosion risk

1. Introduction

Soil erosion is one of the leading environmental problems of the world. In many areas, loss of this valuable natural resource takes place almost imperceptibly and difficulty of detection since erosion is generally a gradual process and because of the long time spans involved as well as significantly large area or large catchment scale (Dengiz, 2007). Today, along with the current techniques such as remote sensing and geographic information system (GIS) technologies, by using multi-criteria decision analysis (MCDA) approaches for making rational analyses and evaluations, these difficulties can be overcome. MCDA can be defined as choosing the one that is most suitable for at least a purpose or factor among a set of options.

The objective of this study is to characterize the spatial distribution of soil erosion risk in Samsun province help of MCDA and GIS. Ultimately, the assessment will help prioritize critical areas for adopting suitable soil erosion prevention measures.

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2. Materials and Methods

2.1 The Study Area

This study was carried out in Samsun province located in the Central Black Sea region of Turkey. The Samsun province is situated between 34° 51’ 59’’- 37° 06’ 21’’ west-east longitudes and 40° 49’ 54’’- 41° 43’ 06’’ north latitudes in the middle of Central Black Sea region (Figure 1).

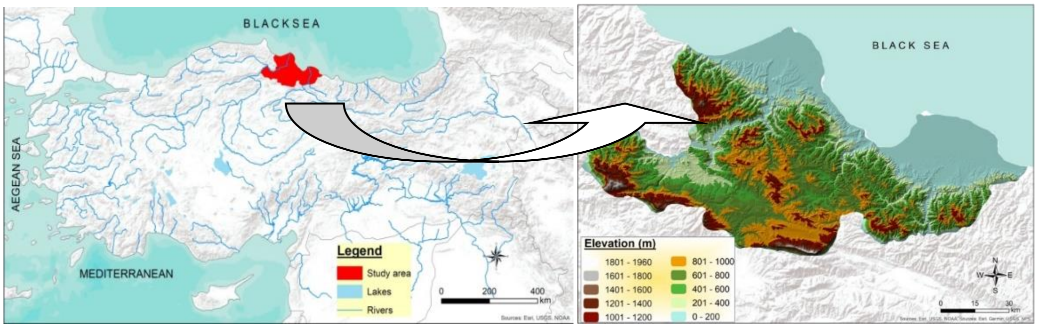


Figure 1. Location of study area

2.2 Methodology

The sites were divided into 2.5 x 2.5 km grid squares. Total 995 soil samples were collected from surface (0-20 cm) depth of each grid intersection point in cultivated fields of Samsun province.

The ten measured parameters were used in a total data set including erodobility, slope, land use, sand, clay, silt, soil depth, organic matter, erozivity and vegetation. All point soil erosion risk was calculated from the total data set obtained. The minimum data set was then created. The Minimum data set selection was determined to reduce dimensionality using principal component analysis (Doran and Parkin, 1994; Qi et al., 2009; Nabiollahi et al., 2017). As a result of factor analysis, groups with eigenvalues equal to 1 or greater than 1 were considered as factors and critical factor load was taken as 0.5 (Andrews et al., 2002, Wander and Bollero, 1999). For each factor, soil variables with high factor loadings were assumed to be the indicators that the best represent changes in soil erosion risk and were defined as having absolute values within 10% of the highest factor loading (Andrews et al., 2002; Govaerts et al., 2006; Sharma et al., 2005; Nabiollahi et al., 2017).

The Analytical Hierarchy Process (AHP) is one of the commonly used methods in multi-criteria decision making problems. The AHP is developed by Saaty (1980). AHP method does not reflect the humanistic way of thinking, even if it takes the knowledge of the expert. Fuzzy-AHP (FAHP) method has been proposed to overcome these deficiencies. In this study, the first step classes for each criteria was made and these classes takes value between 1 and 4. The least favour value of sub-criteria is 1 and the most beneficial value of sub-criteria is 4 for soil erosion risk (Table 1).

There are many FAHP approaches introduced by various authors in the literatures (Buckley, 1985; Chang, 1996; Deng, 1999). In this study erosion analysis, Buckley’s (1985) FAHP method was used in order to determine the criteria weights.

Table 1. Parameters and their weighting factor rates for soil erosion risk.

Erodibility		Slope %		Land use		Erozivite	
Class	Value	Class	Value	Class	Value	Class	Value
0.00-0.05	1	0-2	1	Forest	1	<60	1
0.05-0.10	2	2-6	2	Grassland	3	60-90	2
0.10-0.20	3	6-12	3	Agriculture	4	90-120	3
0.20+	4	12-20	4			>120	4
Organic matter		Texture (sand, silt, clay)		Soil depth		Vegetation	
Class	Value	Class	Value	Class	Value	Class	Value
< 1	4	Clay	4	90+	1	>70	1
1-2	3	L, SİC, SİCL, SİL	3	50-90	2	70-40	2
2-3	2	LS, S	2	20-50	3	40-10	3
3-4.4 <	1	CL, SL	1	0-20	4	< 10	4

In finally step, weighted linear combination formula was used to soil erosion risk for each sample point. Also various interpolation methods (Inverse Distance Weighing-IDW with the weights of 1, 2, 3 and radial basis function-RBF with thin plate spline (TPS), simple kriging (OK) with spherical, exponantial and gaussian variograms, ordinary kriging (OK) with spherical, exponantial and gaussian variograms, universal kriging (OK) with spherical, exponantial and gaussian variograms) were applied for predicting the spatial distribution of soil textural and climatic data with ArcGIS 10.5v. In the present study, root mean square error (RMSE) was used to assess and figure out the most suitable interpolation model. That’s why, the lowest RMSE indicates the most accurate prediction. In addition, in order to create the best arrangement of values in to the different soil erosion risk class, Natural Break method developed by Jenks (1967).

3. Results

In the study, FAHP method was used for the determination of the relative weights of the criteria that will be considered for erosion. Among the total data set (10 criteria) and minimum data set (5 criteria) that were used, there is no hierarchical relationship. The pairwise comparisons that were made by the decision-makers were regulated according to the pairwise comparison scale in Gumus (2009). The pairwise comparison matrix for total and minimum data sets, which was created as a result of the evaluation of the decision-makers, is presented in Table 2 and Table 3. After pairwise comparisons were made, criteria weights were obtained by following the FAHP steps. The highest value (0.214) was for vegetation criterion of erosion. Land use value was 0.193, slope value was 0.139, erozivity value was 0.123, organic matter value was0.108, soil dept value was 0.066, erodobility value was 0.059, clay value was 0.046, silt and sad value was 0.030, 0.021. The linear combination technique was used to calculate each soil sample. Comparison of interpolation methods for erosion is provided. Finally, spherical model of ordinary kriging function was used to estimate at unsampled locations and their distribution maps were presented in Figure 3 (A). Approximately 60.7% of the study area is high and very high erosion risk while approximately 9.9% is included in a low (Table 4).

Table 2. Pairwise comparison matrix for total data set soil erosion risk.

	Erodobility	Slope	Land use	Sand	Clay	Silt	Erozivity	Soil depth	Vegetation	Organic matter
Erodobility	1	1/4	1/4	5	2	3	1/3	1/2	1/3	1/2
Slope	4	1	1/2	3	3	3	2	3	1/3	3
Land use	4	2	1	6	3	4	3	3	1/2	3
Sand	1/5	1/3	1/6	1	1/3	1/3	1/3	1/5	1/7	1/5
Clay	1/2	1/3	1/3	3	1	3	1/3	1/3	1/3	1/5
Silt	1/3	1/3	1/4	3	1/3	1	1/5	1/3	1/5	1/5
Erozivity	3	1/2	1/3	3	3	5	1	6	1/3	2
Soil depth	2	1/3	1/3	5	3	3	1/6	1	1/3	1/3
Vegetation	3	3	2	7	3	5	3	3	1	2
Organic matter	2	1/3	1/3	5	5	5	1/2	3	1/2	1

Table 3. Pairwise comparison matrix for minimum data set soil erosion risk.

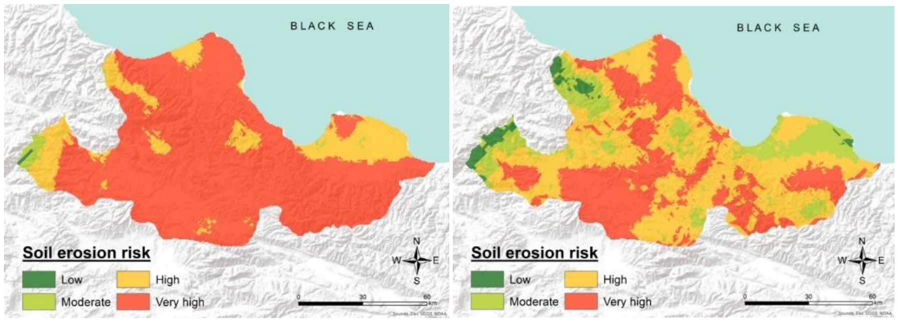
	Erodobility	Vegetation	Land use	Sand	Erosivity
Erodobility	1	1/5	1/5	2	1/5
Vegetation	5	1	2	5	3
Land use	5	1/2	1	3	2
Sand	1/2	1/5	1/3	1	1/3
Erosivity	5	1/3	1/2	3	1

The first five PCs explained 78.810% of the variance of the original data (Table 5). Sand had the highest loading value was selected as reflect PC1, erodobility had had the highest loading value was selected as reflect PC2, vegetation, land use and erosivity had the highest loading value for erosion reflect respectively PC3, PC4, PC5. Pairwise comparisons were made, criteria weights with minimum data set obtained by following the FAHP steps. The highest value (0.407) was for vegetation criterion of erosion. Land use, erozivity sand and erodobility value was respectively 0.270, 0.191,0.066 and 0.066.

According to the minimum data set, the calculation was made to the soil erosion risk. Gaussian model of ordinary kriging function was used to estimate or predict erosion risk at unsampled locations and their distribution maps were presented Figure 3 (B). While more than half of the study area was determined to be high and very high for erosion risk, 10.9% of the total area has been identified low for erosion risk (Table 4).

Table 4. Total and minimum data set area and ratio (%) for soil erosion risk

	Total data set		Minimum data set	
	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)
Low	94924	9,9	104812	10,9
Moderate	281342	29,4	307588	32,1
High	345012	36,0	367860	38,4
Very high	236622	24,7	177640	18,5



A B

Figure 3. Map of total data set for erosion risk (A), map of minimum data set for erosion risk (B)

Table 5. Results of PCA for soil erosion risk in Samsun

Principal Component Analysis	Factor				
	1	2	3	4	5
Eigen value	1.88	1.70	1.49	1.24	1.14
Percent	38.13	15.45	14.54	23.34	11.36
Cumulative percent	28.13	45.58	58.13	69.47	78.81
Eigen vectors					
Erodobility	0.024	**0.785**	0.005	0.475	-0.009
Slope	0.054	0.057	0.146	-0.059	0.103
Clay	-0.021	0.495	0.075	-0.338	0.051
Sand	**-0.955**	0.007	0.095	-0.164	-0.094
Land use	0.733	0.246	-0.518	**0.906**	0.063
Silt	0.486	-0.329	0.567	-0.089	0.013
Organic matter	0.121	0.007	0.483	-0.174	0.271
Soil depth	0.604	-0.135	0.158	0.035	-0.169
Vegetation	-0.172	0.365	**0.941**	-0.045	0.671
Erosivity	0.051	-0.652	0.066	-0.109	**-0.749**

Underlined factor loadings are considered highly weighted.
Bold factor loadings selected as MDS.

4. Conclusions

In this study, it has been tried to determine total data set and mininmum data set for erosion risk. The areas where especially the vegetation cover is poor, and slope is high the areas where the agricultural areas and poor pasture have been identified as too high erosion risk. MCDA technique is a powerful tool for resolving complex alternative choosing problems. Also, using GIS techniques, which is considered as one of the advanced technologies of today, allows obtaining, investigating and/or analyzing, storing a large volume of data and information in a short time, and producing different maps. The soil erosion spatial distribution can provide local practitioners a basis for comprehensive management and sustainable land use in the study area.

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Distribution of Forms of Carbon and Carbon Stock in the Soils of Babaleshwar East Sub-Watershed in Deccan Plateau of India

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Abstract

A study was undertaken during 2018-19 to identify the distribution of forms of carbon and carbon stock in the soils of Babaleshwar East sub-watershed of Deccan Plateau of India. Horizon-wise soil samples were collected from each soil series and analyzed for organic carbon, water soluble carbon, active carbon, inorganic carbon and total carbon. Organic carbon, water soluble carbon and active carbon were decreased with depth in all soil series, whereas inorganic and total carbon did not follow definite trend. Organic carbon, water soluble carbon and active carbon ranged from 700 to 6200, 5.0 to 30.7 and 337.42 to 631.35 mg kg^{-1}, respectively. Inorganic and total carbon ranged from 1470 to 63,050 and 4,000 to 65,000 mg kg^{-1}, respectively. Water soluble carbon and active carbon exhibited significant positive relationship with organic carbon, whereas inorganic and total carbon exhibited significant and positive relationship with $CaCO_3$. Organic, water soluble and active carbon were significantly and positively correlated with each other, whereas inorganic and total carbon were also significantly and positively correlated with each other. Highest organic, inorganic and total carbon stocks were recorded in Karjol (KRJ) soil series and lowest in Atharga (ARG) soil series. Inorganic carbon stock contribution was more to the total carbon stock compared to organic carbon stock.

Keywords: Carbon stock, Forms of carbon, Sub-watershed

1. Introduction

Soil Organic Carbon (SOC) is of native importance as it governs ecosystem functions, influencing soil fertility, water holding capacity and many other functions. It is also of global importance because of its role in the global carbon cycle and therefore, the part it plays a role in the mitigation of atmospheric levels of greenhouse gases (GHGs). Long-term experimental studies have revealed that SOC is highly sensitive to changes in land use, with changes from inherent ecosystems such as forest or grassland to agricultural systems almost always resulting in a loss of SOC (Jenkinson, 1990; Paul *et al*., 1997). We therefore have the chance in the future to adopt land use and land managing strategies that lead to buildup SOC sinks, thereby mitigating GHGs effects and improving soil fertility.

Soil carbon and its different labile fractions are important in minimizing negative environmental impacts and improving soil quality. Thus it is very important to understand the fractions of soil carbon, their distribution and dynamics in soils.

Among many land quality indicators, soil carbon stock is the most reliable indicator for monitoring land degradation (Larson and Pierce 1994). Hence, this study was aimed to estimate the forms of carbon and soil carbon stock in different soil series of Babaleshwar East sub watershed.

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2. Methodology

The organic carbon (OC) content of finely ground (0.2 mm) soil samples was determined by using Walkley and Black's wet oxidation method (Sparks, 1996). The water soluble carbon (WSC) was determined using the method as described by McGill *et al*., (1986). In brief, 10 g of soil was shaken for 1 hour with 20 ml of soil, followed by centrifugation (6000 rpm), filtration and titration against standard ferrous sulphate. The active carbon (AC) was determined by the modified method of Blair *et al*., (1995) as outlined by Weil *et al*., (2003). In brief, active carbon was determined by shaking 5 g air dried soil with 20 ml of 0.02 M $KMnO_4$ for 2 minutes (horizontal shaker-120 rpm), followed by centrifugation and measuring the light absorbance at 550 nm by colorimeter. Total carbon was determined by using CHNS analyzer (Vario EL cube model). The inorganic carbon (IC) was determined by subtracting organic carbon content from total carbon. Carbon stock for each soil series was calculated by using the formula:

$$\mathbf{C_{stock} = C_{conc} \times BD \times D \times A}$$

Where,

C_{stock} ⟶ Carbon stock (Mg)

C_{conc} ⟶ Carbon content in the soil ($g\ g^{-1}$)

BD ⟶ Bulk density ($Mg\ m^{-3}$)

D ⟶ Depth (m)

A ⟶ Area of soil series (m^2)

3. Results and Conclusion

3.1 Distribution of Forms of Carbon

The organic carbon content ranged from 700 to 6200 mg kg^{-1} and it decreased with depth in all soil series (Table 1). It might be due to addition of organic materials in the surface soils through litter fall, external applications, *etc*. Similar results were also observed by Majumdar (2014) in the soils of Northern transition zone of Karnataka.

Water soluble carbon is easily degraded by microorganisms and it plays key role in soil formation. The water soluble carbon distribution is similar to the soil organic carbon in all soil series. The water soluble carbon values decreased with depth in all soil series and it ranged from 5.0 to 30.7 mg kg^{-1} (Table 1). It may be due to decrease in organic carbon content down the depth. Similar results were also observed by Min *et al*., (2011) in the soils of China, Majumdar (2014) in the soils of Northern transition zone of Karnataka

The active carbon also called liable carbon or $KMnO_4$ oxidizable carbon. In different soil series, active carbon content ranged from 337.42 to 631.35 mg $kg^{-1}$and decreased with depth due to decrease in organic carbon content, as it is in accordance with organic carbon content.

The inorganic carbon values ranged from 2,800 to 67,900 mg kg^{-1}.The total carbon values ranged from 4,900 to 69,000 mg kg^{-1} (Table 1). The inorganic carbon and total carbon content did not follow any definite trend with depth. The distribution of total carbon depends on both organic and inorganic carbon; however, contribution from inorganic carbon was more.

Table 1. Forms of Carbon in different soil series of Babaleshwar East sub-watershed

Soil series	Horizon	Depth (cm)	OC	WSC	AC	IC	TC
			(mg kg^{-1})				
ARG(Atharga)	Ap	0-13	2,100	11.4	551.46	2,800	4,900
BBL (Babaleshwar)	Ap	0-10	4,700	25.5	631.35	17,200	21,900
	Bw	10-40	3,500	20.7	622.22	17,200	20,700
	Bss	40-90	2,500	17.4	563.70	17,100	19,600
	$Bssk_1$	90-150	1,400	15.0	527.93	13,600	15,000
	$Bssk_2$	150-180	800	12.6	468.25	16,800	17,600
DMT (Dadamatti)	Ap	0-24	6,200	10.8	619.11	18,900	25,100
	Bw	24-42	4,900	7.5	607.05	20,800	25,700
HNT (Honnutagi)	Ap	0-15	5,700	21.0	584.31	14,200	19,900
	Bw_1	15-49	5,500	17.4	582.95	14,800	20,300
	Bw_2	49-80	3,900	15.0	546.60	24,100	28,000
	Bw_3	80-130	3,400	11.7	528.32	15,100	18,500
	BCk_1	130-160	2,000	9.6	390.84	16,500	18,500
	Bss	160-200	1,200	9.0	370.41	18,200	19,400
JML (Jamunal)	Ap	0-31	4,500	14.5	595.34	49,500	54,000
	Bss_1	31-60	2,700	12.4	583.46	42,600	45,300
	Bss_2	60-97	2,100	9.3	569.29	60,300	62,400
	BCk	97-112	800	8.5	496.51	66,700	67,500
KRJ (Karjol)	Ap	0-16	6,200	29.1	591.70	12,400	18,600
	Bw	16-30	5,700	25.5	567.40	11,700	17,400
	Bss_1	30-60	4,700	21.6	531.82	12,600	17,300
	Bss_2	60-90	3,400	18.9	475.83	14,100	17,500
	Bss_3	90-120	2,300	16.2	448.23	15,900	18200
	Bss_4	120-160	1,800	10.5	402.16	17,000	18,800
NDN (Nidoni)	Ap	0-18	5,900	24.6	630.77	13,000	18,900
	Bw	18-40	5,100	18.6	609.58	12,200	17,300
	Bwk_1	40-70	4,500	15.0	528.32	16,100	20,600
	Bwk_2	70-90	3,700	12.6	475.06	9,000	12,700
	Bwk_3	90-120	1,800	12.0	436.56	5,300	7,100
	Bwk_4	120-150	1,200	10.2	409.35	11,800	13,000
	Bwk_5	150-190	800	9.0	337.42	6,700	7,500
NHL (Nahihalla)	Ap	0-20	5,100	15.0	584.50	25100	30,200
	Bwk	20-60	4,900	10.2	564.87	21,100	26,000
RMB (Rambhapur)	Ap	0-20	3,100	13.5	586.84	33,700	36,800
	BCk_1	20-50	2,700	10.5	565.26	40,100	42,800
	BCk_2	50-78	2,300	8.1	529.29	58,800	61,100
	BCk_3	78-110	1,100	6.3	473.50	67900	69000
	BCk_4	110-143	700	4.5	436.37	39,900	40,600
RPR (Rampur)	Ap	0-15	5,900	28.2	584.31	11,400	17,300
	Bw	15-35	5,100	24.6	579.25	12,000	17,100
	Bss_1	35-70	4,300	21.0	529.29	14,000	18,300
	Bss_2	70-110	3,300	17.1	486.72	14,400	17,700

Soil series	Horizon	**Depth (cm)**	OC	WSC	AC	IC	TC
			(mg kg^{-1})				
	Bssk$_2$	110-160	1,800	12.6	468.45	18,500	20,300
SRD (Sarwad)	Ap	0-10	4,900	29.7	615.80	13,000	17,900
	Bw	10-30	4,300	25.5	606.47	12,800	17,100
	Bss$_1$	30-60	3,900	21.6	585.48	14,000	17,900
	Bss$_2$	60-100	3,500	15.6	567.20	15,900	19,400
	Bwk$_1$	100-140	2,300	14.4	533.18	17,300	19,600
	Bwk$_2$	140-180	1,400	9.9	473.31	16,300	17,700
THL (Tenihalli)	Ap	0-20	5,400	22.5	601.36	13,300	18,700
	BCk$_1$	20-40	3,500	20.6	594.12	12,300	15,800
	BCk$_2$	40-78	2,100	18.5	575.54	25,000	27,100
	CBk$_1$	78-109	1,100	15.7	518.14	29,000	30,100
	CB	109-140	800	10.2	455.24	24,500	25,300
TSL (Tonshyal)	Ap	0-20	4,500	21.0	610.94	13,100	17,600
	Bw$_1$	20-50	3,900	18.6	604.92	11,600	15,500
	Bw$_2$	50-90	3,300	16.5	585.09	22,700	26,000
	CBK$_1$	90-120	2,000	13.8	528.13	27,500	29,500
	CBK$_2$	120-170	1,400	8.1	476.22	28,000	29,400

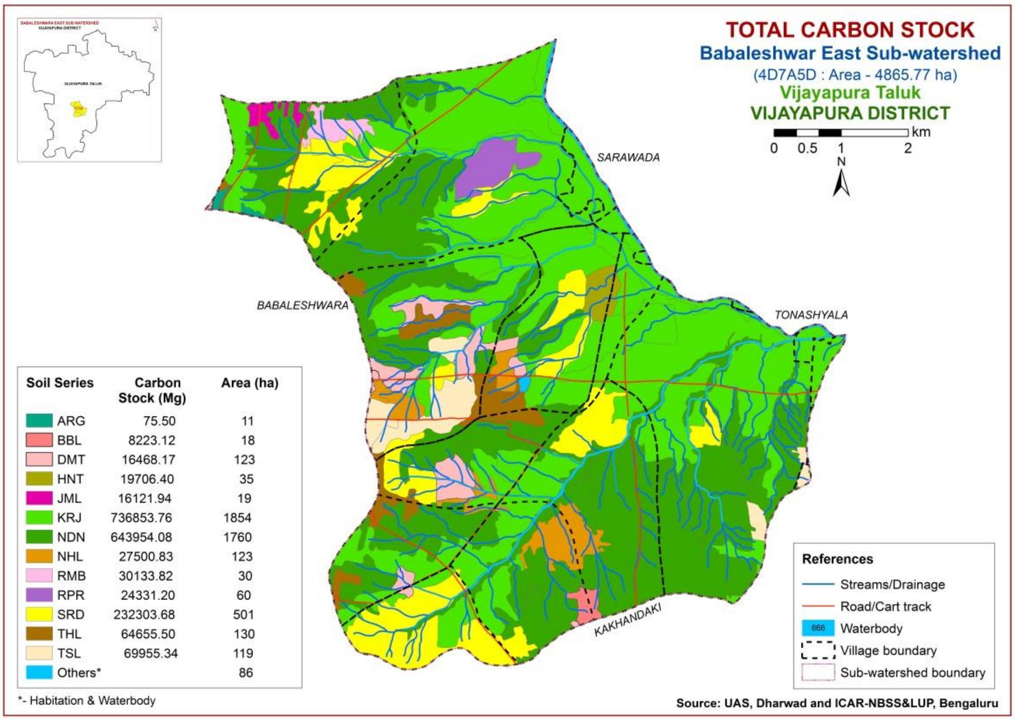

Figure 1. Total carbon stock in different soil series of Babaleshwar East sub-watershed

3.2 Soil Carbon Stock (Organic, Inorganic and Total Carbon Stock) in Different Soil Series of Babaleshwar East Sub-Watershed

Organic carbon stock ranged from 3.60 to 91.08 Mg ha^{-1} and 39.64 to 1,43,277.12 Mg per soil series. Inorganic carbon stock ranged from 4.81 to 966.97 Mg ha^{-1} and 52.85 to 593576.6 Mg per soil series. Total carbon stock ranged from 8.41 to 1004.46 Mg ha^{-1} and 92.49 to 7,36,853.80 Mg per soil series (Table 2) (Fig. 1). Organic carbon stock (per ha and per soil series) was lowest in ARG soil series and highest in HNT soil series (per ha) and KRJ soil series (per soil series). Inorganic carbon stock and total carbon stock (per ha and per soil series) were lowest in ARG soil series and highest in RMB soil series (per ha) and KRJ soil series (per soil series) (Table 2). Highest carbon stock related to high carbon content whereas, lowest carbon stock related to shallow depth of the soils (Singh *et al.*, 2007).

Table 2. Carbon stock in different soil series of Babaleshwar East sub-watershed

Soil series	Area (ha)	Total carbon stock	Organic carbon stock	Inorganic carbon stock	Total carbon stock	Organic carbon stock	Inorganic carbon stock
		(Mg per series)			(Mg per ha)		
ARG	11	92.49	39.64	52.85	8.41	3.60	4.81
BBL	18	8,223.12	959.36	7,263.76	456.84	53.30	403.54
DMT	123	16,468.17	3,624.38	12,843.79	134.65	29.64	105.01
HNT	35	19,706.40	3,187.80	16,518.60	563.04	91.08	471.96
JML	19	16,121.94	787.14	15,334.80	848.52	41.43	807.09
KRJ	1854	7,36,853.80	1,43,277.12	5,93,576.60	397.44	77.28	320.16
NDN	1760	6,43,954.10	1,42,554.72	5,01,399.40	365.88	80.10	285.78
NHL	123	27,500.83	4,918.03	22,582.80	223.58	39.98	183.60
RMB	30	30,133.82	1,124.84	29,008.98	1,004.46	37.49	966.97
RPR	60	24,331.20	4,603.20	19,728.00	405.52	76.72	328.80
SRD	501	2,32,303.70	37,875.60	1,94,428.10	463.68	75.60	388.08
THL	130	64,655.50	6,069.70	58,585.80	497.35	46.69	450.66
TSL	119	69,955.34	8,043.45	61,911.89	596.26	67.59	528.67

Table 3. Correlation amongst forms of carbon in different soil series of Babaleshwar East sub watershed

	OC	WSC	AC	IC	TC
OC	1	0.693**	0.733**	-0.342**	-0.235
WSC		1	0.595**	-0.479**	-0.414**
AC			1	-0.014	0.073
IC				1	0.994**
TC					1

Water soluble carbon and active carbon showed significant positive relationship with organic carbon (r = 0.693** and r = 0.733**, respectively) (Table 4). It clearly indicates that increase in organic carbon content leads to the increase in water soluble carbon and active carbon content. Similar results were also reported by Sofi *et al*., (2012) in the soils of Jammu and Kashmir and Majumdar (2014) in the soils of Northern transition zone of Karnataka. Inorganic carbon was significantly and positively correlated with total carbon, indicates that inorganic carbon contributed more to the total carbon (Table 4).

From the present study, it can be concluded that, management practices influenced the amount of carbon fractions and carbon stock.

4. Acknowledgments

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Spatial Analysis of Prime Quality Agricultural Land in the Irrigated, Drained and Land Consolidated Areas in Slovenia

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Abstract

Protection of prime quality agricultural land is an essential factor in preserving quality soils and increasing food production. The areas that have undergone land consolidations and include drainage and irrigation systems (CDI) are of particular importance as they have an impact on the quality and quantity of the harvested yield. The significance of these areas is demonstrated by using the grading criterion, which is defined by the Rules on detailed conditions for determining the proposal of areas of permanently protected farmland (PPAL) of prime quality. Using the ArcGIS program, we have designed a spatial representation of areas, which are of better quality and potentially best suitable for the implementation of the PPAL proposal and further protection. The total area in Slovenia that is suitable for implementing the PPAL in the CDI areas is 60,030 ha. Most of the CDI areas (86.62 %) are located on strategically exceptional important areas for agriculture and food production. This study showed that even if natural conditions for agricultural production are optimal (flatland, alluvial silty soils, water resources) only land consolidation (C) and further drainage (D) and irrigation (I) systems implementation are added value to strategically important areas for maximizing food production and secure self-sufficiency in time of crises. The CDI areas are as part of PPAL areas a strategic resource, and each country or nation needs to put more emphasis on implementation of legislative and practical measures to permanently protect and preserve its productive capacity.

Keywords: permanently protected agricultural land, irrigation system, drainage systems, land consolidation, strategically important areas

1. Introduction

Potential areas of permanently protected agricultural land (hereinafter referred to as PPAL) are, according to Article 3b of the Slovenian Agricultural Land Act (ZKZ-UPB2, 2011, hereinafter ZKZ) area, intended for agriculture and food production that are of strategic importance for the Republic of Slovenia due to the production potential of agricultural land, their extent, spatial uniformity, ensuring food production or preserving and developing rural areas and preserving the landscape. According to the statistical data from the year 2016, Slovenia has 494,641 ha of agricultural land (arable, grassland, pasture) in total (SURS, 2017). Due to the growing population, increasingly intensive urbanization, and soil sealing of agricultural land due to the expansion of industrial zones, road network, shopping centres and the construction of residential buildings, we are losing agricultural land of the highest quality. In order to preserve it the state, defined four types of strategic areas in the Decree on areas for agriculture and food production that are of strategic importance to the Republic of Slovenia (Pintar et al., 2015). Strategic areas will be defined in the spatial plans of local communities. In the process of adopting the spatial plan, it will be necessary to prepare proposals for the PPAL areas (MKGP, 2017, Cvejić et al., 2012). PPAL areas are determined on the basis of the criteria defined in the

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Rules on detailed conditions for determining the proposal of areas of permanently protected farmland and on the detailed content of the expert groundwork in the field of agriculture (RS, 2017), where among others the implemented land consolidations and drainage and irrigation systems are taken into account.

The purpose of this paper is to present a spatial analysis of permanently protected agricultural land (PPAL) quality in the areas of consolidated land, operating drainage and irrigation systems in Slovenia.

2. Methodology

2.1 Database and Spatial Analysis

After the literature review, a spatial analysis of acquired layers (Actual land use, Operational irrigation systems (I), Operational drainage systems (D), Land consolidations (C), Slope (DEM 12,5 metres), Land Credit Points, State border, Statistical Regions, Types and sub-types of strategic areas for agriculture and food production, Characteristic agricultural landscape) was performed in ArcMap 10.3, Esri ArcGIS (Geographic Information System) program. We selected the entire territory of the Republic of Slovenia for the research area. In order to evaluate the land according to the required criteria of the Rules for determining the proposal of areas of PPAL, a basic map was prepared including areas of completed land consolidations (C) and operational drainage (D) and irrigation (I) systems.

The baseline map had to be elaborated so that we could determine the suitability of individual sites for determining PPAL and evaluate them accordingly (Table 2). The sum of points was mapped accordingly to the model of suitability for determining the individual PPAL areas (RS, 2017), presenting study focus areas of all completed land consolidation areas (C), operational drainage (D) and irrigation (I) systems. For these three focus areas, other criteria (land credit points, slope, permanent crop, local landscape characteristics) for determining the proposal of the PPAL areas were defined based on rules defined in legislation (RS, 2017).

3. Results and Conclusion

3.1 Results of Spatial Analysis

Analysed areas of completed land consolidations (C), and operational drainage (D) and irrigation (I) systems (abbreviation for all three areas is CDI) represent 17 % (60,030 ha) of all potential agricultural land for the determination of PPAL (347,073 ha). The scenario determined the possible extent of the agricultural land in the report on Professional basis for the preparation of the Decree on PPAL (Pintar et al., 2015). The report also differentiates between four strategic areas for agriculture and food production: (1) exceptionally important areas, (2) very important areas, (3) important areas, and (4) other areas (Figure 1).

Primary CDI areas under analysis are located in exceptionally important areas for agriculture and food production (52,000 ha or 86.62 %), followed by very important areas (7,000 ha or 11.69%) and important areas (128 ha or 0.23%). Other areas included 876 ha CDI areas (1.46 %) (Figure 2a). In areas of exceptional importance is 92.77 % of all operational irrigation systems areas, followed by operational drainage systems (86.63%) and completed land consolidation (84.63 %) (Figure 2). In "other areas", prevail with 1.91 % of total drainage systems areas.

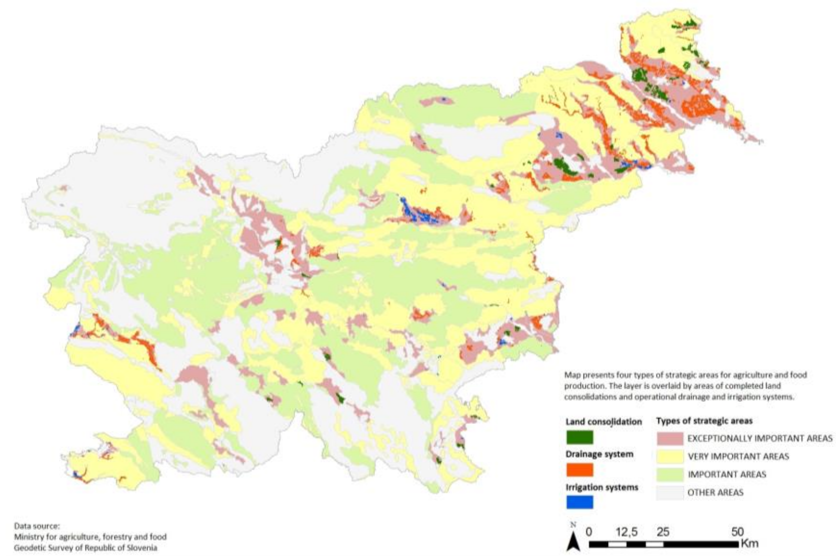

Figure 1. Strategic areas for agriculture and food production in the Republic of Slovenia with presented areas of completed land consolidations (C), and operational drainage (D) and irrigation (D) systems

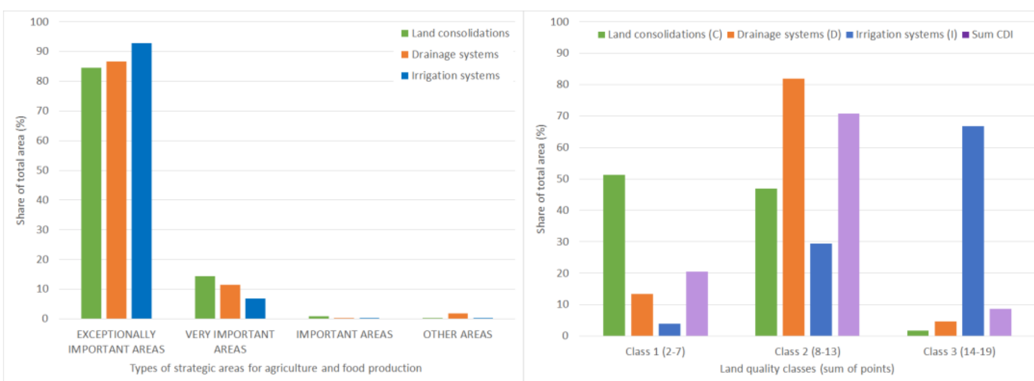

Figure 2. Graphic representation of (a) shares (%) of areas of completed land consolidations, and operational drainage and irrigation systems according to the **types of strategic areas for agriculture and food production** and (b) share (%) of areas of completed land consolidations (C), and operational drainage (D) and irrigation (I) systems according to the sum of points by point criterion (Table 2), divided into three **land quality classes**

Figure 3 shows the CDI areas scored according to the model of suitability for determining the individual PPAl areas. Areas are not necessarily dedicated as agricultural land in municipal spatial plans. The range of scores present sum of points from 1 to 20. In our example, the range was from 2 to 19, since the worst-rated land cannot get less than two points (Table 2). Thus, it receives at least one point from the land credit points and at least one to three points from land consolidations, drainage or irrigation systems. The total area of the CDI is covering 60,030 ha.

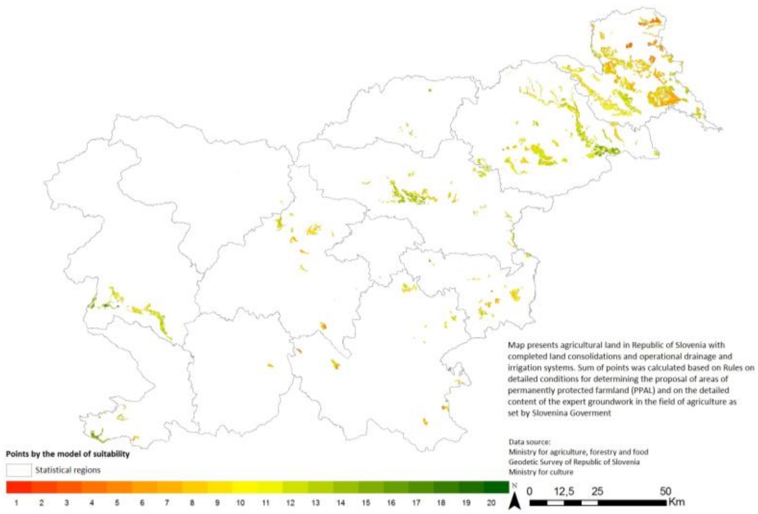

Figure 3. Map of the total possible points according to the model of suitability for determining the individual areas of preparation of the proposal of PPAL for the areas of completed land consolidations (C), and operational drainage (D) and irrigation (I) systems

Figure 2b presents criterion points, as determined by Rules in legislation (RS, 2017) joined into three classes by expected land quality (Class 1 - low quality, Class 2 - medium quality, Class 3 - high quality). The highest sum of points is expected on land with operational irrigation systems (4 to 19 points) with the highest share of areas scored with 14 points (43.57% or 2,925 ha). Follow operational drainage systems with a score range from 3 to 19 points, and the most substantial proportion of areas scored with 8 points (30.91 % or 13,258 ha). The areas of consolidated land score range is from 2 to 16 points, with the highest percentage scored with 12 points (31.95% or 3.940 ha). On average combined CDI area, is the most substantial part of the areas is scored with 8 points (22.27 % and 13.367 ha), followed by 13 points (20.59 % and 12,359 ha) and 11 points (13.76 % and 8,261 ha). Depending on the weighted average of the individual CDI areas surface extent, completed land consolidations average score is 9 points, the operating drainage systems 10 points and the operating irrigation systems 13 points (Tabel 3).

Table 1. A weighted average of the sum of points according to the surface area (ha) by completed land consolidations (C), and operational drainage (D) and irrigation (I) systems

	Area	**Weighted average of points**
	ha	
Land consolidations (C)	12,333	9
Drainage systems (D)	42,893	10
Irrigation systems (I)	6,712	13

3.2 Conclusions

Policy measures and regulations have a significant impact on the use of agricultural land in Europe (Vliet et al., 2014). Therefore, in the future, such measures as PPAL will gain importance concerning planning sustainable agricultural land management and restrictive land use policy at the local level. European land use policy aims to be in line with land use planning and consequently with rural development. With the protection of the best agricultural land emphasis is on more accessible agricultural land for farmers (EC, 2004). A strict measure will have to be implemented to ensure that the best agricultural land resources cannot be changed to urban use without compensation, substitution and justified economic or environmental reasons. Government representatives will have to create a dialogue with those responsible at the local level and with local users of agricultural land, thus endeavouring for better cooperation and agricultural land protection plan (similar to river basin management plans). This study showed that even if natural conditions for agricultural production are optimal (flatland, alluvial silty soils, water resources) only land consolidation and drainage (D) and irrigation (I) systems implementation are real added value to strategically important areas for maximizing food production and secure self-sufficiency in time of crises. The CDI areas as part of PPAL areas are a strategic resource, and each country or nation needs to put more emphasis on implementation of legislative and practical measures to permanently protect and preserve its productive capacity.

3.3 Acknowledgments

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Estimating the Soil Organic Carbon Stocks of Volcanic Lands Under the Different Landuses

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Abstract

In the Turkey, because of existing excessive rock and stone on the soil surface, thousands of volcanic originated lands could not be used in the agricultural practices. In recent years, some parts of these lands are improved for agricultural production by picking up rock and stone existing on and in the soil profile. Changes in natural ecosystems of rocky/stony lands may cause the carbon inputs depending of the different landuses. The soil organic carbon (SOC) has been disturbed continuously by land use change, intensive grazing and cultivation. These practices adversely affected the SOC pool and strongly impacting global warming and climate change.

In this research, we opened and descriped 4 soil profiles in the rocky/stony lands, cereal fields, vineyard garden and acorn forest planted areas, representative of different landuses situated at the volcanic lands.

The soil carbon stocks were obtained by multiplying the carbon content, soil bulk density and thickness of soil profile layers. The SOC was greater in acorn forest planted areas (25.2 ton/ha) followed by rocky/stony lands (23.8 ton/ha), vineyard garden (22.6 ton/ha), cereal fields (21.2 ton/ha), respectively.

Keywords: Volcanic Lands, SOC, Carbon Stock, Rocky Stony Soils

1. Introduction

Increasing population makes pressure on the natural resources coupled with biophysical, social, economic, and political factors, has caused soil quality and total land losses. Expansion of industry and urban sprawl directly plays a more important role in diminishing of the lands under the agriculture, forest and pasture. When the corbon dioxide is not storaged in the soil as organic matter, it is in the atmosphere and contributes to global warming. In the recent years, there are more attempts to sink CO_2 into the soil by increasing plant cover. On the other hand, because of the anthropogenic effect on the landuse change, carbon sink into the soil as organic matter was not enhanced as desirable level.

The Soil organic carbon (SOC) pool, however, is susceptible to human interference, primarily changes in land use/cover. Land-use/cover changes represent major anthropogenic contributions to emissions of greenhouse gases (Harris et al., 2012; IPCC, 2013). Changes in land use have important effects on regional ecological cycles and global climate change (Deng, 2017) and have been associated with approximately 20% of the global CO_2 emissions to the atmosphere (Werf et al, 2009; Baccini et al., 2008).

Soil organic carbon, a critical indicator of soil quality and the basis of soil fertility, provides nutrients to plants and maintains physical-chemical, biological and hydrological capabilities in arable soils (Cui et al., 2011). A small change in SOC would have a high influence on atmospheric CO_2 level of, thus, affecting carbon sequestration and emissions balance of organic matter into the soil (Lal, 2008).

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The SOC stocks of Turkey for the top 20 cm was estimated as 2.23 Pg. Drastic changes in land use and the degradation of soil have depleted the carbon (C) reserves in the Turkey, i.e., a reduction in soil organic matter (SOM) content (Aydın et al., 2017). Spatially explicit soil organic carbon information system was a great need for Turkeys' soils (Sönmez et al., 2017).

The objective of this study was to estimate the carbon stocks of soils formed on the different land-use/cover types of the stony/rocky volcanic Lands

2. Material and Methods

The study area located between Euphrates Rivers and Siverek town affected by the Karacadağ mountains represent a land area approximately 100 km^2 (Figure 1). Karacadağ has diverse geography which is mostly affected by the most recent basaltic volcanic eruptions.

Figure 1. Location of Study Area

Topography in most of the study area is rather complex consisting of dissected ridges and valleys due to volcanic eruption in the different time. Elevation ranges from 850 m to 694 m with a mean of about 772 m. Soils of the area classified as Vertisols, Leptosols, and Cambisols according to WRB (IUSS, 2015) and Vertisols, Entisols and Inceptisols according to soil Taxonomy (Soil Survey Staff, 2014). The study area has the major climatic features under the continental influence, it is hot and dry in summer and cold in winter. The mean average temperature is 16.4 degree (Koçman 1993; Sözer, 1984) and annual rainfall is about 577.9 mm (Cevheri, 2012).

The Karacadağ volcanism formed from basaltic lava and ash materials started in the Miocene age (Ercan et al.,1991). Volcanism showed it's effect at the wide areas totally 7200 km^2 widening around Diyarbakır, Viranşehir, Derik and Hilvan directions with approximately 2000 m depth ((Yalçınlar, 1961, Sözer, 1984; Erinç, 2001; Atalay, 2007, Sütçü, 2009).

In order to estimate the organic carbon stock, 4 soil profiles occurred on basaltic parent materials opened and discriminated at the various landuses. Sampling locations in each soil-landscape unit and the geographical coordinates of each location were recorded with a handheld GPS. Disturbed and undisturbed soil samples were collected from all horizons in order to determine the organic matter content, bulk density and other routine analysis. As a result, organic carbon stocks were estimated by using each horizons depth, organic carbon content and bulk density values. After these parameters are measured, SOC stocks associated with a particular study site calculated using this formula for each depth increment:

$$\textbf{SOC Stock (tons C ha}^{-1}\textbf{)} = \textbf{OC}_S \textbf{x} \textbf{BD}_h \textbf{x} \textbf{Depth}_s$$

where, SOC= soil organic carbon stock (in ton C ha^{-1}) of the depth increment
OCs= organic carbon content (mg C g soil-1) of the soil samples in the depth increment
BD= the mass of the soil per volume of the depth increment (g cm^{-3})

3. Results and Conclusion

In Turkey, due to growing population and food need, there is a great effort to gain some unused lands into agricultural production. The greater part of lands that aimed to open for agricultural purposes are not suitable for tillable agriculture due to high slope and erosion risk. When these lands took into agriculture, in a short time, they will be faced to land degradation threat. Otherwise, misuse of agricultural areas approximately 15% of the Turkey's fertile lands got out of purpose. In recent years, farmers intended to open stony/rocky volcanic areas into agricultural production. Also, the ministry of agriculture and forestry encouraged these activities.

There is a growing concern over the transformation of natural ecosystems to cropland. The growing concern about land-use change and destruction of natural ecosystems has heightened the demand for information on the spatial patterns of soil organic carbon stocks (SOCS) in natural ecosystems. It is thought that where natural vegetation and surface stone and rock are cleaned to expand cropland, it may affect the carbon storage in the soil.

Destruction of natural vegetation causes the loss of SOC and reduces the available SOC stocks (Syswerda et al., 2011). Wang and Gong (1998) report that when soil was cultivated for a long period of time with associated environmental change there was a 20% SOC loss. Convertion of land into the Agricultural application, loss of soil organic matter occurs (Çelik 2005), Grupta and Germina (1998) reported that cultuvation of pasture soils has resulted in 25-50 % decrease in soil organic carbon.

Soil is the largest terrestrial carbon pool (Janzen, 2004) and it has the potential to greatly increase carbon sequestration (Lal, 2004). Although increasing efforts to open new areas for agricultural production, on the other hand, scientist and politicians consumed more time to combat land degradation. Turkey is one of the most heavily affected countries by global warming and climate change which have been escalating particularly in the last century. Therefore, a series of intense efforts were initiated to mitigate the risks and alleviate the damages of desertification, land degradation and drought. Turkey undersigned the United Nations Convention to Combat Desertification in 1998 with a view to reducing the effects of land degradation, desertification and drought, and it plays an active role in the implementation of the Convention. Turkey participated in the 2015 towards achieving land degradation neutrality (LDN). Land degradation neutrality purpose is to halt and reverse land degradation, restore degraded ecosystems and sustainably manage our resources through a commitment (OSİB, 2016).

One of the main three criteria for LDN is the changes in soil organic carbon stocks, soil productivity and land cover change. In this study we estimated the organic carbon stocks in the 4 different landuse types occurred on the volcanic parent materials. Figure 2 presents the descriptive SOC of 4 different soil profile a representative of each landuses.

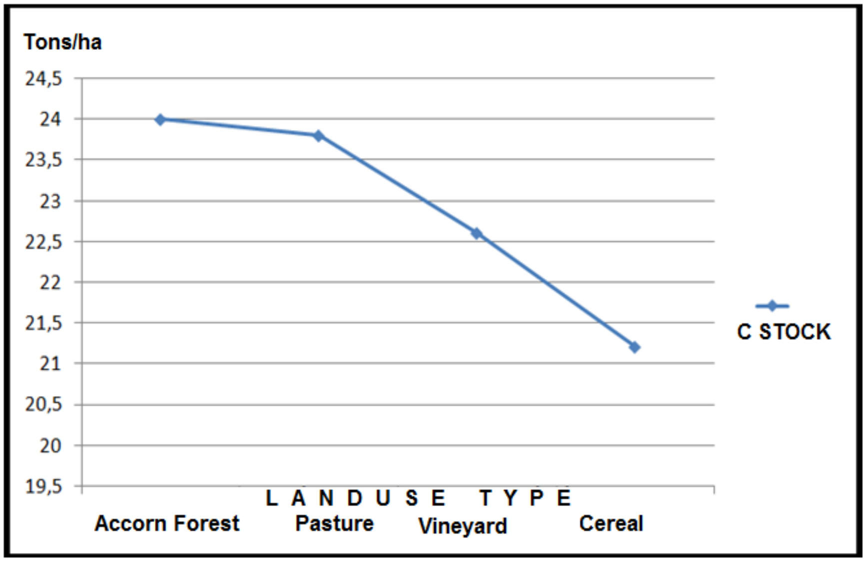

Figure 2. Soil Organic Carbon Stock of Different Landuses.

SOC stock ranged from 25.2 tons/ha for accorn planted lands, 23.8 tons/ha for pasture (rock/stony lands), 22.6 tons/ha for vineyard garden and 21.2 tons/ha for cereal planted area, respectively. However, conversion of rocky/stony lands makes a contribution to agricultural productions, but changes of natural habitat decreased organic carbon stocks. When the soils took under cultivation, the dry and warmer climate accelerated the decomposition of organic matter.

It is recommended that, these areas must be protected in their habitat for preventing the organic carbon losses. The lands can be used for a natural life, grazing and controlled organic farming. Also, these areas can be used as a "*Reserve Lands*" for future food security.

Acknowledgments

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Conversion of forest and grassland into agricultural land is of considerable concern worldwide in the context of environmental degradation and global climate change

Upon conversion of the land to arable agriculture, loss of soil organic matter (SOM) occurs, and Elliott (1986) and Grupta and Germida (1988) reported that cultivation of pasture soils has resulted in 25–50% decrease in soil organic carbon.

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Plant Species as an Indicator Combating Desertification

Melda DÖLARSLAN[1], Ebru GÜL[2]

Abstract

Plant composition and distribution have an important place in combating desertification and vegetation characteristics. Specifically, the plant species that are distributed in arid and semi-arid areas are not only species but also well adapted to arid ecology. Within the scope of this study, plant taxa, which are distributed in 7 sampling areas with typical semi-arid climate in Çankırı province, Eldivan and Yapraklı districts, were determined and also the desertification risk value of the plant sampling areas were calculated. Plant sampling was carried out between April and September 2016-2017 vegetation period. Desertification risk value was calculated by using the DIS4ME (Desertification Indicator System for Mediterranean Europe) system developed for Mediterranean countries. After determining the desertification risk in the sampling areas and identifying plant species, the same plant species found in these areas were determined. The value of desertification risk of these plant species and the field were evaluated together and suggestions were made on whether or not species could be considered as indicator species in desertification.

Keywords: Indicator plant, Desertification, Semi-arid land

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Effects of Tillage Systems on Soil Carbon Stock and Structural Stability of a Typic Haploxerert

Mert ACAR[1], İsmail ÇELİK[2], Hikmet GÜNAL[3], Nurullah ACİR[4], Zeliha BEREKET BARUT[5]

Abstract

Tillage disturbs soil aggregates, enhances organic matter decomposition and accelerates land degradation process. The purpose of this study was to determine the effects of long-term (2006-2017) two conventional (CT-1 and CT-2). three reduced (RT-1. RT-2 and RT-3), no-till (NT) and strategic tillage (ST) systems on soil carbon stock and structural stability index (SSI) of a Typic Haploxerert soil in eastern Mediterranean region of Turkey. Disturbed and undisturbed soil samples were collected from 0-10, 10-20 and 20-30 cm depths of long-term experimental plots in November 2017. Organic carbon, bulk density and particle size distribution in soil samples were analyzed to compute soil carbon stock and SSI. Tillage, depth and tillage x depth interaction had significant effects on soil carbon stock and SSI. Soil carbon stock and SSI values were significantly higher under NT in surface layer while SSI values in subsurface layers were higher under ST treatment. Soil carbon stock and SSI values were reduced with depth. The highest carbon stock and SSI in surface layer were found under NT (19121 kg ha^{-1} and 2.96%) and RT-3 (18284 kg ha^{-1} and 2.86%), respectively. The highest carbon stock and SSI in subsurface layers were found under ST (14892 kg ha^{-1} and 2.27%, 13513 kg ha^{-1} and 1.96%), respectively. The structural quality assessed by SSI in all tillage systems indicated the risk of soil structural degradation (≤5.0%) probably due to the low organic carbon content of soils. However, conservation tillage systems resulted in higher SSI values compared to conventional systems due to increasing carbon values.

Keywords: Tillage, Conservation tillage, Strategic tillage, Structural stability, Carbon stock

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Determination of Land Suitability Classes Using Expert Knowledge and AHP by Validation with Remote Sensing

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Abstract

The use of special indices derived from satellite images become prevalent in the estimation of the productivity potential of soils. In this study, expert knowledge and analytic hierarchy process (AHP) were integrated into the GIS model to create the land suitability map. Different indices obtained from Sentinel - 2A images were used to determine chlorophyll contents. In the model, nine factors including topographic condition, soil properties, and nutrient status were used. The score values of suitability classes were statistically compared with Weighted Difference Vegetation Index (WDVI), Modified Chlorophyll Absorption in Reflectance Index (MCARI) and Normalized Difference Vegetation Index (NDVI) derived from the Sentinel - 2 satellite image. According to results, the most effective factors on the last score values were soil depth and stony for the study area. Accuracy coefficients of WDVI and NDVI were 0.88 and 0.91, respectively. It is a different perspective for the validation of the productivity potential of the land. It can be proposed that the capabilities of the satellite images were useful to classify land suitability.

Keywords: GIS, Land suitability, Sentinel - 2, Vegetation indices

1. Introduction

The most important fact of the 21st century is intensive pressure on agriculture soils. This is a negative situation on the available land resources, which may result in land degradation. Dependable and accurate land evaluation is, therefore, indispensable to the decision-making processes involved in developing land use policies that will support sustainable rural development (Ahmed et al, 2016). Today, the use of GIS-Multi-Criteria Decision Making (MCDM) methods allow the user to derive knowledge from different sources in order to support land use planning and management (Sarkar et al., 2014). One multi-attribute technique that has been incorporated into the GIS-based land-use suitability procedure is the Analytical Hierarchy Process (AHP) (Dengiz and Sarıoğlu, 2013). In this study, there is a GIS-based MCDM land suitability analysis method to classify the study area with respect to the potential for crop cultivation. Plant biomass density was determined by vegetation indices and the success of the model was tested by cross-validation using spectral plant reflections in the research area.

2. Methodology

2.1 Study Area and Soil Properties

The research was conducted on the Konuklar State Farm. This area is located in Central Anatolia region, Konya province, Sarayönü district 38° 22′ 45″ - 38° 16′ 37″ North latitudes, 32° 21′ 32″ - 32° 24′ 22″ East longitude. The total area of the Farm is 4007 ha. The values of the selected factors in the model were extracted

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from the thematic soil map and soil survey report of the area where study carried out by Dinç et al, (2002). The descriptive statistics of the study area based on basic soil properties are presented in Table 1.

Table 1. Descriptive physico-chemical properties of pedons.

Properties	Min	Max	Mean	StDev	SE Mean	Variance
Salty, %	0.010	0.110	0.05867	0.02317	0.00669	0.00054
pH	7.24	7.90	7.5525	0.1781	0.0514	0.0317
$CaCO_3$, %	5.00	26.00	15.00	8.30	2.40	68.91
OM	1.320	3.630	2.225	0.728	0.210	0.530
P_2O_5, mg kg^{-1}	4.99	27.28	11.73	6.64	1.92	44.03
K_2O, me/100gr	0.43	1.12	0.8058	0.2412	0.0696	0.0582
N, %	0.2680	0.6490	0.3610	0.1081	0.0312	0.0117
Sand, %	7.00	53.70	28.53	12.56	3.62	157.66
Silty, %	24.40	51.30	34.57	7.72	2.23	59.58
Clay, %	21.90	50.80	36.91	8.29	2.39	68.74

2.3 Multi Criteria Decision Making Approach

Analytical Hierarchy Process (AHP) was used to Land Suitability Classification. According to soil map and report, 9 soil properties which were depth, slope, stone, texture, organic matter, available phosphorus, exchangeable potassium, $CaCO_3$, and drainage was selected. Comparison Matrix developed by Saaty (1980) for the pairwise comparison of the selected criteria with AHP was used. The criterion was scored on five sub-factors from 0 to 4 in the light of expert knowledge (Malczewski, 2006). The weight coefficients and sub-factor values of the criterion were functionalized by linear combination technique (LCT). The land suitability scores were determined for classification. LCT was applied using the following equation;

$$\boldsymbol{LS} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} (\boldsymbol{Wi}\,.\,\boldsymbol{Xi})$$

Where;

LS: Land suitability score, Wi: weighting of parameter i, Xi: Sub-criterion score of parameter i. The above formula is applied to each soil sample. In the overall result, the higher LS value is the higher suitability of land-use for agricultural activities. In this study, the suitability classification was based on the FAO framework (FAO, 1977) and modified slightly.

2.4 Validation for the Model By Vegetation Indices

In order to determine the relationship between land suitability classes and vegetation index values was studied by SENTINEL 2 satellite image. An available cloud-free Level-2A image in May-2018 that contained heading growth stages for wheat was downloaded. Three vegetation indices which Normalized Difference Vegetation Index (NDVI), Weighted Difference Vegetation Index (WDVI) and REMCARI (Red Edge Modified Chlorophyll Absorption in Reflectance Index), was used. Many papers were focused on the capabilities and potential of these indices because of good indicator to predict biomass density according to crop dynamics (Sawasawa, 2003, Zhao et al., 2015). Specification of the indices was shown in Table 2.

Table 2. Used indices and specifications to predict biomass density.

Index	Formula	Ability	Reference
NDVI	(NIR – RED) / (NIR + RED)	Plant chlorophyll content	Rouse et al. 1973
WDVI	NIR−C * RED with C = NIRbaresoil / $RED_{baresoil}$	Leaf area non reflective subsoil	Clevers, 1989
REMCARI	[(NIR – REedge)- 0.2(RE – G)] x (NIR/REedge)	Plant chlorophyll content	Daughtry et al. 2000

3. Results and Conclusion

The distribution map of land suitability for agricultural uses of the study area is presented in Fig 2. Table 3 showed the size of the land suitability classes.

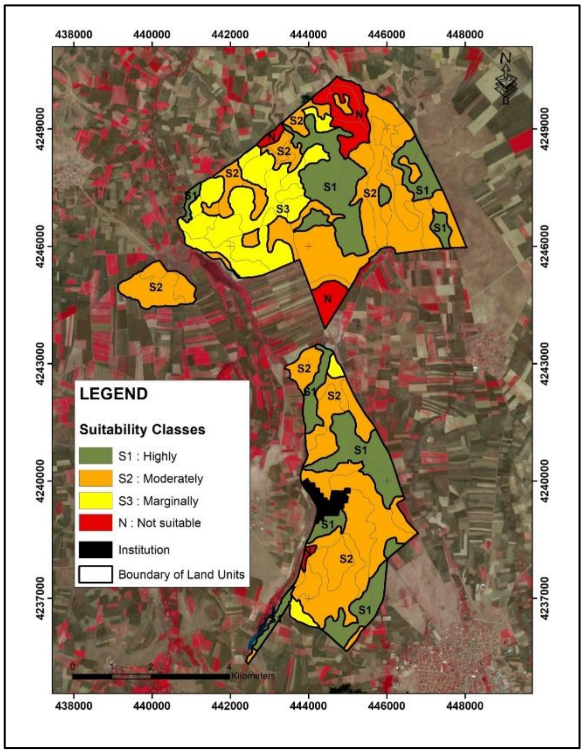

Fig 2. Distributions of suitability classes over the Land Units

Table 3. Land suitability index classes.

Suitability	Class	LS Score	Area (ha)
Highly suitable	S1	> 3.66	985.24
Moderately suitable	S2	3.22 - .3.66	2129.58
Marginally suitable	S3	2.77- 3.21	658.99
Not suitable	N	0 – 2.76	233.09

The mean score values of land suitability classes and the linearity between three different VIs were investigated. For this purpose, the polygon data of the suitability classes of the land units were overlayed in the VIs maps. The average index values of each suitability class were calculated using the zonal statistical tool. It was shown that WDVI and NDVI values were linear with LS scores, r^2 = 0.91 and r^2 = 0.88, respectively, but, REMCAR values did not establish high relations as r^2 = 0.48. The graphs of the suitability scores comparisons and the distribution map of the VIs were presented in Fig 3.

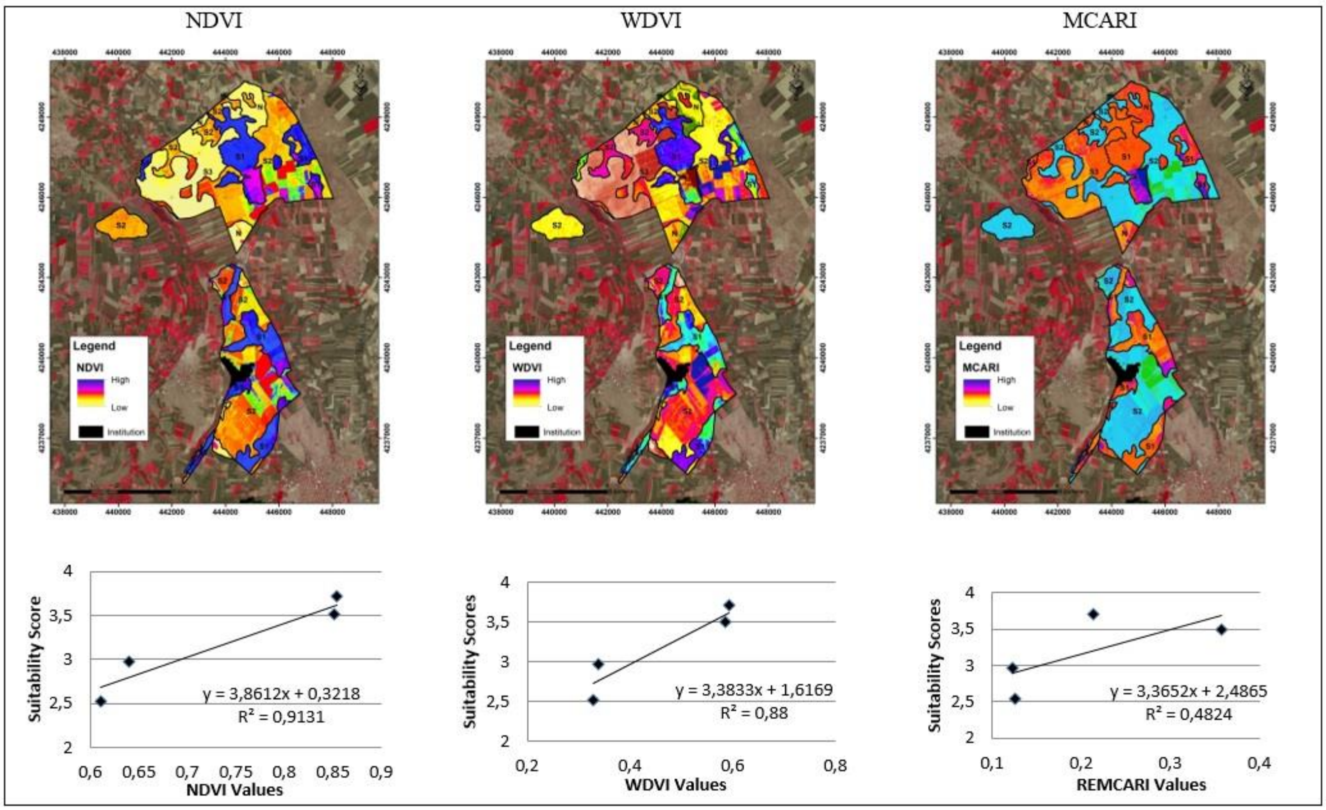

Fig 3. Distribution map of VIs overlay of suitability classes and comparison of mean values.

Parametric approaches provide reliable results in the field evaluation studies with today's developing computer technologies and software capabilities. The most important advantage of these methods has an expressive capability for different soil characteristics mathematically. In this study, it was observed that the AHP method which was integrated with GIS effectively weighted the parameters selected by expert knowledge. This result was validated by comparing the VIs values derived from the SENTINEL 2 image. The developed model was found successful. As a matter of fact, land suitability classes vary in direct proportion to product yields, because of the selection of the criteria and weighting by AHP are used region-specific restrictive factors. These factors also affect the canopy reflections from the existing vegetation. In this way, the accuracy of land suitability classes in areas, where the yield values are not known, can be tested by comparing the plant biomass derived from VIs. Our results were denoted that NDVI and WDVI models can be used for this purpose. However, the REMCARI model was shown a relatively lower correlation with LS scores. This model was observed to be unsuccessful for the objective of the study. The result of the study was demonstrated that GIS-AHP was a powerful tool in land evaluation studies that require complex alternative selections by functioning in pairwise comparisons between soil characteristics of integration. We recommend that the use of AHP-GIS to produce a region-specific model because It can be easily modified for different terrain features. In addition, this study presents a different perspective on future research on the use of satellite imagery in land suitability classifications.

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Evaluation of Land Quality Index for Agriculture Soils Based on Standard Scoring Functions and AHP Approaches

Mert DEDEOĞLU[1], Orhan DENGİZ[2]

Abstract

The aim of this study was to determine soil quality by using Land Quality Index (LQI) model based on standard scoring functions and weight assignment approach in agricultural lands used for agricultural activity in Konya province located on Central Anatolia Region of Turkey. The study area was Konya Beşgözler with an area of 5140 ha. A total of 152 soil samples were collected from surface depth (0-20 cm) in the study. A total of thirty soil quality parameters based on the key predictor variables that determine cultivation mentioned in relevant literatures were included in LQI model by grouping in five classes which are; i-land indicators (soil depth, slope and stoniness), ii-physical indicators (available water capacity, hydraulic conductivity, bulk density, percentage of sand, silty and clay), iii-chemical indicators (soil reaction, electrical conductivity, SAR, organic matter and lime content), iv- nutrient elements (phosphors, potassium, total nitrogen, born, calcium and magnesium, zinc, copper, iron and manganese),v: pollution (aluminum, cobalt, cadmium, chrome, nickel, lead). In addition, in order to generate distribution of LQI class map, fifteen interpolation models were applied, and it was chosen Spline with Tension model of Radial Base Function due to its lowest RMSE value. According to obtained results, 80.2% of the study area was classified as high and very high-quality level whereas, 12.0% of the total study area has low and very low land quality property. Only, 7.7 of the study areas has moderately land quality level.

Keywords: Analytical hierarchy process, GIS, Land quality index, Standard scoring functions

1. Introduction

The planning of the regional development projects, which are described as high cost and national wealth such as Konya Basin Project, should be completed before the start of the operation (Dengiz et al, 2014). Thus, the objective of this study was to evaluate of the Land quality index (LQI) based on standard scoring functions and analytic hierarchy process for K.O.P. agriculture area of Konya – Beşgözler.

For this purpose, thirty parameters were selected as into land indicators, physical indicators, chemical indicators, nutrient elements and pollution indicators for LQI dataset and the degree of impact on the quality values of the soil was determined. In addition, the quality map was produced in GIS environment to decision makers and agricultural policy producers to be a base for land management planning.

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2. Methodology

2.1 Field description, soil sampling and indicator scoring

The study area was Konya Beşgözler with an area of 5140 ha. It is located between 38 ° 31 '- 38 ° 16' North latitude and 32 ° 16 '- 32 ° 19' East longitude. According to the climate characteristics based on Soil Survey Staff (2010), it was determined that the soil is in Aridic moisture regimes and Mesic temperature regime (Dedeoğlu, 2017). In the study area, there are four different physiographic units determined as mud flow, flood plains, side stream alluvium and old stream terrace. The study area has been mostly used as agricultural activities and also for pasture. Field study was conducted in 2015 and a total of 152 soil samples from Entisol, and Aridisol soils orders were collected randomly from the site (Figure 1).

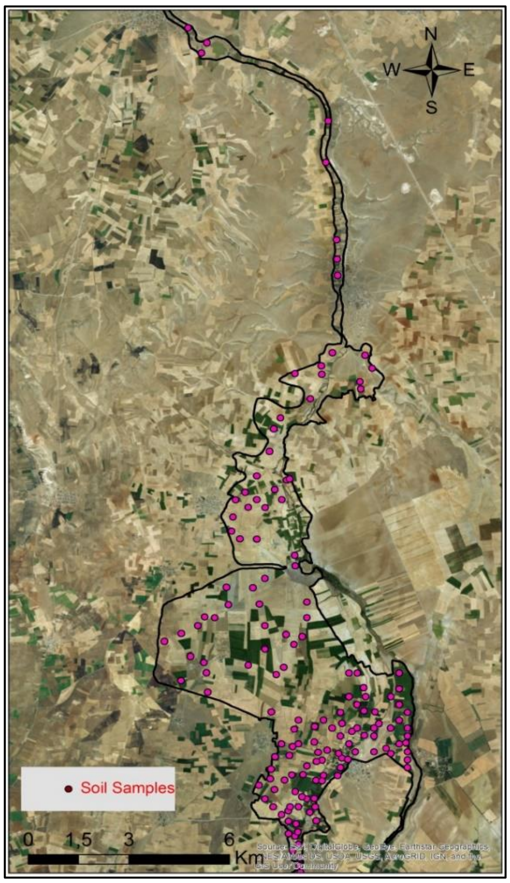

Figure 1. Soil sampling pattern

Each soil sample was collected from soil surface (0–20 cm). A total of thirty soil quality parameters were included in LQI model by grouping in three classes which are; i- land indicators (slope, depth, stoniness), ii-physical indicators (dry bulk density (BD), saturated hydraulic conductivity (HC), available water capacity (AWC), content of sand, silt and clay), iii-chemical indicators (soil reaction, electrical conductivity, organic matter, SAR and CaCO3 content), iv- nutrient elements content (nitrogen, phosphors, potassium, born, iron, copper, manganese and zinc content), v-heavy metal pollution (aluminum, cobalt, cadmium, chrome, nickel and lead). In this study, due to variation of parameters units, a standard scoring function (SSF) was used in order to normalize soil parameters by assigning scores ranging between 0 and 1 (Andrews et al. 2002). “Optimal range” function was applied to pH ad clay content thus; scores were assigned using the more is better or the less is better function depending on whether the indicator value was below or above the optimal range. The SSF equations for the parameters are listed in Table 1.

Table 1. Standard scoring functions and parameters for quantitative soil parameters.

Parameters	FT*	L	U		SSF Equation**
Depth	MB	30.00	120.00	(1)	$f(x)=\begin{cases}0.1 & x\le L\\ 0.9\times\frac{x-L}{U-L}+0.1 & L\le x\le U\\ 1 & x\ge U\end{cases}$
AWC	MB	0.12	0.15		
HC	MB	0.68	5.35		
OM	MB	0.10	3.60		
TN	MB	0.01	0.18		
AvP	MB	1.27	114.46		
AvK	MB	9.92	168.88		
AvCa+Mg	MB	0.25	20.71		
AvFe	MB	4.59	6.68		
AvZn	MB	0.09	0.40		
AvCu	MB	1.43	1.68		
AvMn	MB	8.36	16.58		
B	MB	0.00	2.62		
Sand	LB	10.00	46.00	(2)	$f(x)=\begin{cases}0.1 & x\le L\\ 1-0.9\times\frac{x-L}{U-L}+0.1 & L\le x\le U\\ 1 & x\ge U\end{cases}$
Silt	LB	18.00	45.00		
EC	LB	0.01	1.50		
$CaCO_3$	LB	2.40	53.30		
BD	LB	1.21	1.28		
Stoniness	LB	1.00	15.00		
Slope	LB	2.00	6.00		
SAR	LB	0.10	26.80		
Na	LB	0.08	9.59		
Al	LB	0.00	0.01		
Co	LB	0.01	0.06		
Cd	LB	0.00	0.01		
Cr	LB	0.00	0.00		
Ni	LB	0.03	0.32		
Pb	LB	0.25	0.77		
Clay	OR	L1	U1	(3)	$f(x)=\begin{cases}0.1 & x\le L\ or x\ge U\\ 0.9\times\frac{x-L1}{L2-L1}+0.1 & L\le x\le L2\\ 1 & \end{cases}$
		29.00	40.00		
		L2	U2		
		40.00	56.00		
pH	OR	L1	U1		$f(x)=\begin{cases}0.1 & \\ 0.9\times\frac{x-U1}{U2-U1}+0.1 & L2\le x\le U1\\ 1 & U1\le x\le U2\end{cases}$
		7.80	8.08		
		L2	U2		
		8.08	8.22		

*FT means function type; MB means more is better; LB means low is better; OR means optimal range.

**SSF means standard scoring function; in these three equations, x is the monitoring value of the indicator, f(x) is the score of indicators ranged between 0.1 and 1, and L and U are the lower and the upper threshold value, respectively.

2.2 Land quality index and weight assignment

The indicators were scored and weighted, land quality indices were calculated employing the Land Quality Index (Dengiz et al. 2015) using the following formula (1);

$$LQI = \sum_{i=1}^{n}(\mathrm{Wi.Xi}) \quad (1)$$

Where; LQI: Land quality index for agricultural usage, Wi: Weighting of parameter i, Xi: Sub-criterion score of parameter i. Each of sub-criteria has an importance level that differently affects the land suitability for agricultural usage. The weighting in land and soil quality are useful to assess the importance level of soil parameters for each sub-criterion. In this study, the AHP method (Saaty 1980) was selected and used for weighting the criteria and sub-criteria for the land suitability assessment of agricultural activities.

2.3 Interpolation analyses

In order to get classes of LQI, Natural Breaks Jenks method were used in ArcGIS, program by taking into consideration of frequency distribution and statistical data**.** In the present study, three main interpolation methods (Inverse Distance Weighing-IDW, Radial Basis Function-RBF and Kriging) were performed for predicting the spatial distribution of LQIR. Thus, five classes were detected in this study. Land quality index values were given in Table 2.

Table 2. Land quality classes for agricultural land suitability

Class	Definition	Index value
I	Very high	0,697-0,831
II	High	0,652-0,696
III	Moderate	0,583-0,651
IV	Low	0,501-0,582
V	Very low	0,356-0,500

3. Results and Conclusion

The distribution map of LQI of the study area is illustrated on Figure 2 and classified as five levels according to Table 3. this study also showed almost parallel with research carried out by Dedeoğlu (2017). He investigated different land evaluation approaches such as FAO Soil Productivity Index (SPI), Complex Square Land Quality Index (CI), Productivity Index (PI) and Irrigation Ability Index (SII) in the same area. According to these land evaluation methodologies, SPI, CI, PI and SII were found 71.98%, 82.32%, 65.0% and 79.71%, respectively. According to land quality assessment results, it was detected that more than the total study area is very highly and highly suitable for agricultural activity. Consequently, land quality map for study area generated using SSF, AHP, geostatistics and GIS techniques, can enhance the planning alternatives within an area with meaningful strategy in terms of location. Therefore, the present model will provide logical guidance for new land allocation for the cultivation of agricultural usage.

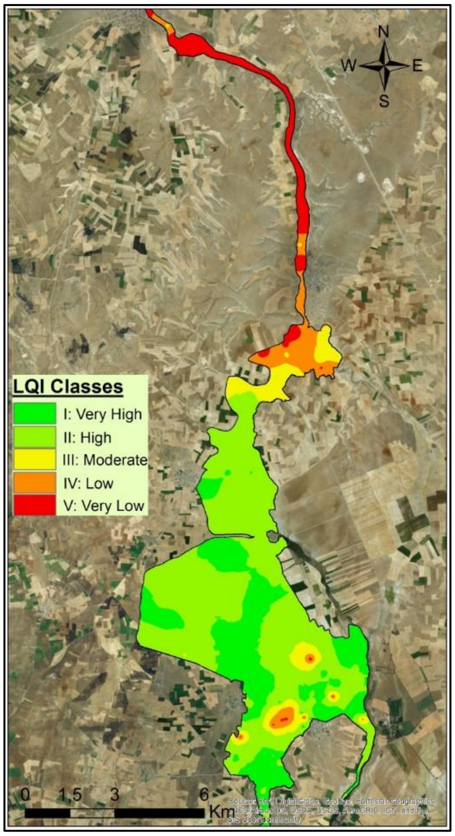

Figure 2. Spatial distribution map of the LQI classes

Table 3. Distribution of land quality classes

Class	Description	Area	
		ha	%
I	Very high	1336,7	26,0
II	High	2784,2	54,2
III	Moderate	397,0	7,7
IV	Low	320,7	6,2
V	Very low	295,4	5,8
Total	-	5134.0	100,0

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Comparison of Classification Systems in Remote Sensing Based Land Use Determination Studies

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Abstract

Turkey has not been standard land use classification system used yet. The determination of land cover/ land use classes and their spatial distribution constitute the basis of planning and evaluation studies. Land cover and land use classes, generated from satellite images, are produced in accordance with certain standards. In this regard, Anderson et al. (1976) and CORINE systems are the most known classification systems. Regardless of which classification system is used, remote sensing is one of the methods used in these studies and provides the most accurate results. Plant patterns, especially agricultural land uses, vary widely in time. Accurate determination of plant patterns will increase the success of land use classification systems.

This research was carried out at Haymana Research and Application Farm of the Faculty of Agriculture of Ankara University, using high-resolution multi-spectral images of acquired different dates. The same training sets were prepared and used for both classification systems during image classification. The images were classified according to different levels of both classification systems and the results were evaluated and compared.

Keywords: Plant Patterns, Remote Sensing, Land Cover, Land Use, Image Classification

1. Introduction

The agricultural sector, which is one of the most important components of a developing economy is closely related with the developments in the economy and the other sectors. Agricultural policies which aiming to develop the agricultural sector help solving the basic problems of the sector. It is important to sustainable management of the natural resources in the planning of the developing the sector of the agriculture. Land cover, water and animal existence are our important natural resources. Determining and updating land cover and plant patterns in the use of the natural resources will increase the success of the planning study.

Although land cover and land use are different things, sometimes they are expressed in the same sense. Soil, water and forest are the examples for the land cover. But land use is called how it is used by human.

Land cover and land use classes, generated from satellite images, are produced in accordance with certain standards. In this regard, Anderson et al. (1976) and CORINE systems are the most known classification systems. Regardless of which classification system is used, remote sensing is one of the methods used in these studies and provides the most accurate results. Plant patterns, especially agricultural land uses, vary widely in time. Accurate determination of plant patterns will increase the success of land use classification systems.

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2. Methodology

This research was carried out at Haymana Research and Application Farm of the Faculty of Agriculture of Ankara University. In this research high-resolution multi-spectral images of acquired different dates were used. The same training sets were prepared and used for both classification systems during image classification. The images were classified according to different levels of both classification systems and the results were evaluated and compared.

Interpretation of study datas analyzed with 5 different stages summerized as below:

1. Arrangement of Ground Truth Datas and Arrangement of Parcel Database and Land Use
2. Preparation of the Satellite Images for Analysis
3. Arrangement of Ground Truth Datas According to Anderson et al. (1976) and CORINE Classification Systems
4. Classiffication of the High-resolution Multi-spectral Satellite Images of the Study Area
5. Accuracy Analysis

3. Results and Conclusion

All the satellite images were classified as supervised according to Anderson et al. (1976) Classification System and CORINE Classification System. In Anderson et al. (1976) Classification System the best results taken from Level 1 Anderson et al. (1976) Classification System. Level 1 is the most general level when compare with the other levels in Anderson et al. (1976) Classification System. The worse results taken from Level 4 Anderson et al. (1976) Classification System. Level 4 is the most detailed level when compare with the other levels in Anderson et al. (1976) Classification System. In CORINE Classification System the best results taken from Level 2 CORINE Classification System. The worse results taken from Level 3 CORINE Classification System.
When compare with the Anderson et al. (1976) Classification System and CORINE Classification System, from Anderson et al. (1976) Classification System were gained more successful results than the CORINE Classification System.

As a result, it can be clearly said that as the levels are elaborated, the success rates declined.

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Determination Relationship Between Stability Criteria Which Are Used Susceptibility to Erosion

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Abstract

This study was carried out to determine the effects of rice husk compost, town waste compost and tobacco waste applications on some physical and chemical soil properties and relationship between structural stability criteria in soils having different pH levels under greenhouse conditions. For these purpose aggregates stability, dispersion rate and erosion rate parameters were taken as a basis. Soil samples used in this study were taken from (0-20 cm) depth of soil surface of the fields around Samsun. In the study carried out in split plot experimental design, rice husk compost, town waste compost and tobacco waste were applied into soils at four doses (0, 2.5, 5.0 and 7.5%) with three replications. After a month of incubation period, plants were grown in prepared media. The results of the analysis show that effectiveness of soil conditioner changed depend on acid, neutral or alkaline soil reaction. While these three parameters have very high relationship in acid-reacted soils, there was a significant relationship between the aggregates stability and dispersion ratio in neutral reacted soils and a significant relationship between dispersion ratio and erosion ratio. In alkaline soil, only erosion rate and dispersion rate were found to be important.

Key words: aggregate stability, dispersion rate, erosion rate, organic waste

1. Introduction

Determining the effects of various applications and processes on soil management on structural stability and susceptible to erosion is very important in terms of sustainable land management. For this reason, it is necessary to know the soil properties, land properties, land use and effect or contribution levels of agricultural applications affecting soil susceptibility to erosion while preparing land protected and land management plans (Özdemir, 2013).

In order to determine the structural stability of soil and its susceptibility to erosion; various tests, ratios and indexes have been developed. In many studies, the relationships between the pedological properties of soils such as textural fractions, water holding and transmission properties, specific surface areas, cation exchange capacities, ph, lime and organic content were investigated and the erosion characteristics of soils were evaluated as the initial approach value.(Öztürk, 2013).

Balcı and Özyuvacı (1974) dispersion rate, Sönmez (1982) and Özden (1992) clay ratio, dispersion rate, erosion rate and permeability rate were based on the criteria as a criterion of soil erosion and. they studied their susceptibility to erosion. Some researchers Özdemir (1987), Ngatunga et al., (1984), also investigated the relationships between these criteria and some other researchers investigated the relationships between the various physical and chemical properties of soils (Özdemir et al., 2018). This research was carried out to determine the relationships between the parameters used to evaluate soil susceptibility to erosion.

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2. Material and Method

2.1 Material

The soil samples used in the study were taken from Tepecik and Çetinkaya villages of the Bafra district of Samsun and OMU Kampüs area and surface (0-20 cm). In this study, tobacco waste (TW), rice husk compost (RHC) and town waste compost (TWC), which are used as organic soil conditioner, were obtained from different institutions.

2.2 Method

In the study conducted according to the split plot design, 4 mm sieved soils were used. In the study conducted in greenhouse conditions as a pot experiment, 1 mm sieved conditioners were applied to the soil in 4 different doses (0, 2.5, 5, 7.5) and 3 replications. During the four-week period of incubation, 75% of the appropriate moisture in the soil was exhausted and watered again. After the incubation period, 1 lettuce seedlings were planted in each pot. The greenhouse phase of the study was continued for 159 days under these conditions. After the harvest of plants, the relevant analyzes and evaluations were made on soil samples.

Table 1. Methods of analyses which are used on experiment soil and conditioner (Rowell, 1996; Kacar 1995; Kemper 1965)

	Analizler	Uygulanan Yöntem
Soil	Soil Reaction (pH)	1:1 (w/v) soil: in pure water mixture pH-meter
	Electrical Conductivity (EC)	1:1 (w/v) soil: in pure water mixture EC-meter
	Organic Matter	Walkey-Black method
	Aggregate Stability (AS)	Wet Screening (Kemper ,W D., 1965)
	Erosion Rate (EO)	According to determined Ngatunga et al., (1984)
	Dispersion Rate (DO)	According to determined Ngatunga et al., (1984)
Conditioners	Organic Matter	Walkey-Black method
	Total N	Kjeldahl method

3. Results and Conclusion

3.1 Some physical and chemical properties of soils

Some physical and chemical properties of soils and organic conditioners used in the experiment are given in Table 2.

Table 2. Some properties of soils and organic conditioners used in the experiment

	Sample Name	**OM, %**	**pH**	**Sand, %**	**Silt,%**	**Clay,%**
Soils	Tepecik	2.40	5.60	26.54	34.06	39.40
	Kampüs	1.13	7.00	34.15	25.63	40.22
	Çetinkaya	1.31	8.33	45.64	39.41	14.95
Conditioners	**Conditioner Name**	**OC,%**	**OM, %**	**N,%**	**C/N**	
	Tobacco Waste	38.40	66.20	1.97	19.49	
	Rice Husk Compost	9.91	17.08	0.88	11.26	
	Town Waste Compost	17.86	30.79	1.55	11.52	

3.2 Stability Criteria

3.2.1 Erosion rate

Erosion rate values determined in soil samples after the experiment are given in Figure 1. As can be seen from the analysis of this data, the ratio values change between the soil.

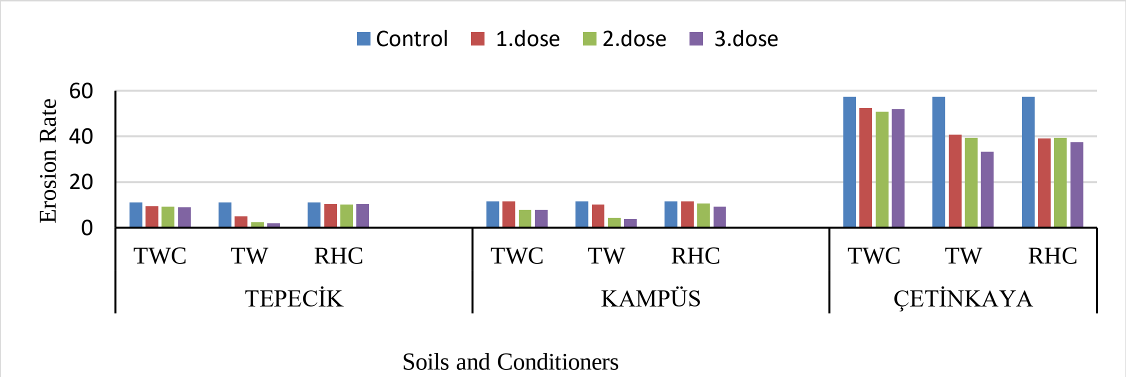

Figure 1. Effect of organic conditioners on erosion rate

Erosion rate is a parameter which is used to evaluate the susceptibility of soils to erosion. This ratio of less than 10% of the soil is considered to be resistant to erosion (Lal 1988). From this perspective (Figure 1), depending on the type, application doses and the pH levels of the soils, the conditioner applications have enabled the soil to be included in the endurance class by decreasing the ratio values in the Tepecik and Kampüs soil below the strength limit. In the case of Çetinkaya, the applications decreased the ratio values but not below the limit value.

3.2.2 Aggregate stability

After the experiment, the aggregate stability values determined in soils are given in Figure 2. As it can be understood from the examination of these data, the conditioners added to the soils provided significant increases in aggregate stability depending on the variety, application levels and pH levels of soils.

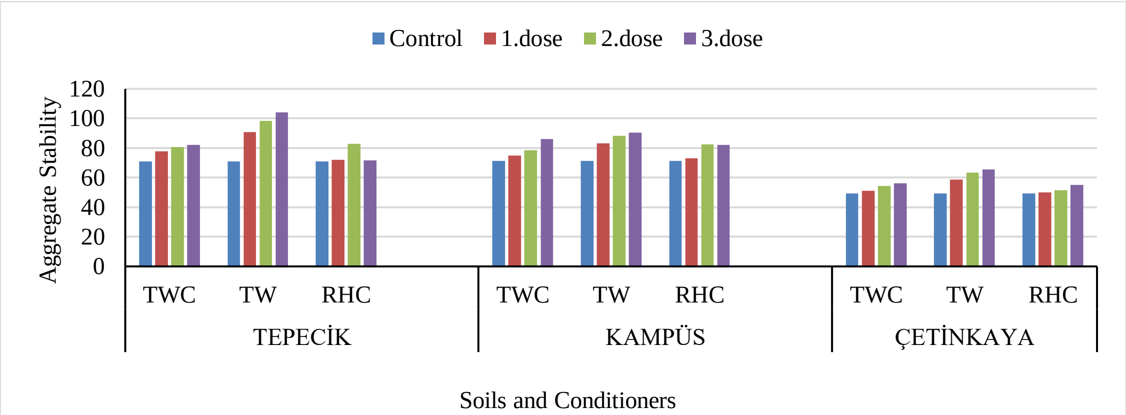

Figure 2. The effect of organic conditioners on aggregate stability

The value of aggregate stability is a parameter used to determine the durability of soil aggregates in the water mixture and to determine the resistance against water erosion. As the stability value increases, the physical conditions improve and the susceptible to erosion decreases. However, by using this ratio value, a limit value could not be developed to evaluate the soil in terms of resistance to erosion.

Through this parameter the materials added to the soil and the application or plant growing systems allows which are demonstrating the effect on erosion sensitivity (Özdemir, 2002).

3.2.3 Dispersion Rate

The dispersion ratio values determined in soils at the end of the experiment are given in Figure 3. According to this results the conditioners added to the soils provided significant reductions in the rate of dispersion, depending on the variety, application levels and pH levels of soils.

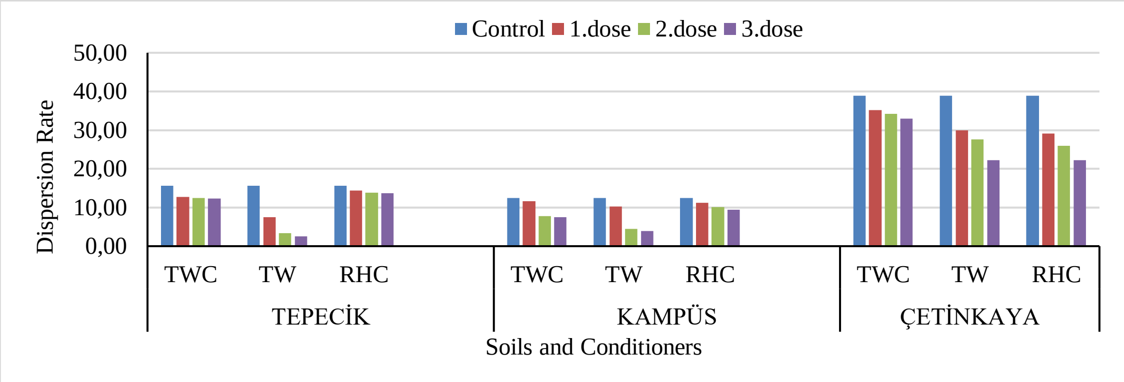

Figure 3. The effect of organic conditioners on dispersion rate

As long as the dispersion ratio value decreases, soil resistance are increases toward erosion, if the ratio value is less than 15%, the soils are resistant againts erosion (Lal, 1988). When viewed from this aspect applied TW, RHC ve TWC conditioners DO value decrease than 15% on Tepeck soil, and this soil resistance are increases toward erosion. Also Çetinkaya soil, conditioners DO value decrease, but substantiality not enough to reduce below the limit value. On the Kampüs soil already dispersion rate value less than 15%, in addition conditioners even more reduced DO value, and so increased abrasion resistance.

3.3 Relations between Stability Criterion

Depending on conditioners applications stability criteria of research soils and changes in these criteria on the figure 1, figure 2 and figure 3. According to this data, limit values of stability criteria discrepancy on the soils type.

Stability criteria are the parameters used in studies on soil erosion and to evaluate the effects of agricultural practices and operations. While some of these parameters contain limit values for evaluation purposes, some of them provide general interpretation. Correlations between the stability criteria are given in Table 2. When the data were analyzed, it was found that there was a negative correlation between the aggregate stability and dispersion ratio (-, 947 **) in Tepecik soil (acid reaction) at p <0.01 level, positive correlation between the dispersion rate and erosion rate (998 **) at p<0,01 level, negative corelation between the erosion rate and aggregate stability (-,949**) at p<0,01 level. In the Campus soil (neutral reaction) it was found that there was a negative correlation between the aggregate stability and dispersion ratio (-,637*) at p<0,05 level, positive correlation between the dispersion rate and erosion rate (,992**) at p<0,01 level. However, was not found significant correlation between erosion rate and aggregate stability (-, 558). And in the Çetinkaya soil (alcali reaction), While it was found that there was a possitive correlation between the dispersion rate and erosion rate (,947**) at p<0,01 level, among other parameters was not found correlation.

Table 2. After the experiment correlation coefficients between soil stability measures

ACID SOIL				NEUTRAL SOIL				ALCALI SOIL			
n=10	**AS**	**DO**	**ER**	**n=10**	**AS**	**DO**	**ER**	**n=10**	**AS**	**DO**	**ER**
AS	1	-,947**	-,949**	**AS**	1	-,637*	-,588	**AS**	1	-,457	-,418
DO	-,947**	1	,998**	**DO**	-,637*	1	,992**	**DO**	-,457	1	,947**
ER	-,949**	,998**	1	**ER**	-,588	,992**	1	**ER**	-,418	,947**	1

The stability criterion used in the evaluation effect of estimation significantly affected by soil structure (Table 2). It was determined that the parallelism between the criteria was classified as acid> neutral> alcali.

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Land Suitability Evaluation of Arjunagi Sub-Watershed in Deccan Plateau Agro Ecological Sub Region (AESR 3) of India Using Geospatial Techniques for Watershed Development

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Abstract

Land resource inventory of Arjunagi sub-watershed, Vijayapura district, Karnataka was made using geospatial techniques. The transects were identified in the field representing different landforms and soil profiles were dug open and studied. The horizon wise soil samples were collected and analysed for various physical and chemical parameters. The soil map showing eighty phases and seventeen series was prepared. Out of 5932 ha major area of 1826 ha is occupied by Dadamatti series which is shallow (25-50cm) and gravelly (15-35 %) with texture varying from clay to clay loam with moderate to severe erosion. Atharga series occupies 983 ha area with very shallow deep gravelly to very gravelly soil having clay loam to sandy clay loam texture and moderate to severe erosion, Kalgurki series accounts for 666 ha with moderately shallow (50-75 cm), gravelly (15-35%) clay to clay loam texture with slight to moderate erosion. The land suitability for major crops like maize, cotton, sorghum, amla, custard apple, mango, pomegranates, grapes *etc* was worked out based on the soil properties and database was used for suggesting appropriate cropping system for the location, there by utilizing land resource for the best suited crop. Majority of crops occupied moderately suitable area followed by not suitable and marginally suitable area. Major constraints for moderately and marginally suitable area are soil characteristic, rooting condition and texture.

Key words: Land resources inventory, land suitability classification, agriculture and horticulture crops

1. Introduction

Inappropriate land use leads to destruction of land resource, poverty and other social problems. The land is the ultimate source of wealth and the foundation on which many civilizations are constructed. Society must ensure that land is not degraded and that it is used according to its capacity to satisfy human needs for present and future generations while also maintaining the earth's ecosystems. Part of the solution to the land-use problem is land evaluation in support of rational land-use planning and appropriate and sustainable use of material and human resources.

Land evaluation is the process of assessment of a particular tract of land for specific purposes involving the execution and interpretation of data of natural resources, survey of soils, vegetation, climate and other related aspects of land in order to identify and make a comparison of the promising kinds of land uses. According to Van Wambeke and Rossiter (1987) land evaluation is the ranking of soil units on the basis of their capabilities to produce optimum returns per unit area. Several systems of land evaluation are used in soil survey programmes, the most important being land capability classification (Klingebiel and Montgomery 1961) and FAO framework for land evaluation (FAO1976).

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The USDA land capability classification is a general purpose land evaluation system useful for farm planning with bias on conservation. The land suitability classification is a specified land assessment system suitable for qualitative and quantitative evaluations.

In the coastal agro-ecosystem, with the increasing human and animal population, the competition between various land uses has become intensive and otherwise unsuitable land is brought under cultivation and thereby causing physical and chemical degradation of land. Suitability of the area along the coast should be evaluated for crops grown on there and alternate land use options should be suggested for sustainable productivity.

The present study was carried out in Arjunagi sub-watershed of Northern dry zone of Karnataka to find out the potential and constraints of these soils through land capability classification and soil suitability evaluation.

1. Methodology

Arjunagi sub-watershed in Deccan Plateau agro ecological sub region system of India lie between latitude of 16o 35’ 30” to 16o 43’ 30"N and longitude of 75o 26’ to 75o 31’ E extends over entire Kopal, Vijayapur and Bellary districts. The study area has a hot arid ESR with deep loamy and clayey mixed red and black soils, low to medium AWC and LGP 60-90 days; maximum and minimum temperature of 32.4 and 20.9oC respectively;

Seventeen soil series with different phases were identified in the study area and mapped into 80 mapping units(Fig.1). Weighted average of each property was calculated and soil site characteristics of different soil units were obtained as shown in Table 1. These weighted average data were evaluated according to various interpretation systems such as land capability classification and soil site suitability evaluation. The mapped soils from the study area were matched with criteria for land capability classification and soil site suitability evaluation as suggested by Sehgal (1996). The kind and degree of limitations were evaluated. Land capability map and soil site suitability evaluation maps were prepared using Areview 3.2a GIS soft ware.

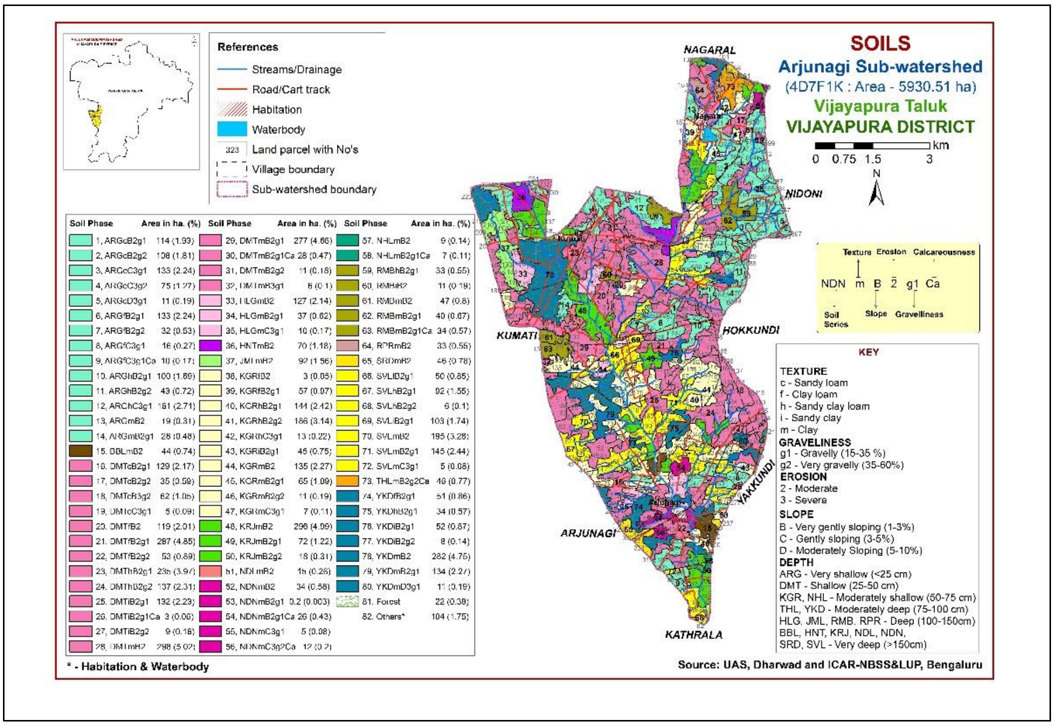

Figure 1. Soil phase map of Arjunagi sub-watershed

2. Results and Conclusion

In general soils were deep with more than 100 cm depth. Texture of the soil varied from sandy loam to clay loam, clay. The pH values of all the soil series were low and the base saturation was in the range of 29-54%. Organic carbon content was higher in majority of the series. Based on the soil site characteristics of the study area, the soils were classified for land capability classes (Fig 2). These soil phases were grouped in to land capability class II, III, IV and VI. The Arjunagi sub-watershed comprises lands of class II, III, IV and class VI land capability classes. The classes and sub-classes pertaining to the land capability are presented in Table 2 and depicted in land capability map. The details and limitations are presented below.

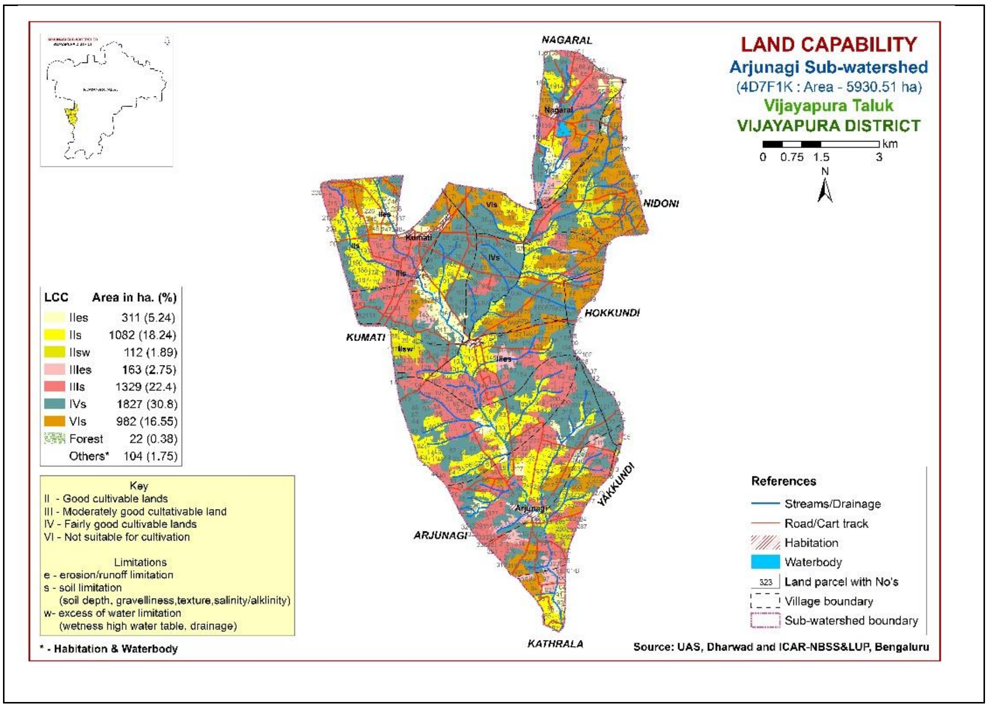

Figure2. LCC map of Arjunagi sub-watershed

3.1 Soil-site Suitability Evaluation

Land suitability is the fitness of a given type of land for a defined use. The land may be considered in its present condition or after improvement. The process of land suitability classification is the appraisal and grouping of specific areas of land in terms of their suitability for defined uses. The framework at its origin permits complete freedom in determining the number of classes within each order. However, it has been recommended to use only three classes within order S and two classes within order N. The class will be indicated by an Arabic number in sequence of decreasing suitability within the order and thereof (Naidu *et al* 2006).

The evaluation class for the crops' suitability ranges from highly suitable to permanently not suitable. This is due to the different condition that the crops require for their developments in the local area in question.

The mapped soils from the study area were evaluated for the soil-site suitability criteria using FAO framework. Suitability criteria for agricultural and horticultural crops were compared with soil-site characteristics (Table 2) and arrived at different soil site suitability classes (Table 3) and soil site suitability maps were prepared.

Table 2. Land capability sub classes for Arjunagi sub-watershed

Land capability class	Land capability sub class	Area (ha)
II	erosion and soil condition (es)	311
	soil condition (s)	1082
	soil condition and excess of water (sw)	112
III	erosion and soil condition (es)	163
	soil condition (s)	1329
IV	soil condition (s)	1827
VI	soil condition (s)	982

Table 3. Area (%) under different suitability classes for different crops

Class	Crops							
	Maize	Sorghum	Cotton	Mango	Custard apple	Grapes	Amla	Pomegranate
S1	-	3.48	-	4.14	4.14	3.61	3.58	5.35
S2	50.52	47.04	-	23.53	23.53	35.42	23.52	33.68
S3	30.8	30.8	80.60	11.37	11.37	11.48	23.42	11.48
N	16.55	16.55	16.55	58.84	58.84	47.35	47.35	47.35

3.1.1. Land suitability for agricultural crops: The suitability assessment for maize crop showed that 50.52 per cent micro-watershed area is moderately suitable, 30.8 per cent area is marginally suitable and 16.55 per cent area is not-suitable. The suitability assessment for sorghum crop showed that 3.48 per cent micro-watershed area is highly suitable, 47.04 per cent area is moderately suitable, 30.8 per cent area is marginally suitable and 16.55 per cent area is not-suitable. The suitability assessment for cotton crop showed that 81.32 per cent micro-watershed area is marginally suitable and 16.55 per cent area is not-suitable. The main constraints for marginally suitable area is soil characteristics and climatic regime.

3.1.2. Land suitability for horticultural crops: The suitability suitability assessment for both crops showed that 4.14 per cent area is highly suitable, 23.53 per cent area is moderately suitable, 11.37 per cent area is marginally suitable and 58.84 per cent area is not suitable. The main constraints for moderately and marginally suitable area is soil condition, texture and rooting condition.The suitability suitability assessment for amla crop showed that 3.58 per cent area is highly suitable, 23.52 per cent area is moderately suitable, 23.42 per cent area is marginally suitable and 47.35 per cent area is not suitable. The suitability suitability assessment for grape crop showed that 3.61 per cent area is highly suitable, 35.42 per cent area is moderately suitable, 11.48 per cent area is marginally suitable and 47.35 per cent area is not suitable. The suitability suitability assessment for pomegranate crop showed that 5.35 per cent area is highly suitable, 33.68 per cent area is moderately suitable, 11.48 per cent area is marginally suitable and 47.35 per cent area is not suitable. The main constraint for moderately suitable area is soil condition, texture and rooting condition. Rooting condition is the main constraints in marginally suitable area.

Land belonging to class II and III has varying suitability for different crops. According to suitability classification, these soils were found to be suitable for crops like mango, amla, cuatard apple, grape and pomegranate. Results of soil-site suitability evaluation indicated that these areas are moderately suitable for cultivation of maize, sorghum and cotton.

3.2. Acknowledgments

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Vertical Distribution of Phosphorus Fractions and Their Relationship With Soil Properties in Kanginhal Sub-watershed in Deccan Plateau of India

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Abstract

A study on vertical distribution of phosphorus fractions in different land management units (LMU) of Kanginhal sub-watershed was undertaken during 2017-18. The saloid-P, Fe-P, Al-P, RS-P, Org-P and available-P decreased with depth in all the LMU and were positively and significantly correlated with OC. Occl-P, Ca-P and total-P did not follow definite trend in most of the LMU. All the forms of phosphorus were positively correlated with clay (except Occl-P). CEC is positively and significantly correlated with Saloid-P, Al-P, Fe-P and available-P. Occl-P was positively correlated with $CaCO_3$, whereas Ca-P and total-P were significantly and positively correlated with $CaCO_3$. Fe-P, Al-P and RS-P negatively correlated with pH and $CaCO_3$ content. Saloid-P, Fe-P, Al-P, RS-P, organic-P and available-P were positively and significantly correlated with each other. However, Ca-P, Occl-P and total-P were also positively correlated with each other.

Keywords: Land Management Units, Phosphorus fractions, Sub-watershed

1. Introduction

Phosphorus is one of the major nutrient elements, next to nitrogen which limits the crop growth. McKelvey *et al.* (1953) declared rightly that phosphorus is the bottleneck of world's hunger. Because of the complex nature of soil phosphorus, the availability of phosphorus has become the subject of controversy and problem of continuous research.

There are two forms of phosphorus which occur in soil. They are organic and inorganic forms. However, more importance is given to inorganic forms. Inorganic P forms are divided into two groups *viz.*, active forms of inorganic P and inactive forms of inorganic P. Active forms of inorganic P include phosphorus bound to aluminium (Al-P), iron (Fe-P) and calcium (Ca-P). Inactive forms of P are occluded and reductant soluble (RS) forms of P. All the forms exist in all soil but Al-P and Fe-P are abundant in acid soils, while Ca-P predominates in alkaline soils. Phosphorus fractions serve as sensitive indicators of weathering environment. Variation in phosphorus fractions is the function of pedogenic manifestation, stage of soil development and age of soils. The relative proportions of different forms of inorganic phosphorus depend on various soil characteristics like pH, organic carbon, $CaCO_3$, CEC and texture (Jaggi, 1991). Consequently, studies on vertical distribution of different inorganic P fractions helps in better understanding and manipulation of the applied P fertilizers.

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2. Methodology

2.1 Forms of phosphorus

Phosphorus fractions were determined by modified method of Chang and Jackson (1957) as outlined by Peterson and Corey (1966).

2.2 Total phosphorus

The total phosphorus content of soil was determined by microwave digestion followed by vanadomolybdo-phosphoric acid method using spectrophotometer at 470 nm wavelength (Tandon, 1998).

2.3 Available phosphorus

The available phosphorus in soil samples was determined by Olsen's method (Sparks, 1996).

3. Results and Conclusion

3.1 Vertical distribution of forms of phosphorus

Vertical distributions of forms of phosphorus, available and total-P are presented in Table 1.

Table 1. Vertical distribution of forms of phosphorus in different land management units

LMU	Series	Horizon	Depth (cm)	S-P	Al-P	Fe-P	RS-P	Occl-P	Ca-P	Total mineral P	Org-P	Total-P	Available P
				(mg kg^{-1})									
LMU-1	HGK	Ap	0-20	1.0	15.7	10.2	28.0	29.8	306.5	391.2	67.8	459	6.0
LMU-2	NPT	Ap	0-18	1.5	21.9	17.0	39.5	51.1	326.2	457.2	103.8	561	12.6
		Bw	18-46	1.3	19.3	15.7	32.9	49.5	310.5	429.2	87.8	517	9.9
LMU-3	VKP	Ap	0-14	3.1	34.7	25.9	82.0	10.2	129.7	285.6	160.4	446	20.1
		Bw_1	14-39	3.0	33.4	24.9	75.0	12.5	167.7	316.4	144.6	461	19.2
		Bw_2	39-72	2.5	30.5	24.2	70.6	6.6	184.7	319.0	131.0	450	17.7
LMU-4	MVD	Ap	0-19	3.6	37.0	27.2	88.8	34.4	420.5	611.4	183.6	795	21.6
		Bw_1	19-36	2.6	32.8	25.2	68.9	26.5	428.4	584.4	141.6	726	18.6
		Bw_2	36-52	2.1	28.2	21.9	62.9	79.3	446.7	641.1	122.9	764	15.6
		Bw_3	52-76	2.0	25.2	20.0	54.4	42.3	455.3	599.0	118.0	717	14.4
		BCk	76-109	1.5	21.6	16.7	39.0	78.0	464.4	621.1	100.9	722	12.0
LMU-5	NGT	Ap	0-22	3.9	39.6	31.1	103.0	14.1	467.7	659.4	211.6	871	27.6
		Bw	22-62	2.0	26.5	20.3	65.2	20.0	474.9	608.8	121.2	730	14.7
		Bss	62-118	1.8	22.6	19.0	43.4	39.0	446.7	572.5	108.5	681	13.5
		BC	118-154	1.6	22.3	17.4	40.6	30.8	330.1	442.8	105.2	548	12.9
LMU-6	MGR	Ap	0-17	3.3	35.4	26.2	90.2	7.9	459.8	622.7	163.3	786	20.4
		Bw	17-25	2.3	29.5	23.6	67.0	33.1	488.6	644.0	127.0	771	17.4
		Bss	25-98	1.8	23.3	19.7	44.4	40.6	522.7	652.4	110.6	763	13.8
		Bssk	98-152	1.2	16.7	14.1	30.5	22.3	588.2	672.9	86.2	759	8.7

3.1.1 Saloid bound phosphorus (Saloid-P)

The saloid-P content decreased with depth in all the LMU and ranged from 1.0 to 3.9 mg kg^{-1}. Similar observation was also made by Bhavsar *et al.* (2018) in soils of Nagpur. This might be due to the high P-fixation capacity of these soils and also due to transformation of soluble forms of P into relatively less soluble forms with progress of time. The high content in the surface may be due to the effect of addition of inorganic fertilizers, manures and easily mineralizable organic-P.

3.1.2 Aluminum bound phosphorus (Al-P)

It was observed that Al-P decreased with depth in all LMU and ranged from 15.7 to 39.6 mg kg^{-1}. Tekalign Mamo and Haque (1987) also found high amounts of Al-P in the surface layers compared to sub-surface layers of some highland Ethiopian Vertisols which was due to a high content of Al-oxides in surface soils. The low content may be due to increased amount of calcium carbonate in the soil with increasing depth.

3.1.3 Iron bound phosphorus (Fe-P)

Fe-P content varied from 10.2 to 31.1 mg kg^{-1} and decreased with depth in all the LMU. Similar observation was also made by Bhavsar *et al.* (2018) and Trivedi *et al.* (2010). The higher Fe-P content in surface soils might be attributed to the presence of more organic carbon which provides organic acids which leads to solubilization of iron to ferrous form along with phosphates resulting in precipitation of ferrous phosphate as reported by Sacheti and Saxena (1973) and Jaggi (1991) and also due to higher amount of calcium carbonate at higher pH, where iron activity was less to precipitate P into Fe (Chandra Bhanu and Harishankar, 1973).

3.1.4 Reductant soluble phosphorus (RS-P)

RS-P content recorded highest in surface horizons and decreased down the depth. It ranged from 28.0 to 103.0 mg kg^{-1}. The low value of RS-P was observed in the soils having relatively higher pH and sand content. This might be due to iron and aluminum bound P content and rise in the content of calcium bound P and also Red-P as also reported by Bhavsar *et al.* (2018).

3.1.5 Occluded phosphorus (Occl-P)

The Occl-P content did not follow any definite distribution and ranged from 6.6 to 79.3 mg kg^{-1}. The highest Occl-P content was accumulated in the surface horizons indicating non mobility of P in soils down to lower layers (Bhavsar *et al*., 2018).

3.1.6 Calcium bound phosphorus (Ca-P)

The data revealed that Ca-P content increased with depth in LMU-3, LMU-4 and LMU-6, whereas it decreased with depth in LMU-2 and did not follow any definite trend in LMU-5. It ranged from 129.7 to 588.2 mg kg^{-1}. In general, low content of Ca-P content of surface soil may be due to low pH and $CaCO_3$ content as reported by Puranik *et al.* (1979) and Kothandaraman and Krishnamoorthy (1977).

3.1.7 Total mineral phosphorus (Tot. Min. P)

Total mineral phosphorus did not follow any definite trend with depth and ranged from 285.6 to 672.9 mg kg^{-1}. The similar results were reported by Kothandaraman and Krishnamoorthy (1977).

3.1.8 Organic phosphorus (Org. P)

The Org. P content decreased with depth in all the LMU and varied from 67.8 to 211.6 mg kg^{-1}. The decrease of organic phosphorus in soil may be attributed to the decreased organic matter and organic carbon with depth. Similar trends were recorded by the Kothandaraman and Krishnammorthy (1977). Since all soils were calcareous in nature, organic phosphorus was relatively low.

3.1.9 Available phosphorus

The available phosphorus ranged from 6.0 to 27.6 mg kg^{-1} and decreased with depth in all the LMU. The higher values of available phosphorus content were observed in the surface horizons.. This might be due to the presence of organic matter which increases the availability of phosphorus in soil. The lower phosphorus content in sub surface horizons could be attributed to the fixation of released phosphorus by clay minerals and oxides of iron and aluminium.

3.1.10 Total phosphorus (Total-P)

The Total-P content decreased with depth in LMU-2, LMU-5 and LMU-6 and did not follow any definite trend with depth in LMU-3 and LMU-4. It ranged from 446 to 871 mg kg^{-1}. Similar results were also reported by Viswanath and Doddamani (1991). The higher total-P content might be due to higher oxides of iron and organic carbon content which are effective immobilizers of P (Chang and Chu, 1961).

3.2 Correlation studies

Correlation between the forms of phosphorus and soil properties is presented in Table 2 and correlation among forms of phosphorus is presented in Table 3.

Table 2. Correlation between the forms of phosphorus and soil properties in different LMU

	Sand	Silt	Clay	$CaCO_3$	CEC	pH	EC	OC
S-P	-0.440	0.214	0.411	-0.319	0.459*	-0.068	0.012	0.978**
Al-P	-0.407	0.199	0.379	-0.359	0.497*	-0.137	0.028	0.993**
Fe-P	-0.384	0.124	0.404	-0.280	0.575*	-0.108	0.075	0.991**
RS-P	-0.464*	0.206	0.448	-0.309	0.449	-0.080	0.045	0.978**
Occl-P	0.988**	-0.657**	-0.795**	0.261	-0.185	-0.309	-0.062	-0.421
Ca-P	0.253	-0.597**	0.102	0.951**	0.085	0.312	0.457*	-0.125
Total inorganic-P	0.282	-0.625**	0.086	0.868**	0.181	0.224	0.440	0.079
Organic-P	-0.386	0.190	0.359	-0.241	0.406	-0.086	-0.015	0.973**
Total-P	0.166	-0.537*	0.171	0.753**	0.272	0.188	0.409	0.320
Available-P	-0.381	0.174	0.364	-0.272	0.470*	-0.115	0.028	0.988**

The saloid-P had significant and positive relationship with organic carbon and CEC. The negative correlation of pH with saloid-P may be due to conversion of loosely adsorbed P into less soluble form of P. Similar results were reported in clayey soils of Rajasthan by Sacheti and Saxena (1973). Soil pH had negative correlation with

Al-P. This may be due to low aluminum activity at higher pH, thus P is not precipitated as Al-P in larger quantity (Jaggi, 1991). Correlation study revealed that Al-P showed significant positive correlation with organic carbon and positive correlation with clay. A significant positive correlation with organic carbon was due to the mineralization of organic P and conversion into Al-P fraction due to high biological activity (Sacheti and Saxena, 1973).

Table 3. Correlation amongst forms of phosphorus under different LMU

	S-P	**Al-P**	**Fe-P**	**RS-P**	**Occl-P**	**Ca-P**	**TIP**	**OP**	**TP**	**Available-P**
S-P	1	0.985**	0.965**	0.979**	-0.487*	-0.158	0.035	0.986**	0.282	0.974**
Al-P		1	0.983**	0.985**	-0.447	-0.185	0.019	0.967**	0.262	0.977**
Fe-P			1	0.963**	-0.422	-0.111	0.090	0.959**	0.326	0.987**
RS-P				1	-0.496*	-0.134	0.060	0.965**	0.300	0.964**
Occl-P					1	0.320	0.338	-0.430	0.208	-0.426
Ca-P						1	0.971**	-0.075	0.892**	-0.105
Total inorganic-P							1	0.120	0.968**	0.094
Organic P								1	0.120	0.968**
Total P									1	0.366
Available-P										1

Fe-P had a significant and positive correlation with organic carbon and positive correlation with clay. This relationship with organic carbon may be due to the mineralization of organic-P and conversion into Fe-P. When soluble-P is added, it reacts with Fe and Al of soil clay mineral to form insoluble Fe and Al-P (Kanwar and Grewal, 1990). Fe-P showed a negative relation with pH, which showed an increase in pH is associated with decrease in Fe-p content (Jaggi, 1991). There was a negative correlation observed between free $CaCO_3$ and Fe-P. High amount of Ca-P was found at high pH at which Fe-activity is usually less to precipitate P into Fe-P.Reductant soluble-P showed a negative correlation with pH. Reductant soluble P showed positive correlation with organic carbon and positive relationship with clay content. Similar finding were observed by Viswanath and Doddamani (1991) and Trivedi *et al.* (2010). Occl-P had significant and positive correlation with sand and positive correlation with $CaCO_3$. However, negative correlation with organic carbon (Bhavsar *et al.*, 2018).

Ca-P exhibited a positive correlation with pH and clay. A positive correlation with pH indicates an increase in Ca-P with increase in pH (Jaggi, 1991). Correlation coefficient between $CaCO_3$ and Ca-P was highly significant, high $CaCO_3$ content of samples might have reacted with P resulting in higher Ca-P.

Organic carbon also exhibited significant and positive correlation with organic P in all the LMU. The phosphorus in the surface soils might have complexed with the organic acids as organic carbon was in greater amount in surface soils. Similar observation was also made by Kothandaraman and Krishnammorthy (1977). Since all soils were calcareous in nature, organic phosphorus was relatively low (Bhavsar *et al.*, 2018).

The total P content is significantly and positively correlated with EC, organic carbon and $CaCO_3$. Similar results were also reported by Trivedi *et al*. (2010).

Most of the forms of P were significantly and positively correlated with each other, which showed the natural equilibrium among various P fractions. These results are also in accordance with Majumdar *et al.* (2004). Saloid-P, Al-P, Fe-P, RS-P and total-P were significantly and positively correlated with each other whereas, Ca-P and Occl-P were positively correlated with each other (Bhavsar *et al.*, 2018).

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Pasture Management and Soil Protection

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Abstract

In pasture management, there are two highly important points. The first one is the protection of vegetation, soil and other resources, and the second one is paying attention to this vegetation, soil and other resources to obtain the highest animal products. The most influential factor in soil protection is the presence of plants on the soil surface. For this purpose, the pasture management principles especially the principles related to complying with grazing capacity and grazing season ensure the establishment of a balance for the environment between the plants which ensure the soil protection and the animals benefiting from the plants. There is a strong relationship between soil protection and pasture management principles. Compliance with these principles is essential for a sustainable economy and environment. In Turkey, the un-implementation of these principles caused erosion of most pasture areas. And these problems also exist in different parts of the world with similar ecology.

Keywords: Forage crops, pasture management principles, rangeland, sustainable environment.

1. Introduction

The destruction of meadow pastures and forests in Turkey increased the rate of soil erosion. Vegetation cover protects the soil against the erosive force of erosion. It is also not possible to have well-formed soil without vegetation cover. In other words, plants, soil, and climate are in a strong relationship that cannot be separated one and another. In order to be able to benefit from pasture management principles, these relationships should be well known. The balance of climatic and vegetation, which is balanced with the climate and part of the soil conditions of a region, is not static but dynamic and is influenced by the environment. One of these environmental conditions is animal status and existence (Bakır, 1987; Altın et al., 2011). Heavy grazing, early grazing and uncontrolled grazing by farm animals cause soil erosion. The improvement and rehabilitation of pastures with soil erosion is an extremely difficult and expensive process. However, in areas where soil moisture is sufficient, pasture improvement becomes easier and faster (Tükel & Hatipoğlu, 1997; Gökkus & Koç, 2001; Acar, 2019).

Water conservation in the soil is also important in terms of renewal and sustainability of the pasture. Healthy pasture is a pasture where soil and other ecological factors complement each other and ensure continuity in production (Tükel & Hatipoğlu, 1997). Unfortunately, most of the areas with erosion problems in Turkey are in the pasture areas (53.66%) and in the form of water erosion (soil erosion by water) (Avcı et al., 2015). The growth and development needs of plants and animals in the pasture are opposite to each other. For this reason, it is very important in term of pasture management to establish a suitable balance between the presence of

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plants and animals in order to ensure pasture sustainability. The feed production determined by the ecological structure should be considered as a constant and the animal should be considered as a variable factor. The principles of grazing management are specified in 4 main principles. They are; grazing season, grazing capacity, uniform grazing and grazing with the suitable animal type. These principles aim to ensure the sustainable management of pasture without damaging the environment especially the soil (Bakır, 1987; Gökkus & Koç, 2001; Acar, 2019). Figure 1 provides the summary of the impacts of prover grazing management and excessive grazing.

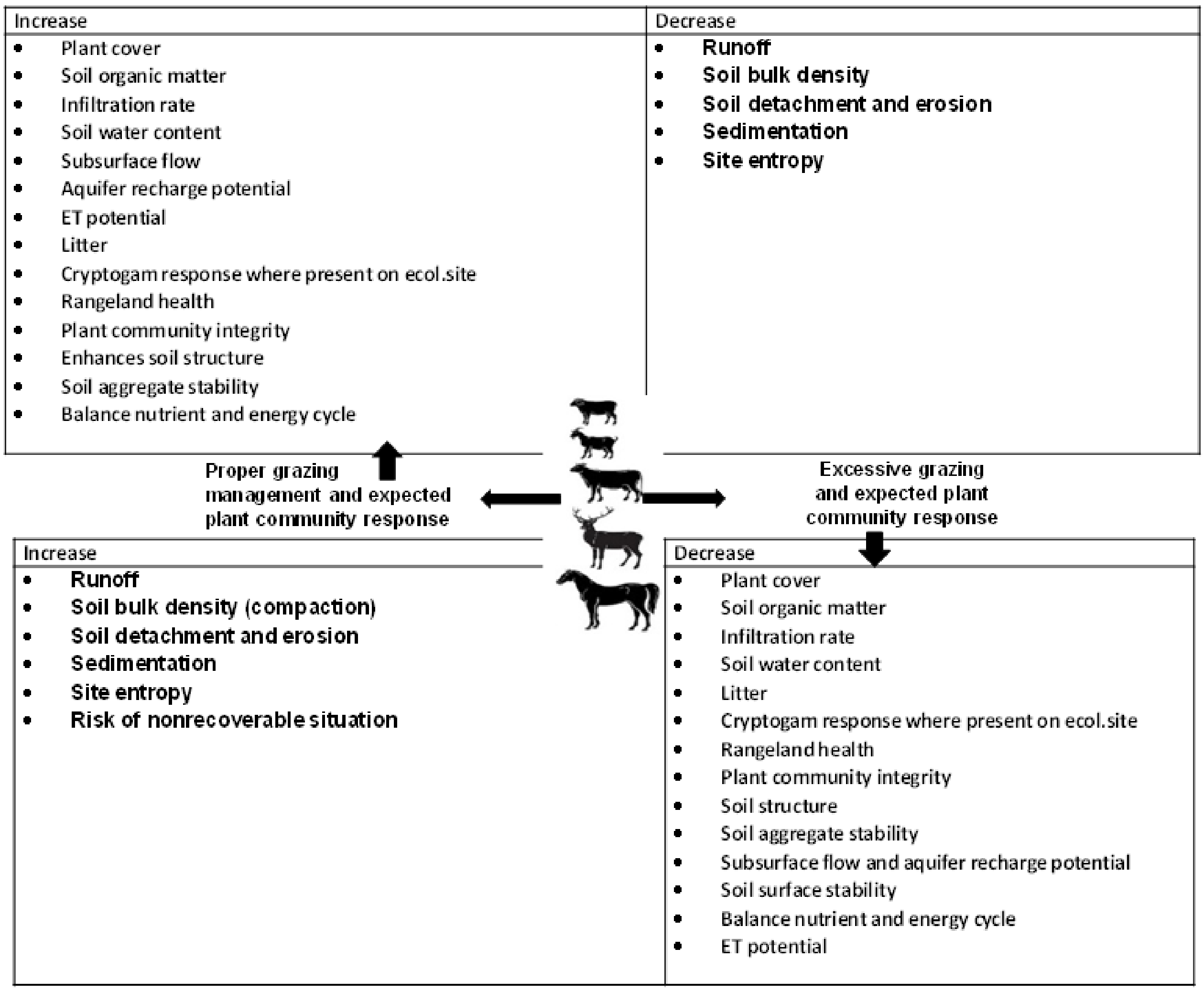

Figure 1. Diagrammatic representation of grazing and the relationship to soil surface modification, plant species compositional change, and the consequential effects on hydrology and erosion (Johnson & Butler, 2003)

2. The Principles of Grazing Management

2.1. Grazing Season

The grazing season is the period when it comes to the grazing of plants. Grazing maturity is the period of development of long years cover crops and important pasture plants where grazing will begin without damaging the soil. Two important factors such as plants and soil are taken into account in the determination of grazing maturity. The determination of the grazing season is important in determining the critical periods in which plants should not be grazed (Bakır, 1987; Gökkus & Koç, 2001; Altın et al., 2011).

The plants that protect the environment especially the soil need the energy to sustain their lives. In this case, the roots of plants that absorb water and nutrients from the soil to do photosynthesis with their leaves are really important. In terms of the health of the plant, grazing during critical periods of time makes the plant weak and may lead to death (Gökkus & Koç, 2001; Altın et al., 2011). Bare soil surface increases water and wind contact and causes erosion. The effect of early grazing before the grazing season takes place not only to the plant but also to the soil (Avcı et al., 2015). During the spring and autumn season when the soil is moist, the large pressure of the animals with their hooves causes the compaction of the soil, the damage of soil structure and texture, and negatively affects organic matter and water content of the soil. These effects are larger especially in clay soils and the compaction of the pores decreases soil aeration and reduces the infiltration of the water to the lower layer of the soil. In addition, the indentations of the animals' hooves (the pugs) cause the damage of the soil surface (Altın et al., 2011).

When the grazing principles are not implemented and when the soil is over disturbed, soils compact, grazing paths occur (increases water erosion), a landslide on steep slopes occurs, the infiltration of rain into the soil decreases, and eventually the risk of erosion increases. Improper grazing season with soil compaction occurs during the grazing harms plant root development and decreases plant growth and pasture yield. Seed cannot develop new seedlings, the seed cannot mix with the soil and the seed cannot keep enough moisture and cannot germinate in the soil. In addition, the thinning of plants increases the negative effect of raindrops on erosion in the pastures (Tükel & Hatipoğlu, 1997; Gökkus & Koç, 2001). Detachment damage of horses and donkeys is greater than of other animals. Due to the mentioned issues, attention to grazing time is needed not only for the conservation of the pasture but also of the soil (Altın et al., 2011).

2.2. Grazing Capacity

Grazing capacity is defined as the maximum number of animals that can be grazed in a pasture with a certain width without damaging the vegetation, soil and other natural resources for many years during the grazing season. It is impossible to maintain the sustainability of pastures that are grazed with more animals than the carrying capacity and environmental protection. This type of grazing is called overgrazing. In this way, with overgrazing, the vegetation cannot renew itself and the soil becomes a bare area that is open to erosion. There are some indications of overgrazing in the pasture; negative changes in botanical composition, provision no grass pathways, an increase of water and wind erosion, a decrease of growth and yield of animals (Bakır, 1987; Allred, 1999). Any event that affects plant growth, which is the first in terms of soil protection, will also indirectly affect soil conservation. In over-grazed pastures, a lot of walks and pathways will be formed with no plant on, the soil will compact, the water holding capacity will decrease, especially runoff and soil erosion will increase depending on the slope (Bakır, 1987; Altın et al., 2011).

Grazing density in a pasture negatively affects soil organic matter and consequently effects pasture productivity. In a continous and overgrazing pasture, the roots of pasture plants cannot go deep into the soil. This means that the deeper layer of soil is not used, or the soil is not used economically. It also causes the decreases of soil vitality, infiltration amount and consequently decreases the productivity of the pasture. When the roots are concentrated on top, they cannot benefit from groundwater (Tükel & Hatipoğlu, 1997; Altın et al., 2011).

This situation increases drought negativity in arid regions. Water that does not infiltrate into the ground causes runoff and water erosion. The overgrazing of pasture decreases the benefiting rate of plants. It also causes damage to growing young seedlings and plants. The most important environmental factor affecting the grazing capacity calculations is the rainfall zone as well as the characteristics of the soil (such as sandy, clayey and shallow), as it affects the efficiency of rainfall. The grazing of the pasture with uncalculated grazing capacity affects soil degradation and erosion as well as pasture productivity (Tükel & Hatipoğlu, 1997; Gökkus & Koç, 2001).

2.3. Uniform Grazing

Uniform grazing is the arrangement made to ensure that all sides of the pasture are grazed at the same level. It is essential to prevent the destruction of plants from being heavily grazed and to prevent the loss of feed in the lightly grazed part, with preventing slight grazing of some parts and heavy grazing of the other parts of the pasture. The formation of bare areas in heavily grazing places implies erosion and loss of soil (Bakır, 1987). Another benefit of uniform grazing is the animal feces and urine, which increase soil productivity and quality, are distributed all over the pasture. The result of always leaving the animal fertilizers in the same place is reducing the usefulness of the forage crops by changing the plant composition and forming the weed patches as well as changing the structure of the soil in that places. Again, excessive feces and urine accumulation reduces the usefulness by creating odor. Another harm to occur when uniform grazing is not provided is the old plants that are aging in the pastures without grazing cause the decrease of the productivity of new crops and prevent the mixing of organic matter plucked and trampled while grazing process into the soil. In addition, plants left without grazing will cause shading to cause soil temperature to be low and to reduce the activity of microorganisms in the soil. Uniform grazing is necessary for the stability of the ecosystem and economic pasture management (Bakır, 1987; Allred, 1999; Gökkus & Koç, 2001).

2.4. Grazing with Suitable Animals

Grazing the pasture with suitable animals prevents feed waste and also prevents the opening of certain places. It is the state of the plant species and topography grown in the pasture that determines the animal species. The choice of grazing of each animal is determined primarily by plant varieties and topography. For example, small animals usually prefer rough terrain. If the natural pastures are flat and composed of crops with different characteristics, then these pastures also need to be grazed with different animal types instead of one type. Soil properties also affect plant composition (Bakır, 1987; Altın et al., 2011).

2.5. Grazing Systems

There are many grazing systems applied in pastures. Consideration in selecting an effective and applicable grazing system is the importance to ensure the sustainability without the vegetation destruction, to create economic production, and not to cause erosion and soil compaction as a result of the trampling of animals. Important elements of a sustainable grazing system are the condition of the soil, the condition of the plant, the condition of the animal and the situation of marketing. Soil condition consists of soil fertility, soil depth, biological viability, rich water resources, salinity and alkalinity, pit status, erosion and drainage. For example, the benefits of a rotation system in grazing systems are to ensure uniform plant growth, to prevent soil erosion, and to provide more uniform distribution of organic fertilizers on the pasture. According to the current structure of the pasture and animal condition, grazing systems are needed (Bakır, 1987; Altın et al., 2011).

3. Result and Conclusion

The protection of pasture soil, which is one of the important targets of pasture management principles, is ensured by complying with the principles of management. In pastures without the implementation of the principles, the last of the vegetation destruction stages is the condition when there are not enough plants left, and water and wind erosion become important problems. In the case where vegetation and soil are severely destroyed, it is impossible to get close to the desired pasture improvement or to the climax vegetation without soil stabilization and improving the degraded physical and chemical properties of the soil.

In such places, the pioneer with using the regulatory plants increases the success of pasture improvement. With the heavy and unseasonable grazing without adhering to the grazing season and the grazing capacity, poorly rooted plants benefit from a smaller volume of soil, which in particular cannot afford enough water in drought periods, decrease yields, and the soil will not be protected. The degree of negative effects of grazing animals on pasture soil depends on topography, soil, climatic conditions and vegetation status (Bakır, 1987; Gökkus & Koç, 2001). Grazing with principle implementation affects the balance of water and soil nutrients absorption under excessive competition between plants and growth pressure. The nutrient cycle in the ecosystem makes it more favorable for plants. In some pastures, this condition allows seeds of the plants to be mixed in the soil and facilitates their emergence during the favorable season. It helps continuity of the pasture.

The evaporation surface decreases with grazing. Again, in the grazing areas, animal feces and urine increases the amount of nutrient cycling towards the soil, which affects the productivity of the pasture soil. In Turkey, the pasture management principles have not been implemented and consequently, the erosion of pasture soils became an important problem today. The implementation of pasture management principles and pasture improvement in required areas are needed to be done in order to prevent soil erosion and to ensure the environmental sustainability and soil protection.

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A Modernized Application to Survey Soil Cohesion Changes

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Abstract

The methods and approaches used in the evaluation of soil erosion problem, which is one of the most important causes of land degradation, necessitate multi-disciplinary studies within the scope of current facilities and requirements. Developing sensor technologies supply significant opportunities to monitor natural resources. Hereby, more suitable solutions in terms of time and infrastructure costs compared to direct land measurements could be obtained. In this study, a modernized experimental setup by using sensor technology was prepared and presented for measuring mechanical soil cohesion (Co) with fluidized bed approach which was introduced a few years ago and tested by a limited number of researchers. What makes the approach tested important is the potential to be associated with rill erodibility for the transition from empirically-based models to process-based models in water erosion estimations. Preliminary experiments performed with this modernized experimental setup for different soil types have been shown that the tested approach can be used reliably in water erosion studies.

Keywords: Fluidized bed approach, Soil erosion, Sensor technology

1. Introduction

Soil detachment is the process of separating the soil particles from the soil mass by the shear force of the flowing water. And, this process occurs when the shear stress of flowing water overcomes the critical shear stress of the soil. In this context, soil cohesion is expressed as a measure of the external forces required to separate the soil aggregates and an indicator of the internal soil strength against erosive forces (Lei et al., 2002; Das, 2008; Nouwakpo et al. 2014).

The soil cohesion decreasing under increasing water pressure causes the soil to breakdown due to the density and speed of the water flowing. This significantly increases the soil erodibility against rill and gully formation. It is also thought that there is a close relationship with the sediment concentration rates transported along with the flowing water (Römkens et al., 2002). Therefore, it is extremely important that the changes in cohesion forces are measurable. However, the methods and approaches used for this purpose are quite limited. The success of a method is, of course, closely related to the fact that other processes affecting the soil or affected by cohesion change are accountable.

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Within the scope of the study, it is aimed to present an experimental setup modernized by using sensor technology for measuring mechanical soil cohesion (Co) with fluidized bed approach proposed by Nouwakpo et al. (2010). In this context, the effectiveness of the modernized experimental setup prepared in accordance with the approach has been examined with pre-tests for different soil conditions.

2. Material and Method

The fluidized bed approach/method has been used in the evaluation of mechanical soil cohesion (Nouwakpo et al., 2010). In this approach, when a pressurized fluid enters the pore space of a solid particle bed, the bed is forced to act as a fluid and forms a fluid bed. When the solid-bed used here is thought to be soil, which is a cohesive material when the water pressure applied to the soil mass is gradually increased, the cohesive force between the particles is transferred from mass to water. Briefly, the approach is based on observing changes in the cohesion force between the particles as a result of the gradual increase in the water pressure passing through a particular mass of soil and measuring the decrease in water pressure as the cohesion drifts away. For this purpose, differential pressure drops (psi) formed as a result of gradually increasing the water level in 25 mm long soil mass and outlet flow rates (g) corresponding variation in water pressure are transferred to the computer by sensors and transducers placed in the upper and lower part and over time the pressure change inside the soil mass and monitored as a function of time on the graphs (Figure 1).

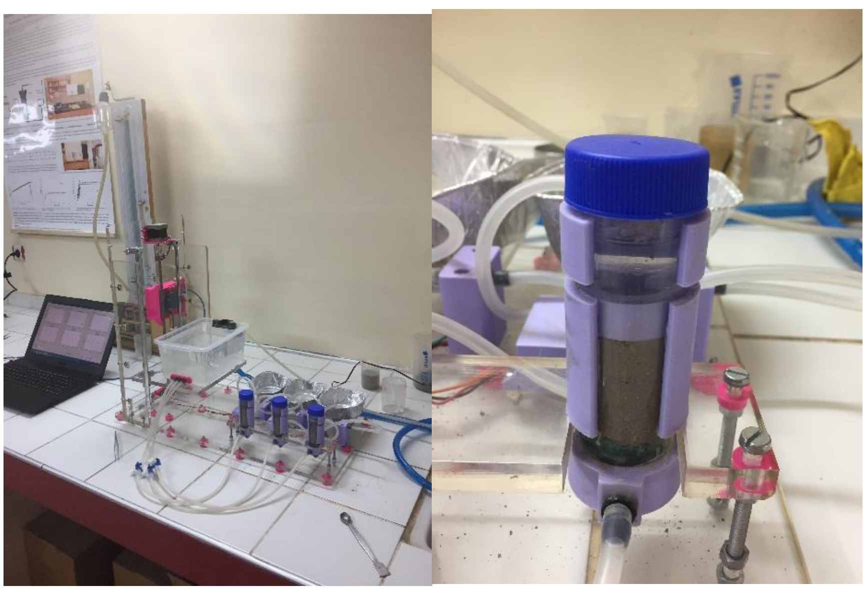

Figure 1. A view from the fluidized bed experiments

In order to evaluate the changes in the cohesion conditions and the performance of the method applied by a modernized instrument, the samples with different soil characteristics were selected and used in the experiments. And, some properties of these test soils are given below (Table 1).

Table 1. Physical and chemical soil properties

Material	C[1]	Si[2]	S[3]	OM[4]	BD[5]
Clay soil	45	39	16	2,12	1,15
Sandy clay loam soil	29	10	61	1,45	1,03
Sandy soil	2	1	97	0,14	1,63

The percentage of [1]clay, [2]silt, [3]sand, [4]soil organic matter contents of the soils. [5] is measured the bulk density values.

Each experiment was tested under the same physical conditions as three replicates (Figure 1). One of the most important benefits of the instrument developed is that there are additional cells that allow three replications to prevent differentiation between the soils in terms of physical ambient conditions. Thus, experiments were performed under the saturation conditions, and pressure variations corresponding to increasing water pressure passing through soil mass were recorded and monitored.

3. Results and Discussion

Obtained ΔPf values refer to the differential pressure rates of the studied soils when they reach the fluidization point at which soil behaves as a fluid. Nouwakpo et al. (2010) state that the difference between ΔPf and the buoyant specific weight of the bed material is the cohesion. In this study, the measured highest cohesion value (Co) was 55808,56 $Nm^{-3}$for clayey soil and the lowest value was measured for sandy soils as 30990,14 Nm^{-3}(Figure 2). On the other hand, sandy-clayey loam soil samples have a lower cohesion than the soils having more fine material, whereas they have higher cohesion than the soils having more coarse material. Taking into consideration the cohesive soils generally include fine-grained silt and clay mineral particles less than 0.075 mm (Shan et al. 2015), these results confirm the role of clay and silt on the intrinsic cohesion development in soil matrix (Yokoi, 1968; Kemper et al., 1987; Nouwakpo and Huang, 2012).

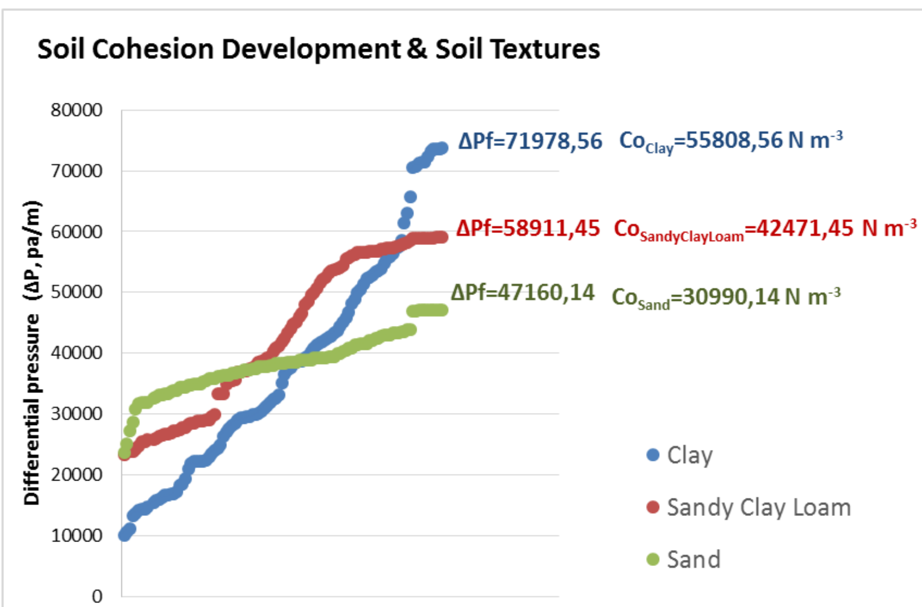

Figure 2. Relationship between soil cohesion and texture classes

4. Conclusion

The soil cohesion variations according to the fluid bed approach which is a very important variable for modeling to the bed movements in the erosion researches. In this study, it was measured with the help of a modernized test setup by sensor technologies. To assess the effectiveness of the experimental setup and the approach used for it, soils having mainly different textural combinations as a significant soil parameter for varying internal soil cohesions were selected and tested. The findings show that the method has the potential to reveal the textural difference between soils.

Acknowledgments

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Changes Between Erodibility Parameters and Some Soil Properties for Tea Planting Soils in Orta Çay Catchment of Rize

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Abstract

One of the most important problems of our country's land is soil erosion leading to land degradation and desertification. It's inevitable to conserve and improve the productivity of the lands that are sensitive to eroison and showing tendency to desertification because of different climate zones and very rugged topography. Moreover, generation of accelerated soil erosion depends on land use and soil properties directly and also other factors determine its dimension and direction. In this present study; in order to assess erodibilities of soils taken from tea cultivated land in Orta Çay Catchment of Rize province located in Eastern Black Sea Region of Turkey, soil structure stability index (SSI), clay ratio (CR) and erosion ratio index (ER) were determined. 28 surface soil samples (0-0.2 m depth) were taken from agricultural fields which have been used as tea planting. According to description statistical analysis results, SSI values varied between 59.31 – 22.73, CR between 23.27 – 3.27% and ER between 85.28 – 8.50%. SSI had the highest variation in the erosion sensitivity parameters. According to the results of erodibility analysis for soil samples, it was determined that the soils of sampling areas have high variability of erodibility. For that reason, some suggestions can be given for better soil conservation to sustain land resource for tea planting.

Key words: Soil structure stability index, Clay ratio, Soil erosion, Tea plant.

1. Introduction:

Soil erosion is a serious environmental, economic, and social problem. It not only causes severe land degradation and soil productivity loss, but also threatens the stability and health of society in general and sustainable development of rural areas in particular (Lal, 1991; Jing et al., 2005). Detachment of soil particles by wind and/or water forces which is named soil erosion (Panagos et al., 2012) becomes a global problem especially in vulnerable and fragile environments (Bagarello et al., 2012; Manyiwa and Dikinya, 2012). Soil erosion has widespread and serious negative effects on agricultural production, water quality, biodiversity, useful life of reservoir dams and many other environmental risks (Pazhouhesh et al., 2011). Soil erodibility is related to the integrated effects of rainfall, runoff and infiltration on soil loss and is commonly called the soil erodibility factor (K) which represents the effect of soil properties and soil profile characteristics on soil loss (Renard et al., 1997). The K factor has been recently used as an indicator of erosion because of its susceptibility to particulate detachment and transport by erosion agents (Manyiwa and Dikinya, 2012). The progressively increasing exploitation of agricultural areas and the ongoing climate changes are largely favoring soil loss related on particular to the action of running water. As the susceptibility of soils to erosion depends on the complex interactions between geologic-environmental parameters and soil features, (which are also affected by modifications just due to the acting erosive processes), it appears particular important to ascertain their spatial variability in relation to slope features and local relief. Predictive methods to reliably estimate soil erodibility are generally based on the analysis of spatial variability of a few soil properties, such as soil structure, soil texture and organic matter content (Wischmeier and Smith, 1978). Since then, soil erosion research received increasing emphasis, and erodibility became an important parameter for estimating soil loss and implementing soil conservation

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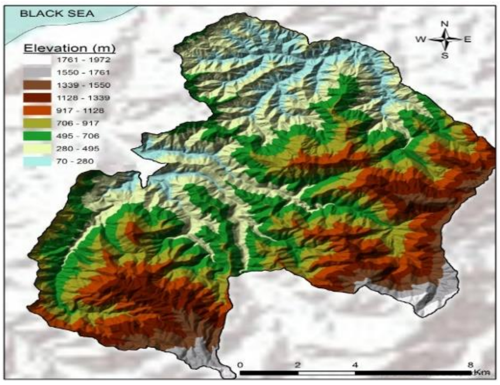
practices. In recent years, soil erodibility has also become an imperative parameter for assessing and predicting environmental impacts on surface water bodies. Due to the complexity of erosion processes, the inherent complicated nature of soil erodibility, and the inadequate or incomplete data sets of many past studies, large gaps exist between what is available and what is needed in current soil loss prediction and soil conservation technologies.

This is especially true when considering areas with various topographies, soil types, cropping practices and systems, and erosion patterns. Therefore, it is useful to discuss and update the concept of soil erodibility and its evaluation. The aim of the current study was to evaluate and to discuss the changes between erodibility parameters and some soil properties for tea planting soils in micro basin in Rize.

2. Material and Methods

This study was conducted in tea production areas with comparatively high tea production potential. In order to assess soil erosion sensitivities of soils taken from tea cultivated land in micro basin of Rize province located on Eastern Black Sea Region of Turkey. Soil samples taken from 0-20 cm depth. The study area is located in Orta Çay Catchment, which extend from 4527000 to 4545000 N and from 633000 to 645000 E (UTM, 37 Zone m) in eastern Black sea highland region of Turkey.

The study area covers about 170 km^2. The catchment lies at an elevation from sea level of 70-1972m. The study area has various topographic features (flat, hilly, etc.). Whereas just 7.2% of the total area is almost flat, hilly and rolling physiographic units are particularly common in the study area (Figure 1).



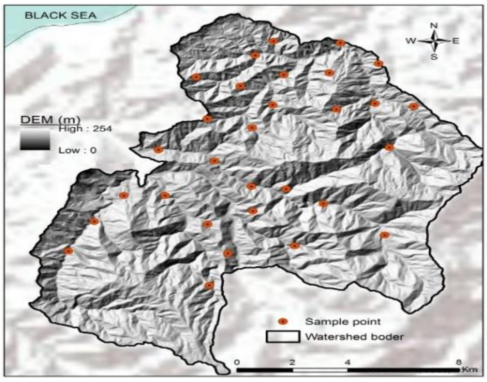


Figure 1. Elevation and hillshade maps of the study area

The current climate in the region is semi-humid. Meteorological data covering the period of 1981-2011 years, average annual precipitation and temperature are 2304.1 mm and 14.3 ºC, respectively.

2.1 Method

Field study was conducted in 2017 and 28 soil samples were taken on agriculture land cultivate for tea production. The samples were taken in the fall after harvest and before the next cropping season in order to avoid the effect of direct fertilization during the crop growing season and cultivation activities. Particle size distribution was determined by the hydrometer method and clay ratio (CR) determined after hydrometer readings (Bouyoucos, 1951), Organic matter was determined by Walkley-Black wet digestion method (Nelson and Sommers, 1982). Soil reaction (pH) and electrical conductivity (EC) in 1:1 soil:water suspension (w:v), Exchangeable cations were measured using a 1 N NH_4OAc (pH 7) method (Soil Survey Laboratory, 1992). Lime content by Scheibler calsimeter (Soil Survey Staff, 1993). Soil structure stability index (SSI) and erosion ratio index (ER) (Lal and Elliot, 1994).

3. Results and Discussion

Physical and chemical analysis results of 28 soil samples taken from the research area are given in Table 1 and Table 2. Correlation matrix between soil properties are given in Table 3. Significant positive and negative correlations were determined between soil physical and chemical properties and erodibility parameters. As shown in the Table 1; clay, silt and sand contents of soils varied between 4.12-23.41%, 15.34-53.90% and 35.37-76.31%, respectively. Soils have generally course texture. pH values varied between 3.38 and 7.37 and have generally acidic reaction. OM contents varied between 1.17-11.50% and average OM value is 5.39% and soils have higher OM contents. EC values of soils are under the threshold levels (2.0 dS m^{-1}) for salty soils and they haven't salinity problems.The susceptibility of the soil to erosion is mainly controlled by the structural properties of the aggregates (Legout et al., 2005). The structure stability index of soils were calculated by using the percentages of silt and clay contents obtained from mechanical analyse and measured in suspension. The SSI values varied between 22.73% and 59.31%. If SSI increases, susceptibility of soils to the erosion reduced. Higher SSI values of the study area's soils are depends due to the higher OM and clay content. Several authors have shown importance of soil OM content on susceptiblity to erosion (Tejade and Gonzales, 2007).

The organic matter regulates the structure stability in the soil and reduces the erodibility and contributed to the formation of stabilized aggregate (Eraslan et al., 2016). Sönmez (1994) stated that clay, organic matter, calcium and magnesium contents in soils reduced soil susceptibility to erosion by increasing structural stability.

Table 1. Some chemical analysis results of soil samplings

Sample	pH	EC dSm^{-1}	Lime %	OM %	N %	P mg.kg^{-1}	K	Ca	Mg	Na
							me/100g			
1	4.00	0.268	0.0	5.59	0,39	29.90	0.42	0.74	0.55	0.03
2	4.11	0.167	0.0	1.17	0,14	23.25	0.16	1.26	0.51	0.00
3	3.61	0.025	0.0	2.24	0,13	39.17	0.06	0.53	0.39	0.00
4	3.66	0.223	0.0	6.76	0,38	7.65	0.20	0.46	0.33	0.02
5	3.55	0.485	0.0	5.31	0,34	114.19	0.15	0.74	0.28	0.05
6	3.56	0.546	0.0	8.82	0,40	21.04	0.10	0.08	0.23	0.08
7	5.15	0.343	0.0	3.83	0,21	27.13	0.51	11.89	3.09	0.11
8	3.88	0.159	0.0	3.80	0,20	20.35	0.15	0.32	0.26	0.01
9	4.62	0.187	0.0	5.38	0,20	7.20	0.23	0.60	0.23	0.35
10	4.29	0.121	0.0	3.54	0,19	69.21	0.21	1.62	0.66	0.00
11	5.69	0.236	0.0	5.42	0,28	32.80	0.64	9.01	2.07	0.01
12	3.38	0.371	0.0	7.83	0,47	53.01	0.16	0.21	0.12	0.05
13	3.51	0.324	0.0	5.49	0,32	101.18	0.33	0.32	0.28	0.05
14	4.20	0.547	0.0	5.46	0,35	25.96	0.14	22.38	1.27	0.02
15	3.68	0.456	0.0	8.48	0,33	21.94	0.41	0.12	0.05	0.03
16	4.92	0.208	0.0	7.20	0,45	73.72	0.36	3.48	1.06	0.44
17	7.37	0.546	1.6	5.46	0,36	93.25	0.50	24.96	2.18	0.35
18	3.79	0.256	0.0	5.70	0,31	48.97	0.25	0.10	0.20	0.11
19	4.32	0.180	0.0	3.30	0,16	4.55	0.13	0.10	0.23	0.25
20	3.89	0.211	0.0	2.88	0,23	128.18	0.72	0.55	0.32	0.07
21	4.81	0.319	0.0	8.17	0,35	17.93	0.18	0.61	0.29	0.85
22	3.55	0.225	0.0	4.16	0,29	48.70	0.29	1.86	0.72	0.02
23	6.44	0.455	0.0	5.56	0,34	43.22	0.68	13.43	2.36	1.06
24	4.53	0.169	0.0	2.82	0,17	29.17	0.67	5.31	0.69	0.23
25	5.33	0.162	0.0	2.90	0,16	8.96	0.12	10.14	3.09	0.07
26	4.38	0.210	0.0	11.50	0,63	108.24	1.18	3.96	1.48	0.68
27	3.63	0.614	0.0	7.30	0,34	83.62	0.99	0.88	1.42	0.57
28	3.90	0.136	0.0	4.88	0,29	67.97	0.08	0.21	0.10	0.08

According to description statistical analysis results, CR values varied between 23.27 – 3.27%. Candemir (1998) found that the basic soil properties such as; clay content and OM gave significant relationships with SSI, CR and ER in her study conducted in order to determine susceptibility of soils to erosion in Çarşamba plain.

According to description statistical analysis results ER values varied between 85.28 – 8.50%. Soil ER index had the highest variation in the erosion sensitivity parameters. Erosion rate is a measure of the susceptibility of soils to erosion. The limit value for the erosion rate was accepted as "10". Soils with an erosion rate greater than 10 were reported to be resistant to erosion (Bryan, 1968). Basin soils mean value of ER is 29.87%. This means soils are very weak to erosion. Correlations results between soil properties and some erodibility parameters were given in Table 3.

The highest positive correlation relation was found between SSI and silt content whereas the lowest negative correlation relation was found between CR and clay content ($p<0.05$). It was also found significantly positive relation between SSI and clay, lime content ($p<0.01$). In addition, it was detected significantly positive relation between CR and sand content. It was not found any relation between organic matter and soil erodibility indexes.

Table 2. Some physical analysis results of soil samplings

Sample	Sand	Clay	Silt	Texture class	SSI	CR	ER
1	65.19	7.05	27.76	(SL)	32,77	13,18	24,65
2	53.41	13.34	33.25	(SL)	40,59	6,50	21,39
3	53.52	7.17	39.32	(SL)	38,91	12,95	40,23
4	61.27	19.41	19.32	(SL)	33,19	4,15	21,61
5	43.12	23.41	33.46	(L)	51,40	3,27	9,46
6	55.24	9.25	35.51	(SL)	40,18	9,81	34,24
7	49.53	15.14	35.33	(L)	45,36	5,61	16,32
8	48.92	17.46	33.62	(L)	44,12	4,73	22,71
9	55.84	12.82	31.34	(SL)	41,98	6,80	8,50
10	53.35	12.95	33.7	(SL)	42,54	6,72	12,05
11	64.44	11.01	24.54	(SL)	32,66	8,08	15,07
12	61.88	11.22	26.9	(SL)	31,58	7,91	30,20
13	47.61	9.24	43.15	(L)	48,07	9,82	18,58
14	66.18	4.89	28.93	(SL)	30,60	19,45	34,77
15	76.31	8.35	15.34	(SL)	22,73	10,98	16,39
16	51.29	12.75	35.96	(L)	45,60	6,84	19,24
17	35.37	10.73	53.9	(SiL)	59,31	8,32	32,54
18	52.08	14.46	33.46	(SL)	44,88	5,92	18,55
19	66.66	7.75	25.59	(SL)	29,34	11,90	50,43
20	54.35	22.57	23.08	(SCL)	40,51	3,43	16,26
21	71.13	5.69	23.17	(SL)	27,54	16,57	32,18
22	51.68	5.74	42.58	(SL)	40,14	16,42	37,20
23	56.33	14.96	28.7	(SL)	38,12	5,68	32,99
24	54.11	10.69	35.2	(SL)	38,67	8,35	46,04
25	48.41	16.4	35.2	(L)	42,24	5,10	42,41
26	55.61	7.97	36.42	(SL)	39,50	11,55	85,28
27	72.62	4.12	23.26	(SL)	25,20	23,27	77,15
28	67.48	5.7	26.82	(SL)	31,27	16,54	19,81

Table 3. Correlations between soil properties and some erodibility parameters

	ER	SSI	CR	Sand	Clay	Silt	pH	EC	Lime	OM	P	K	Ca	Mg	Na
ER	1,00	-0,27	0,53*	0,20	-0,48	0,08	0,01	0,14	0,03	0,32	0,10	0,53*	0,09	0,24	0,45
SSI		1,00	-0,57	-0,98	0,50*	0,82**	0,34	-0,05	0,50*	-0,26	0,40	-0,06	0,29	0,24	-0,10
CR			1,00	0,59*	-0,89**	-0,12	-0,21	0,27	-0,05	0,26	-0,03	0,12	0,03	-0,09	0,19
Sand				1,00	-0,52	-0,83	-0,31	0,11	-0,45	0,34	-0,35	0,08	-0,29	-0,27	0,14
Clay					1,00	-0,03	0,07	-0,13	-0,03	-0,28	0,18	-0,07	-0,05	0,07	-0,18
Silt						1,00	0,32	-0,04	0,55*	-0,21	0,29	-0,05	0,37	0,27	-0,04
pH							1,00	0,14	0,63*	-0,07	-0,04	0,27	0,76**	0,73*	0,48
EC								1,00	0,32	0,48	0,19	0,22	0,41	0,19	0,25
Lime									1,00	0,01	0,25	0,10	0,61*	0,28	0,11
OM										1,00	0,17	0,34	-0,07	-0,08	0,43
P											1,00	0,46	0,01	-0,02	0,11
K												1,00	0,18	0,40	0,49
Ca													1,00	0,73*	0,18
Mg														1,00	0,28
Na															1,00

* Correlation 0.05 significance level. ** Correlation 0.01 significance level

4. Conclusion

This study was performed in micro basin of Rize province located in Eastern Black Sea Region of Turkey in order to evaluate some erodibility indexes of soils taken from tea cultivated land. According to results, when some areas in the basin are more resistant to soil erosion, some areas are less resistant. Also, these indices were estimated by using multiple correlations between several soil properties. It is concluded that the soils of tea cultivated basin showed differences in terms of erodibility indexes such as SSI, ER and CR. According to the results of erodibility analysis, it was determined that the soils of sampling areas have high variability of erodibility. For that reason, it should be taken some biophysical measures to increase soil quality level by creating optimum tea plant growing medium such as liming, application of suitable fertilization program, increasing of resistance of soil erodibility.

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National Dynamic Erosion Model and Monitoring System (DEMIS) in Turkey

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Abstract

Turkey has mountainous physiography with unsteady topography and rather variable climate conditions, which in total induces soil erosion processes to occur frequently and become one of the principal threats in terms of both Sustainable Soil Management (SSM) and Sustainable Land Management (SLM) in the country. Therefore, soil loss by erosion poses a great risk to sustain soil ecosystem function and services that greatly underpin the food security.

The General Directorate of Combating Desertification and Erosion (GDCDE) has commenced a program to assess water erosion risk at the national scale by the Dynamic Erosion Model and Monitoring System (DEMIS) based upon the RUSLE equation and modelling approach. The DEMIS process the RUSLE at the 25 basins of Turkey, generating water erosion rates for each basin. Also, the Water Erosion Atlas of Turkey (WEAT) turned out as map layers along with statistics on soil erosion hazard distribution over the country. Conclusively, this paper aims to make the DEMIS and WEAT widely known for natural resource conservationists and decision makers in implementing the Land Degradation Neutrality (LDN), SLM and SSM.

Keywords: Soil, Erosion, RUSLE, DEMIS, SSM, SLM, LDN

1. Introduction

Generally, due to the topographical situation, a big part of country lands are not appropriate for agricultural activities and organic matter content in agricultural soils is lower than 5% (Anonymous, 1978; Anonymous, 1982; Çanga and Erpul, 1994). Studies have done (Telles et al., 2011; Ritter and Eng, 2012) obviously show that there is an urgent need to prevent fertile top soils from eroding by water erosion processes to improve the current situation by conservative measures.

In parallel with recent scientific and technological developments in erosion prediction methodologies that successfully use various available tools of Remote Sensing (RS), GIS and geostatistics, it is now very getable to make water erosion risk assessments at basinal, regional and national scales (Van der Knijff et al., 1999; Van der Knijff et al., 2000; Le Bissonnais et al., 2002; Le Roux et al., 2008). Similarly, studies of assessing erosion risk by USLE/RUSLE technology have been for a long time used at the scale of small watersheds in Turkey (Erdogan et al., 2007; Tunc and Schröder 2010a, b; Hacisalihoglu 2010; Ozcan et al., 2015; Saygin Deviren et al., 2014; Efe et al. 2008; Yüksel et al. 2008; Karaburun et al., 2009; Demirci and Karaburun, 2012; Bayramin et al., 2008; Erpul et al., 2016; GDPS, 2018).

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In order to reveal the soil losses caused by erosion in Turkey, the General Directorate of Combating Desertification and Erosion (GDCDE) developed the DEMIS software, which is based the RUSLE equation greatly integrable with RS and GIS.

2. Materials and Methods

2.1. Study Area and Material

The study is national base and aims to assess the spatial extent of erosion for the 25 river basins. The databases (cellular [raster] and vector databases) that DEMIS utilizes are:

- Digital Elevation Model (1: 25.000)
- National Forest Maps (1: 25.000, 2016)
- Land Use/Cover Data (CORINE, 2012)
- Basin, River and Dam Data (DSI)
- Soil Information System Data (ÇEM)
- River Sediment Data (E.İ.E.İ, 2012)
- Automatic Meteorological Observation Stations Data (Directorate General of Meteorology)

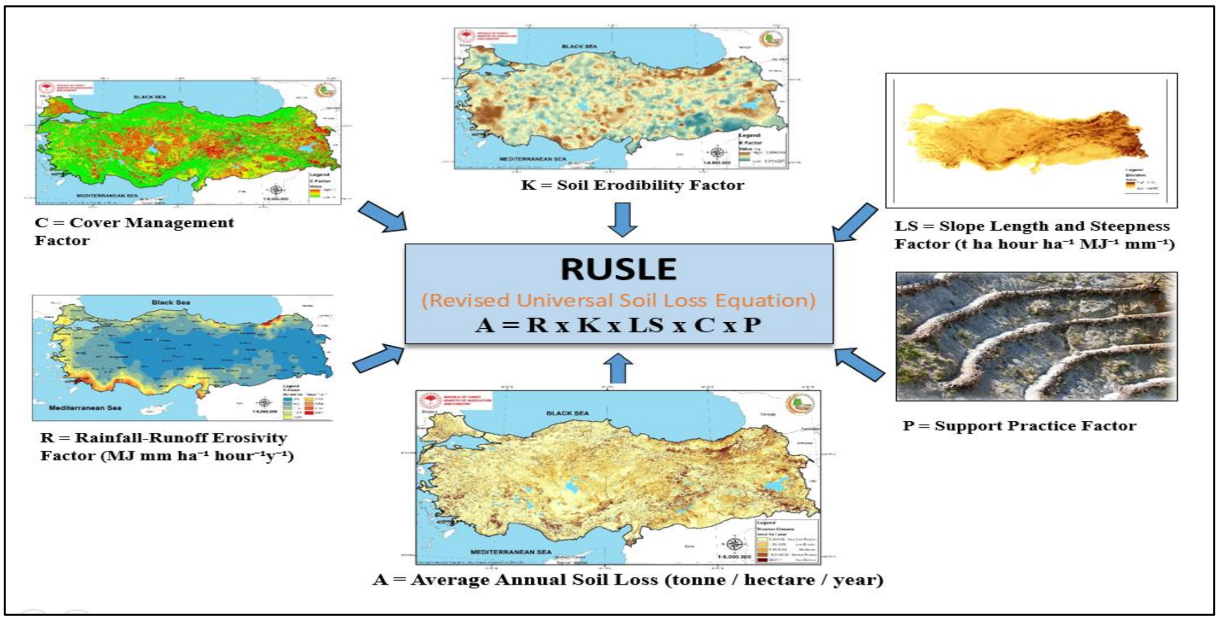

Figure 1. A Workflow Scheme of the Dynamic Erosion Model and Monitoring System (DEMIS)

2.2. Operational Method

The DEMIS assesses the erosion risk by the RUSLE model (Renard *et al.* 1991 and 1997; Wishcmeier and Smith, 1978).

Precipitation data (in minute) were collected from 357 automatic meteorological observation stations and were obtained from the Turkish State Meteorological Service. Rainfall energy (E, MJ ha^{-1}) and intensity (I, mm h^{-1}) were calculated with Eq. [1] and Eq. [2] (Brown and Foster, 1987).

$$E = 0.29.\left(1 - 0.72e^{(0.05I)}\right) \quad [1]$$

$$I = \frac{P_m}{t} \quad [2]$$

Here, Pm is rainfall amount (mm) and t is the duration of rainfall (h). The R Factor is explained as the long term average sum of individual storms in a yearly manner and computed by Eq. [3], where , E is the total storm kinetic energy per unit area (Ri, MJ ha^{-1} mm h^{-1}), and I30 (mm h-1) is the maximum 30-minute rainfall intensity: $R_i = E_i.(I_{30})_i$ [3]

The DEMIS computes soil erodibility by an approach that Torri et al. (1997) (Eq. [4] recommended since countrywide available soil data fitted to it more than other possibilities of estimating RUSLE-K did. .

$$K_T = 0.0293\left(0.65 - D_G + 0.24{D_G}^2\right) * exp\left\{-0.0021\frac{OM}{C} - 0.00037\left(\frac{OM^2}{C}\right) - 4.02C + 1.72C^2\right\} \quad [4]$$

RUSLE-LS factor is calculated through DEM and flow accumulation tool as suggested by Moore and Burch (1986a, 1986b) (Eq. [5]) with a set value of 15 m for slope length (Ogawa et al 1997):

$$LS = \left(\frac{x\mu}{22.13}\right)^{0.4}.\left(\frac{\sin\theta}{0.0896}\right)^{1.3} \quad [5]$$

Explicitly, the RUSLE-LS factor is obtained considering not only slope length and slope steepness but also flow accumulation by the DEMIS software.

National Forest Map and CORINE 2012 are combined to achieve the RUSLE-C factor and the adapted factor values from Panagos et al. (2015) were assigned to each land use and cover class given distinctive conditions of Turkey.

The system is building land-based data and information for different vegetative and engineering practices at various scales from relevant applicator state institutions and since this is still in progress and currently infeasible, the DEMIS assigns a unit value for the RUSLE-P until the process is fully completed at national scale.

3. Results and Conclusion

The GDCDE DEMIS software resulted predictively in soil erosion risk assessment as a map layer at the national scale (Figure 2), which was indeed a lumped product of those from 25 river-basins in Turkey. Estimated total soil loss in the country is approximately 642 million ton ha^{-1} y^{-1} and 24% of this is being carried by rivers to outlets of basins, which is reckoned in Sediment Delivery Ratios (SDRs).

When this sum is differentiated by land use types as percentages, the pastures (50%) were more vulnerable than arable land (38%) and forest (4%). That showed water erosion outweighed in semi-arid rangeland and agricultural land in Turkey.

Regarding countrywide severity class distributions of water erosion risk, it is statistically marked that 60.28% of the country is under the influence of very low erosion, and while 19.13% and 7.93%, summing up a value of 27%, were under the low and moderate erosion, around 12% exposes to either severe (5.97%) or very severe (6.7%) erosion.

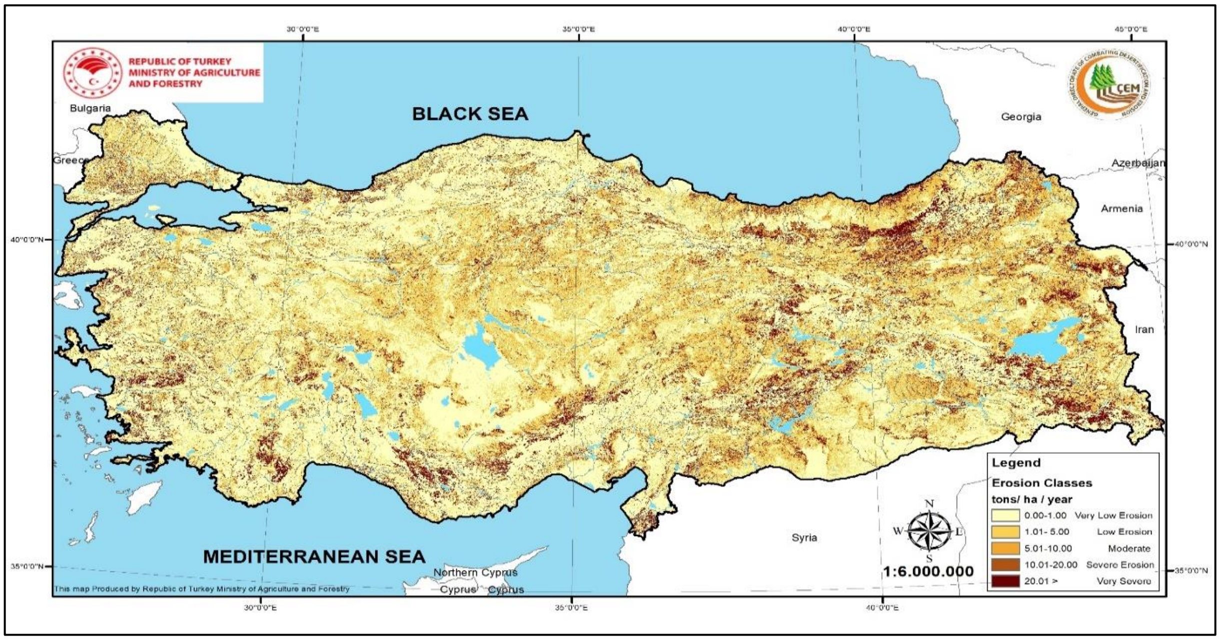

Figure 2. Soil erosion map of Turkey

As well, the GDCDE DEMIS software has an ability to regularly estimate soil losses at various scales ranging from micro and macro basins up to sub-regions and country, picturing erosion severity classes with bounds of quantitative soil losses evaluated by soil solum depth given limitations and sustainable use of soil resources under semi-arid and arid conditions. In-depth statistics are also acquired for comparative or proportional effects of climate, soil, topography and land use and land cover on water erosion process at the required scales. In terms of country level computations these were 47.55%, 34.82%, 14.26% and 3.36% for topography, cover management, rainfall erosivity and soil erodibility, respectively. It is significant to note that those for any distinctive basin were quite changeable.

3.2. Conclusion

Maps of the soil losses and risk assessments relied on the RUSLE methodology are successfully produced as new and updated factor data come in and feed in the DEMIS regularly across the country. It is highly expected from the GDCDE DEMIS to exclusively delineate water erosion-affected areas and to draw the attention of conservation institutions and organisations to privilege preventive measures and cares to sustain soil resources by tapping into practices of Sustainable Soil Management (SSM) and Sustainable Land Management (SLM).

3.3. Acknowledgments

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Transformation of Some Soil Characteristics Affected by Low Severity Ground Wildfire Occurring in Mediterranean Forest Ecosystem Has Low Environmental Sensitivity Index (ESI)

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Abstract

This study was conducted to evaluate of status of the some soil physical, chemical and hydrological features exposed to low severity ground wildfire in Bulutoglu village, Kahramanmaraş. In total 108 surface soil samples (0-30 cm) were collected according to the aspect and altitude features in burned and unburned fields. Soil properties including particle size distribution, soil reaction (pH), electrical conductivity (EC), organic matter content (OM), dispersion ratio (DR), moisture content (MC), field capacity (FC), colloid/moisture equivalent (CM), grain density (GD), bulk density (BD) and porosity rate (PR) were determined. Correlation analysis and independent samples t-test were applied to identify the relationship and to determine the significance between two group soils (burned and natural soil) features. According to the results, except of porosity rate and bulk density values, negative effects of ground wildfire were observed to have diminished in three years after from wildfire and in similar vein, statistically significant differences were not found between the analyzed soil samples groups. It was concluded that the difference between the bulk density and porosity rates is not only due to fire effect but also with grazing pressure on the unburned area. The results suggested that the soils in the area has low environmentally sensitivity index (ESI) and suffered from low severity surface ground wildfire have substantially been naturally rehabilitated itself within three years. Specifically, as a result of the reduction in soil pores and soil aggregation due to the filled of macro pores with organic ash in soil profile deformations in structure are possible to be observed in the sink areas. Thus available water capacity of soil may decrease and this is trigger to activate of surface flowing and erosion risk. Finally it was recommended that for increase natural resilience of forest ecosystem after ground wildfire, it has been to provide homogeneity distribution of organic ash ruins, addition of organic substances and to avoid activities that compaction of the land.

Keywords: Ground wildfire, Soil, Resilience, Fire ecology, ESI

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The Effect of Four-wing Saltbush (*Atriplex canescens* (Pursh) Nutt.) on Runoff and Erosion Control in Unsuitable Areas for Plantation –A Case Study of Eskişehir

Uğur ŞAHİN

Abstract

The study was conducted to evaluate whether the four-wing saltbush plant can be used to prevent erosion in the areas with shallow soil and steep slopes in the semi-arid regions, which is not suitable for afforestation, by applying different tillage methods and planting space in Eskişehir region. For this purpose, 20 m2 plots with 2m by 10 m in size were established in the study site to measure amount of runoff after precipitation in 2015 and 2016 as well as the amount of soil loss. Thus, a total of 24 plots consisting of 8 treatments with 3 replications were established on the experimental area where vegetation cover was completely removed by spraying herbicide. There were no treatment in control plots. On the other plots, planting holes and terraces were established and half of the planting holes and terraces were planted with saplings of fourwing saltbush with different planting spaces (3m interval, 0.5 m and 1 m distances) to determine if different soil tilligae types or combination of them with planting have any impact on soil loss and surface runoff . 2+0 Enso fourwing saltbush saplings were planted with 50 – 100 cm intervals at planting holes and in the terraces. Results showed that terracing without planting shrubs was the most effective method for soil and water conservation in this study. In contrast, combination of soil tillage and panting with shbrub saplings had effect on soil loss and surface runoff regardless of planting spaces. On the other hand, seedling survival of fourwing saltbush was 100 percent in this study site with high slope degree and shallow soil conditions which was not appropriate for afforestation.

Keywords: Fourwing saltbush, different soil tillage, seedling density, erosion control

Determination of Erodible Particles on Cultivated and Non-Cultivated Soils by Wind Tunnel Simulation

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Abstract

Wind soil erosion is an important problem in many regions of the world and in our country, but it may be a significant problem in semi-arid regions. The susceptibility of a soil surface to wind erosion can be measured in a variety of ways, including field-based monitoring of wind regime and sediment transport, using laboratory or field-based wind tunnels. Wind tunnels have become a useful tool for studies in the field of wind erosion because they are used to simulate erosion at small spatial scales. Here, we present laboratory wind tunnel experiment to investigate the effects of 3 different wind velocities (5, 7 and 9 m s^{-1}) on wind erosion in cultivated and non-cultivated soils collected from Karapınar, Konya-Turkey. We also determined the threshold wind speed in which the wind erosion was observed in both soil types. We found that the wind-induced soil loss decreased significantly in cultivated soils. At 7 m.s^{-1}, sediment transport rates were 0.014 and 0.244 g.cm^{-2} /5min. for cultivated and non-cultivated soil, respectively. Furthermore, we determined that the percentage of dry aggregate in the cultivated soils was lower than the non-cultivated soils when the dry aggregate percentages (<0.84 mm) of the soils used in the study were compared. These results are all the more remarkable because there was significant difference in terms of wind-induced soil loss between two soil types.

Keywords: Wind Tunnel, Erosion. Thresold wind speed.

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Comparison of Mountainous Agricultural Lands in Terms of Soil Erodibility at Three Different Altitude

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Abstract

The precondition for sustainable use of soil is definitely to protect and heal the health of its. Climate change will lead to and continue to change management practices in agricultural systems. Observing soil health in this change will make a positive contribution to food safety in the medium and long term. Vegetable cultivation is one of the most important food provide source. Especially in mountainous regions with over 1200 m, where anthropogenic effects predominate, vegetable gardens are more exposed to degradation. In this study, soil erodibility of high areas of vegetable cultivation on the eastern slope of Erciyes Mountain was determined and these areas were divided into three different height groups (<1500m, 1500-1700m and> 1700m, asl) and these three elevation groups were compared in terms of their erodibility. According to the results of this study, it was concluded that these three height groups were statistically different (P <0.01) in terms of wet aggregate stability and dispersion ratio. Aggregate stability was highest in 1500m and lowest in 1500-1700m. According to the Duncan multiple comparison test, these two height groups are different. The lowest dispersion rate was determined for vegetable gardens in <1500m, and the highest dispersion rates were determined for 1500-1700m and> 1700m height groups which statistically same. It is thought that these differences in soil erodibility were caused by some changes due to elevation in soil properties. Elevation differences may have caused events such as weathering, eluviation, illuviation and leaching to occur in different degrees. Appropriate soil protection measures should be taken at 1500-1700m altitude in order to make vegetable agriculture sustainable in the mountainous areas on the eastern slope of Erciyes Mountain. When developing new management strategies in these areas, height above sea level should be taken into consideration.

Keywords: Altitude, Dispersion ratio, Wet aggregate stability

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Determination of Erosion-Based Structural Degradation in Soils by Micromorphological Observations

Zeki ALAGÖZ[1]

Abstract

One of the most important elements of the environment is the soil. Erosion causes short-term and long-term structural degradation, leading to the deterioration of physical, chemical and biological properties of soils. On the one hand, this deterioration causes a reduction in the crop production level, while on the other hand, it causes serious environmental problems by transporting the chemicals accumulated in the soil as a result of various agricultural, industrial and other activities along with suspended soil colloids to streams, lakes and seas. In this study, in order to determine the structural degradation of erosion origin, micromorphological observations were made in the undisturbed soil samples taken from the soils and the following occurrences were determined. As a result of the impact and wetting of raindrops, which are the beginning of erosion event, formation of structural degradation by the steps of; a) fragmentation of existing aggregates on the soil surface; b) reduction of soil porosity; and c) formation of crust layer. With the start of surface flow; a) by moving the thin material on the soil surface the formation of the course textured A horizon; and b) the complete destruction of the A horizon by the transport of the soil material and the rise of the B horizon to the surface. At the moment of storage, which is the final stage of erosion; a) covering the existing surface soil with the carried materials; and b) coating the soil surface as a result of precipitation of very fine material in suspended water.

Keywords: Soil Crust, Soil Degradation, Soil Micromorphology

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THEME 3:
Soil and Forestry Activities

The Effects of Release Cuttings on Soil Respiration and Microbial Properties in Anatolian Black Pine (*Pinusnigra*Arnld. subsp. *pallasiana* (Lamb.) Holmboe.)

Aliye Sepken KAPTANOĞLU[1], Aydın ÇÖMEZ[2]

Abstract

Soil respiration is a major flux of CO_2 to the atmosphere, accounting for up to 25% of global CO_2 emissions It includes autotrophic and heterotrophic respiration and plays an important role in global carbon cycling. Therefore soil respiration may be a valuable indicator that shows how the forest management practices affect the forest ecosystem function. Forestry practices may cause significant changes in carbon dioxide flow depending on their characteristics and size.

Altough there are few information about thinning practises, a lack of information on impacts of release cutting on microbial biomass and microbial respiration was realized. In this study we aimed to determine release cutting effects on soil respiration and some microbial parameters.

Different releasing practices were applied on fifteen plots within the study. These practices have five operations which contains control (no release cutting), 2000 (heavy), 4000 (moderate), 6000 (light) left per hectare and a classical practise respectively. Ten samplings were carried out between 2014 and 2017 for soil microbial parameters and respiration and two at the beginning and end of the study for physical and chemical parameters. Repeated measure variance analysis was used to determine the effects of release cutting on soil parameters by using the first measurements as covariance to eliminate the differences.

According to the project results, practices are different with respect to microbial biomass C and N, and their ratio, basal and soil respiration, metabolic quotient in some periods. The effects of operations were clarified out of the cold and dry periods. In the biological parameters,the lowest levels of respiration were seen in severe practices among the release cuttingswhile the most of the othersshowedthe highest values in classical.

Keywords: Release cutting, microbial biomass, soil and microbial respiration, *Pinusnigra*

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The Effect of Silvicultural Treatments on Litterfall Decomposition and Stocks of Carbon and Nitrogen in the Soil in *Pinussylvestris* Stands

Aydın ÇÖMEZ[1], Şükrü Teoman GÜNER[2], Doğanay TOLUNAY[3]

Abstract

In this study, the effect of thinning and regeneration cutting on litter decomposition and carbon stock as well as nitrogen stock in the soil of Scots pine stands (*Pinus sylvestris* L.) were investigated. The study was carried out in pure Scots pine stands in which thinning treatment and regeneration cutting were performed in 2008-2011 by the local forest authorities in Eskişehir (Turkey). Sample plots were taken from 2 aspects (northern and southern slopes) and 3 treatments (un-thinned, thinned, and regeneration cutting) with 3 replications. The litterbag method was used to measure the mass loss of litter, placing 60 litterbags on the surface in each plot. Litterbags were collected by four monthly for four years. Decomposition coefficients of the litterfall of each treatment were calculated from the mass loss of decaying litter. Soil samples were taken from the horizons of Ah and Ael by soil cores from each sample plot. Carbon and nitrogen contents of the soil were determined by wet digestion and Kjeldahl methods, respectively. Data were evaluated by ANOVA.

As a result, regeneration cutting (seed cut) decreased the decomposition rate significantly, while thinning effect remained insignificant. Decomposition rate of seed cut on northern slopes was lower ($k= -0.309 \pm 0.074$) than that on southern slopes ($k= -0.267 \pm 0.011$). Silvicultural treatments increased soil carbon stocks from 32 t ha^{-1} in un-thinned stands to 39 t ha^{-1} in seed cuts. Similarly, soil nitrogen stocks increased from 1.5 t ha^{-1} in un-thinned to 1.9 t ha^{-1} in seed cuts. However, these effects were not statistically significant. Results indicated that litter would decompose slower on southern slopes than on northern slopes and seed cutting could cause a rise in carbon and nitrogen mineralization in forest soils.

Keywords: Organic matter, decomposition, forest soil, Scots pine

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Relationships Between Growth of Maritime Pine (Pinus Pinaster ait.) Plantation and Site Characteristics

Cezmi ÖZEL[1], Mehmet TÜRKKAN[2], Selda AKGÜL[3], Ş. Teoman GÜNER[4]

Abstract

With this study, it is aimed to determine the relations between the height growth and site conditions in corsican Maritima pine plantations. For this purpose, 69 sample areas were randomly selected areas from Maritima pine plantations over the age of 20, which differ in terms of inclination, elevation, slope position and growth in the Marmara and Black Sea Regions.In the study plots, height of 3 trees at upper stand height were measured, the one which of closest arithmetic mean height was cut. Its height at the level of cm precision was measured, then tree rings were counted on the stump left to determine the tree age. Inclination, elevation, aspects and slope position of the sample plots were measured. In each sample plot, a soil pit was digged and soil samples were collected according to depth intervals. Some chemical and physical properties of the soil samples were determined in laboratory. Bedrock samples were taken to identify from 9 sample plots where the bedrock was reachable. Due to the lacking of main rock samples they were not evaluated as independent variable in statistical analysis. Correlation analysis was used to evaluate the relationships between site index and environmental factors, such as physiographical, climatic and edaphic factors including density (%) and pedon (kg m-3) values.The Mediterranean climate (according to Emberger principles) classification was used to determine the climate types of the sampling areas. According to this classification, it was determined that the sampling areas were in four different bio-climatic classes which are very rainy, rainy, low rain and semi-arid.

Significant relationships were determined between with the site index and physiographical factors like inclination, as well as climatical factors like annual rainfall, annual mean spring rainfall, annual mean summer rainfall (june-july-august), annual mean spring summer rainfall, rainfall amount of four summer months (june-july-august-september), the driest month rainfall, dry period (S), mean high temperature and mean temperature of the hottest month. Significant relations were also determined between with the site index, and the soil depth intervals properties, as skeleton volume, sand, silt, clay ratios, pH, electrical conductivity, available moisture. The relations between the site index and the values from the unit volume of soils like skeleton volume, silt, clay, organic carbon, available water content were significant, as well. Height development of Maritime pines was explained at ratio 57.9% with stepwise regression analysis, 50.14% with regression tree model.

Keywords: Maritime pine, afforestation, growth site conditions, height growth

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Ecological Evaluations of Plantations on Istanbul-Durusu Coastal Dunes

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Abstract

Although having a significant portion of its coastal dunes by the Mediterranean Sea, Turkey has also coastal dunes by the Black Sea, especially within the boundaries of Istanbul. Durusu coastal dune, which is located between Durusu Lake and Black Sea, is an important location because of being the first afforestation study in Turkey concerning to stabilize coastal dune movement. The first plantation treatment was done between the dates 1885 and 1887 by introducing *Pinuspinaster*. However, this plantation was not successful so sand movement went on. Reforestation studies of Durusu coastal dunes were continued since the end of 1950's by testing *Pinuspinaster*, *Pinuspinea*, *Pinusbrutia*, *Pinusnigra*, *Cupressussempervirens*, *Alnusglutinosa*, *Fraxinusoxycarpa*, *Populus x euroamericana*, *Acer negundo*, *Platanusoccidentalis*, *Castaneavesca* and *Robinia pseudo-acacia* species. After successful results of *Pinuspinaster* and*Pinuspinea*plantations, both species were mostly used on reforestation studies since 1960's. On the other hand, because of the requirement of sand stabilization before plantations, windbreaks were set. After the slowing down of dune movement, seeds of some herbaceous species such as *Ammophillaarenaria* and*Isatisarenaria* were sowed among wind breaks. Thus, roots of these herbaceous species kept the sand. Stone pine and maritime pine seedlings were planted among these windbreaks converted to grasslands. Currently, 1674 hectares of maritime pine and 371 hectares of stone pine plantation areas exist in Durusu coastal dune area. Full canopy covered stands were occurred especially on sea effected locations and humid sites. Thick forest floor layers exist under these stands because of the slow decomposition rate, and sand dune movement were mostly controlled because of the effects of both forest floor and planted trees. However, tree growth was not good on the sites under dry conditions and ridge shaped geomorphological sites. In addition, *Pinuspinaster*plantations over 50 years old have been regenerated since 2013.

Keywords: Coastal Dunes, stabilization, plantation

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Monitoring & Evaluation of the Effects of Forestry Activities on Soil Loss and Erosion; the Case of Hamzabey and Büyükçay Microcatchments

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Abstract

Erosion and soil losses are the most important environmental problems in Turkey. Soil loss is gaining momentum especially due to the wrong use of land by human and timely measures not taken. These soil losses and erosion must be prevented with soil conservation and erosion control activities. This study was carried out in Büyükçay and Hamzabey Micro-catchments of the Murat River Watershed Rehabilitation Project. The aim of this study is to determine the effects of forestry applications on soil erosion in the watersheds. Three-stage mechanisms have been established on Büyükçay and Hamzabey Micro-catchments. The surface flow parcels and precipitation meters have been established in the upper part of the MC, the siltation pools in the central part of the MC, and sediment flow measurement station in the lower part of the MC. And, the effects of different forestry activities on erosion and soil losses are tried to be revealed through the monitoring and evaluation method of the data received from these mechanisms after each rainfall.

Keywords: MRWRP, Soil Loss, Erosion, Surface Flow Parcels, Büyükçay, Hamzabey, Micro-catchment

1. Introduction

The scientific measurement of soil conservation activities and soil erosion in the modern sense was carried out with data obtained from the land in the first quarter of the 20th century. (Sanders 2004). Initially, surface flow and erosion measurements started in 1915 in Utah of the United States, and in 1917, surface flow and erosion measurements were performed on land using surface flow parcels. (Smith 1958; Hayward 1967; Chisci 1981; Presbitero 2003; Sanders 2004). Between 1928 and 1933, experimental parcels were established on the lands in the ten states of the United States, and soil erosion and its effects were investigated. (Smith 1958). With the help of the data obtained from the first applications, after reaching the general evaluations about erosion, surface flow and the factors affecting them, these evaluations started to be combined with the laboratory studies. After 1965, various erosion estimation models were developed by using laboratory studies on soil erosion and the results obtained from experimental parcels especially in the United States. Soil losses were tried to be estimated through these models by taking into account the factors influencing erosion such as land use, climatic features, management applications (Wischmeier and Smith 1978). The best models of soil erosion can be called as; Universal Soil Loss Equation (USLE), Revised Universal Soil Loss Equation (RUSLE) and Water Erosion Prediction Project (WEPP) (Römkens et al. 2001).

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Considering that the assessment of erosion and superficial flow in terms of soil sensitivity with the studies carried out on land requires a long and costly time (Barthes and Roose 2002), the benefits of the erosion estimation equations will be better understood.

Surface flow parcels, rain gauge, siltation pools and sediment flow stations were established in Hamzabey and Büyükçay (Elazığ) Micro-catchments (MC) to determine the amount of surface flow water and the amount of sediment carried by precipitation. The interaction values between surface flow parcels, soil properties, precipitation, surface flow and erosion are given under natural precipitation conditions. As well as Büyükçay and Hamzabey MCs located in Elazığ province are neighboring MCs, Büyükçay MC has 9,619.7 ha area, and Hamzabey MC has 14,385.5 ha area. The general area of the two MCs is 24,005.20 ha.

Table 1. Slope groups of Büyükçay, Hamzabey MCs.

Büyükçay			**Hamzabey**		
Slope Groups %	**Area (ha)**	**Ratio (%)**	**Slope Groups %**	**Area (ha)**	**Ratio (%)**
0-12	**2609.6**	**27.13**			
13-20	**1157.9**	**12.04**	**0-20**	**4329.46**	**30.1**
21-40	**2881.5**	**29.95**	**21-40**	**5394.39**	**37.5**
41-60	**2114.8**	**21.98**	**41-60**	**3454.95**	**24.1**
61 and above	**855.9**	**8.9**	**61 and above**	**1206.07**	**8.3**
TOTAL	**6928.8**	**100**	**TOTAL**	**14385.5**	**100**

The general geological structure of the MC is heterogeneous and consists of serpentine, diorite, basic rocks and colluvial materials at the creek sides. In addition, cretaceous-paleocene formations and lutetian formations are observed. General characteristics of soils on these bedrocks are; shallow and medium depth soil in the upper parts of the MC with slope, medium to deep soils in the down and stream edges, sandy, sandy-clayey textured, no drainage problem, no lime, pH is close to a neutral feature.

In this study, it was aimed to determine the effects of forestry activities in Büyükçay and Hamzabey MCs on erosion and soil loss.

2. Material Method

The materials used in the study consists of afforestation, soil conservation and erosion control sites in the Hamzabey MC Yolüstü Village, and a total of 9 surface flow parcels established in the forestry area (Figure 1), and 1 rain gauge, flowmeter, Turbidimeter and rain gauge established in the output of Büyükçay MC, and 3 siltation pools in Hamzabey MC. A total of 3 siltation pools have been established in the MC areas. 2 of them were established in the areas where forestry activities were carried out, and 1 of them was established in a control area with no activity.

It was determined that the catchment has forest, rangeland and agricultural fields, and mostly oak trees (*Quercus sp*) and juniper species as forest vegetation. There are walnut, apple, pear, etc. fruit trees and wheat, barley, alfalfa etc. species in the agricultural fields. It was determined that there were different forage crops in the rangelands.

The size of each surface flow parcel was determined as 20 x 4 = 80 m² by using the natural land slope. 0.5mm galvanized sheet was located at the edges of the surface flow parcel to prevent surface flows from the sides. It was established as 20-25 cm in the ground and 15-20 cm on the ground surface. Different parcels were constructed according to different land use and activities in Hamzabey and Büyükçay MCs.

Figure 1. Surface flow parcel established in the field.

3. Discussion and Conclusion

Surface flow parcels: The results obtained from the surface flow parcels and siltation pools established in the trial fields are given in Tables 2 and 3.

Table 2. Data from the surface flow parcels.

Surface Flow Parcels in Hamzabey MC	1.1 Terraced + Planted Parcel	1.2 Terraced Parcel	1.3 Control Parcel	2.1 Terraced + Planted Parcel	2.2 Terraced Parcel	2.3 Control Parcel	3.1 Cleared Parcel	3.2 Thinned Parcel	3.3 Control Parcel
Precipitation (mm)	316.4	316.4	316.4	316.4	316.4	316.4	316.4	316.4	316.4
Surface Flow (mm)	59.18	51.06	98.63	22.05	39.45	68.46	24.37	69.62	62.66
Surface Flow (%)	18.7	16.14	31.17	6.97	12.47	21.64	7.7	22	19.8
Soil Loss (g/80 m2)	160	161	250	82	25	230	115	88	193
Tons/Hectare	0.02	0.02	0.03	0.01	0.003	0.029	0.014	0.011	0.024

Table 3. Data from siltation pools.

	Siltation Pool Area (Ha)	Sediment Accumulation Area (m^2)	Elevation (m)	Volume (m3)	Unit Volume Weight (Ton / m^3)	Total Weight (Ton)	Soil Loss (Ton/Ha)
Siltation Pool_1 Terracing Works + Seedling Planted Area	41.66	124	0.80	99.2	1.6	158.72	3.80
Siltation Pool_2 Control Parcel, Not Terraced Area	4.72	212	0.90	190.8	1.6	305.28	64.67
Siltation Pool_3 Terraced Area	5.27	256	0.20	51.20	1.6	81.92	15.55

In the evaluations made in Section 1, it was observed that the surface flow was 51.16 (16.14%) mm in the parcel no 1.1 with terrace application and plantation. And, surface flow was measure as 59.18 (18.17%) mm in the parcel no 1.2 with terrace, and as 98.63 mm (31.17%) in the control parcel. While the surface flow was decreased by 48.12% in terraced and planted parcels, it was determined that the surface flow was decreased by %39.99 in the only terraced parcels.

In the assessments made in Section 3, the surface flow was observed to be 69.62 mm (22%) in the parcel no 3.1 with clear-cutting. The surface flow was observed to be 24.37 (.7%) mm in the thinned parcel no 3.2. 62.66 (19.8%) mm surface flow was measured in the control parcel. It was observed that the surface flow is 64.99% less in the thinned parcels than the clear-cut parcel. When the control parcel was compared with the thinned parcel, it was observed that the surface flow is 62.50% less in the thinned parcel.

When the 1st part of the parcels in Hamzabey MC are observed, while 59.18% of the total precipitation in the terraced and planted parcel was included in the surface flow, and soil loss was 160gr/80m^2**(0.02ton/ha)** . While 51.06 mm of the precipitation was included in the surface flow in the only terraced parcel, the soil loss occurred in the parcel was calculated as 161 gr/80m2 (0.02 ton/ha/year).

In the control parcel, while the surface flow was 98.63 mm, the soil loss was calculated as 250 gr/80m^2 **(0.03 ton/ha/year)**. While the soil loss decreased by 36.00% in the terraced and planted parcels, the soil loss decreased by 35.60% in the only terraced parcels.

When the 2nd part of the parcels in Hamzabey MC are observed, while 22.05% of the total precipitation in the terraced and planted parcel was included in the surface flow, and soil loss was 82gr/80m^2**(0.01ton/ha/year)** . While 39.45 mm of the precipitation was included in the surface flow in the only terraced parcel, the soil loss occurred in the parcel was calculated as 25 gr/80m2 (0.003 ton/ha/year). In the control parcel, while the surface flow was 68.46mm, the soil loss was calculated as 230 gr/80m.^{2} **(0.028 ton/ha/year)** . Soil loss decreased by 64.34% in the terraced + planted parcels.

When the 3rd part of the parcels in Hamzabey MC are observed, while 224.37% of the total precipitation in the clear-cut parcel was included in the surface flow, and soil loss was 115 gr/80m^2**(0.014ton/ha/year)** . While 69.62 mm of the precipitation was included in the surface flow in the thinned parcel, the soil loss occurred in the parcel was calculated as 88 gr/80m2 (0.011 ton/ha/year). In the control parcel, while the surface flow was 62.66 mm, the soil loss was calculated as 193 gr/80m^2 **(0.024 ton/ha/year)**. While the soil loss decreased by 40.41% in the clear-cut parcel, the soil loss decreased by 54.40% in the thinned parcel.

4. Acknowledgements

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The Effect of Integrated Yield Program on Stone Pine in Kozak Basin

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Abstract

Kozak Basin (38.691 ha) located in İzmir-Bergama has optimum geographic and ecologic conditions for stone pine (*Pinus pinea* L.). Stone pine stands cover total of a 18.690 ha in Kozak Basin. Pine nut production has 60 percent of economic value in this area. Yet, cones and pine nut yield have decreased since 2009. Thus, the study was carried out between 2014 and 2017. The aim of the study was to prevent yield issue by using plant activators under two different integrated program included two different spraying techniques in stone pines. One of the techniques is conventional spraying method. The other is electrostatic spraying method which is newly used in this sort of studies. The applications were performed in selected experimental site with 830 m altitude for each 5 trees during 3 years. The preparations were applied both soil and trees in January, February and March; however for trees is only in April. Control trees and trees with the integrated program were compared for yield of cones and pine nuts as a result of statistical methods.

Key words: Stone Pine, Plant Activator, Cone Yield

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Identification of Potential Forestry Activity Fields

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Abstract

As in the many area activities in forestry field are not being utilized sufficiently for recently developing technology.At the present time, it will be possible to develop activities for the development and implementation of policies by utilizing advanced analysis methods and data set.

Project units in our forestry sector are trying to determine potential working areas for the purpose of the Project by surveying the field. During these analysis on the field, a lot of resources and time are spent, and even in spite of work done, potential areas for study might not be identified. "Identification of Potential Forestry Activity Fields (PFF) Project" was initiated within the framework of the "Watershed Monitoring and Evaluation System (HİDS) Project" which is carried out in the year of 2014 in order to determine the areas where potentially forestry activities by the General Directorate of Combating Desertification and Erosion.

In project scope; Determination of potential areas such as afforestation, degraded forest rehabilitation, soil conservation and pasture rehabilitation were determined by developing a suitable model and method. As PFF model; The M-AHP method based on the expert opinion, which gives the percentage distributions of the factors affecting the decision, is used when the decision hierarchy can be defined. The software based on GIS was completed in 2014, and the calibration and verification was carried out in the model areas within Ankara Regional Directorate of Forestry; Kızılcıhamam, Beypazarı, and Çamlıdere forestry department in 2015. The software was completed in 2014, and the calibration and verification studies was carried out in the model areas within Kızılcıhamam, Beypazarı, and Çamlıdere forestry operation directorate of Ankara Regional Directorate of Forestry in 2015. After that, between the years of 2017-2018,results were produced within the boundaries of Kırıkkale forestry operation directorate.

With thismodel, potential work areas can be determined within a basin in a short time and reports about theseareas will be prepared. Thereby determine potential forestry field; labor, cost and time spent on fieldwork will be minimized.

Keywords: PFF, M-AHP, Potential Fields, Degraded Forest Rehabilitation, Soil Conservation, Pasture Rehabilitation, Afforestation, GIS, Model

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Determination of Nutrition-Growth Relationships of Scotch Pine (Pinussylvestris L.) Trees According to Site Properties on Sundiken Mountains (Eskişehir)

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Abstract

Since 2001, a two-step research series has been started aiming the determination of the ecological structure on the forests, which constitute the Scots pine zone on Sundiken massif and aiming the selection of the silvicultural methods to be applied on this structure. This research was carried out from 2009 till 2014 as the third work of the second step of the above mentioned investigation series.

The objective of this research is to determine the relationships between nutrion and growth of Scotcs pine according to different site units. The research will be carried out pure Scots pine stands spreading over Sündiken Mountain ranges in Eskişehir.

To reach the Scots pine zone on Sündiken Mountain to 1650 m on south and 1150 m on north aspects, so being the main distribution area on north aspects, depended on being widespread of fresh, slightly moist and moist sites. 4 of them were described as VERY DRY sites (5 %), as SLIGHTLY FRESH (16 %), as FRESH (26 %), as SLIGHTLY MOIST (30 %), as MOIST (23 %).

For this purpose, about 74 sample plots will be chosen from 5 different site units and elevation belts with 3 replications. Soil and forest floor samples will be collected from each sample plot. Besides, a representive tree will be cut down and performed stem analysis for growth determination and needle samples will be extracted from the sample trees in each plot.

Beside the variety of the site units, especially its humidity should be accepted as an ecological property, which influence stand structure and the nutrition/growth relations and the silvicultural methods to be applied for Scots pine forests on Sundiken massif.

Keywords: Sündiken massif, site, nutrition/growth relations, Scots pine.

Changes in Carbon Stocks of Soil and Forest Floor in Black Pine Plantations

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Abstract

This study was carried out; i) to find out the carbon stock changes in soil and forest floor, ii) to determine the effects of thinning on annual carbon accumulation in soil and forest floor and, iii) to investigate the relationships between the annual carbon storage in soil and forest floor and stand characteristics in black pine (*Pinusnigra* subsp. *pallasiana*) plantations in Eskisehir, Afyonkarahisar, Kutahya, Balıkesir, Canakkale and Kastamonu provinces. Samplings were performed totally in 90 plots taken from stands at the stage of pole (dbh=11.0-19.9 cm) and sawlog (dbh=20.0-35.9 cm), varied in aspects, elevation, slope degree, slope position and site index. One soil pit was dug in each sample plot and soil samples were taken from the soil horizons. Additionally, four forest floor samples were taken from each sample plot in size of 25x25 cm. Carbon analyzes for the samples of soil and forest floor were performed in the laboratory. Data were evaluated using one-sample t test, one-way ANOVA, and correlation analysis. Results showed that, in unthinned black pine plantations, the amount of annual organic carbon accumulated in forest floor and soil is statistically ($P<0.001$) significant, with a mean of 1.47 t ha^{-1} year^{-1} in soil and 0.20 t ha^{-1} year^{-1} carbon in forest floor. The amount of annual organic carbon sequestered in the soil were found to be significantly ($P<0.05$) different between thinned and unthinned stands while the differences in forest floor were not significant ($P>0.05$). It was determined that more carbon accumulated in the soil under unthinned stands. Significant correlations were found between the carbon sequestration in soil and the age of the stands, mean diameter at breast heightof the stands, mean height of the stands, site index, stand basal area and stand density. Additionally, significant relationship was found between carbon sequestration in forest floor and stand basal area. The findings will contribute to carbon-focused forest management and to the improvement of national greenhouse gas inventories.

Keywords: *Pinusnigra*, afforestation, climate change, carbon sequestration, thinning

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Site Factors and Plant Species of Marn Soils

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Abstract

The purpose of the study is to determine the plant species that would be used in erosion areas exhibiting the characteristics of marl soils and to specify the site factors of these species. The study was carried out in the eroded soils in Eskisehir-Bozan district where the bedrock is generally marl. The size for sampling vegetation was determined according to the minimal area method. The study was conducted between 2011 and 2015, and 36 data belonging to the sampling areas were used in the analysis. The vegetation sampling was performed in August and September when the most drought months and, all vascular plants were listed. The vegetation measurements were utilized according to Braun-Blanquet's scale. The slope, aspect and elevation in physiographic factors were determined. In order to determine some physical and chemical properties of the soil, the decomposed samples were taken from 0-10 cm and 10-30 cm depth levels. Herbaceous ground cover, shrub and tree species having the highest coverage and frequency by the listed plant species had been determined. The relationships between the presence/absence data of the plant taxa and some characteristics of their habitats were analyzed by Wilcoxon Rank-Sum Test. In this research, we have proposed that the species *Festuca valesiaca, F. callieri* subsp. *callieri*, *Bromus tomentellus* which form bunch; *Alyssum sibiricum, Convolvulus phrygius, Thymus leucostomus, Globularia orientalis* which are form of a pillow and small colonies; *Salvia tchihatchettii*, *Genista aucheri*, *Jasminum fruticans*, *Rhamnus thymifolius, Berberis crataegina, Juniperus oxycedrus* subsp. o*xycedrus* which are chamaephyte and shrub would be used in this location and the similar habitats that are subject to erosion. The taxa *Quercus pubescens* and *Pinus nigra* subsp. *pallasiana*, from the species of small tree and tree, would be used in the area. Besides, in order to achieve success in revegetation studies, it can be paid attention to obtain seeds from species grown in similar conditions. As a result of the numerical analyses conducted between the abovementioned 15 plant taxa and site factors were determine that there were negative and positive relations between soil properties (N, P, organic matter, lime, elevation, aspect [radiation index] and slope) and the species *J. oxycedrus, Q. pubescens, G. orientalis, J. fruticans, F. valesiaca, G. aucheri, C. phrygius* ve *R. thymifolius*. It can be said that they have wider ecological tolerance of seven plant taxa which any relation is found according to the study area.

Keywords: Erosion, Marl, Soil, Plant Species, Eskişehir-Bozan

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THEME 4:
Changes in Soil Characteristics due to Miscellaneous Treatments

Effect of Biochar Applications on Soil Aggregation Status

Qutaiba Riyadh ABDULWAHHAB[1], Cevdet SEKER[2]

Abstract

Biochar is a product produced from pyrolysis process of biomass. Because of its physical properties, it can be used as a structural improvement material which is able to stay longer in the soil as compared to other organic amendments. The objective of this study is to evaluate the effects of biochar amendment produced from sunflower residues on soil aggregate stability and some other soil properties, such as organic matter content, electric conductivity, soil pH and CaCO3 content in clay soils. During experiment, biochar was mixed with the soil at rates of 1%, 2% and 4%, and then incubated for the period of 30 days. At the end of incubated period, rainfall simulator devise was used to evaluate soil aggregate stability. The results showed that soil aggregates stability was significantly increased compared with the control. However, soil aggregate stability was decreased at 4% biochar application of compared with 1% and 2% due to increasing of electric conductivity.

Keywords: Biochar, Aggregate stability, Rainfall simulator, Clay soil

1. Introduction

Soil organic matter improves soil structure by increasing soil aggregation, soil porosity due to its highly porous nature, nutrient and water retention due to its high adsorption capacity and high surface area, and thereby resulting in better root growth and crop yield. Biochar which is the pyrolysis product of biomass has attracted attention for remediation of degraded soils recently. As a soil amendment, biochar can greatly influence various soil properties and processes (Lehmann and Joseph, 2009). Soil aggregate formation and stabilization which promotes long term carbon sequestration and soil structural stability is affected by various factors, including clay content and types, as well as the amount of soil organic matter (Six, et al., 2004). Production of biochar from the pyrolysis can sequester atmospheric CO_2into a more stable soil C pool (Lehmann et al., 2009). Agronomic benefits are mainly derived from the quality of biochar and its effects on the improvement of soil physical conditions, in particular, the soil water holding capacity, soil aggregate stability and soil drainage characteristics.The aim of this study was to evaluate the effects of biochar amendment produced from sunflower residues on soil aggregate stability in a clay soil. And assess the relationship between aggregate stability and some other soil properties, such as organic matter content, electric conductivity, soil pH and $CaCO_3$ content.

2. Methodology

2.1 Site Description, Soil Samplingand Experimental Design

Agricultural clay soil, were collected from the surface (0 -20 cm) of a field located at Central Anatolia region, Konya plain, Sarıcalar research and application farm) . Soil samples were sieved in situ by 4 mm sieve from different selected points, transported to the laboratory whereby were passed through a 2 mm mesh after air-drying prior to the experimental establishment at the laboratory in April 2018.Based on dry weight basis were

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completely mixed with biochar (BC) at a rate of 0%(control), 1%, 2% and 4% (w/w), the mixtures were placed in the pots , then watered at field capacity and subsequently incubated for 30 days at 23±2°C.

2.2 Preparation of Biochar

The sunflower residues collected from SÜ, Sarıcalar Research and Application Farm were used to produce biochar through the pyrolysis process. After drying, they were wrapped with aluminium foil to prevent the oxygen from entering sunflower residues, then placed in the muffle furnace and pyrolyzed at 450^{o}C for 1 hour. After cooling, the biochar was passed through 2 mm sieve and stored in a plastic container until the starting of the experiment.

2.3 Physical and Statistical Analysis

Soil texture was determined by Bouyoucos hydrometer method. Soil pH and EC(1:2.5). Calcium carbonate (CaCO3)Soil organic carbon (OM) was measured by a wet combustion method proposed by (Smith andWeldon, 1941). Soil aggregate stability was determined by rainfall simulator according to (Gugino et al., 2009).

2.4 Statistical Analysis

The study was a pot experiment with four replications in accordance with a completely randomized plot design, and analyzed by one-way ANOVA, and differences in means were compared by the least significant difference test at $P < 0.05$. All statistical analysis was carried out by Minitab software (Version 16.2.4, Pennsylvania, USA).

3. Results and Conclusion

a. Effects of Biochar on Soil Organic Matter (OM)

According to experimental results, Figure 1 shows that biochar addition significantly ($P<0.001$) increased the OMcontent, However, after one month of incubation at the field capacity, and due to the effect of mineralization process by microorganisms on soil organic carbon, the rate of OM was reduced by a certain amount at all doses compared with OM content in the soil before incubation.

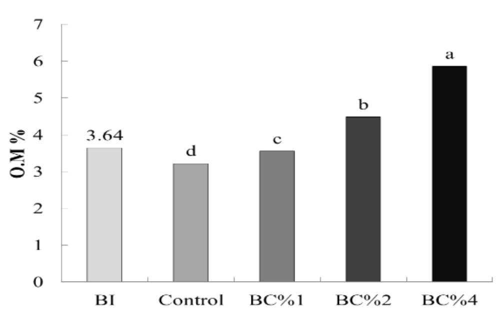

Figure 1. Effect of biochar amendments on organic matter content.

3.2 Effects of Biochar on Soil Electric Conductivity (EC)

Figure 2 shows that EC was significantly ($P<0.001$) increased with increasing of BC. Due to the releasing of weakly bound mineral nutrients of biochar in the soil solution (Chintala et al., 2013).

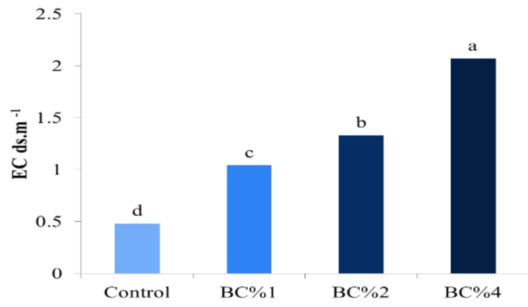

Figure 2. Effect of biochar on soil EC.

3.3 Effects of Biochar on Soil pH

Figure 3 shows that soil pH decreased with an increasing application rate of biochar. Application rate of 1, 2 and 4% compared to the control (0%) significantly($P<0.001$) decreased pH. This could be attributable to the effect of incubation on increasing of oxidization process, and thereby decreasing soil pH of biochar particle as reported by (Cheng et al. 2006).

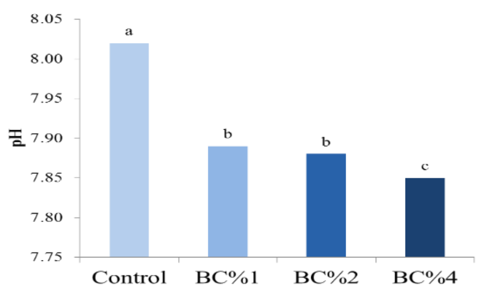

Figure 3. Effect of biochar on soil pH

3.4 Effects of Biochar on Soil Lime Content

Figure 4 illustrates the effect of biochar application on lime content. The results show that the addition of all BC did not significantly affect the lime content ($CaC0_3$).

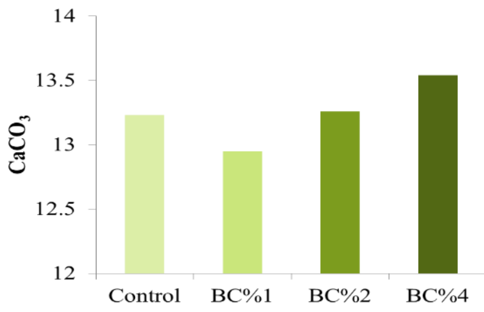

Figure 4. Effect of biochar on $CaCO_3$ content

3.5 Effects of Biochar on Soil Aggregate Stability (AS)

Figure 5 provides information about the effect of biochar's application on AS.The results of the study indicate that AS experienced an upward trend and its increase was associated with an increase in application rate. But this trend was downward in biochar applied at 4% compared with 1% and 2%. The effectiveness of biochar addition was significantly (P<0.001) increased aggregate stability and enhance the formation of macroaggregates as evidenced by (Herath et al.,2013). However, the relative decrease in AS at 4% of BC application compared with other doses, probably occurred because of the excessive rate of BC might have placed a stress on the microbial community by creating the unfavourable condition, which probably led to reduced microbial activity (Paz-Ferreiro et al., 2012).

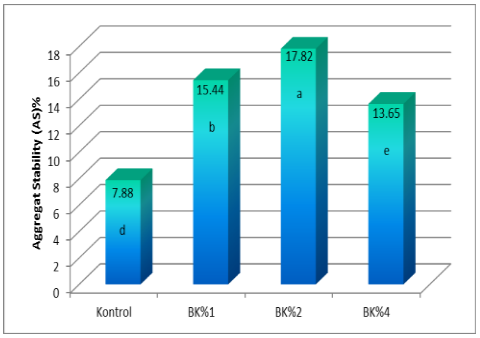

Figure 5. Effect of biochar on soil aggregate stability

4. Summary and Conclusion

Amendment of biochar contributed to more stabilized soil structure by making more resistant soil aggregates against raindrop impact. The result showed that the application of biochar significantly increased the soil aggregate stability. However, when compared OM results with soil before incubation, the OM content was decreased, due to the mineralization process on organic carbon which obtained by microorganisms during the incubation period. No significant effect was detected on $CaCO_3$ content. Soil pH was significantly decreased compared to the control.The present results showed that biochar addition had benefits to improve the studied soil properties such as OM, pH and AS, however the rate of 2% (W/W) was sufficient to improve soil aggregation status under short period of experiment and can be used for remediating degraded soil, and thereby increasing agricultural production.

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Estimating Aggregate Stability by a Linear Regression Model Using Soil Properties

Coşkun GÜLSER[1], İmanverdi EKBERLİ

Abstract

Aggregate stability (AS) is one of the most important soil physical properties that influence the soil structural functions. Determination of AS is time consuming process and takes time during the laboratory studies. In this study, aggregate stability values of 110 surface soil samples were predicted using soil physical and chemical properties as variables in a linear regression model. Aggregate stability, clay, silt, sand contents, soil pH, electrical conductivity (EC), organic matter (OM) content and exchangeable cations (Ca, Mg, K, Na) of 110 field soil samples were analyzed. While AS values had significant positive correlations with OM (0.546**), clay (0.438**), Ca (0.245*), they had significant negative correlations with pH (-0.292*), EC (-0.240*), sand (-0.282**), and Na (-0.394**) contents. The R^2 values in the models for predicting AS values were determined as 234** for soil physical variables and 594** for the soil chemical variables used in the models. When using all soil parameters to predict AS with a linear model, the model was created by the OM, silt, pH, clay, K, EC and Ca parameters in the stepwise analysis. The R^2 of the model increased from 234** to 712**using the physical and chemical soil properties in the model. It can be concluded that AS of field soils can be estimated from the linear regression model obtained in this study.

Keywords: Aggregate stability, texture, soil chemical properties, regression, predict

1. Introduction

A group of soil particles bind to each other more strongly than to adjacent particles is called as aggregate. Aggregation is one of the most important soil physical properties and affects erosion, movement of water, and plant root growth. The pore space between the aggregates provides retention and exchange of air and water in soil. A good soil structure is defined as an arrangement of soil particles into stable larger units and of the pore spaces between those units that allows movement of water through the soil, movement of air into and out of the soil, and ease of penetration by roots and that protects the soil against erosion (Gülser 2006). Aggregate stability is the ability of soil aggregates to resist disruption when outside forces are applied.Aggregate stability is affected by soil texture, type of clay, extractable cations, organic matter content and microbial population (Tisdall and Oades, 1982; Oades, 1993; Aggelides and Londra, 2000; Candemir and Gülser, 2011; Gülser and Candemir, 2015).Multiple regression equations that correlate the soil properties with other easily available soil properties are known as pedotransfer functions or models (Salchow et al., 1996). These models have been used successfully to determine hydrologicaland physicochemical properties of soils (Pachepsky et al., 2006;Gülser et al., 2007; Candemir and Gülser, 2012). The objective of this study was to estimate aggregate stability by a linear regression using basic soil properties.

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2. Material and Methods

In this study, 110 surface soil samples (0-20 cm) were taken from agricultural fields in Samsun, Turkey. After the soil samples were air dried and passed through 2 mm sieve, some basic soil properties were analyzed as follows; organic matter (OM) content was determined using the modified Walkley-Black method, particle size distribution by hydrometer method (Day, 1965), soil reaction (pH, 1:1 (w:v) soil:water suspension) by pH meter, electrical conductivity ($EC_{25^{\circ}C}$) in the same soil suspension by EC meter, exchangeable cations by ammonia acetate extraction (Kacar, 1994). Aggregate stability (AS) was determined for soil samples using a wet sieving method (Kemper and Rosenau, 1986). To estimate the AS values of the soils, a linear regression equation between AS and the soil properties was obtained with stepwise analyses using the SPSS statistic program.

3. Results and Conclusion

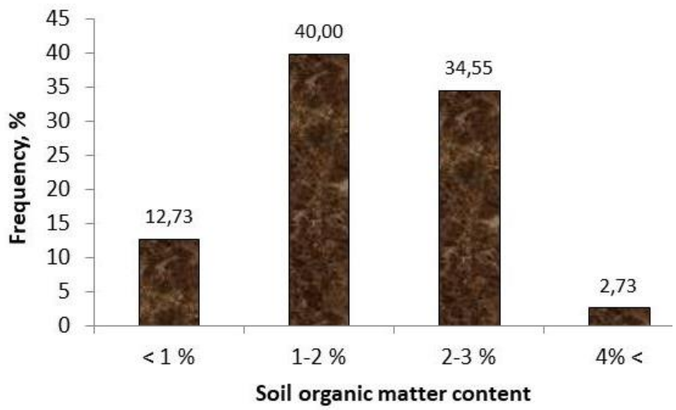
Descriptive statistics of some physical and chemical properties of the soils are given in Table 1. The clay content of the soil samples varied between 9.99% and 64.36% with a mean of 33.70%. Soil samples varied between strongly acid and slightly alkaline in pH (1:1), and non-saline according to the mean EC values (Soil Survey Staff., 1993). Soil OM contents varied between 0.20% and 4.90% with a mean of 2.00%. Rating of organic matter content results of soil samples showed that 7.2% of the samples is very low, 40% is low, 34.5% is moderate and 2.7% is high in organic matter content (Figure 1).

Table 1. Descriptive statistics of aggregate stability values and some soil properties (n=110).

	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Clay, %	9.99	64.36	33.70	14.08	0.10	-0.92
Silt, %	12.33	48.74	25.97	8.08	0.66	-0.02
Sand,%	13.16	74.51	40.36	16.55	0.35	-1.16
PH(1:1)	4.03	8.31	7.38	0.78	-1.82	3.56
EC, dS/m	0.11	2.95	0.66	0.51	2.54	7.94
OM, %	0.20	4.90	2.00	0.84	0.58	0.57
Ca, cmol/kg	1.67	52.53	21.80	11.26	0.01	-0.63
Mg, cmol/kg	1.01	21.12	7.25	4.62	0.71	-0.01
K, cmol/kg	0.11	1.79	0.57	0.33	1.129	1.59
Na, cmol/kg	0.08	5.64	0.70	0.95	3.484	14.04
AS, %	2.93	79.14	27.22	12.80	0.80	1.99

OM: organic matter, AS: aggregate stability.

Aggregate stability of the soil samples used in this study varied between 2.93% and 79.14% with a mean of 27.22% (Table 1). Frequency distribution of the aggregate stability values is given in Figure 1. The results showed that AS in 7.27% of soil samples less than 10% is very low, 23,63% between 10-20% is low, 24.54% between 20-30% is moderate and 44.54% more than 30% is high according to the AS classification by Hazelton and Murphy (2007).



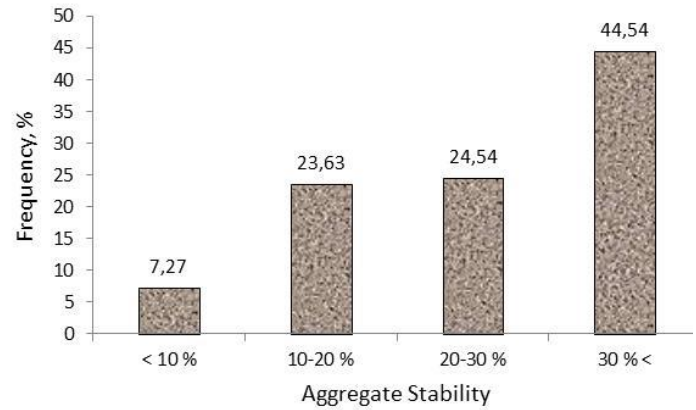


Figure 1. Frequency of soil organic matter contents and aggregate stability values of the soil samples.

The correlation matrix between AS values and soil properties is given in Table 2. Aggregate stability values showed significant positive correlations with clay (0.438**), soil OM (0.546**), exch. Ca (0.245**) contents and significant negative correlations with sand (-0.282**), soil pH (-0.292**), EC (-0.240*) and exch. Na (-0.394) contents. In most studies, it was reported that AS values of soils increase with increasing clay, OM and Ca content (Oades, 1993; Gülser, 2006; Candemir and Gülser, 2011; Gülser and Candemir, 2015). It is known that soil OM is metabolized by a variety of microorganisms to produce polysaccharides that act to bind soil particles into micro aggregates (Tisdall and Oades, 1982; Oades, 1993).While calcium ions associated with clay generally promote aggregation, sodium ions promote dispersion (Soil Quality Institute, 1996). Aggregate stability values of the soil samples reduced with increasing soil pH and exch. Na content.

Table 2. The correlation matrix among the soil properties and aggregate stability.

	Silt	Sand	pH	EC	OM	Ca	Mg	Na	K	AS
Clay	0.045	-0.873**	0.441**	0.353**	0.581**	0.798**	0.518**	0.102	0.593**	0.438**
Silt		-0.527**	0.183	0.037	0.266**	0.087	0.244*	0.066	0.080	-0.186
Sand			-0.465**	-0.318**	-0.624**	-0.721**	-0.560**	-0.119	-0.544**	-0.282**
pH				0.399**	0.074	0.635**	0.507**	0.293**	0.358**	-0.292**
EC					0.010	0.342**	0.634**	0.902**	0.335**	-0.240*
OM						0.456**	0.234*	-0.186	0.464**	0.546**
Ca							0.476**	0.118	0.590**	0.245**
Mg								0.532**	0.489**	-0.097
Na									0.199*	-0.394**
K										0.028

**significant at 0.01 level; *significant at 0.05 level.

To predict the aggregate stability (AS) values of soil samples, three linear regression models were obtained running the stepwise analyses in the SPSS programme with using soil physical, chemical and all properties together, respectively (Table 3).Comparison of measured AS values to estimated AS values by the linear models are given in Figure 2. The AS values were estimated with a lower R value (0.484**) by using the model 1 including only soil physical properties than the estimated AS values (0.771**) by the model 2 including only chemical properties. Using all soil properties in the linear regression model 3 gave the highest R value (0.844**) for the estimation of AS (Figure 2).Candemir and Gülser (2012) determined that using clay and silt fractions together with EC, exch. Na, ESP, or SAR in the second order equations significantly increased the accuracy and reliability of multiple regressions to estimate saturated hydraulic conductivity.

Table 3. Linear models used to estimate aggregate stability (AS) values.

Model	Linear Regressions	R	R^2
1	AS= 21.985 + 0.407Clay - 0.326Silt	0.484**	0.234
2	AS= 73.885 + 6.384OM - 8.933pH + 0.666Ca - 11.085K - 2.266Na	0.771**	0.594
3	AS= 68.740+6.133OM–0.346Silt–7.434pH+0.449Clay–13.798K–4.908EC+0.283Ca	0.844**	0.712

OM: organic matter, AS: aggregate stability.

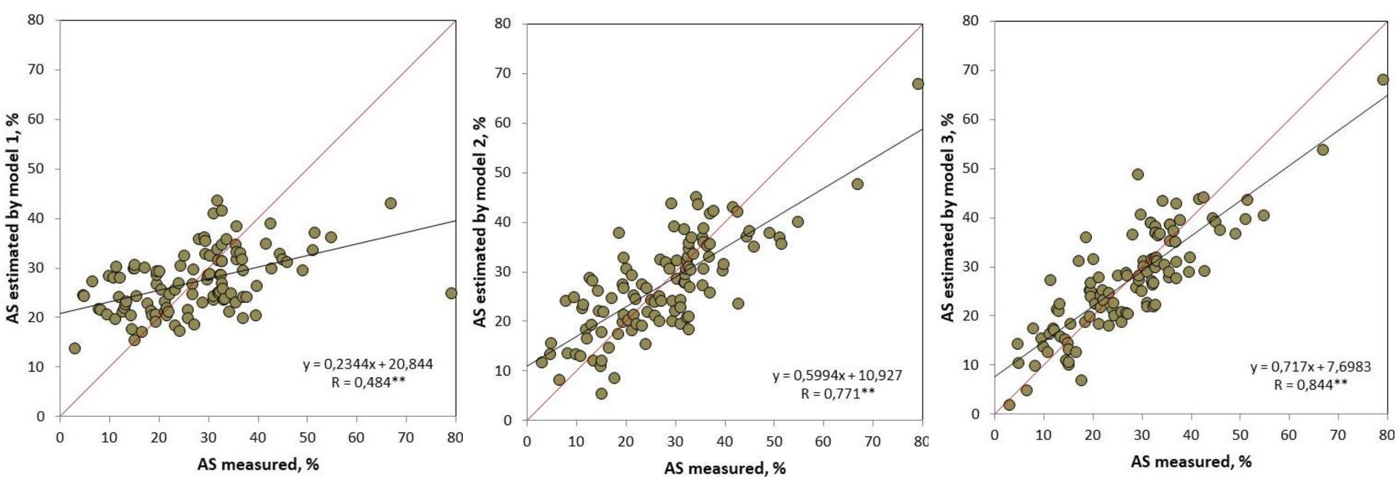


Figure 2. Comparison of measured aggregate stabilities (AS)with AS values estimated by the linear model 1, model 2 and model 3.

In this study, AS values of the soils had significant positive relationships with soil OM, clay, exch. Ca contents, and significant negative relationships with soil pH, sand, EC and exch. Na contents. It was determined that including soil physical (silt, clay) and chemical (OM, pH, EC, K, Ca) properties together in the linear regression model gave the highest R value to estimate AS values of the soil samples.

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Investigation of Soil Cohesion Changes for Two Different Soils and Initial Moisture Conditions

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Abstract

Intrinsic soil cohesion is considered as one of the most important variables to figure out the variation in the erodibility potential of soils. The scope of this study was to quantify interparticle cohesion Co (Pa) by fluidized bed approach under different texture and initial moisture conditions. This approach is based on the principle of creating a frictional force that eliminates the gravity and cohesive forces of soil by flowing water through the soil mass. The findings confirm that the applied approach has a high potential for reflecting changing soil conditions so that a close relation was found between Intrinsic cohesion with physical and chemical soil properties such as particle size distribution, hydraulic conductivity, aggregate stability and organic matter contents of the soils. Another important finding is that changes in soil cohesion values due to changing initial moisture contents (air dry, saturation and drainage soil conditions) were successfully observed by the fluidized bed technique.

Keywords: Initial soil moisture, soil cohesion, fluidized bed approach

1. Introduction

The cohesive forces of soils measured directly with the help of the fluid bed approach, which is not yet known, while it is determined by experimental approaches with the help of other soil properties in general terms. The basic theory on which the approach is based is that under the increasing water pressure, the cohesion forces that hold the soil aggregates together decrease and that the soil has reached the certain level and the soil has tended to move from the soil mass.

Physicochemical force bonding particles to one another is named as the soil cohesion and is part of the complementary component for friction forces which create soil shear strength (Das, 2008). It is known that the aging processes promote the aggregate stabilization in soil (Blake and Gilman, 1970; Kemper and Rosenau, 1984; Nouwakpo et al., 2014), by the way, soil susceptibility to erosion could be reduced significantly especially for rill formation processes (Shainberg et al., 1996). In addition, it leads to a decrease in the runoff and sediment concentration rates (Mamedov et al., 2006) and oppositely increases hydraulic conductivity (Moutier et al., 1998).

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The fluidized bed technique is based on the theory that a fluid passing through a packed cohesive bed would need to overcome the weight of the particles and interparticle forces before fluidization can occur. When such fluidization is possible, cohesion which encompasses mechanical interlocking between particles and cementation can be experimentally estimated as the difference between forces needed for fluidization and bed weight. Nouwakpo and Huang (2012) have shown that cohesion values estimated using the fluidized bed strongly correlated with critical shear stress values obtained by Laflen et al. (1991) for the same soils and also that cohesion values estimated for hypothetical eroding layers of soil were within the range of observed critical shear stress values.

Within the scope of the study, it is aimed to determine the mechanical soil cohesion conditions of the two different soil types (clay loam and sandy loam) with the help of fluidized bed method proposed by Nouwakpo et al. (2010) for different initial moisture contents in terms of inherent soil conditions such as soil organic matter contents, hydraulic conductivity and water stable aggregate percentages.

2. Material and Method

Study area

The soils used in the study were sampled from two different locations, Beypazari-Ankara (36412134E – 4432775N) and Karapinar-Konya (36545473E-4172469N). Some physical and chemical properties of these soils are given in Table 1 and particle size distributions are presented in Figure 1.

Table 1. Chemical and physical properties of the research soils

Soil Samples	WSA %	HC cm/h	OM %	BD g/cm^3	Clay %	Sand %	Silt %	Texture Classes
Beypazari, ANKARA	59,18	29,13	1,83	1,2736	27,00	44,00	29,00	Clay loam
Karapinar, KONYA	66,28	4,89	1,66	1,4758	10,00	80,00	10,00	Sandy loam

WSA= Water Stable Aggregate, HC= Hydrolic Conductivity, OM= Organic Material, BD= Bulk Density

When soil analysis results were examined (Table 1.), WSA values were higher in sandy loam soil. When the hydraulic conductivity values are examined, it is observed that the sandy loam soil has a lower value.

Although these results appear to be contrary to the nature of the sandy soils, it can be explained by the difference particle size distribution of the soils. Sandy soils has much more higher fine sand contents (having between 0,25 and 0,10 mm partcile sizes). The method which applied for WSA could not be ability to deteched the passing fine sand particles from 0,25 mm sieve opening. This lead to calculate higher WSA value than real soil conditions. At this point, it can be recommended other methods for sandy soils based on the wet particle size distribution (Saygin et al., 2017) (Figure 1).

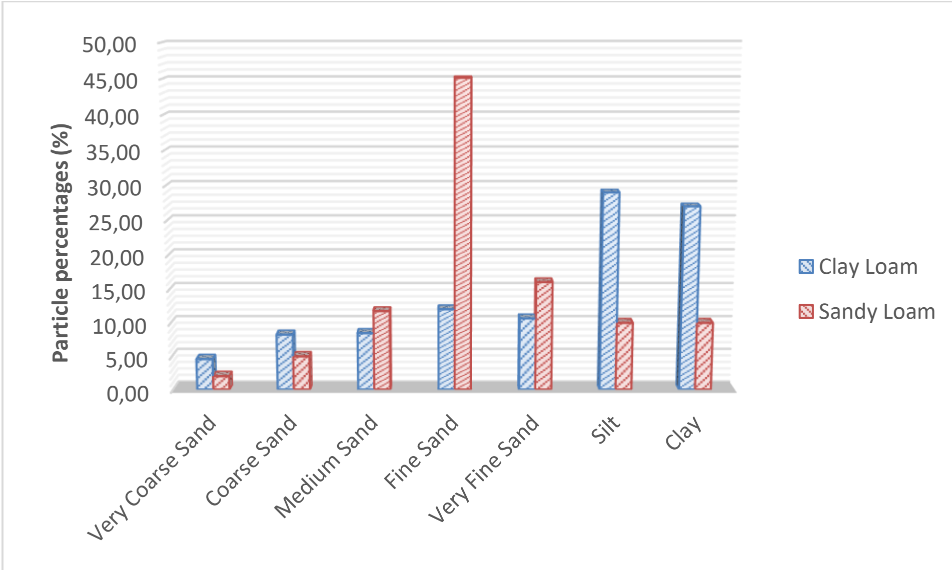

Figure 1.P article size distribution of the soils

3. Results and Conclusion

Differential pressure drops (psi) formed as a result of gradually increasing the water level in 25 mm long soil mass and outlet flow rates (g) corresponding variation in water pressure are transferred to the computer by sensors and transducers placed in the upper and lower part and over time the pressure change inside the soil mass.For this purpose, 3 different moisture conditions (dry, saturation and drainage) were analyzed for two different soil with 3 replicates. Results are presented in Figure 2-5.

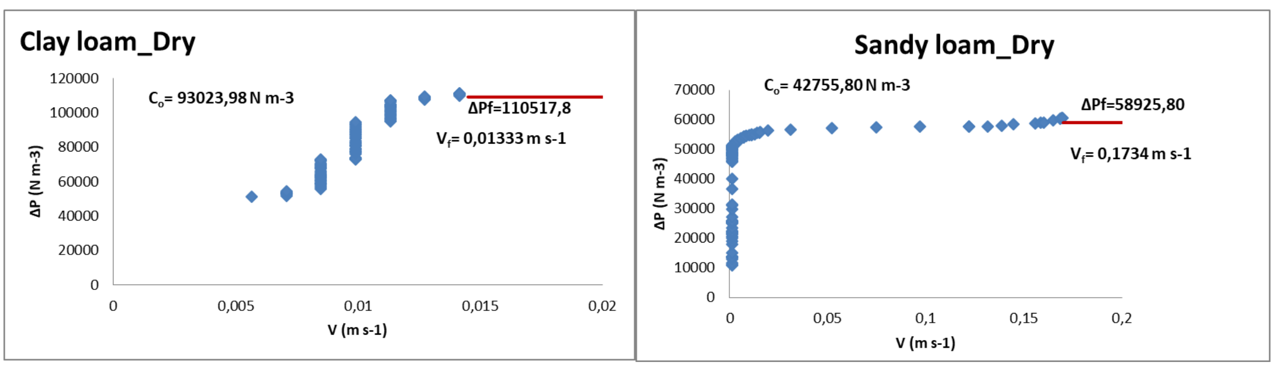

Figure 2. Soil cohesion changes for two different soils and dry moisture conditions

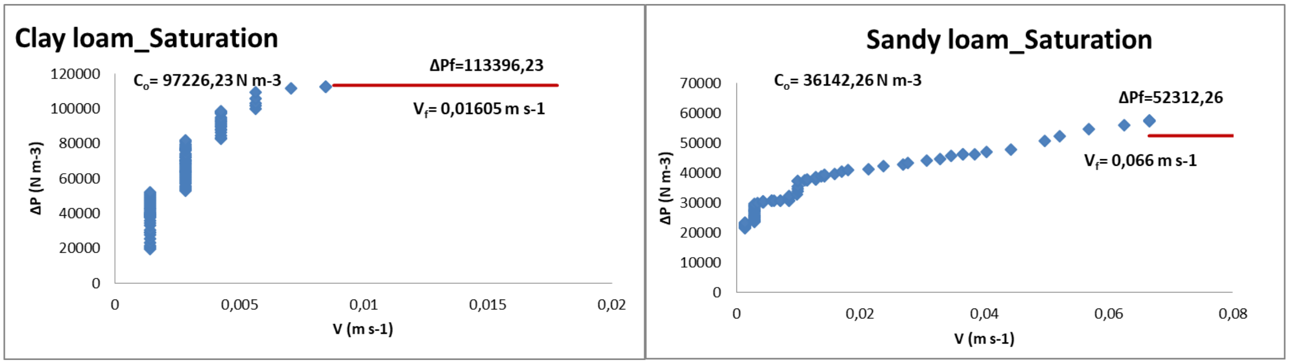

Figure 3. Soil cohesion changes for two different soils and saturation moisture conditions

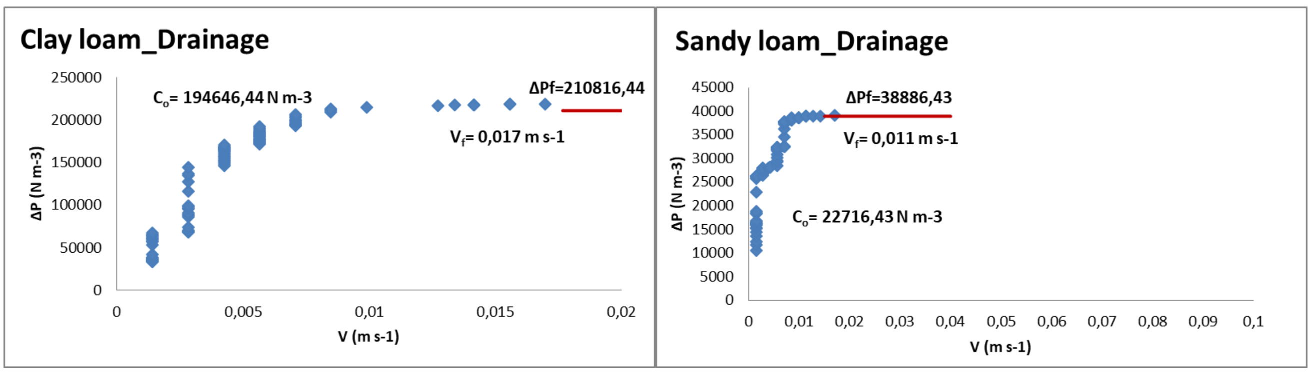

Figure 4. Soil cohesion changes for two different soils and drainage moisture conditions

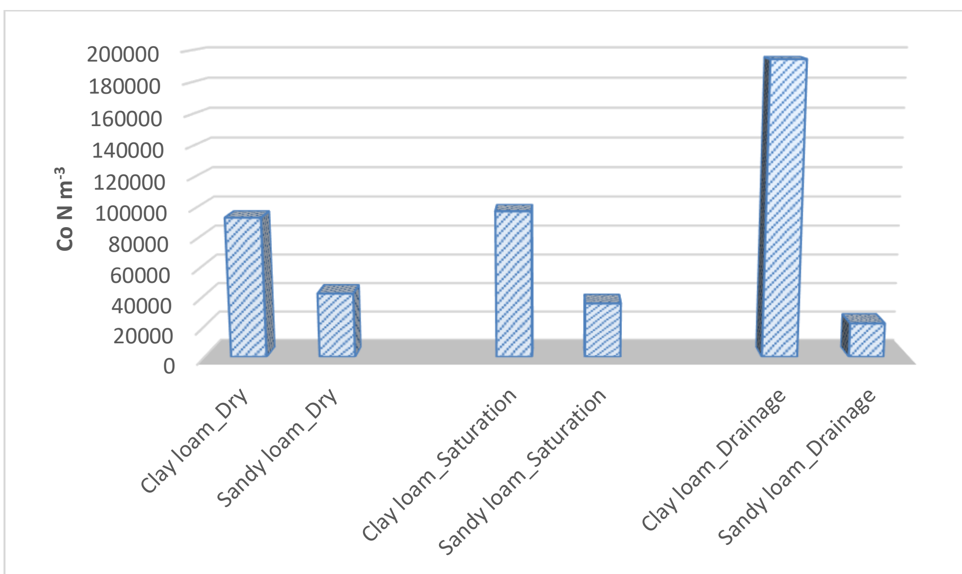

Figure 5. Soil cohesion changes for two different soils and three moisture conditions

Obtained ΔPf values refer to the differential pressure rates of the studied soils when they reach the fluidization point at which soil behaves as a fluid. Nouwakpo et al. (2010) state that the difference between ΔPf and the buoyant specific weight of the bed material is the cohesion. In this study, the measured highest cohesion value (Co) was 194646,44 $Nm^{-3}$for clay loam-drainage condition and the lowest value was measured for sandy loam drainage condition as 22716,43 Nm^{-3} (Figure 5).

3.2 Acknowledgments

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Evaluation of Variability in Some Physical and Chemical properties of Soils Under Different Agricultural Uses with Interpolation Models

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Abstract

It is crucial to do sustainable soil management planning without harming the existing natural resources in terms of utilizing limited cultivated lands efficiently. In line with this objective in question, this research was carried out in the land covering approximately 400 ha in Baskil district of Elazığ province to determine some physical and chemical properties of the soils under different agricultural uses. It was also aimed to analyze the spatial variability of these properties with interpolation models and determine the relations pertaining to the distance among them. In this context, some physical (% clay, % silt, % sand, water amounts retained in tensions of pF0, pF1,7, pF2,54, and pF4,2) and chemical (organic matter) properties emerging in 174 soil samples, collected from surface depth (0-15 cm) in the study area, were determined. Definitional statistics were produced for each soil indicator using the obtained findings, then, five different interpolation models were applied to detect spatial distributions, and spatial distribution maps of the soil properties were generated detecting the most suitable model, which provided the distribution. When the spatial distribution maps of the soil properties discussed in the study were examined, it was revealed that soil texture components were consonant and substantially related to the water amounts in the soil. Therefore, variability in regards to texture components and soil moisture content should be taken into consideration for soil management plans in the area in the future. Furthermore, topographical features of the land and soil management applications were the other factors affecting the variability of the soil properties. It was detected that organic matter contents of the soils were at a medium level in a very small part of the study area; however, at a very low/low levels in general. It was indicated that the organic matter content of the soil is significantly interrelated with the physical indices of the soils and varies in accordance with particularly soil management methods and frequency in the area. It is necessary to apply a qualified soil management system to enhance and preserve the organic matter in the soil, which is an influential and significant agent to persist the ecological balance of the soil in the study area.

Keywords: sustainable soil management, soil physical and chemical properties, interpolation.

1. Introduction

Soils, regarded as the main factorof agricultural production, vary considerably depending upon land use and management practices along with natural processes which areeffectivein soil formation and development(Castrignano et all., 2000).The improvement and development of soils by taking these variation factors of soil properties into consideration may influence soil productivity positively.Therefore, determining and identifying the distribution and amount of variability is essential for agricultural production. This research which was carried out in the land covering approximately 400 ha in Seyh Hasan Village in Baskil district of Elazığ province aimed at analysing some physicaland chemical properties of soils under distinct land uses withfive different interpolation models and creatingtheir distribution maps. It was alsoaimed to determine the relations pertaining to the distance among them.

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2. Materials and Methods

2.1 Location, Soil and Climate Properties of the Study Area

The research was carried out in the area in Baskil district of Elazığ province, the Eastern Anatolia Region of Turkey. The study area is located within the borders of Seyh Hasan Village, and its western border extends to Karakaya Dam Lake. It covers approximately 400 ha, situated between the northern latitudes (38° 331 4211 – 38° 321 0911) and the eastern longitudes ($38^\circ\ 23^{1}\ 42^{11}$– $38^\circ\ 25^{1}\ 45^{11}$)(Figure 1).

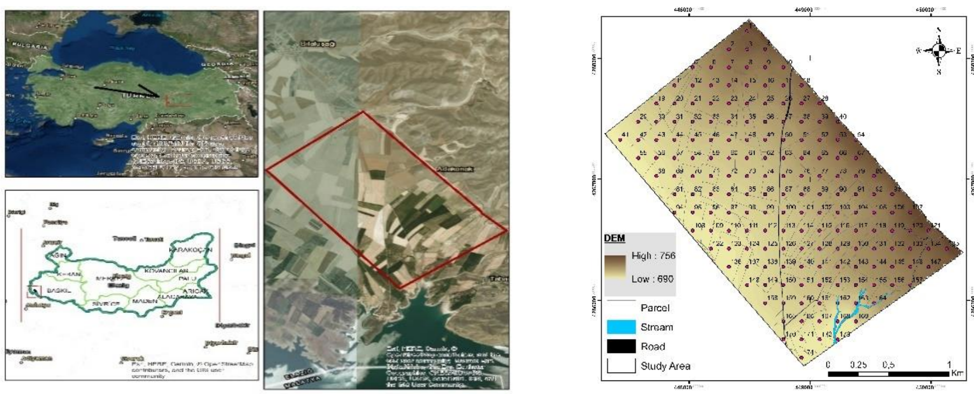

Figure 1. Location and DEM (Digital Elevation Model)/soil sampling pattern map of the study area.

Continental climate exhibiting hot and dry weather in summers and cold and snowy weather in winters is characterized in the district. The village where the study area is located is also under the impact of the continental climate and has temperate climatic characteristics dues to the Dam Lake. Its annual average precipitation is 408 mm, and annual average heat is 13.2 °C. According to Soil Taxonomy (1999), its soil temperature and moisture were detected as Mesic and Xeric, respectively.

The study area is mostly flat, flat-like and slightly sloped (2%-4%), and the slope increases beyond 12% in the north-eastern parts (Figure 2). The average elevation of the study area from the sea level varies between 690 m and 760 m (Figure 2). 7 different plants comprised of apricot, wheat, barley, corn, and pepper, tomato, and eggplant were produced in mixed vegetable fields in 171 parcels of the study area during the season production of 2015. Apricot covered the most part of the study area, approximately 165 ha, in comparison to the other products, whereas mixed vegetable was produced in the least part, 1.5 ha of the area. The study area includes pasture lands, blank (unused)lands which are qualitatively characterized as fields and public lands in addition to agricultural lands (Arslan et all, 2018).

2.2 Soil Samples and Analyses

174 soil samples were collected from the surface depth (0-15 cm) by forminga grid system of 150m x 150m in the study area (Figure 1).

In soil samples;the texture was determined with theBouyoucos hydrometer method (Bouyoucos, 1951), the organic matter (OM)contentwiththe Walkley-Black method (Jackson, 1958) and the water amount retained in tensions of pF 0, pF 1.7, pF 2,54 and pF 4,2 as suggested by Richards (1954) and Klute (1986) .

2.3 Descriptive Statistics and Interpolation Methods

Descriptive statistics were calculated by means of the SPSS programme. The distribution map of soil properties was prepared with ArcGIS 102.2 programme. Radyal Based Function (RBF), InverseDistance Weighting (IDW) Interpolation method out of deterministic methods, and Ordinary Kriging (OK), Simple Kriging (SK), Universal Kriging (UK) methods out of stochastic methods were compared within the scope of this study. In the study, first, second and third power (IDW-1, IDW-2, IDW-3) in IDW method, Completely Regularized Spline (CRS), Thin Plate Spline (TPS) and Spline With Tension (ST) models in RBF method, Spherical, Exponential and Gaussian models in Kriging method were used. While determining the most appropriate methods for the study, the method resulting in the lowest root mean square error (RMSE)value was evaluated as the most appropriate one. The Equation1 below was used to calculate RMSE values (Ding et al., 2011).

$RMSE = \sqrt{\frac{\sum(Z_{i^*}-Z_i)^2}{n}}$In the equation,$Z_i$ =estimated value, Z_{i^*} =measured value ve n =sample number

3. Findingsand Discussion

3.1 DescriptiveStatisticalandInterpolationMethods

The descriptive statistics of the data obtained from the soil analyses were determined (Table 1) and five different interpolation methods were compared to determine the spatial distribution; thus, the method presenting the lowest RMSEwas chosen as the most appropriate method (Table 2).

Table1. Descriptive statistical parameters of the soil samples in the study area

DescriptiveStatistics	Mean	St.Dev.	Coef.Var.*	Variance	Minimum	Maksimum	Skewness**	Kurtosis
Clay (%)	29,46	6,62	22,47	43,81	11,33	47,94	0,02	-0,45
Sand (%)	36,73	12,26	33,38	150,32	16,01	69,95	0,48	-0,65
Silt (%)	33,77	7,30	21,62	53,31	17,77	46,05	-0,48	-0,64
pF 0	54,27	4,63	8,53	21,45	26,37	60,61	-3,68	19,84
pF 1,7	42,32	4,66	11,01	21,72	20,06	50,26	-1,60	5,34
pF 2,54	27,53	5,08	18,45	25,80	12,51	36,06	-0,39	-7,72
pF 4,2	14,21	3,36	23,65	11,27	5,30	20,37	-0,31	-0,69
OM (%)	1,80	0,52	28,74	0,27	0,72	3,73	0,73	1,22

*: Coef.Var.: < 15= LowVar.:, 15-35 = MediumVar., >35= HighVar.
**: Skewness: < │∓0.5 │= Normal distribution,0.5-1.0= Character transformation is applied to data set, ÇK>1.0 → Logarithm transformationis applied.

Table 2. RMSE values of the interpolation methods for the soil of the study area

	IDW			RBF			Kriging								
	1	2	3	TPS	CRS	ST	Ordinary			Simple			Universal		
							G	E	S	G	E	S	G	E	S
Clay (%)	4,62	**4,58**	4,61	5,53	4,66	4,61	4,68	4,75	4,67	4,64	4,70	4,62	4,68	4,75	4,67
Sand (%)	7,32	7,28	7,33	8,68	7,37	**7,28**	7,32	7,64	7,42	7,42	7,57	7,46	7,32	7,64	7,42
Silt (%)	4,90	4,90	4,95	5,57	4,94	**4,89**	4,90	5,01	4,93	5,03	5,12	5,01	4,90	5,01	4,93
pF 0	**4,31**	4,35	4,41	5,30	4,51	4,43	4,31	4,32	4,31	4,35	4,36	4,32	4,31	4,32	4,31
pF 1,7	**4,13**	4,16	4,21	4,94	4,30	4,24	4,27	4,28	4,26	4,15	4,18	4,15	4,27	4,28	4,26
pF 2,54	3,02	3,00	3,03	3,53	3,03	**2,99**	3,01	3,17	3,07	3,06	3,10	3,07	3,01	3,17	3,07
pF 4,2	**1,90**	1,91	1,94	1,94	1,98	2,40	1,96	2,11	2,06	2,03	2,07	2,07	1,96	2,11	2,06
OM (%)	**0,48**	0,48	0,48	0,59	0,50	0,49	0,52	0,52	0,52	0,49	0,49	0,49	0,52	0,52	0,52

The values written as bold black and underlined in the table are the data belonging to the lowest root mean square error values chosen as appropriate interpolation methods.
G: Gaussian, E: Exponential, S: Spherical

3.2 Distribution of Clay, Sand, Silt in the Study Area

The dominant soil texture of the study area is included in the texture classes in which clay fractions dominate. According to the prepared spatial distribution map, clay contents of the soils exhibit a distribution extending from the middle part of the study area in the northern and southern directions intensifying in the western part of the area. These sections are generally in lower parts than their around vicinity, and they cover flat or flat-like lands (Figure 2). Soils have developed on the alluvial deposits surfacing the study area by accumulating in the areas where the streams spread as a result of the movement of the streams(Turan and Bingöl, 1991). In the study area, the areas which are more sloping and located in higher positionthan the ones where the slope is flat or flat-like are comprised of mostly skeletal structured soils. Furthermore, this sort of places is either very steep or extremely steep. Sand values are the highest in these areas where the clay content is the lowest.

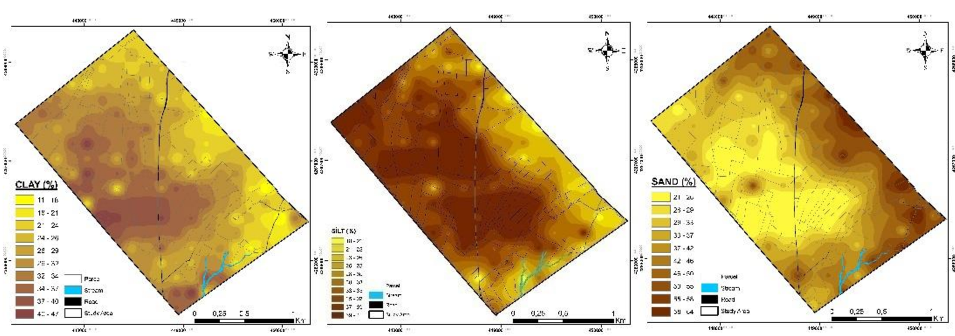

Figure 2. Distribution map of clay, silt, sand in the study area.

3.3 Distribution of Water Content Retained for Critical Tensions in the Soils

According to the spatial distribution map prepared in order to determine the variability of the water content retained in critical tensions of the soils in the study area, it was determined that the distribution of the most water content retained in the pF 0, pF 1,7, pF 2,54 and pF 4,2 tensions of the soils became intensive mostly in the middle and western parts of the study area (Figure 3).

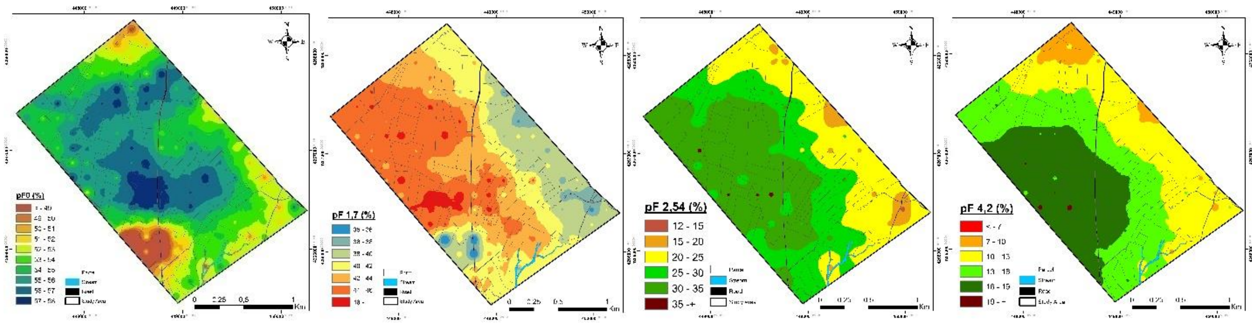

Figure 2. Distribution map of water amounts retained for critical tensions in the study area.

As the areas,the slope of which is flat and flat-like, are located near Karakaya Dam Lake, they contain intensively irrigated agricultural lands, and that the clay contents of the soils in these areas also exhibit distribution in high rates results in the fact that water amount the soils contain in these areas is high.

3.4 Distribution of Organic Matter in the Study Area

According to the spatial distribution map prepared in order to determine the variability of the organic matter content retained in the soils in the study area, it was determined that the organic matter content of the soils was at the medium level in a very small part, about 0,26 ha of the study area and at the very low/low level in almost the whole the study area.(Figure 3). It was also revealed that the areas where the organic matter content of the soils was very low includingfields where the soil wasfrequently cultivated.

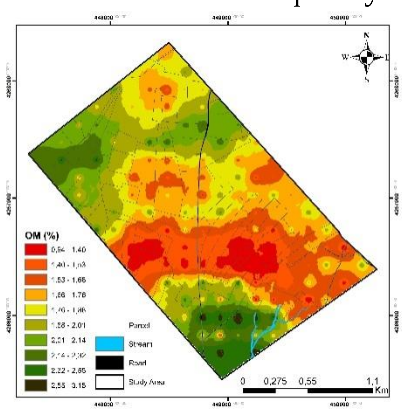

Figure 3. Distribution map of organic matter in the study area

4. Conclusion and Recommendations

It is asserted that the organic matter in the soil was destroyed as the soils in the areaswere intensely cultivated, and thus, the organic matter content has declined. It was determined that the changes in the land use in the study area and soil management methods affected the spatial character of the organic matter in the soil significantly and that they are the most significant deterministic factors.

The texture components of the soil affecting the productivity levels of the soil were found to be consistent and significantly associated with the amount of the water content of the soil. Therefore, texture components and variabilities related to soil moisture content should be taken into consideration in soil management plans in the future. Furthermore, the topographical properties of the land and land-use types and frequency are the other factors affecting the variability of these soil properties. It was determined that the organic matter content of the soils was at the medium level in a very small part of the study area but at the very low/low level in almost the whole study area. It was also detected that the organic matter amount the soil contained was significantly related to soil physical indices and that it varied in the study area depending on particularly soil cultivation methods and frequency. Therefore, it is crucial to take precautions required to improve the organic matter level of the soils in the study area in terms of both productivity and sustainability of the soils and the fertility and quality of the cultivated products. To this end, a qualified soil management application is necessary for enhancing and preserving organic matter content in the soil.

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Effect of Biochar Applications on Soil Compaction of a Heavy Clay Soil

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Abstract

Many soil physical properties and product yield are influenced by compaction. Soil compaction is a threatening risk to cultural soils. Tillage with heavy machinery on soil is accountable for damaging soil physical, chemical and biological properties. Bulk density is an indication of soil compaction. Increasing organic matter as a method to lighten or reduce effects of soil compaction was evaluated. For this reason, in this study, the effects of biochar supplementation on soil volume weight value in laboratory conditions were investigated by standard proctor test. In the study, in a soil with a high clay content sieved from 4 mm, biochar was added in the range 0-0.5-1-2 and 4% (wt/wt). After addition of biochar, soils were wetted to 15-18-21-24-27% and 30% humidity for the proctor test. As a result of the proctor tests, the maximum bulk density values with the increase in biochar doses of the soils have decreased. According to the control sample, it is seen that the addition of 0.5-1-2-4% biochar reduces the maximum bulk density by 0.03-0.07-0.13-0.23 g cm^{-3} respectively. In this study the addition of biochar to the soil due to the very low elasticity of biochar suggests, shows that the soil makes it overlooking resistant to compaction.

Keywords: Biochar, proctor test, bulk density, soil compaction

1. Introduction

The physical properties of the soil, such as bulk density, field capacity, porosity and penetration resistance, are amongst basic soil quality indicators of soils(Lipiec & Hatano, 2003). Soil compaction is an important agricultural problem due to its effects on productivity and quality in crop production(Keesstra et al., 2016). As a result of the compaction, the surface area of the soil decreases while the bulk density increases. The soil bulk density is considered to be a key factor, particularly associated with soil compaction and many physical, chemical and biological characteristics of the soil(Walter et al., 2016). The soil bulk density is significantly affected by soil health and influenced by various factors such as porosity, mineral type, organic matter content and moisture(Chaudhari et al., 2013). Therefore, the bulk density value of soil degradation has a significant effect on soil and agricultural production(Watts & Dexter, 1997). It plays a key role in leading to the high bulk density and low organic matter content in the upper soil and decreasing the organic matter content of soils(Shi & Shao, 2000).The organic matter protects the soil water, and thus makes the soil resistance to compressive strength by increasing its plasticity(Thomas et al., 1996).However, the type of organic matter is of great importance here. Easily oxidizable soil organic matter is more important than total organic matter in terms of mechanical change of soil(Ball et al., 2000).Organic matter-rich substances have lower bulk density and more porosity than mineral soils. Mixing organic matter-rich compounds into soils improves the bulk density and porosity of soils(Zhang et al., 2012).In recent years, the addition of biochar in soil has continued to gain interest in the field of soil and crop yield effect (Lu et al., 2015). Many researchers have investigated the potential of biochar in electrical conductivity, water-holding capacity and cation exchange capacity (Lehmann & Rondon, 2006), as well as in the development of soil

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physiochemical properties (Zhang et al., 2012). However, studies on the physical properties of soils with high clay content in arid and semi-arid areas are not sufficient.

2. Methodology

2.1 Site Description and Experimental Set Up

The soil with high clay content used in this study was taken from the field of wheat-corn-sugar beet-sunflower cultivation in the last 20 years. The sampled soil for the experiment was taken from 20 cm depth and passed through 4 mm sieve. The general characteristics of experimental soil are given in Table 1.

Table 1. Physical and chemical characteristics of study soil.

Property	Average	References
pH	7.92	Kacar (2009)
EC µS/ cm	1015	
Lime %	13.32	
Sand %	14.30	Gee and Bauder (1986)
Silt %	36.40	
Clay %	49.30	
Texture class	C	
Field capacity %	34.37	Cassel and Nielsen (1986)
Permanent wilting point %	18.28	
Available wilting point %	16.09	
Organic matter %	1.99	Smith and Weldon (1941)

In order to find the maximum bulk density, samples were subjected to proctor test (Das, 2002). Moisture contents for the proctor test were determined (15-18-21-24-27% and 30%) between the field capacity and permanent wilting point as specified in Table 1.According to the results of the completed proctor test, porosity (p) and void ratio (e) values were calculated (Mertoğlu, 1982). In addition, the measured volume weight and the penetration results from the moisture contents were calculated.

Biochar was ground fromsmall sized parts toa very fine powder prior to application where small pieces were sieved through a 4 mm sieve and the remainders were mixed with the soils. The general properties of biochar used are given in Table 2.

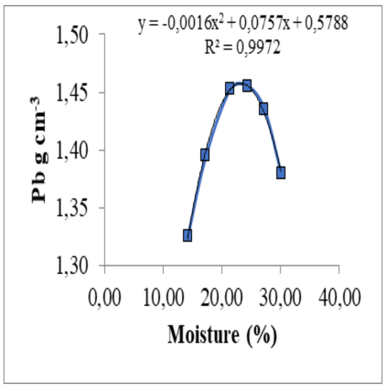
Table 2. Biochar characteristics.

Property	Average	References
pH	10.05	Kacar (2009)
Lime	10.54	
EC (ds m^{-1})	15.32	
% Carbon	62.23	Wright and Bailey (2001)
% Nitrojen	2.41	

3. Results and Conclusion

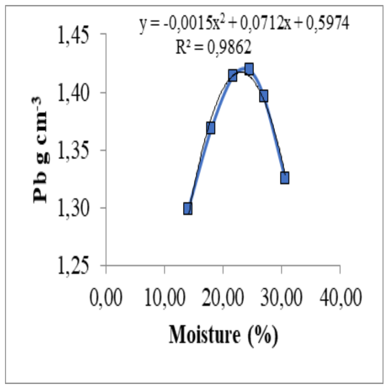
Proctor test results are given in Figure 1.Table 3 shows the results of the change in the maximum volume weight in the optimum moisture content calculated according to the equations created in Figure 1.

Control



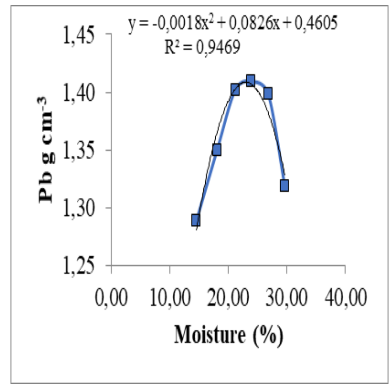
Optimum humidity value corresponding to maximum bulk density = **%23.65**
Maximum bulk density = **1.47**

% 0.5 Biochar



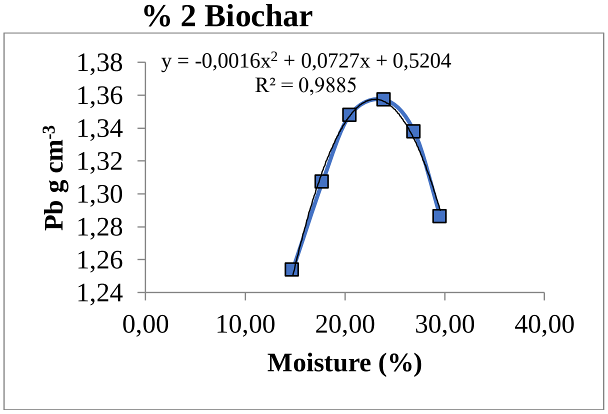
Optimum humidity value corresponding to maximum bulk density = **%23.65**
Maximum bulk density = **1.44**

% 1 Biochar



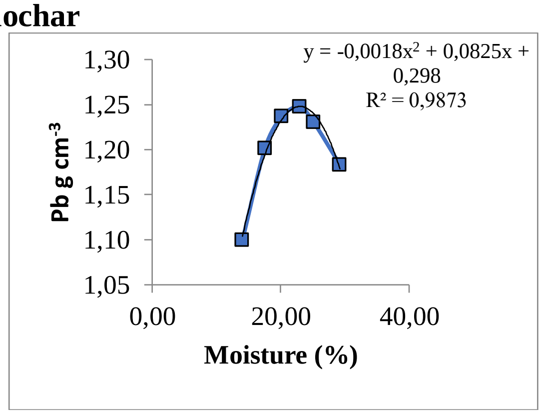
Optimum humidity value corresponding to maximum bulk density = **%22.90**
Maximum bulk density = **1.40**

% 2 Biochar



Optimum humidity value corresponding to maximum bulk density = **%22.71** Maximum bulk density = **1.34**

% 4 Biochar



Optimum humidity value corresponding to maximum bulk density = **%22.91** Maximum bulk density = **1.24**

Figure 1. Effect of different biochar doses on maximum bulk density

When Table 3 is examined, the maximum Pb in the control soil was calculated as 1.47 g cm^{-3} and this value was found to be 1.44, 1.40, 1.34 and 1.24 g cm^{-3}, respectively, with the increase in biochar rate.According to the control example, the decrease in the maximum volume weight of the addition of 0.5-1-2-4% biochar is 0.03-0.07-0.13-0.23 g cm^{-3} respectively.When the porosity values of soils were examined at the maximum bulk density, the porosity of the control sample was 44.53%, while the addition of biochar increased the porosity and it was 45.66%, 47.17%, 49.43% and 53.21%, respectively (Figure 2). Due to the increase in biochar levels, the porosity and void ratio increased significantly in the soils and a decrease in the bulk weight was observed as a reason.Significantly, biochar treatment may increase the porosity and reduce the volume weight, possibly due to the high porosity of the biochar and its hollow structure and lower volume weight than the soil particles(Gul, Whalen, Thomas, Sachdeva, & Deng, 2015).

Table 3. Calculated maximum bulk density and penetration resistance values

Design	Max. Bulk Density	Optimum moisture	Calculate PR
Control	1.47	23.65	5.70
%0.5 biochar	1.44	23.65	5.03
%1 biochar	1.40	22.90	4.50
%2 biochar	1.34	22.71	3.50
%4 biochar	1.24	22.91	2.15

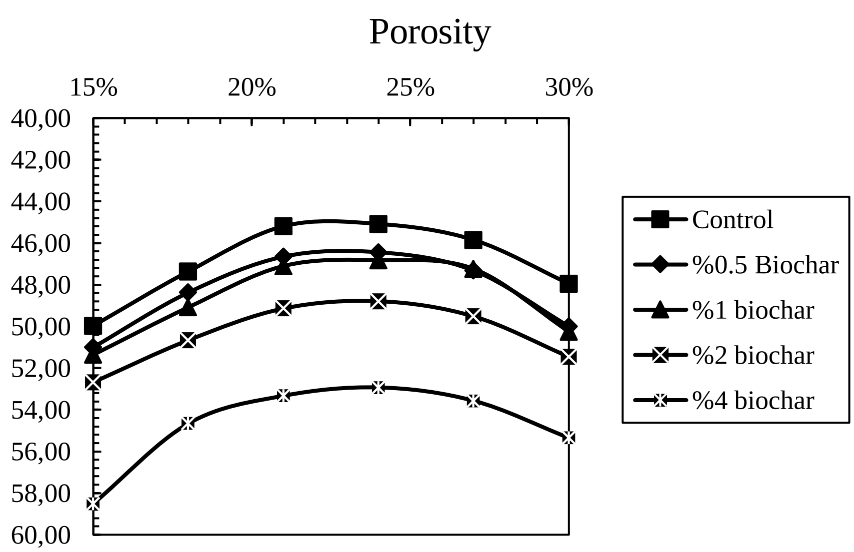


Figure 2. Effect of biochar addition on porosity

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Effects of Agricultural Subsidies and Supports on Soil and Water Resources in Arid and Semi-Arid Regions

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Abstract

Farmers take into account the market and profitability as well as the direct support they receive from the state in the selection of the crop they will grow. In this study, firstly, the effects of the crops that are not suitable for the region on the soil and water ecosystem were determined in the Central Anatolia Regions where there is water scarcity, and secondly, recommendations were made for the implementation of appropriate subsidizing policy for the region. In recent years, the selection of the region to support meat production is not meticulously made, resulting in a lack of feed and fodder crops in these regions. In order to meet this, the farmers preferred to grow fodder crops without considering the environmental impacts. Thus, the pressure on underground and surface water resources and the risk of soil quality deterioration increased. Plants such as corn and alfalfa, that are not suitable for the natural structure of the region, increase the salinity of soils because of high water consumption. On the other hand, it has been determined that oilseeds and legume production which are entirely suitable for the regional climate, water and soil resources cannot be adequately encouraged and, therefore, this deficit had to be meet by imports. In this study, the total water consumption of the plants grown in these regions and the amount of salt transported to the soil in various scenarios and the risk of salinization have been estimated approximately.

Keywords : alfalfa, corn, legumes, oily seeds, soil salinization, plant water consumption, irrigation, water requirements, dry areas, agricultural subsidies and supports

1. Introduction

In arid regions, soil salinization is mainly caused by human activity (Reynolds2007)]. According to Endo et al (2011) attempts to grow crops which are not suitable to this environment and depended on irrigation have mainly resulted in the salinization and sodication of the soil. Farmers in arid regions tent to practice irrigating farming by wrong subsidizing policies and advancing technology on irrigation system. Most of the farmers in dry Central Anatolia prefer to grow high income crops such as corn and alfalfa for animal feeding. Although, irrigation increases productivity and income and fulfils the need to produce food in the short term, yet in the long run, losses are greater than benefits in arid areas due to soil salinization/sodication and deterioration in soil structure. Increasing food safety concern and economic pressure might result in the conversion of grazed, rain-fed, and even virgin lands to irrigated fields (Rost et al, 2008).

Central Anatolia Region, located in arid and semi-arid region, is generally characterized by highlands and wide ranging plateaus with an average altitude of 1150 m. According to Yıldız (2014) the northern Anatolian mountain ranges in the north and the Taurus mountain ranges in the south have a significant influence on the climate of the region acting as a barrier against humid air masses from coastal regions. The region has a typical dry climate with a mean temperature of about 10°C and a mean annual precipitation of about 400 mm (Yıldız 2014).

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The aims of the study were to (1) determine the size of the cultivation area of oily seeds, legumes and irrigated corn and alfalfa, in dry Central Anatolia region, (2) estimate crop water needs and total amount of water in each provinces and finally, (3) estimate the probability of soil salinity levels under the current management practices.

2. Materials and Methods

This study was produced from the data obtained from the arid and semi-arid region of the central Anatolia (Figure 1). Data of farmer registration systems (ÇKS) for Afyonkarahisar, Ankara, Eskisehir, Karaman, Kayseri, Kırıkkale, Kırsehir, Konya, Nevsehir, Niğde provinces in 2014-2018 were taken from the Ministry of Agriculture and Forestry. ÇKS provides the area of cultivation, yield of the crops, and many other information and bases on the declaration of the farmers each year. The most common crops were determined according to the size of area and their suitability for the region. These are safflower and sunflower as oily seeds, bean, lentil, chickpea as legumes, and finally, corn for seed and silage and alfalfa for fodder crops. Firstly, the area of cultivation of these crops clissified as irrigated and dry (rain-fed) area.

Figure 1. Research area

Secondly water needs (m^3) were computed by multiplying irrigating cultivated area (ha) by total irrigation water requirement (mm) for each crop. The net irrigation water requirement (mm) is calculated by subtracting total precipitation (mm) from seasonal crop evapotranspiration (mm) in order to determine the total irrigation water. We assume the irrigation is performed by sprinkle irrigation and, therefore, efficiency is taken as 70% for predicting total irrigation water (mm). Therefore, net irrigation water requirements were multiplied by 0.7 to obtain total irrigation water requirements. Consumptive use and irrigation water requirements of principal crops in Central Anatolia were taken from Plant Water Consumption Guide of Irrigable Crops in Turkey (Anonymous, 2017)

After calculating water needs, the amount of total dissolved salts were calculated with two scenarios: EC= 1 dS/m and EC=2 dS/m. Although the fact than, generally, the ground water salinity level is much higher than these values in the region we chosen them to show the severity of salinization even with low saline content of irrigation water. Total dissolved salts is calculated as fallows

TDS mgl^{-1} =EC(dSm^{-1}) x640

3. Results and Conclusion

Import values of all animal and animal by-products, legumes and oilseeds are shown in Table 1. All animal and animal imports have increased continuously during the study period. In the same period, a slow decline was observed in oil seeds and oil imports.

Table 1. Shows the area of cultivation between 2014 and 2018 in all the research area.

	Foreign Trade Import Values ($)			
	2015	2016	2017	2018
Other live animals; non-breeding	118,090	207,752	350,212	307,202
Breeding animal	164,456,683	396,913,047	1,061,490,647	1,355,742,722
Animal by-products	53,265,611	48,832,902	49,294,174	60,343,798
Cattle and cattle products	85,069,487	165,202,333	254,472,271	397,552,671
Total Animal import	**302,909,871**	**611,156,034**	**1,365,607,304**	**1,813,946,393**
Pea, chickpeas, beans, lentils,	906	5,601	11,300	537
Oil, oil seeds and fractions	2,274,518,065	2,152,061,197	1,917,104,953	1,558,013,331
Total Legumes and oily seed import	**2,274,518,971**	**2,152,066,798**	**1,917,116,253**	**1,558,013,868**

Table 2 shows that there are some changes in the cultivation areas of oily seeds but there is no regular increase or decrease. This is mostly due to the farmer's preference for fluctuations in sales price. There is generally a steady increase in the cultivation area of the legumes over the years. While the bean cultivation was almost steady, lentil and chickpea showed a decrease over the years. However, it is known that both oily seed and legume production are not sufficient for the domestic market in these production areas and yield conditions. Cultivation area of corn used for animal feeding increased until 2015 and then decreased. There was no major change in area of alfalfa, which is a perennial plant. The production area of the sugar beet, which has an excess production in the dry Central Anatolia region, shows a slight increase.

Table 2. The size of the cultivated areas for all crops between 2014 and 2018 (ha).

	Crops	**2014**	**2015**	**2016**	**2017**	**2018**
Oily seeds	Safflower	137,046	124,898	171,031	106,649	53,245
	Sunflower	1,273,677	934,794	1,250,455	1,491,886	1,281,960
	Total	**1,410,723**	**1,059,692**	**1,421,486**	**1,598,535**	**1,335,205**
Legumes	Bean	384,964	363,685	311,626	396,007	339,478
	Lentil	27,059	1,033,416	1,680,483	2,601,808	380,841
	Chikpea	663,318	619,685	824,246	1,192,625	2,026,098
	Total	**1,075,340**	**2,016,787**	**2,816,355**	**4,190,440**	**2,746,417**
Products for animal feed	Corn	892,818	3,591,990	3,300,104	2,736,189	2,020,133
	Alfalfa	734,316	840,818	905,965	995,780	1,008,774
	Total	**2,702,474**	**6,449,595**	**7,022,425**	**7,922,409**	**5,775,323**
Industrial crops	Sugar beet	878,953	939,042	1,081,167	1,197,074	1,022,172

For all plants investigated in this study seasonal crop evapotranspiration, net irrigation water requirement, total irrigation water requirement and water needs were calculated. As an example, Table 3 shows them for corn (silage) in irrigated areas in all provinces. .Total irrigation water requirement mainly depend on the seasonal crop evaporation and total precipitation of the provinces.

Table 3. Total irrigation water requirement and water needs of corn (silage)

Province	Cultivated area (ha)	Seasonal crop evapotranspiration (mm)	Total precipitation (mm)	Net irrigation water requirement (mm)	Total irrigation water requirement (mm)	Water needs (m3)
Afyonkarahisar	453.2	550	115	435	621.43	2,816,084
Aksaray	993.2	649	78	571	815.71	8,101,901
Ankara	4217.2	568	106	462	660.00	27,833,826
Eskişehir	4268.2	585	83	502	717.14	30,609,337
Karaman	2159.1	618	70	548	782.86	16,902,293
Kayseri	1381.7	533	103	430	614.29	8,487,826
Kırşehir	453.8	596	99	497	710.00	3,221,700
Kırşehir	30.8	630	79	551	787.14	242,306
Konya	4410.6	597	76	521	744.29	32,827,317
Nevşehir	58.8	548	93	455	650.00	382,506
Niğde	81.1	620	84	536	765.71	621,132

Total water needs for each crop in whole irrigated study area are shown in Table 4. Legumes consume less water fallowed by oily seeds. More water is needed for sunflower, corn, alfalfa and sugar beet than the others. The water used in animal feed crops is the highest with 2,588,207 m^3.

Table 4. Total water needs for each crop in whole irrigated study area

	Crops	Water needs (m3x1000)
Oily seeds	Safflower	4,113
	Sunflower	630,068
	Total	**634,181**
Legumes	Bean	245,914
	Lentil	5,622
	Chikpea	112,656
	Total	**364,192**
Products for animal feed	Corn (seed)	1,635,549
	Corn (silage)	132,046
	Alfalfa	820,612
	Total	**2,588,207**
Industrial crops	Sugar beet	801,875

Total dissolved salt transported with irrigation increase with increasing amount of water. Due to the low water used in legume cultivation, the lowest salt transport to the soil was estimated in the whole study area. A small salt value was estimated for oily seeds.

The amount of salt carried to field for the production of corn and alfalfa in the study area was estimated to be 2.6 times higher than the total amount of salt transported with the production of oily seeds and beans. It has been estimated during the production of sugar beet that, high amount of salt is transported to the soil with irrigation water. However, since sugar beet production is allowed once every 4 years, this value is proportionally low compared to the others.

Table 5. Total dissolved salt estimated from two EC values of irrigation water.

	Crops	Total dissolved salts EC=1 dS/m (tonx1000)	Total dissolved salts EC=2 dS/m (tonx1000)
Oily seeds	Safflower	2,632	5,264
	Sunflower	403,244	806,488
	Total	**405,876**	**811,752**
Legumes	Bean	157,385	314,770
	Lentil	3,598	7,196
	Chikpea	72,100	144,200
	Total	**233,083**	**466,166**
Products for animal feed	Corn (seed)	1,046,751	2,093,502
	Corn (silage)	84,510	169,019
	Alfalfa	525,192	1,050,384
	Total	**1,656,453**	**3,312,905**
Industrial crops	Sugar beet	513,200	1,026,400

During 2014-2018, animal and by-products were continuously and rapidly increased, while oil and oil products imports decreased slowly. According to the data of the last 5 years, no significant increase in oilseed production was observed in the dry Central Anatolia region. Legume production increased considerably. In the same period, a continuous growth was observed in the production areas of corn and alfalfa used for animal nutrition. Water demand of corn and alfalfa's is high. However, due to the climatic characteristics of the region, the amount of rainfall is low and total evapotranspiration requirement is high. Water needs of plants are mostly met by underground water sources and partly by dams. Depending on the amount of irrigation water used, there is a very high salt transfer to the soils. This is not sustainable for soil and water resources. With state support, both soil and water resources will be protected and imports of oilseeds and legume will be partially restricted. Considering the need for feed, the majority of this region is not suitable for meat production. Current support for corn and alfalfa production may be shifted to more suitable regions in the country. Increased soil salinity is not sustainable anymore.

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Losing Soil Heat as a Function of Soil Layer and Volumetric Water Content

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Abstract

Cooling of soil layers has an important effect on soil micro climate and soil formation processes. In this study, one dimensional heat conductivity equation was investigated in case of instant cooling soil layers. Similarity theory was applied for solution of the equation. The solution was expressed in a simple way with using error and complementary error functions. The prediction of changes in soil temperature along soil layers during the cooling process was shown on a theoretical solution as a function of soil depth and volumetric water content. Heat diffusivity coefficients for 0-10 cm and 0-20 cm soil layers were determined as $0.27 \cdot 10^{-5}\ m^2 sn^{-1}$ and $0.88 \cdot 10^{-5}\ m^2 sn^{-1}$, respectively. Volumetric heat capacities for $0.267\, cm^3 cm^{-3}$, $0.336\, cm^3 cm^{-3}$ and $0.403\, cm^3 cm^{-3}$ volumetric water contents were calculated as $0.514\, cal\, cm^{-3}\, °C^{-1}$; $0.582\, cal\, cm^{-3}\, °C^{-1}$ and $0.649\, cal\, cm^{-3}\, °C^{-1}$. Soil temperature increased from 23.6 to 27.2°C for 10 cm and from19.9 to 23.1°C for 20 cm soil depth with increasing the volumetric water content. After 10 hours of losing heat process soil temperatures decreased from 23.6 to 14.6°C for 10 cm and from 19.9 to 13.1°C for 20 cm soil depth. These results indicate that decreasing soil temperature during the losing heat process controlled by volumetric water content and depth of soil layer.

Keywords: Temperature, volumetric heat capacity, similarity theory, moisture, soil depth

1. Introduction

Soil temperature and its change should be determined in the studies related with assessment of soil heat properties, soil energy and moisture balance. Theoretical determination of soil heat change based on heat amount and its practical applications are possible with investigating heat conductivity equation. The amount of total heat in soil-plant media occurred from the heat storage components (air, biomass, water, soil heat storage). Soil heat amount is a component of effective soil heat storage and depends on soil heat change. Oncley et al. (2007) reported that released soil heat amount from total heat was 10 watt m^{-2}, and heat storage was generally higher from noon to evening. Heat conductivity models without plant covered (Ekberli and Gülser, 2016) and with plant covered soils (Ekberli and Sarılar, 2014) give a chance to determine temperature values and heat changes in soils. In the solution of heat conductivity equation, different methods based on the different boundary and initial conditions are used related with the aim of study (Zhu et al., 2014; Kuznetsovet al., 2018). In a study subjected on the determination of heat diffusivity (Passerat de Silanset al.1996), harmonic Laplace transformation, corrected Laplace transformation and Lettau method (Lettau, 1954) in non-homogenous soil system were applied in the solution of heat conductivity equation. On the other hand, some researchers (Samanta and Guha, 2012; Ekberli et al., 2015) used to similarity theorem in the solution of heat conductivity equation with decreasing the number of independent variables. Evett et al. (2012) considered to sinusoidal and cosinusoidal harmonic change of surface soil temperature in the solution of heat conductivity equation. In a study by Gülser et al. (2018), functions including sinus and cosinus as a boundary condition were used to

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investigate of heat conductivity equation with consideration of phase change in soil depth. The objective of this study was to determine one dimensional heat conductivity equation using similarity theory to investigate heat amount loss in case of instant cooling soil layers.

2. Material and Methods

Theoretical investigation of heat conductivity depends on determination of temperature change with respect to space (x, y, z special coordinates) and time (t),

$$T = f(x, y, z, t) \tag{1}$$

function should be done. Eq. (1) is a mathematical statement that shows the sum of temperature values in all pointsof soil and every time interval. Constant and variable temperature zones are determined by the temperature values with respect to time. In case of considering temperature as a function of a coordinate, one dimensional temperature zone $\left(T = f(x,t); \ \frac{\partial T}{\partial y} = \frac{\partial T}{\partial z} = 0\right)$ and change of temperature according to time at any soil layer is stated by the one dimensional heat conductivity equation. Heat conductivity equation is the material in this study in order to determine distribution of soil temperature at any soil layer with respect to time. In deriving the equation, similarity theory was used with combining dimensional physical parameters to get a dimensionless statement.

3. Results and Conclusion

3.1. Theoretical Investigation of Soil Temperature Depends on Heat Amount

The process of one dimensional soil heat conductivity as a function of time is expressed as the statement (2) that is used widely in soil and other science branches (Thiery et al., 2018; Gülser et al., 2019)

$$\frac{\partial T}{\partial t} = a\frac{\partial^2 T}{\partial x^2} \quad (0 \le x < \infty, -\infty < t), \ a = \frac{\lambda}{C_H} \tag{2}$$

(where, T- soil layer temperature, ºC; t- time, sn; a-heat diffusivity coefficient, cm^{2}sn^{-1}; λ-heat conductivity coefficient, $J\,m^{-1}sn^{-1}\,°C^{-1}$ *or watt* $m^{-1}\,°C^{-1}$; C_H - volumetric heat capacity, $J\,m^{-3}\,°C^{-1}$ or $cal\,cm^{-3}\,°C^{-1}$; x- distance, cm).Let's investigate the dimensionless solution of heat conductivity equation (2) with respect to heat amount occurred heat differences among the soil layers and passed through unit area (Q, $J\,m^{-2}$).Soil heat amount significantly depends on the surface temperature. In this case, (2) heat conductivity equation theoretically supplies the boundary condition, if $x \to \infty, T \to T_0$ (where, T_0-soil surface or average temperature of a soil layer). Heat amount passing through unit area ($J\,m^{-2}$) depend on heat distribution in soil is expressed as follow,

$$Q = \rho C_g \int_{-\infty}^{\infty} (T - T_0)\,dx = 2\rho C_g \int_{0}^{\infty} (T - T_0)\,dx \tag{3}$$

(where, ρ - soil particle density, $kg\,m^{-3}$; C_g - gravimetric heat capacity, $cal\,gr^{-1}\,°C^{-1}$ or $J\,kg^{-1}\,°C^{-1}$) Also, in the solution of one dimension heat conductivity equation (Kreith and Black, 1983; Ekberli et al.,2015), dimensionless heat function depends on similarity variability is obtained as $\eta = \frac{x}{2\sqrt{at}}$ (4)

Due to temperature and heat passing through unit area influencing each other, dimensionless heat function can be written as below (Turcotteand Schubert, 1985):

$$\theta = \frac{T - T_0}{Q/2\rho C_g \sqrt{at}} = \frac{2\rho C_g \sqrt{at}\,(T - T_0)}{Q} \quad (5)$$

As it is shown in (5) statement, θ is only as a function of η similarity variable.

When $dx = 2\sqrt{at}\,d\eta$ and $T - T_0 = \frac{Q\theta}{2\rho C_g \sqrt{at}}$ statements derived from (4) and (5) are used in (3), θ for dimensionless temperature function,

$$Q = 2\rho C_g \int_0^{\infty} \frac{Q\theta}{2\rho C_g \sqrt{at}} 2\sqrt{at}\,d\eta \text{ or } \int_0^{\infty} \theta\,d\eta = \frac{1}{2} \quad (6)$$

is obtained. When the heat conductivity is written as dimensionless, from $T = T_0 + \frac{Q}{2\rho C_g \sqrt{at}}\theta$ (7)

statement, $\frac{\partial T}{\partial t}$, $\frac{\partial T}{\partial x}$ and $\frac{\partial^2 T}{\partial x^2}$ are derived and used in (7), the statement is obtained as $-2\frac{d}{d\eta}(\eta\,\theta) = \frac{d^2\theta}{d\eta^2}$ (8)

In this case, from (8), $\theta = \frac{1}{\sqrt{\pi}} e^{-\frac{x^2}{4at}}$ is obtained and used in (7) statement, the solution of heatconductivity equation depends on heat change amount is stated as

$$T = T_0 + \frac{Q}{2\rho C_g \sqrt{\pi at}} e^{-\frac{x^2}{4at}} \quad (9)$$

The statement (9) helps to predict temperature loss in a soil layer depend on changing amount of temperature in soil layer.

3.2. Determination of daily change in soil temperature and heat diffusivity

Soil temperature measurements taken from the experimental field of Agricultural faculty in OndokuzMayısUniversity (41° 21.86' North, 36° 11.41' East, 190 m altitude) are given in Table 1.

Table 1. Measured soil temperatures (°C)

Date	Depth, cm	Time, hours						Mean temperature, °C
		09^{00}	11^{00}	13^{00}	15^{00}	17^{00}	19^{00}	
19.04.2005	0	19.1	23.0	33.0	28.6	21.0	16.0	23.5
	10	15.8	17.3	22.8	15.7	15.4	15.5	17.1
	20	14.7	16.5	21.2	16.3	15.5	16.2	16.7
05.05.2005	0	23.0	35.4	37.8	36.8	26.0	21.2	30.0
	10	17.4	16.6	22.1	17.5	17.4	16.6	17.9
	20	14.5	15.5	19.0	14.5	15.3	15.4	15.7
14.06.2005	0	31.5	38.4	43.8	42.0	37.8	25.4	36.5
	10	22.4	22.9	27.8	23.2	22.4	23.2	23.7
	20	21.6	21.8	26.0	22.6	22.1	22.4	22.8

After measured soil temperature values were used in Eq. (10)estimated mean heat diffusivity values and the parameters influencing heat diffusivity ($T_{maksimum}, T_{ortalama}, A = T_{maksimum} - T_{ortalama}$)are given in Table 2.

$$a = \frac{\omega(x_i - x_{i+1})^2}{2(\ln(A_i / A_{i+1}))^2}\left(i = \overline{1,3}\right) \qquad (10)$$

(where A_i and A_{i+1} are amplitude values of x_i and x_{i+1} depths of soil, respectively; $\omega = \frac{2\pi}{P} = \frac{6.28}{36000sn} \approx 0.000174sn^{-1}$ - angle frequency) (Arias-Penaset al., 2015).Changes in the soil temperature values from surface to deeper soil layers is lower in early morning and late evening than in noon time (Table 1). Heat diffusivity in 10-20 cm soil layer is generally more stable and higher due to effect of surface temperature on this layer. Fluctuations and differences in heat diffusivity values occur due to climatic factors, effects soil properties each other, horizon depth, frequency of temperature waves.

Table 2. Parameters influencing heat diffusivity and the coefficient values of heat diffusivity

Date	Depth, cm	$T_{maximum}$, °C	T_{mean}, °C	A, °C	$a, m^2 sn^{-1}$
19.04.2005	0	33.0	23.5	9.5	
	10	22.8	17.1	5.7	$0.33 \cdot 10^{-5}$
	20	21.2	16.7	4.5	$1.56 \cdot 10^{-5}$
05.05.2005	0	37.8	30.0	7.8	
	10	22.1	17.9	4.2	$0.23 \cdot 10^{-5}$
	20	19.0	15.7	3.3	$1.50 \cdot 10^{-5}$
14.06.2005	0	43.8	36.5	7.3	
	10	27.8	23.7	4.1	$0.26 \cdot 10^{-5}$
	20	26.0	22.8	3.2	$1.42 \cdot 10^{-5}$

3.3. Determination of soil heat amount (Q) depend on temperature change

Soil heat amount, linearly related with volumetric heat capacity and temperature change, is given below

$$Q = C_H V (Ti - T_{i+1}) = C_H V \Delta T \; (i = 1, 2) \qquad (11)$$

(where, C_H - soil volumetric heat capacity, $cal\, cm^{-3}\, °C^{-1}$ or $J\, m^{-3}\, °C^{-1}$; V -bulk volume, cm^3 or m^3; ΔT - mean temperature difference between x_i and x_{i+1} depths, $^\circ C$). Depend on soil gravimetric heat capacity (C_g) values of $C_{min} = 0.22\, cal\, gr^{-1}\, °C^{-1}$ and $1.12\, gr\, cm^{-3}$, volumetric heat capacity is 0.246 cal cm^{-3}°C^{-1}. In this case, using soil volumetric water contents $(W_\theta = 0.267 cm^3 cm^{-3};\, 0.336\, cm^3 cm^{-3};\, 0.403\, cm^3 cm^{-3})$, volumetric heat capacity of soil is estimated as $C_H = (0.246 + W_\theta)\, cal\ cm^{-3}\, °C^{-1}$
(12)

Using the (11) and (12) statements, estimated volumetric heat capacity values with respect to volumetric water content and temperature difference (ΔT)between x_i and x_{i+1} depths are given in Table 3.

Table 3. Some soil thermo-physical parameters

Depth, cm	$W, \%$	$W_\theta, cm^3 cm^{-3}$	Mean ΔT, $^\circ C$	C_H, $cal\, cm^{-3}\, °C^{-1}$	$Q \cdot 10^7$, $J\, m^{-2}$
0-10	24	0.267	10.43	0.513	2.240
	30	0.336	10.43	0.582	2.542
	36	0.403	10.43	0.649	2.834
10-20	24	0.267	11.60	0.513	2.492
	30	0.336	11.60	0.582	2.827
	36	0.403	11.60	0.649	3.152

Change in volumetric heat capacity depend on moisture content occurs within a narrow range compare with the soil heat amount. Temperature differences among the soil layers are important for heat store in soil profile. Storage of heat in soil depends on some factors such as; daily atmospheric temperature change, net radiation, talent heat flow and evapotranspiration.

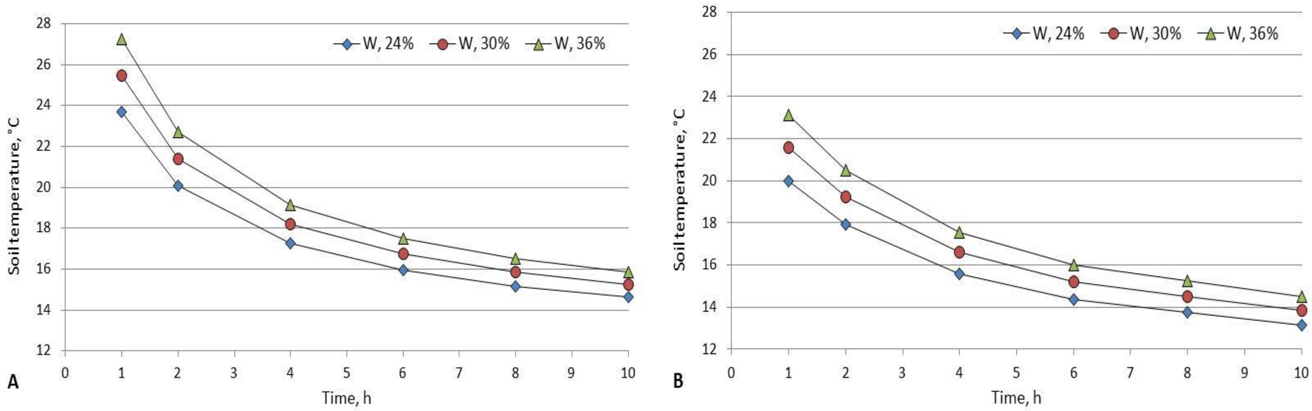

Figure 1. Heat loss at 10 cm (A) and 20 cm (B) of soil layers at different gravimetric water contents (W).

3.4. Determination of heat loss in soil layer

Heat loss at different soil layers can be calculated for different gravimetric water conditions using the statement of (9). In this study, soil temperature reduce for 10 and 20 cm soil layers at 24, 30 and 36 % gravimetric water content conditions were estimated using the statement of (9) and given in Figure 1. Soil temperature increased from 23.6 to 27.2°C for 10 cm and from 19.9 to 23.1°C for 20 cm soil depth with increasing the gravimetric water content from 24% to 36%. After 10 hours of losing heat process soil temperatures decreased from 23.6 to 14.6°C for 10 cm and from 19.9 to 13.1°C for 20 cm soil depth. Heat loss at 10 cm soil depth was 4% higher than heat loss at 20 cm soil depth. These results indicate that decreasing soil temperature during the losing heat process controlled by volumetric water content and depth of soil layer. It can be concluded that surface soil temperature has an important effect on heat change in soil profile and surface soil layers are more influenced from this heat change. Heat loss from surface soil layers are higher than deep soil layers during the cooling of soil from afternoon to early morning in a day time.

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Effect of Different Organic and Inorganic Fertilizer on Soil Structure Stability, Under Long Term Field Experiment

Mehmet IŞIK[1,*], Veysi AKŞAHİN[1], Feyzullah ÖZTÜRK[1], Saeed Ulah JAN[1,2], İbrahim ORTAŞ[1]

Abstract

Maintenance of optimum soil physical condition is an important component of soil fertility management. Breakdown of soil aggregates has negative affect on root growth, water and nutrition uptake for plants. Weak soil structure negatively impacts soil physical conditions, reducing yield, soil fertility and plant fertility. In addition to this, the physical condition of the soil affects the chemical and biological status of the soils. The aim of this study is to understand different organic and inorganic fertilizer on soil structure stability. The hypothesis of this study is to investigate organic fertilizer enhances soil Water Stable Aggregate (WSA) and Mean Weight Diameter (MWD). A long term field experiment was established in 1996 and since then regularly each year, 25 t ha^{-1} compost, animal manure and 10 t ha^{-1} compost + mycorrhizal inoculum and NPK inorganic fertilizers were applied. Under irrigating conditions, corn (Zea Mays L.) seeds were sown in June 2017 and harvested in October 2017. After harvesting, soil samples were taken from both Rhizosphere and Non-Rhizosphere soils at 0-0.15 m and 0.15-0.30 m soil depth. Soil structure analysis was performed with wet sieving method. Data shows that organic fertilizer treatments increased WSA and MWD compared to inorganic artificial fertilizers. The best application of WSA was manure with 86 % in Rhizosphere soil of 0-0.15 m depth. Also, manure was best application for MWD (with 4.06) in Rhizosphere soil of 0-0.15 m depth. Under long term field experiment, organic fertilizer condition has increased soil aggregations. Which needs to increase soil aggregation for sustainability and health production.

Keywords: Soil aggregation, MWD, WSA, Organic fertilizers

1. Introduction

Soil aggregate has been described as "a naturally occurring cluster or group of soil particles in which the forces holding the particles together are much stronger than the forces between adjacent aggregates" (Martin, Martin, et al., 1955). Soil aggregates are created especially by physical forces whereas stabilization is emphasized by many factors including clay, iron and aluminum oxides, and organic materials (Lynch and Bragg, 1985). The stability of soil aggregation has key indicator of soil quality. Aggregate stability of soils has both agricultural and ecological significance. In the agriculture, soil aggregate stability impacts soil fertility through its role in soil aeration and availability of nutrients and water to plants(Obalum, Uteau-Puschmann, et al., 2019). This role of aggregate stability ismainly evident in agro-ecosystems where organic matter plays a very important role in soil aggregation(Whalen, Hu, et al., 2003).

Soil aggregation is a key factor operation of soil, it could support animal and plant lives, and increase environmental quality with particular significance on quality of water and carbon (C) sequestration(Bronick and Lal, 2005). In addition,soil aggregation emphasis soil physical, chemical and organic fertilizers(Rillig and Mummey, 2006).Aggregation are influencedby soil properties like Soil Organic Matter (SOM), fertilizers and

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liming (Šimanský, 2013) to improve soil aggregation which are the most important bonding agents (Šimanský, 2013, Tisdall and Oades, 1982).

Organic fertilizers have influenced Soil Organic Carbon (SOC), consequently altered soil fertility(Bastida, Hernández, et al., 2018) and increased structure stability. Increasing SOC improve soil aggregation(Mikha, Benjamin, et al., 2010). In addition to SOC, also mycorrhizal fungal speciesapproach soil aggregation(Rillig, Aguilar-Trigueros, et al., 2015). In the soil, as known mycorrhizae, lived with mutual benefit 90% of the plant species, is also stated to alter the soil organic carbon. These mutual benefit enhance soil structure and increase uptake of nutrients and water via extension of mycorrhiza hyphae into the rhizosphere.

In this respect, organic fertilizer has importance for increase soil aggregation for sustainable and ecologic plant production. That's way, how organic fertilizers affectWSA and MWD that have importance for the productive capacity of soils.The aim of this study is to understand different organic and inorganic fertilizer on soil structure stability. The hypothesis of this study is to investigate organic fertilizer enhances soil (WSA) and (MWD).

2. Material and Method

2.1 Material

The experiment was established in 1996 inthe Menzilat soil series (Typic Xerofluvents) located on the Research Farm of the Cukurova University, in the eastern part of the Mediterranean region of Adana-Turkey. Five applications with three replications have realized since than 1996. The treatments were (i) control; (ii) traditional N-P-K fertilizers (160 kg N ha^{-1} as $(NH_4)_2SO_4$, 83 kg K ha^{-1} as K_2SO_4, and 26 kg P ha-1 as 3Ca $(H_2PO_4)_2.H_2O$); (iii) compost at 25 Mg ha-1; (iv) animal manure at 25 Mg ha-1; and (v) +mycorrhiza-inoculation with 10 Mg ha^{-1} compost addition.

2.5 Method

2.5.1 Soil Sampling

Bulk soil samples were obtained after the harvesting corn (*Zea Mays L.*) in October 2017 in each treatment at 0 to 0.15 m and 0.15 to 0.30m depths with Rhizosphere and Non-rhizosphere soils.

2.2.2 Soil MWD and WSA Analyses

Air-dried bulk soil samples were gently crushed and sieved through an 8mm sieve, and 8 g of aggregates were used for wet sieving (Youker and McGuinness, 1957). Aggregate size distribution (MWD) and WSA were determined with method by (van Veen and Kuikman, 1990).

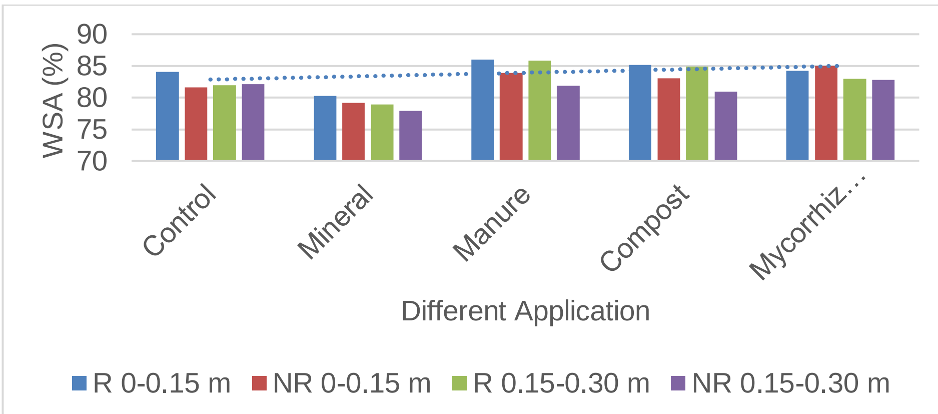
2.2.3 StatisticalAnalysis

JMP 8 program was used for statistical analysis of ANOVA analysis and LSD test.

3. Results and Discussion

3.1. Soil WSA Percentage

There was no statistical difference (P>0.05) at WSA but figure 1 shows that according to control, organic fertilizers application increase soil WSA percentage. Especially, manure application has best practice on average with 86 % WSA in 0-0.15m depth. It was known that surface soils have better aggregation from crop residual or organic matters. In soil, different enzyme activity, microbial activity and organic matter effected soil WSA(Udawatta, Kremer, et al., 2008). Inorganic fertilizer application has worst soil WSA percentage.



R= Rhizosphere, NR= Non-rhizosphere

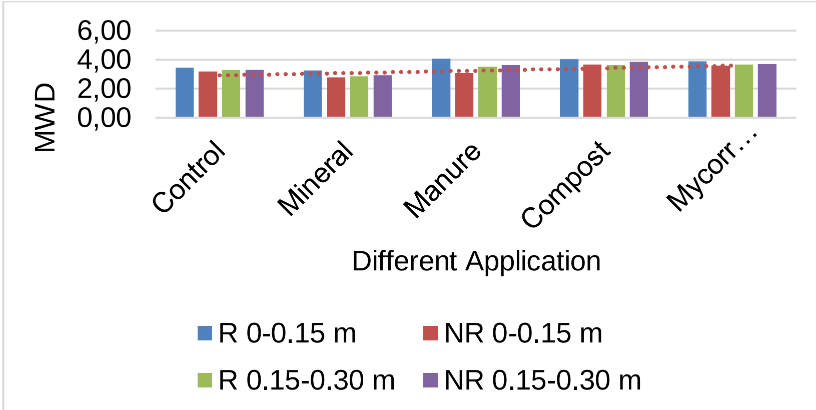
Figure 1. Effect of different organic and inorganic fertilizers on WSA (%).

The result shown that mineral fertilizer application decreased soil WSA percentage under long term experiment condition. Compare to organic fertilizer application inorganic fertilizer application was worst.It seems long term mineral fertilizer have negative effects on aggregation. Inorganic fertilizers negative effects soil aggregation (Šimanský, 2013). It has been indicated early better aggregation affect soil quality (Lal, 2001). It is important to have a good aggregation with fertilizer application. Manure application also improved soil structure (Meng, Ma, et al., 2019). Also it was reported that mycorrhiza increased soil aggregation(Wilson, Rice, et al., 2009).

3.2. Soil MWD

There was no statistical difference (P>0.05) as MWD in Figure 2. Manure, mycorrhiza and compost application improved soil MWD compared to control. Also, inorganic fertilizers application worst application under long term experiment condition. Especially, manure (4.06 MWD) and compost(4.02 MWD) application in rhizosphere soil of 0-0.15m depth.

There were different studies that application of organic fertilizer increases soil MWD.It was reported that organic fertilizers (manure, compost and mycorrhiza+compost) increased soil MWD(Ortaş, Lal, et al., 2017). Also,It was reported that mycorrhiza improved soil MWD(Wilson, Rice, et al., 2009).



R= Rhizosphere, NR= Non-rhizosphere

Figure 2. Effect of different organic and inorganic fertilizers on MWD.

Consequently, organic fertilizers improve soil WSA percentage and MWD. It means organic fertilizer emphasis soil quality and production. So it has been proved by experimental research that useof organic fertilizers increases soil sustainability and also enhance quality plant production.

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Effects of Some Agricultural Residues on Soil Mechanical Properties

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Abstract

The objective of this study was to determine the effects of different agricultural residueson water holding capacity and Atterberg limits of a loam textured soil. Four different agricultural residues, pea (P), bean (B), hazelnut husk (HH) and maize (M), were used in this study. The agricultural residues at the application rate of 4 ton/dadry weight basis were incorporated into 15 cm depth of the loamy textural soil with three replications in a randomized plot design for 6months. Application of agricultural residues increased field capacity (FC), permanent wilting point (PWP), available water capacity (AWC), liquid limit (LL) and plastic limit (PL) values according to the control treatment. While the lowest FC (28.82%), PWP (17.14%) and AWC (11.68%) values were determined in the control treatment, the highest FC (30.52%), PWP (17.56%) and AWC (13.21%)values were determined with B, HH and B applications, respectively. The values of Atterberg limits increased with the residue applications over the control in the following orders: P < B < M < HH for LL and P < HH < B < M for PL. While the PI value increased with HH application, it decreased with the applications of other residues. While the lowest LL (41.05%) and PL (25.66%) values determined in the control, the highest LL (45.25%), PL (29.23%) and PI (17.68%) values were determined with HH, M, and HH applications, respectively. These results indicate that recycling post harvesting agricultural residues in soil management systems helps to improve soil structural and mechanical properties and allows field operations in high moisture contents depends on agricultural residue characteristics.

Key words: Atterberg limits, organic waste, field capacity, permanent wilting point.

1. Introduction

Soil mechanics is an important branch of mechanical engineering and defines the behavior of soils under mechanical forces (Verruijt, 2011).The subjects of soil mechanics are generally soil friction, shear stresses, adhesion and cohesion, shear strengths, compression, swelling and soil consistency (Munsuz, 1985).Depending on the gravimetric water content, Atterberg (1911) defined the consistency limits as shrinkage limit, plastic limit and liquid limit. Shrinkage limit, the boundary between solid and semi-solid states; the plastic limit the boundary between the semi-solid and plastic states and the liquid limit is expressed as the boundary between the liquid state and the plastic state (Das, 2006; McBride, 2008).Atterberg limits vary depending on the clay content of the soil, the type of dominant clay minerals, the type of exchangeable cations and the amount of organic matter (Head, 1984).There is a very close relationship between soil organic matter content and consistency limits and land use. The preservation and continuity of the organic material is only possible with the addition of organic matter to the soil. Organic matter has important effects on the physical, chemical and biological properties of soil (Candemir and Gülser, 2011). Gülser and Candemir (2004) determined that the possible changes in the consistency limits of organic matter added to soils, determined positive relationships between soil organic matter and Atterberg limits.Plastic limit value in agriculture is considered as a good index in determining the tillage time. Soil cultivation should be done below the plastic limit value but close to the moisture content (Marshall et al., 1996).Gülser and Candemir, (2006) found that the values of the maximum

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soil water content for optimum tillage of soil series in OndokuzMayıs University Kurupelit Campus were determined as the moisture contentsaround the field capacities which provide a consistency index about 1.0 or 90 % of the water content at the plastic limit. The objective of this study was to determine the effects of different agricultural residues on water holding capacity and Atterberg limits of a loam textured soil.

2. Material and Methods

Four different post harvesting residues, pea (P), bean (B), hazelnut husk (HH) and maize (M), were used in this study. The agricultural residues at the application rate of 4 ton/da dry weight basis were incorporated into 15 cm depth of the loamy textural soil with three replications in a randomized plot design for 6 months.Some soil propertiesof 20 cm depth of the field were determined as follows; particle size distribution by hydrometer method (Day, 1965), soil reaction, pH, in the 1:1 (w:v) soil water suspension by pH meter, electrical conductivity (EC) in the same soil suspension by EC meter, organic matter content by Walkley-Black method (Jackson, 1962) and exchangeable cations by ammonia acetate extraction (Kacar, 1994). After six months, soil samples were taken from each plot for physical and mechanical analyses.Moisture contents at the field capacity (FC) and the permanent wilting point (PWP) were determined equilibrating soil moisture of the saturated samples on the ceramic pressured plates at 33 kPa for 24 hours and 1500 kPA for 96 hours, respectively (Tüzüner, 1990). Liquid limit (LL), plastic limit (PL) and plasticity index (PI) values of the soil samples were determined according to Black (1965). Statistical analysis of the results was accomplished by standard analysis of variance, pairs of mean values compared by Duncan and correlations between the limit values and the other soil properties estimated using the SPSS software package programme.

3. Results and Conclusion

Some physical and chemical properties of the soil are given in Table 1. The results can be summarized as follows; the textural class of soil is loam, slightly alkaline in pH, low in organic matter content, none saline according to EC value (Soil Survey Staff, 1993).

Table 1. Some physical and chemical properties of the soil used in this study

Sand, %	15.70	Organic matter, %	1.56
Silt, %	33.94	K, cmol/kg	1.20
Clay, %	50.36	Na, cmol/kg	0.59
EC_{25^oC}, mmhos cm^{-1}	0.44	Ca, cmol/kg	5.91
pH(1:1)	7.80	Mg, cmol/kg	4.78

Effects of post harvesting residues on the water holding capacities of the soil are given in Figure 1. All organic residue applications increased FC, PWP and AWC of the soil compared with the control treatment. The post harvesting residue of bean and hazelnut husk significantly increased the field capacity and available water content of soil ($p<0.01$). There was not a significant increment in the permanent wilting point values over the control by the organic residue application. The highest increments in FC (6.0%) and PWP (2.7%) according to the control were determined at bean and hazelnut husk residue applications, respectively (Figure 2). Demir and Gülser (2015) found that rice husk compost application increased the moisture contents of the sandy clay loam soil at FC and PWP.The percentage increments in AWC over the control were ordered by the organic residue applications as follows; maize (2.3%) < pea (6.7%) < hazelnut husk (9.5%) < bean (13.0%). Candemir and

Gülser (2011) found that application of farmyard manure, hazelnut husk, tea and tobacco wastes increased the field capacity values of clay and loamy sand soils over the control.

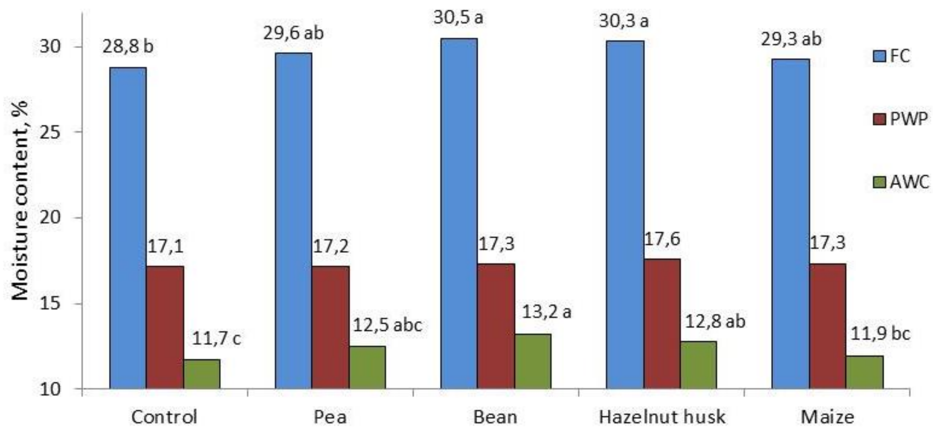

Figure 1. Effects of agricultural residues on the moisture contents at field capacity (FC), permanent wilting point (PWP) and available water content (AWC).

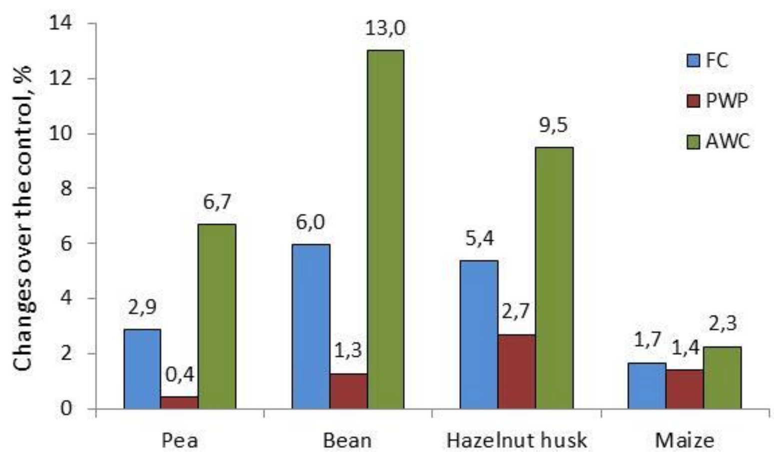

Figure 2. Changes of field capacity (FC), permanent wilting point (PWP) and available water content (AWC) by the organic residue applications over the control treatment.

Effects of post harvesting residues on the Atterberg limits are given in Figure 3. All organic residue applications increased LL and PL of the soil compared with the control treatment. The PL value in maize residue was significantly higher than the PL of control soil ($p<0.01$). However, there was not a significant increment in the LL values over the control by the organic residue application. The highest increments in LL (9%) and PI (11%) according to the control were determined at hazelnut husk application (Figure 4). The percentage increments in PL values over the control were higher than that in the LL values. According to the control treatment, these increments by the organic residue applications were ordered as pea (5%)<hazelnut husk (8%) < bean (10%)<maize (14%) for PL and pea (2%) < bean (5%) < maize (8%)< hazelnut husk (9%) for LL.

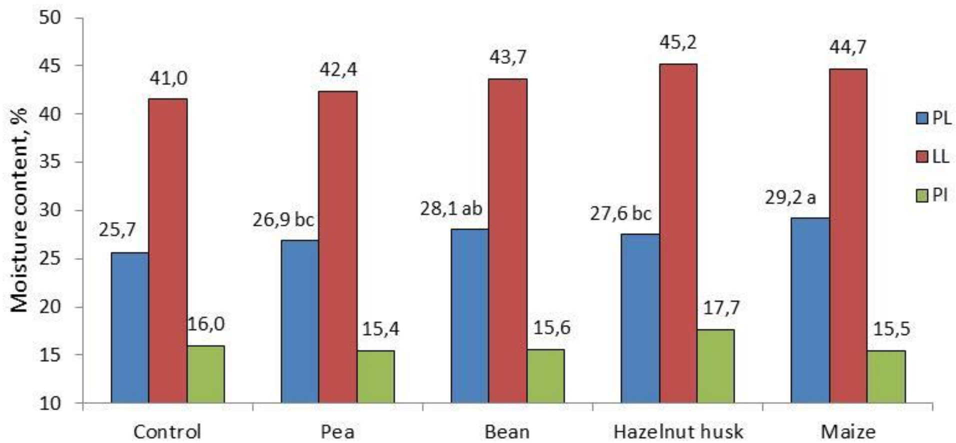

Figure 3. Effects of agricultural residues on the moisture contents at liquid limit (LL), plastic limit (PL) and plasticity index (PI).

Plasticity index, which is the difference between LL and PL, was also influenced by the organic residue treatments. Plasticity index varied from 15.4% for the pea residue application to 17.7% for the hazelnut husk application (Figure 4).Gülser and Candemir, (2004) determined that there were positive relationshipsamong soil organic matter contents and Atterberg limits. They also reported that manure and tobacco waste applications decreased the plasticity index, applications of hazelnut husk and tea waste increased the plasticity index compared to the control. Also in this study, hazelnut husk application just increased plasticity index while the other treatments decreased PI over the control treatment (Figure 4).

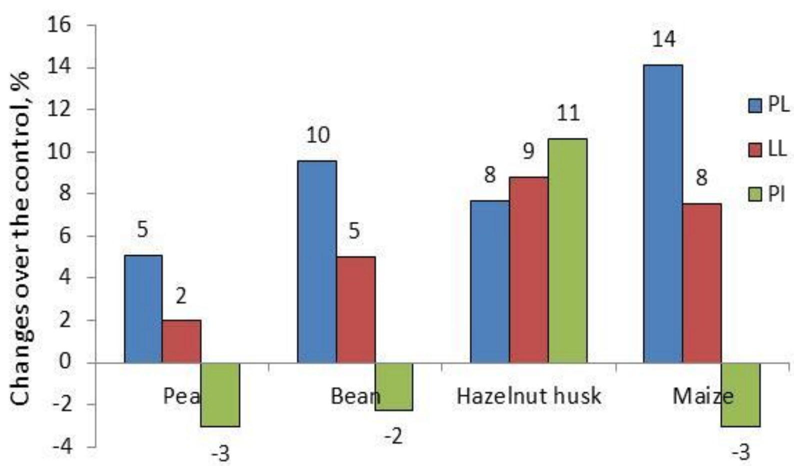

Figure 4. Changes of liquid limit (LL), plastic limit (PL) and plasticity index (PI)by the organic residue applications over the control treatment.

Cultivating the soil when it is wet causes structural damage and muddy condition instead of friable condition in soil if soil shows high plasticity index(Demiralay and Güresinli, 1979). In this study, hazelnut husk treatment had only increase in PIcomparing with the other treatments. Therefore, HH application can cause structural damage in soil when tilling soil at higher moisture content. The post harvesting residues of bean, pea and maize applications to soil can give a benefit to tilling soil at higher moisture content without damaging the soil structure and having friable condition.

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Effect of Compost and Biochar Application on Hydrological Properties of a Sandy Clay Loam Soil

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Abstract

Soil quality degradation is one of the utmost threats, which affects agricultural land due to irrational land management practices. Soil degradation is ascribed to low organic matter content culminating in low soil water holding capacity within the soil system. Enhancing soil productivity in the agricultural soils and rebuilding fertility by adding organic materials as an organic matter source in the soil is a promising way of alleviating the adverse effects induced by soil degradation, which negatively affect retention of plant available soil water and soil water storage at large. The objectives of this study was to determine the effects of compost and biochar application on water retention at different matric potential (0,10,33,100,1500 and5000kPa), as well as plant available water content (*AWC*) under a sandy clay loam soil (SCL).Compost and biochar application, both produced from Elaeagnus tree were applied at 0 (control), 1, 2 and 4 % (wt/wt) to SCL, moistened up to field capacity and then incubated for the period of 62 days. Experimental results showed that both applied compost and biocharsignificantly improved water retention capacity at different selected matric potentials and *AWC*in a SCL. Conclusively, compost and biochar can be a useful avenue for increasing soil water storage capacity of a SCL, and thereby enhancing soil fertility of a SCL, which in turn improve agricultural production.

Keywords: Compost, Biochar, SCL, soil water holding capacity, matric potential

1. Introduction

The profitability of a SCL is well known to be constrained due to low capability of retaining water and nutrients culminating in decreased water and fertilizer use efficiencyIt has been noted that soil amendments effectively play an important role in increasing water retention, decreasing infiltration rate and evaporation as well as enhancing conservation of water under a sandy soil (Al-Omran et al., 1987), and also the benefits of compost and biochar in improving soil water holding capacity were reviewed by Manirakiza and Şeker (2018).

2. Methodology

2.1 Field Site and Experimental Design

The study was a pot experiment designed in line with completely randomized plot design and 4 replication, conducted in the laboratory and employed materials were: a) Sandy clay loam textured collected from Karapinar region subjected to wind erosionlocated in Konya, Turkey; b) compost as soil amendment was produced from pruning residues of Elaeagnus tree through windrow composting processc) Biochar as soil amendments was produced from Elaeagnus tree through pyrolysis processat 450 ^{0}C. The applied rates were: 1, 2 and 4 % (wt/wt) of the both compost and biochar, which were thoroughly mixed with 3 kg of air-dried

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soil sieved through 2-mm sieve, subsequently potted in a 5 litre plastic pot, all pots including the control were moistened to exactly field capacity, then incubated for 62 days.

2.2 Soil Sampling and Analysis

Soil samples were collected from every pot for evaluating the responses of water retention at differentselected matric potential to the applied amendments at the end of incubation period. Water retention at different matric potential was determined using sandbox and pressure plate method(Klute, 1986) and water potential meter device (WP4C) (ASTMD6836-02, 2008). Specimen per pot was collected in all pots and compacted (at *bulk density*of 1.4 g cm^{-3}) into a stainless steel cylinder with diameter and height of 5 and 5 cm respectively. After compaction, specimens were saturated for four days using sandbox and subsequently water retention measurements at 0kPa (saturation), 10kPa, 33 kPa (field capacity, *FC*), 100kPa, 1500 kPa (permanent wilting point, *PWP*) and5000kPa (residual water content)were determined. Prior to applying any pressure to saturated sample, water content at saturation was considered saturated water content. Thereafter, saturated sample was subjected to 33 kPa through pressure plate to get water content at filed capacity. Water retention at 1500kPa and 5000kPa matric potential was calculated from the water retention curve obtained from matric potentials measured by WP4C. Seven samples of 10 g oven dry sample at 105^0C for each were respectively moistened to 2, 4, 6, 8,10, 12 and 14 %, then mixed evenly and sample were kept for 24 hrs prior to being red using WP4C. Thereafter, the red value from the entire sample was used to plot water retention curve and water retention at 1500kPa and 5000kPa were calculated from the predicted equation from the curve. Plant available water contentwas calculated as (*FC-PWP*).Water content was gravimetrically measured, and subsequently converted into volumetric water content.

2.3 Statistical Analysis

The responses of water retention capacity at different selected matric potential(ψ_{m}) to compost and biochar applications were quantified andthen statistically subjected to one-way ANOVA using Minitab 16 software and differences between amendment means were considered statistically to be significant at $P< 0.05$ through Tukey's test.

3. Results and discussions

3.1 Effect of Compost

The experimental results revealed that compost application significantly increased water retention at different selected matric potential, as well as plant available water content as presented in Figure 1. This increment was linear to applied rates. Unexpectedly, retained water content at saturation (0kPa) was decreased at the highest applied rate. This upward trend in water retention capacity was due to increased organic matter which might have adsorbed a sizeable amount of water and increased specific surface area, and thereby increasing water storage capacity. Furthermore, compost might have increased pore size distribution (i.e. meso, micro-and macro-pores) (Herath et al., 2013), which probably led to increased water retention capacity and *AWC*. Similar trends were also reported by Hillel (1982). Additionally, increased soil total porosity, aggregation and aggregate stability, as well as decreased infiltration rate, bulk density and particle density due to compost addition, might have been also another reason for increasing water holding capacity and *AWC* of a sandy clay loam soil. The effect of compost in improving soil water holding capability and *AWC* has been previously reported by other researchers. (Gümüş and Şeker, 2017; Laila, 2011) pointed out that compost addition increased water retention at matric potential of 33 and 1500kPa. Similar study illustrated that compost improved soil water storage via decreasing evaporation(Opara-Nadi and Lal, 1986), increased soil water retention capacity and plant available water content (Barus, 2016).

3.2 Effect of Biochar

The findings of the study indicated that biochar significantly increased *AWC* (Figure 2). This was due to increased organic matter and soil porosity, all of which might have adsorbed and stored a huge amount of water, respectively. The improvement was proportional to applied rates. There was an upward trend in water holding capacity at the lowest matric potential and a downward trend at the highest matric potential. This downward trend contributed to increased range of *AWC*. In contrast to our study, Herath et al. (2013) found a controversial effect where biochar addition increased water retention at the highest matric potential, yet under long-term experiment.Hydrophilic feature from the oxidation of carboxylic acid group featured on external surface of biochar can be attributable to increased soil water retention capacity and *AWC* (Zimmerman, 2010). Glaser et al. (2002) reported that biochar increased water retention at 33kPa. Our results are consistent with (Hseu et al., 2014) who pointed out that biochar increased *AWC* due to increasing soil micro-pores.Van Zwieten et al. (2010) stated that biochar is endowed with a sizeable amount of porosity and surface area, which might have been a reason for increasing soil water holding capacity and *AWC*. The effectiveness of biochar application in improving soil water holding capacity and plant available water content was also validated by (Downie, 2011; Tammeorg et al., 2014).Previous results revealed that biochar application decreased bulk density and(increased soil water holding capacity(Ouyang et al., 2013), increased total porosity (Omondi et al., 2016) and mean weight diameter (Hseu et al., 2014). In short, water content gradually decreased from saturation (0kPa) to the highest matric potential (5000kPa) and increased in water content at every matric potential was linearly to applied rates. This shows how biochar as soil amendment has the potential of improving plant available water content, which help plants to perform their physiological functions, and consequent growth and yield increases.

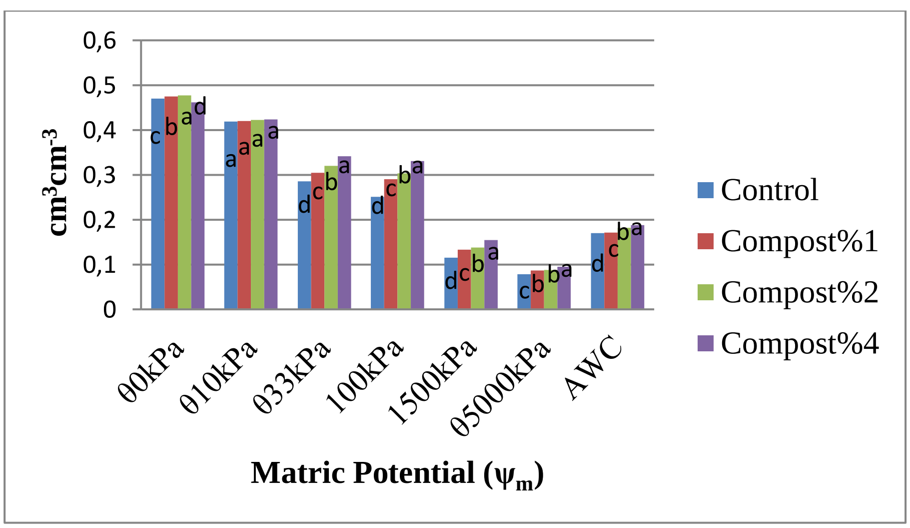

Figure1. Effect of applied compost on soil water holding capacity;with *AWC* (plant available content)

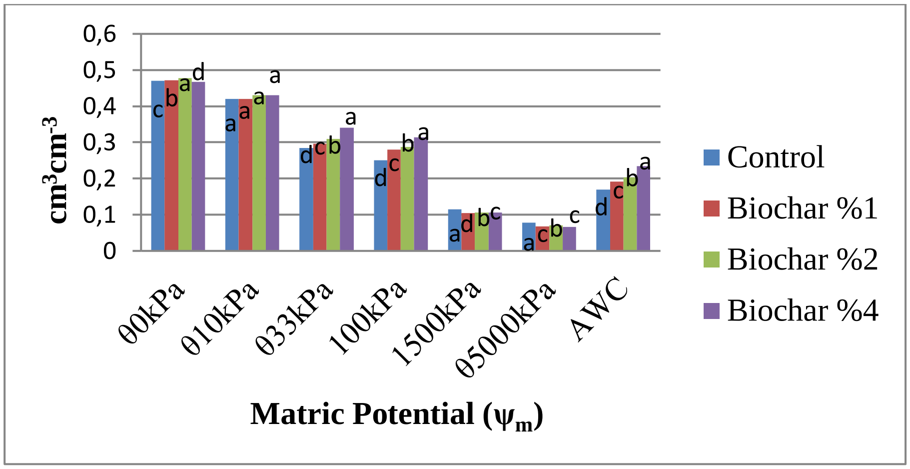

Figure2. Effect of applied biocharamendment on soil water holding capacity; with *AWC* (plant available content)

4. Conclusion

Overall, increased in water retention capacity and *AWC* due to compost and biochar addition could be a solution for drought experienced region by increasing elongation of irrigation frequencies which results in decreased irrigation water need and costs, thereby increasing agricultural production.

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Spatial and Temporal Variability of Soil Moisture Content in Different Soil Types

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Abstract

Spatio-temporal measurements of soil moisture through soil profile are necessary for many hydraulic, atmospheric, land and soil-plant models. On the other hand, when considering time-consuming and cost, measurement spatio-temporal of soil moisture within soil profile is not applicable in large areas. With this project monitoring of soil moisture were performed in the research area using profile based soil moisture sensors and the model data that use soil and meteorological data. Soil moisture sensors were calibrated and converted into volumetric moisture based on gravimetric soil moisture measurements.The results showed that estimating soil moisture values with the model were different depending on soil depth. It was determined that the soil moisture values produced by the model on the surface horizons were similar to the measured values, and the similarity between the moisture values declined with the depth for all soil series. However the model was found usable for estimating soil moisture in fallow lands.

Keywords: Soil moisture, soil moisture model, DSSAT, moisture map.

1. Introduction

Soil moisture plays a key role in understanding many hydrological and natural processes (geomorphological, climatic, environmental, etc.). Many factors such as net radiation, evapotranspiration, the amount of available water, surface and sub-surface flow, the transport of chemicals to the aquifer are controlled by soil moisture and are key to many models (hydrological, erosion, etc.). Accurate measurement and monitoring is critical because it is the most important factor for a stable agricultural production.

Due to its interaction with the ecosystem and the hydrological cycle, it is of great importance to collect, analyze and map the soil moisture at different spatial and temporal scales along the profile. On the other hand, considering the temporal and economic dimension, direct measurement of the spatial and temporal distribution of soil moisture content at the profile scale in large areas is not easy to implement. Especially when it is considered on a national scale, it can be seen that the feasible way to monitor soil moisture is to collect sufficient data and to estimate the humidity by remote sensing and model simulation. In fact, soil moisture monitoring and mapping studies are carried out by satellite images and simulation supported by ground observations on large scales. Nowadays, all of the vehicles used in the estimation of soil moisture contain error rates and resolution in varying proportions. The estimation of soil moisture, especially due to the soil profile, is still not of the desired precision as it contains high uncertainties.

With this study, it is aimed to monitor and map the soil moisture using the model. Soil moisture was monitored by the sensors placed in the soil series (Hotora) and the soil-plant-atmosphere module (SPAM) contained in the DSSAT model produced moisture values for one year for this series. It was evaluated by using statistical methods that the model data were compatible with the measurement values obtained from the sensors.

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2. Materials and Methods

2.1 Materials

The research was performed soil series that classified according to Soil Taxonomy (Soil Taxonomy, 1998) and define in Inceptisol Ordo. The research area has mainly high clay content, flat and near flat areas where drainage problems are observed.

2.2. Methods

2.2.1 Soil and soil moisture data

As a result of the detailed soil survey and mapping study, soil moisture measurement sensors (Pico 64 Theta Probe) were placed in series according to the horizon depths and the measured soil moisture values collected data loggers. Soil samples taken for physicochemical analyzes were prepared for necessary laboratory procedures. The values measured with the moisture sensors were compared with the actual measurement values and the sensors were verified.The model parameters such as daily rainfall, minimum and maximum temperature values, solar radiation, wind velocity, relative humidity values were taken meteorology station in 2010-2016 years.

2.2.2. DSSAT (Decision Support System for Agrotechnology Transfer) soil moisture model

The soil moisture model was developed in 1985 under the name of CERES (Ritchie and Otter, 1985) and then renewed as a DSSAT model. The model calculates the daily change in soil moisture caused by rain, irrigation, infiltration, drainage, unsaturated flow, evaporation from the soil and root intake. The DSSAT model water quantity is defined as follows (Equation 1).

$$\Delta S = P + I - T - E - R - D \tag{1}$$

Equation P is given as precipitation, I irrigation, T plant water use, E evaporation from soil, R surface flow and D drainage.

2.2.3. Statistical approach

The relationship of the model values with the actual measurement values was evaluated by the mean absolute error (MAE) (Equation 2), the square root of the error squares mean (RMSE) (Equation 3), the correlation analysis (Pearsons) and the effective E value coefficient (E) (Equation 4). The use of RMSE is an evaluation method which gives information about the magnitude of the average error made for the model derived values after the simulation. The harmony between the observed and the soil moisture values after the simulation was tested by the effective E value content

$$MAE = \frac{1}{n}\sum_{i=1}^{n}[|P_i - O_i|] \tag{2}$$

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}[P_i - O_i]^2} \tag{3}$$

$$E = 1.0 - \frac{\sum_{i=1}^{n}(O_i - P_i)^2}{\sum_{i=1}^{n}(O_i - \bar{O})^2}$$
(4)

In the equations Oi measured values, Pi model estimation values, the sample is given as the number. The E value varies between -∞ and 1. When E is 1, it is assumed that there is a one-to-one alignment between the measurement values and the simulation values.

3. Results and Conclusion

Soil moisture values taken from three different depths have been recorded for 24 hours a day (at 1 hour intervals). In addition, the monthly gravimetric moisture measurements of the soil horizons were made for the calibration of the sensors. Moisture measurements of the sensors in the series were converted to daily average values and compared with the moisture values produced by the model. Model data are produced daily for each horizon under the conditions of fallow.The moisture values of the sensors and the moisture values produced by the model were compared statistically and the error statistics and the observed and predicted humidity values were determined.

3.1.Hotora series

Soil moisture sensors and model data were compared with horizon depths. The soil data of the Hotora series used in the model are given in Table 1. The series is formed on alluvial fan and flat topography. They are deeply profiled but poorly developed. The surface horizon contains high claycontent, the soil color is determined to be yellowish orange. The surface roughness curve of the series was calculated as 61 and albedo value as 0.17.

Table 1. Hotora Series soil profile properties

Series	Horizon	Clay %	Silt %	Sand %	TC	OM %	pH	CEC cmol kg^{-1}	S %	FC %	PWP %	BD gcm^{-3}
Hotora	0-30	68	18	14	C	2.28	8.07	45.4	84	41.1	22.1	1.24
	30-51	32	21	47	CL	0.76	7.84	34.1	63	28.3	15.5	1.41
	51-95	68	17	15	C	0.28	8.18	43.6	89	42.6	21.7	1.24

TC: texture class; OM: organic matter; CEC: cation exchange capacity; S: saturation with water; PWP: permanent wilting point; FC: field capacity; BD: dry volume weight

For 0-30 cm depth, the model produced daily moisture values for wet and dry periods close to each other compared to sensor data. However, the difference between the values produced by the model and the measured values in the dry periods without precipitation was opened. For this depth, a high correlation (0.92) was found between the sensor and produced model values throughout the year and the error values produced were also low (Figure 1).

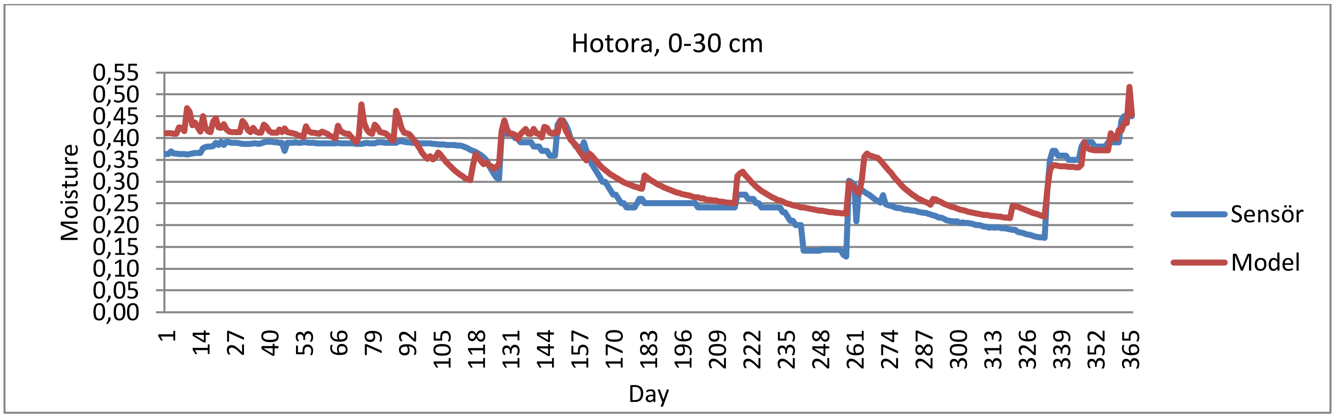

Figure 1. Estimated and measured moisture values at 0-30 cm depth

The moisture data measured and produced for the C1 horizon (30-51 cm) showed seasonal differences. Moisture values measured until the end of May were higher than the produced moisture values, but this situation reversed after May. Model data were found to be higher than the measured values during the dry periods. For this depth, a higher relation (0.71) was found between the measured and produced data (Table 2). Mean absolute error values were calculated at a similar rate. The spatial and seasonal changes of precipitation affected the performance of the model (Figure 2).

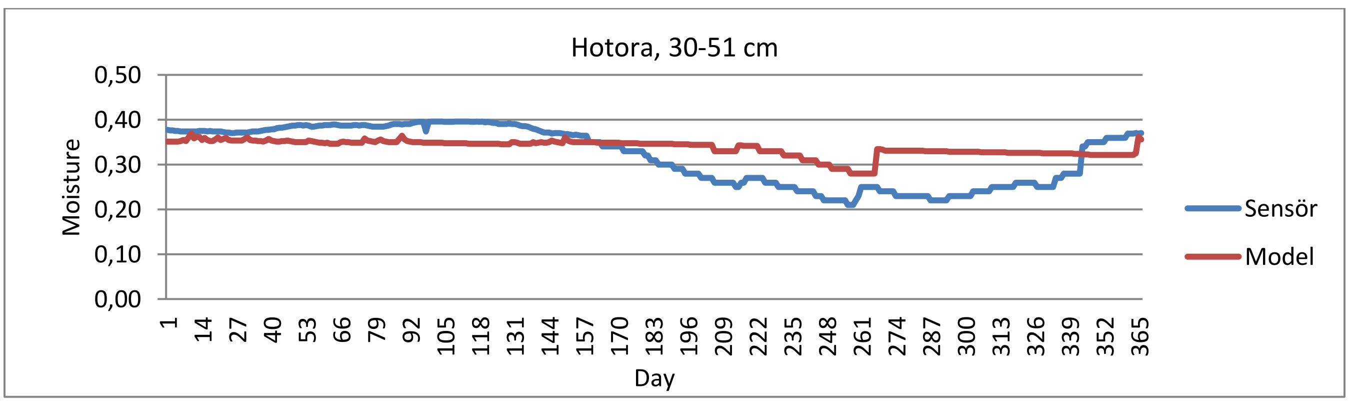

Figure 2. Estimated and measured soil moisture values at 30-51 cm depths

The figure of the measured and estimated moisture values for the C2 horizon is given in Figure 3. For this depth, the model produced higher moisture values than measured every day of the year. The relationship between measured and model values decreased to 0.39. Although the model takes into account the water movement in unsaturated conditions, its similarity with the actual values decreased with the increase of the profile depth. The values produced for this horizon were almost all over the field capacity value. Although the water on the field capacity is calculated as water penetrating through the drainage in the model, the model produced high moisture values.

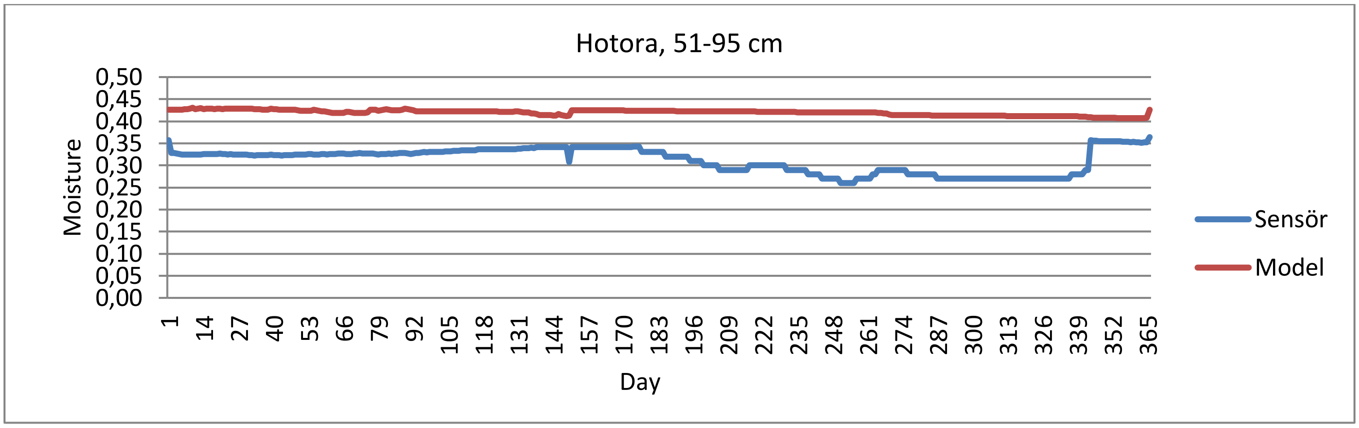

Figure 3. Estimated and measured soil moisture values at 51-95 cm depths

Table 2. Statistical values for Hotora series

Series name	Hotora		
Horizon depth	0-30 cm	30-51 cm	51-95 cm
Correlation (r)	0.92	0.71	0.39
MAE	0.03	0.02	0.11
RMSE	0.04	0.06	0.11
E	0.75	0.62	-3.22

MAE: mean absolute error; RMSE: root mean square error; E: model similarity

Table 3. Hotora series soil water balance values

Modul	P (mm)	I (mm)	T (mm)	E (mm)	D (mm)	SR (mm)	ΔS (mm)
SWBM	356.0	0.00	0.00	249.28	104.91	0.00	1.81

SWBM: soil water balance model; P: precipitation; I: irrigation; T: transpiration; E: evaporation; D: drainage; SR: surface runoff; ΔS: soil water balance change

4. Conclusion

Due to its interaction with the ecosystem and the hydrological cycle, it is of great importance to monitor and map the soil moisture at the spatial and temporal scale along the profile. The moisture values produced by the model with the sensor placed on the surface horizon are generally similar. The model estimates the water movement in all horizons by evaporation and non-saturated conditions in terms of moisture estimation. The evaporation values for this depth are accurately estimated. Considering the difficulties in estimating soil moisture content due to changes in atmosphere and soil conditions, estimation values for surface horizons were found to be applicable.

Depending on the depth of the soil profile, the difference between the moisture values measured by the model and the moisture values increased. and the model produced higher humidity values for these depths. Although the model uses water movement in the unsaturated conditions during the year and evaporation from the profile in the water budget calculation, the estimated soil moisture content for these depths is higher than the actual values.

The soil parameters used by the model to calculate the soil water budget directly affect the quality of the produced moisture values. For this reason, soil properties and land conditions need to be defined correctly. However, in order to reduce the increased margin due to soil depth. monitoring of water movement in unsaturated conditions should be improved.

The importance of soil moisture monitoring has become more important. especially in arid and semi-arid areas where the stability of meteorological conditions is more effective. Today, the models used in the country-scale studies of increasing soil moisture are of great importance in terms of reflecting the soil moisture distribution despite the low resolution and high error margins.

The classification of soils with the current classification technique in the conditions of our country, moisture distribution maps to be made and moisture distribution maps to be produced is a requirement to reduce the margin of error.

5. Acknowledgments

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Utilization Of Near Infrared Spectroscopy (NIRS) Technique To Determine Some Chemical Properties Of The Biochar Applied Saline And Non-Saline Soils

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Abstract

This study has been taken into a consideration regarding the biochar-NIRS (Near Infrared Spectroscopy) relationship, because of lacking of any study about this concern in the literature. The aim of this study is to estimate the effect of biochar applications on soil properties in soil science, using NIRS technique as well as put forward the most convenient method to apply the technique. The 90th day samples of an incubation work have been used in this study. The used samples of this study were composed of mixing materials of which have been converted to biochar by using carbonization method, such as tobacco stalks (TS), cotton stalks (PS), olive pulp (ZP), corn cobs (MK) and pistachio shells (FDK) with saline and non-saline soils at different doses. After soil samples were dried and sieved, the soil samples grouped as sieved and grinded as well as the reflections were obtained by using NIRS technique. The reflection effects of properties of biochar mixed soils such as soil organic matter (SOM), lime, cation exchange capacity (CEC), pH, and electrical conductivity (EC) were determined. The results of the study indicated that NIRS technique can be used much more properly in saline soils than non-saline soils. The results demonstrated that the grinded samples were more effective in applying the technique. As the obtained statistical estimation results have been evaluated, it has been determined that the higher estimated values were in SOM for saline grinded soils. As a result; it can be concluded that the study performed with NIRS technique along with biochar is more effective when the saline and grinded soils studied, especially for the estimation of SOM amount easily and quickly.

Keywords: NIRS, biochar, saline soil, non-saline soil

1. Introduction

Biochar is a soil conditioner, which forms as a results of burning of organic matter with very little or no oxygen (after pyrolis or carbonization methods) and contains activated carbon. They are porous materials rich in carbon that are obtained from vegetables and animal residues (Sohi, 2010; Lehmann, 2007). In order to obtain biochar, hard shell nuts (i.e. hazelnut, pistachio and walnut) and outer shell of rice can be made use of (Demirbaş etal., 2004). Researchers have reported that biochars can also be obtained from materials such as wood, bark, product residues (straw, stalk etc.), organic wastes, oil wastes, chicken bones (Das et al., 2008), manure (composted and non-composted) and solid wastes (Shinogi etal., 2002). In order to obtain biochar from different products the suitability of short-rotated woody plants (stalks etc.), lawns (Miscanthus spp) (Brown, 2009) and herbaceous plants have been investigated. In addition, Lehmann et al. (2006) reported that forest wastes, peanut shells and urban wastes can be used as biochar source.

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The studies performed revealed the fact that although many materials have been involved in producing biochar there are plenty of materials that can be tested for the biochar production.

Biochar applications prevent the wash of nutrients from soils, increase soil cation exchange capacity (CEC), change soil pH depending upon the biochar used and increase soil water holding capacity and soil biological activity (Saygan and Aydemir 2016; Ayaydın, 2017).Biochar applications have healing properties for almost every soil. In addition to this, they are more advanced in the soils of the areas with low rain and poor nutrients (IBI, 2008).

Spectroscopy is the measurement and interpretation of light emitted from a material at a given wavelength, emitted or absorbed during the transition from one energy level to another. It allows analyzing a large number of samples in a short time period in order to reach high accuracy information. It is important because it can be applied directly and without damaging the sample (Pasquini, 2003). Near Infrared Reflectance Spectroscopy (NIRS) technique is used to characterize soil and other environmental variables in a cheap and easy way under field and laboratory conditions. It is a fast, economical, accurate and efficient analysis method that does not destroy the sample. Agriculture is one of the areas where the NIRS technique is used extensively. This technique can be used in characterizing many properties such as organic matter (OM), $CaCO_3$ (lime), pH, cation exchange capacity (KDK) and electrical conductivity (EC). Accurate determination of these features varies depending on many features. Especially the soil characteristics that directly concern the color have a higher chance of success compare to the others (Boyaci and Topal 2008).

The goal of this study was to test the potential of NIRS method in determining some properties (organic matter and $CaCO_3$ content, Cation Exchange Capacity (CEC), pH and Electrical Conductivity (EC) of salt and unsalted soils treated with biochar. For this purpose the same samples were evaluated both using chemical analyses and also NIRS spectral readings and compared. The fact that there is not much literature on the relationship between biochar and NIRS technique makes the results of this study significant.

2. Materials and Methods

2.1. Materials

In the study, Harran-II series (salted) and İkizce series (non-salted) samples taken from 0-30 cm depth were used. As biochar material, the residues produced in the GAP region are converted into biochar (250 ° C) by carbonization; TS (Tobacco Stalk), PS (Cotton Stalk), ZP (Olive Pulp), MK (Corn Cob) and FDK (Pistachio Shell) were used as crop residues. In Near Infrared Reflectance Spectroscopy technique, spectral measurements has been obtained using ASDI FieldSpec 3 equipment in the laboratory (www.malvernpanalytical.com).

2.2. Methods

2.2.1. Preparation of incubation study

Incubation study was a study performed at a specific temperature (25 °C-26 °C) and humidity (65%). Samples taken from 0-30 cm depths of saline and non-saline soils from different soil series were sieved through 2 mm sieve and 500 g of soil and biochar materials for each 1 liter container were measured in 0.2, 0.4, 0.6, 1.2 and 2.4 percent, respectively 0, 5, 10, 15 30 and 40 g/kg soil were mixed homogeneously and then filled into containers. The containers were incubated for 3 months at the field capacity humidity rates. In this study, 2 soil samples (saline and non-saline) x 5 biochar material (FDK, PS, ZP, MK and TS) x 6 application doses (biochar ratio) x 3 (replicates), a total of 180 containers were used. Soil and biochar mixtures were taken in 90th day of the incubation for analyses.

2.2.2. Preparation of soil samples for analysis

Samples taken on the 90th day of incubation were passed through a 2 mm sieve directly and partially grinding after drying in the open air. Directly grinded samples were used in routine laboratory analysis and the samples directly sieved and sieved by grinding were used for NIRS analysis

2.2.3. Soil analysis

Routine analyses performed in the study; the amount of lime ($CaCO_3$ %) was obtained according to Nelson (1982), organic matter amount (%) (OM) according to Chapman and Pratt (1982), Cation Exchange Capacity (CEC) analysis ($cmol_+$/kg) according to Sumner (1996), pH and Electrical Conductivity (EC) analyzes according to Thomas (1996).

2.2.4. NIRS analysis

Spectral readings of soil materials; unground directly sieved from 2 mm and ground sieved from 2 mm were made with NIRS device in the laboratory using a ASDI FieldSpec 3 equipment (www.malvernpanalytical.com).

3. Results and Conclusion

NIRS results of the ground and sieved saline soils showed that the reflection values of biochar applications relative to the control showed a significant increase in all materials (FDK, PS, ZP, MK and TS). On the other hand, when we look at the reflection values according to the dose increments, it was determined that only the MK and TS materials showed significant differences in the reflection values with the inverse proportions depending on the increase in dose, and the reflection values of the other 3 materials with the dose did almost not change (Figure1).

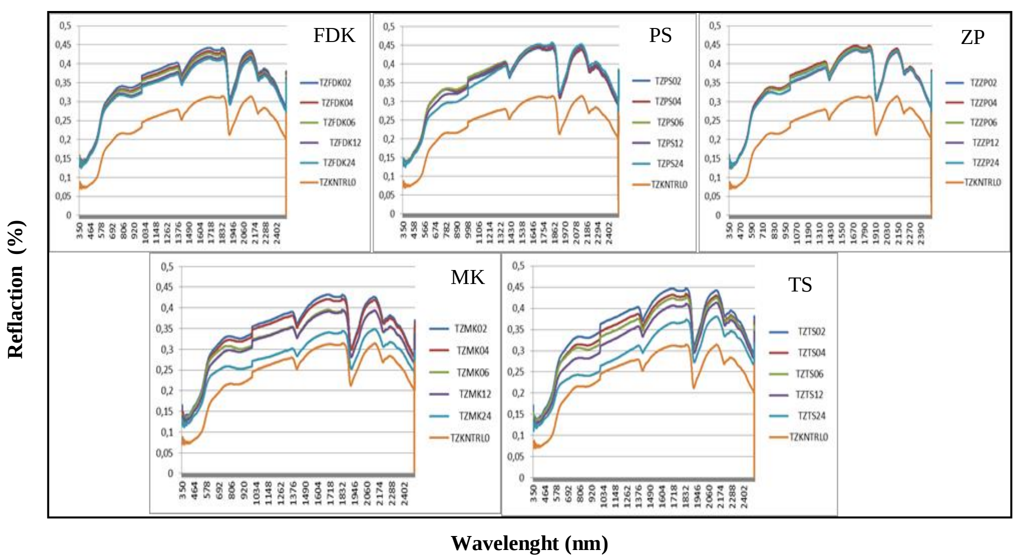

Figure 1. NIRS reflection values of ground and sieved saline soils with different materials (FDK, PS, ZP, MK and TS) and doses.

Directly sieved NIRS results of saline soils showed that the reflection values of biochar applications according to the control did not differ significantly in all material applications. The reflections gave values so that the applications could not be separated from the control. It was observed that only there was an inverse relationship with reflections due to dose increase of MK and TS applications, just as above.

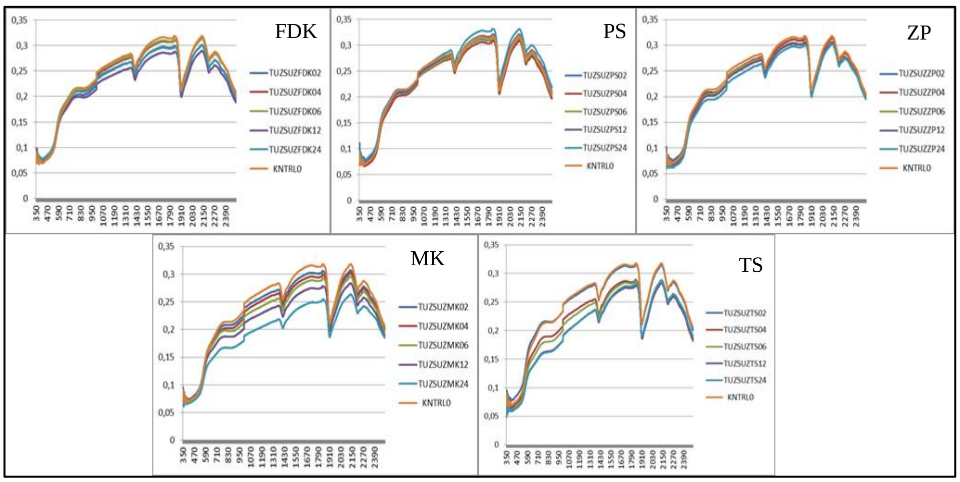

Figure 2. NIRS reflection values of ground and sieved non-saline soils with different materials (FDK, PS, ZP, MK and TS) and doses.

The reflection graphs of five different materials (FDK, PS, ZP, MK and TS) on non-saline ground soil are shown above. In contrast to the saline soil, we see that the control material has the most effect on reflection. Biochar applications in non-saline soils and the increase in the amount of dose have negative effect on the reflections. As oppose to other three materials, dose effects of MK and TS materials on reflection were evident and inverse as in the case of the saline soils, whereas dose effects of other three materials were not evident (Figure 2).

The process of comparing saline soils, which are sieved by grinding, directly sieved (without grinding) and the control soils, is shown in the above reflection graph. As seen in the graph, ground soils have more effect on reflection than unground soils. It is seen that the reflection values of unground soils and control samples are very close to each other and very low compared to the ground samples. Figure 3 shows that in NIRS studies, especially in biochar applied saline soils, the collection of the reflection values in the ground and sieved samples will provide better results.

On the other hand, when we look at the results of the analysis of non-saline soils, the grinding samples reduces the reflection values in contrast to the saline ones. In salt-free soils, the reflections of ground and control samples showed higher values (Figure 3). These results show that the saline and ground soils give higher reflectance values in NIRS analysis only in biochar applied case, while in the case of non-saline soils the ground soils treated with bioachar and untreated with biochar gave the higher values. According to these results, we can say that while working with saline soils, the sieving of the samples after grinding them is important in the analysis with NIRS in order to see the impact of biochar application. In addition, the grinding process to be carried out in the non-saline soil masks the biochar effect of biochar and gives values close to the control results. The differences in the reflection values mentioned above are seen as statistically significant ($p<0.01$).

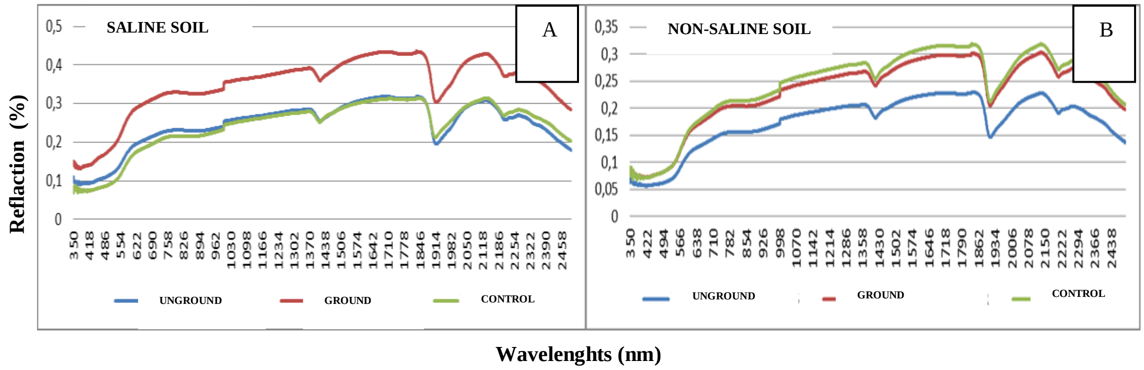

Figure 3. Reflections of ground and sieved, unground sieved saline (A) and non-saline (B) soils treated with biochar and control samples at different wavelengths (nm).

Table 1. The results of routine chemical analysis of soil samples and the relationship between NIRS technique and reflection values.

	Ground soil samples				**Unground soil samples**			
	Saline soils		**Non-saline soils**		**Saline soils**		**Non-saline soils**	
	RMSEP	**R^2**	**RMSEP**	**R^2**	**RMSEP**	**R^2**	**RMSEP**	**R^2**
pH	0.064	0.77	0.058	0.735	0.074	0.683	0.052	0.764
EC	0.425	0.38	0.056	0.773	0.414	0.018	0.056	0.784
SOM	0.155	0.808	0.21	0.483	0.13	0.84	0.209	0.476
$CaCO_3$	0.515	0.433	0.379	0.626	0.508	0.31	0.441	0.271
CEC	4.65	0.436	6.47	0.44	4.72	0.55	5.85	0.107

EC: Electrical conductivity;SOM: Soil Organic Matter; CEC: Cation Exchange Capacity.

In the study, statistical models between routine soil chemical analyses and NIRS reflectance were made using PLSR method and the results of linear modeling were shown in Table 1. The results showed that for soil pH, grinding or salinity did not impact the estimation results and there were not much difference in the results of ground or unground or saline and non-saline soils and the models provided an average R^2 value of 0.72. In the case of EC, estimation values for non-saline soils were higher (R^2 = 0.77), which showed that high salt concentrations made the estimation of EC more difficult. Especially R^2 values highly decreased in ground saline soils (R^2=0.02). This situation showed that an estimation success of 77 % for non-saline soils was possible with NIRS method. The relation between SOM and NIRS were over 80 % and successful estimations can be made especially in ground saline soils. The success rate was under 50 % in non-saline soils. In the case of $CaCO_3$, it can be seen that groundnon-saline soils could provide higher estimation accuracies compare to others. The values were found the lowest in ground saline soils. When we look at the CEC, the estimations were better in groundsaline soils with 55 % accuracy comparing to others. The lowest estimation accuracy with

0.11 % was obtained for groundnon-saline soil samples.As a result; it can be concluded that the study performed with NIRS technique along with biochar is more effective when the saline and ground soils studied, especially for the estimation of SOM amount easily and quickly.

3.2 Acknowledgements

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Potential of machine learning techniques for estimating soil water capacity

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Abstract

Accurate information about soil water capacity parameters are very important for calculating irrigation scheduling, drainage, surface runoff, determining water availability in the soil, and crop growth simulations. In addition, exact information about soil moisture is very necessary to make better management about fertilization. Field capacity (FC) and permanent wilting point (PWP) are two important soil water capacity parameters. These parameters are measurable parameters, so they need direct measurement in the field and laboratory. However, these processes are time consuming, laborious and expensive. There are more economical and less time consuming methods are existed that they are called mathematical methods like pedotransfer functions. Unfortunately, these methods are very difficult to develop due to its nonlinear dynamic complexity. These mathematical approaches use some soil parameters input such as soil texture, bulk density, organic matter, organic carbon, cation exchange capacity and geometric mean particle size. However, these input variables are not always available to estimate FC and PWP. Another limitation is that these input variables are not enough to get significant result in some local area. Thus, estimation of FC and PWP needs to be adopted for regional scales under different soil characteristics. Over the last few years, innovative approaches such as machine learning techniques have successfully been applied to estimate soil water capacity. The results demonstrate that machine learning techniques have better statistical results than pedotransfer functions.

Keywords: Soil water capacity, field capacity, permanent wilting point, available water, machine learning

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Effect of Phosphorus (P) Level Application on Soil Structure Development

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Abstract

Increased human population have significant effect on soil to provide sufficient production for foodsafety. In order to provide this increasing food demand, various agricultural practices are carried out; however, fertilization, soil tillagewhich have negative effects on soil physical, chemical, biological health and soil sustainability. Soil sustainability is directly related with soil fertility as well asmanagement of crop and soil. Soil sustainability is also effected with soil parameters such as texture and structure development. Structure development is further influenced by several soil, plant root and microorganism's factors. Increasedfertilizeruse haspositive and negative effects on soil structure development. Aggregate stability, which is one of the most important parameters of soil physical properties which can be disturbed by intensive fertilization.

The aim of this study is to investigate the effect of long term differentphosphorus level application on structure stability of soil.The hypothesis tested in the study islong term phosphorus applications negatively affects the aggregate stability of the soil.

The research was carried out in Çukurova University Research and Application Farm under field conditions and Adana-99 wheat varieties were used. The experiment was carried out by applyingfour different phosphorus doses.

After harvesting, Rhizosphereand non-rhizosphere soil samples were collected from 0-15 cm and 15-30 cm depth. Wet sieving was done by using a nest of five sieves (4.75, 2, 1, 0.5, 0.25 and < 0.25 mm). Aggregates retained on each sieve were backwashed with deionized water for determining WSA. Aggregate size distribution was used to compute the mean weight diameter (MWD). The resultsshowed that, the water-resistant aggregate and average weighted diameter decrease with increasing phosphorus dose application. It seems that applying phosphorus fertilizer, soil aggregate formation is depredated. Similar results were previously found in the same research work. The result is very important for better soil and crop management for sustainable agriculture. The obtained data gave support to our hypothesis.

Key words: water-stable aggregates, phosphorus fertilizer, long term field condition.

1. Introduction

Nowadays, human population is increasing rapidly. Increasing human population brings with it many problems and demands. At the beginning of these problems and demands sufficient and healthy food demand. People apply various agricultural administrations to provide adequate food. fertilization programs are the leading agricultural administrations. Unconscious and over-applied fertilizers endanger the health and sustainability of the soil. For sustainable agriculture, soil health is very important. The physical, chemical and biological

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properties of soil and soil health are closely related. Wrong and extra fertilization programs disrupt the physical chemical and biological properties of the soil and endanger sustainable agriculture. The most important parameter of the physical property of the soil is undoubtedly the aggregate stability. Aggregate stability affects soil water holding capacity, airing, nutrient mobility, so aggregate stability is closely related to sustainable agriculture and soil health. Improper and excess fertilizers applied destroys the aggregate stability of soils. Plant management is also very important for sustainable agriculture. The plant roots increase the diameter of the aggregates with the secretions they secrete in the soil and provide the formation of water-resistant aggregates. The results of (Liu et all., 2019) show that plant root and their rhizosphere effects significantly influence soil aggregate formation and aggregate stabilization. Plant residues remain in the soil as a source of organic matter, which increases the stability of the aggregate. Soil aggregate stability has been involved to organic matter content (Tisdall and Oades, 1982).

Aggregation is defined as the combination of sand, clay silt fractions in the soil under the influence of various factors, forming groups. soil aggregation is very important for mediates numerous chemical, physical, and biological properties and improves soil quality and sustainability (Moreno-de las Heras, 2009). Aggregation can change over time and this change can occur in a certain period of time. The aggregates formed can disintegrate and occur repeatedly (Hillel, 1982). Aggregation and structural stability in soil are two important parameters that affect the fertility potential of soils. Aggregation in soil plays an important role in the relationship between plant-soil, root development and respiration, gas exchange in the soil and consequently the development of the plant. The higher the aggregate stability of a soil, the greater its resistance to erosion. One of the main problems for soils is soil erosion. Moreover, the high amount of water resistant aggregate prevents soil erosion, which is one of the main factors in soil degradation (Dinel et all., 1991).

The aim of this study is to investigate the effect of long term different phosphorus level application on structure stability of soil.

2. Materials and Methods

The work was conducted at the Çukurova University Agricultural Experimental Station of the Soil Science and Plant Nutrition Research Center in the Mediterranean region of Adana, Turkey. The experiment was established in 1998, and since then it is continued through 2019 with two consecutive crops years: wheat in winter and maize in summer terms. The experiment also set up Arik soil series which is classified as typic Haploxererts. There is a typical Mediterranean climate with a long-term average annual air temperature of 19.0 °C (ranging from 14.3°C in January-February to 25.6°C in July – August), and precipitation of 650-680 mm. About 75-80% of the annual precipitation is received during November and April.

The experiment was set up with four treatments such as (1) P0 control, (2) P1 50 kg P_2O_5 ha^{-1}, P2 100 kg P_2O_5 ha^{-1}, and P3 200 kg P_2O_5 ha^{-1} as 3Ca $(H_2PO_4)_2.H_2O$ and experiment comprised of 12 plots laid out in a randomized block design with three replications, and plot dimensions of 10X20 m at2018. Also, plants delivered 160 kg N ha^{-1} as $(NH_4)_2SO_4$, for wheat and 200 kg, N ha^{-1} as $(NH_4)_2NO_3$ for maize. Residues of maize and wheat were not removed in the field and they were incorporated by moldboard ploughing to 15- cm depth after each harvest. Soil physical, chemical, and biological properties are presented in Table 1.

Table 1. Soil initial physical, chemical and biological characteristics of Arık soil series

Properties	Unit	Depth 0-15 cm	
Clay	g kg^{-1}	535	±15
Silt		291	±35
Sand		174	±44
Soil Organic Carbon	g kg^{-1} soil	0.87	±0.07
Inorganic carbon		3.44	±0.42
Total nitrogen		0.09	±0.01
CEC	$Cmol^{+}$ kg^{-1}	35	±1.00
pH	H_2O	7.60	±0.50
Salt	%	0.032	±0.03
P	mg kg^{-1}	13.52	±1.44
K		1102.2	±14.9
Number of mycorrhizae spores	10 g^{-1} soil	73.0	±22.00

Mean of two replicates ± SD.

Soil Sampling, Preparation, and Analyses

Non- distributed soil sample was obtained from 0-15 cm and 15-30 cm depth of rhizosphere and non-rhizosphere after the harvest of wheat from each replicate of all treatments.

Mean Weight Diameter and Soil Water Stable Aggregate (WSA) Analyses

For wheat plant soil samples were collected at 2018. After air-dried bulk soil samples were gently crushed and sieved through 8 mm sieve. 8 g of aggregates were used for the wet-sieving technique (Yoder, 1936; Youker and McGuiness, 1957). Soil aggregates on different sieves were oven dried at 40°C, and the mean weight diameter (MWD) was determined (Nimmo and Perkins, 2002; van Veen and Kuikman, 1990).

3. Results and Conclusion

Soil aggregate stability and mean diameter is an important aspect of soil function and health. Fertilization can potentially enhance soil properties and thereby affects aggregate stability Aggregate stability and aggregate diameter decreased with increasing phosphorus doses but this decrease was not statistically significant.

Table 2. Under long term field experiment, the effects of different level P fertilization on wheat plant 0-15, 15-30 deep MWD and water aggregate stabilization at the year 2018.The results showed that, the water-resistant aggregate and average weighted diameter decrease with increasing phosphorus dose application. In control treatment, in 0-15 cm soil depth, MWD is 3.61 mm and in P 200 treatment is 2.54. Similar results were got in 15-30 cm soil depth.

WSA % also was determined and with increasing P fertilizer level increase WSA % is decreased. It seems that under long term phosphorus fertilization soil aggregation was negatively effects.

In generally aggregate development in 0-15 mc depth is bigger than 15-30 cm. But it is not statistically significant.

Table 2. Under long term field experiment, the effects of different level P fertilization on wheat plant 0-15, 15-30 deep MWD and water aggregate stabilization at the year 2018

Fertilizer	0-15 cm				15-30 cm			
Treatments	MWD mm		% WSA		MWD mm		% WSA	
Control	**3.61**	±1.07	82.06	±13.42	**3.44**	±0.84	81.68	±6.20
P*50	**3.02**	±0.84	83.21	±4.45	**2.63**	±0.41	78.72	±2.44
P100	**2.13**	±0.25	77.19	±9.21	**2.41**	±0.50	82.99	±3.90
P200	**2.54**	±0.10	77.74	±2.74	**2.52**	±0.05	76.30	±2.07
MEAN	**2.83**	**±0.57**	**80.05**	**±7.46**	**2.75**	**±0.45**	**79.92**	**±3.65**

*P source was P_2O_5 kg^{-1} soil. Means (±SE) within 3 replicates. ns: There is no statistically significant difference

It seems that, applying phosphorus fertilizer, depredated soil aggregate formation. Similar results were previously found in the same researches. The results of (Šimansky and Tobiašova, 2008) show that application of NPK fertilizers alone decreased the content of TOC by 15% in size fraction of WSA 0.25–0.5 m and by 19% in size fraction of WSA 1–2 mm in comparison. Application of mineral fertilizers to the soil decreased TOC content.

Under 12-year fertilization application there is a larger effect of fertilizer on aggregate stability and related soil properties in a 0–15 cm soil layer, whereas no effect was evident at a soil depth of 15–40 cm. MWD(Guo et al., 2019)

It has been observed that the organic wastes left from the plants improve the physical chemical and biological properties of the soil and also increase the aggregate stability and aggregate diameter.

In the study, it was determined that there is a positive relationship between the aggregate stability with the soil organic matter and clay content.It has been determined that the application of organic material to the soils which are poor in organic matter has a positive corrective role in improving the soil organic matter content, aggregate stability and soil permeability(Canbolat, 1992).

Finally, the results showed that, the water-resistant aggregate and average weighted diameter decrease with increasing phosphorus dose application. It seems that chemical fertilization has a negative effect on aggregation. This is an important founding for future soil management.

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The Effect of Using Organomineral Fertilizer on Soil Nitrogen Processes

Efsun DİNDAR[1]

Abstract

This study aimed to evaluate the effect of solid organomineral fertilization on soil nitrogen processes under optimum conditions. To evaluate the effect of different organomineral fertilizer concentrations (50 and 100 t/ha dry soil) on soil nitrogen processes, 100 g soil portions were placed into plastic receptacles, and different amounts of OMFs were added with distilled water to bring the soil to 70% of its field capacity. Samples were then incubated under controlled conditions in the dark at 28°C for 15 and 30 days-the experiment was planned with a completely randomized design. At each sampling time two sets of soil pots were removed and the NH_4-N, NO_3-N, arginine ammonification rate and nitrification potential were determined.

The results showed that nitrogen related processes in the soil can be used as bioindicators of soil fertility caused by organomineral fertilizer. It was found that ammonium nitrogen levels increased by 71% and 73%, in the presence of 50 and 100 t/ha organomineral fertilizer, respectively. Besides, ammonification rate in soil enhanced 61-80% by addition of fertilizer at the end of incubation.

The nitrification potential of soils amendment with different dose of organomineral fertilizer were lower than the respective control values during incubation. The study was concluded that organomineral fertilization can enhance the nitrogen use-efficiency of plants, thus further increasing the productivity of terrestrial ecosystems.

Keywords: ammonification, nitrification, nitrogen, soil, organomineral fertilizer.

1. Introduction

Organo-mineral fertilizer can be defined as "a fertilizer obtained by blending, chemical reaction, granulation or dissolution in water of inorganic fertilizers having a declarable content of one or more primary nutrients with organic fertilizers or soil improver" (Antille et al.,2013)

Studies carried out by Ayeni (2012) confirmed that organo-mineral fertilizer improves the soil fertility.

Nitrogen (N) is one of the most important nutrients for soil fertility. The nitrogen cycle includes several biological and non-biological processes. The biological processes are: ammonification/ mineralization, nitrification, denitrification, nitrogen fixation, etc.

Ammonification of soil nitrogen is the term used for the process by which nitrogen in organic compounds is converted by soil microorganisms into ammonium ion (NH_4^+) as follows (Guggenberger, 2005). Nitrification is the oxidation of ammonium nitrogen to nitrites and nitrates. The availability of NH_4^+ or NO^{3-} depends on the environmental conditions that affect the production of NH_4^+ and the conversion of NH_4^+ to NO_3^-. Nitrification is important process which is responsible for the N balance in soils (Jetten, 2008). Nitrification potential is a

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method that was first developed as an approach to estimate the biomass of nitrifiers in soil. It aims to determine the maximum capacity of nitrifiers to transform ammonium into nitrate under assumed optimum conditions.

The aim of the present study is to understand the environmental status in agricultural soil through determination of nitrogen processes (ammonium nitrogen, nitrate nitrogen, ammonification, nitrification potential) content due to the organomineral fertilizer dose.

2. Material and methods

2.1. Materials

Soil samples were collected from the top 20 cm of an agricultural field located in Bursa-Balabancık village (Latitude, 40°15′55.1″N; longitude, 28°47′07.55″E). The data presented in Table 1 depicted that the soil used in the incubation study was sandy clay loam in texture (sand: 56.1%, silt: 18.5% and clay: 25.4%).

The solid OMFs samples were obtained from Sütaş-Enfaş Karacabey Fertilizer Plant in Bursa, Turkey. It contains compost, DAP, Urea, Potassium Sulphate, Ferrous Sulphate Monohydrate, Zinc sulfate monohydrate, Manganese Sulfate Monohydrate, other agent.

General characteristics of the OMF and soil are presented in Table 1.

Table 1. General characteristics of the OMF and soil samples.

Properties	**Value**	
	OMF	**Soil**
pH (1:5 deionized water)	5.5-7.5	7.66
EC25 °C (1:5 deionized water, dS m−1)	38.3	0.18
Organic C, %	30	1.25
Total-P, %	10	0.18
Total-N, %	6	0.14
Zn, %	0,2	0,135
Ammonium-N, %	4	7
Nitrate-N, %	2	4

In an effort to evaluate the effect of organomineral fertilizer concentrations on soil nitrogen processes, 100 g soil portions were placed into plastic receptacles and different amounts of OMFs (50 and 100 t/ha) were added with distilled water to bring the soil to 70% of its field capacity. Control soil without OMFs was also included. Samples were then incubated under controlled conditions in the dark at 28 °C for 15 and 30 days. The experiment was planned with a completely randomised design. Water loss by evaporation was compensated daily using distilled water to maintain soil water content. At each sampling time two sets of soil pots were removed and the NH_4-N (day 15 and 30), NO_3-N (day 15 and 30), arginine ammonification rate (day 15 and 30), nitrification potential (day 15 and 30) were determined.

2.3. Laboratory analysis

The arginine ammonification rate was determined by treating 2 g soil with 0.5 ml of arginine solution (2 g/l) at 30° C for 3h followed by extraction with 20 ml 2M KCl (Alef and Kleiner, 1986). Ammonium concentrations in the extracts were determined using the indophenol blue method (Keeney and Nelson,1982). The arginine ammonification rate was calculated as the difference between the arginine-treated and untreated sample values. Arginine ammonification activity was expressed as µg NH_4^+–N.g^{-1} dw soil h^{-1}.

Nitrification potentials were determined using the shaken slurry method with ammonium sulphate as the substrate (Hart et al., 1994). Samples were incubated on an orbital shaker at 180 rpm at 25°C for 24 h. Nitrate from the centrifuged supernatant at 0, 4 and 24 h was measured using the salicylic acid method as described by Cataldo et al. (1975) Rates of NO_3^- formation were calculated using linear regression analysis and nitrification potential was expressed as µg NO_3 –N.g^{-1} dw soil h^{-1}.

3. Results and Discussion

3.1. Nitrification potential and NO_3-N levels

Accurate determination of nitrification potential essential to understanding nitrogen-cycling processes. The effect of organomineral fertilizer on the nitrification potential of the soil investigated is shown in Fig. 1. The nitrification potential of control soil did not change under incubation conditions during time.

The nitrification potential of soils amended with 50 and 100 t/ha dose of OMFs were lower than the respective control values throughout the incubation period. A marked decrased was observed in 100 ton/ha treated soil for all of incubation. High concentrations of NH_4-N can inhibit nitrification (Smith et al., 1997). During the incubation period, the nitrification potential of the all soil has generally increased.

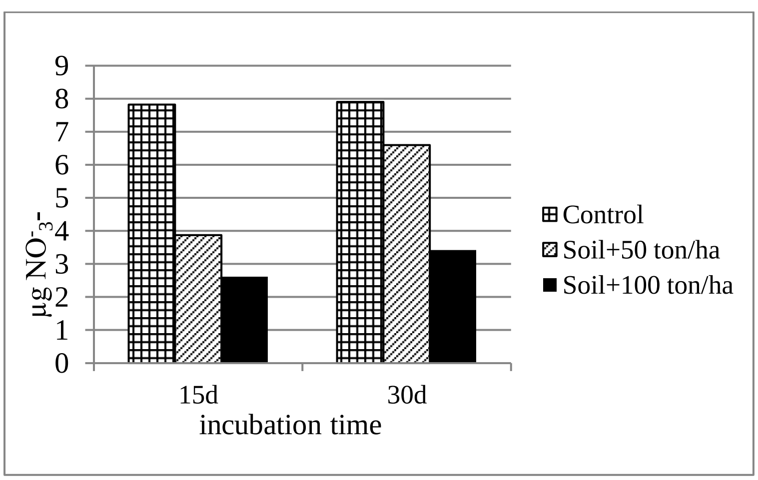

Figure 1. Variation in nitrification potential of soil treated with varying doses of OMF

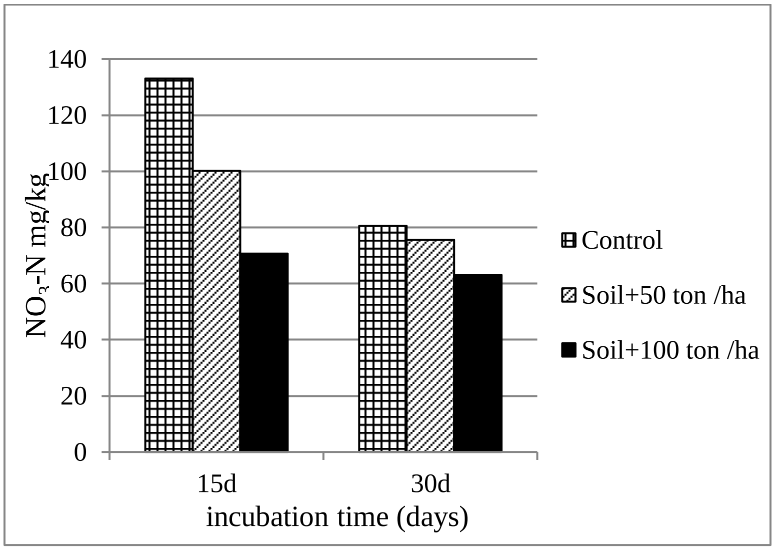

Figure 2. Variation in nitrate concentration of soil treated with varying doses of OMF

Fig. 2 shows the variation in NO_3-N concentration of organomineral fertilizier amended soil throughout the incubation period. The availability of NO_3^- depends on the environmental conditions that affect the production of NH_4^+ and the conversion of NH_4^+ to NO_3^- (Ghaly and Ramakrishnan, 2015). Nitrate has to be reduced to ammonium prior to being incorporated into organic compounds; namely, amino acids in the chloroplasts (Kirkby et al., 2009). The ammonium concentration of all soil tended to decrease under ideal incubation conditions during time. The level of ammonium in soil containing 50 and 100 t/ha OMFs was lower than the respective control values throughout the all days of the incubation. The lowest level was found in soil amended with high doses of OMF.

3.2. Nitrogen mineralisation potential

Mineralization (or ammonification) of soil nitrogen is the term used for the process by which nitrogen in organic compounds is converted by soil microorganisms into ammonium ion (NH_4^+) as follows (Schimel and Bennett, 2004)

Figure 3 shows the rate of arginine ammonification in tire dust and wastewater sludge-treated soil during incubation period. According to result, the rate of arginine ammonification in control soil did not change during incubation.

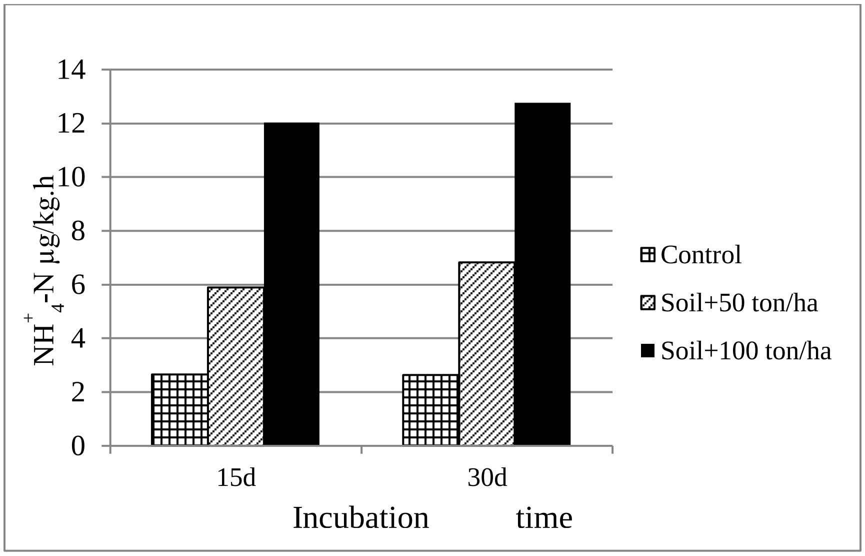

Figure 3. Variation in arginine ammonification rate of soil treated with varying doses of OMF

The effect of organomineral fertilizer application on the ammonium concentration of the soil investigated is shown in Fig. 4.

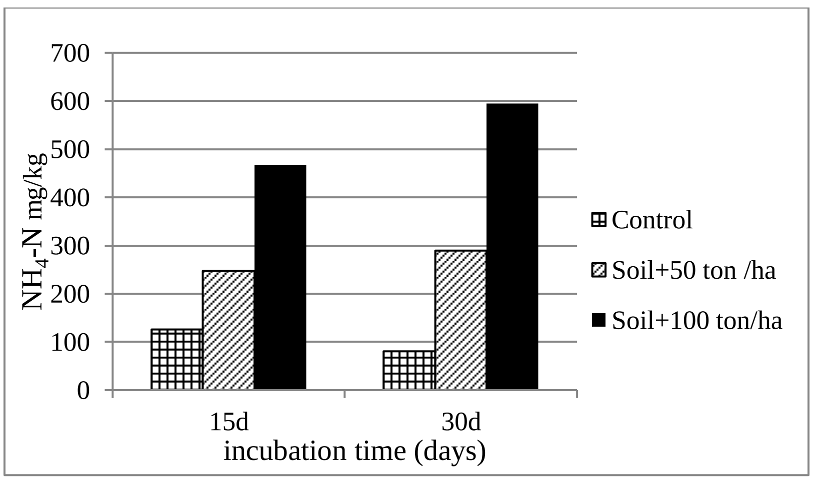

Figure 4. Variation in ammonium concentration of soil treated with varying doses of OMF

The results showed that the addition of OMFs in the soils significantly increased the ammonification rate. The most increased was found in soil amended with high doses of OMFs. Increased the amount of OMFs has increased ammonification rate in all the incubation period.

The ammonium concentration of control soil tended to decrease under ideal incubation conditions during time. The level of ammonium in soil containing 50 and 100 ton/ha OMFs was higher than the respective control values throughout the all days of the incubation. Application of OMFs enhanced the ammonium levels in agricultural soil. Meyer et al., (2001) and Stitt (1999) reported that plants use ammonium as a nitrogen source and show better growth in the presence of nitrate.

Conclusions

Results of this study indicated that levels of nitrate nitrogen form in amended soil samples were lower than ammonium nitrogen form. The presence of excess ammonium in the soil environment suppresses the assimilation of nitrate by heterotrophic bacteria. The nitrification potential of soils amendment with different dose of organomineral fertilizer were lower than the respective control values during incubation. It was found that ammonium nitrogen levels increased by 71% and 73%, in the presence of 50 and 100 t/ha organomineral fertilizer, respectively. Besides, ammonification rate in soil enhanced 61-80% by addition of fertilizer at the end of incubation.

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Evaluation of Quality Parameters of Vermicomposts Produced in Different Facilities

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Abstract

The organic materials being used as soil conditioners are composted in accordance with the quality standards. Some standards have been developed and widely accepted for thermophilic composting which is the oldest and most common composting method. However, the information on composting by earthworms (vermicomposting), which is an alternative and advantageous composting method, is not detailed and widespread. The aim of this study is to evaluate the quality parameters of vermicomposts produced in different locations. Sampling was made from these vermicomposts, which were producedfrom different feed sources (cow manure sources) and foodstuffs. For this purpose, 14 farmers in Kırşehir/TURKEY those previously attended to a vermicompost producing training and readily producing vermicompost, were selected. Some physical (moisture content, particle size, water holding capasity), chemical (pH, EC, $CaCO_3$, TOC, total N, C/N, P, K, Na, Ca, Mg, Fe, Cu, Zn, Mn), and biological properties (basal respiration, microbial biomass C) of these samples were determined. All samples were determined as between the lower and upper limit values of parameters investigated in this study. According to the results of the analysis, all vermicomposts produced by 14 producers are different from each other and meet the quality criteria. Minimum pH and EC values of samples were determined in Sample 11 (S11) as 7,1 and 503.0 µS, respectively. Maximum TOC and C/N values of samples were determined in S12 as %36,03 and 14,01, respectively. Maximum total N and minimum C/N values of samples were determined in S1 as 3,18% and 9,8, respectively. Maximum biological parameter values of samples were determined in S1. Microelements contents were determined to be well below the upper limits in the all of samples. It has been determined that farmers produce according to quality criteria. This work was supported under the project number 2017-1411 by KOP BKİ TEYAP.

Keywords: Vermicompost Quality Criteria, Organic Soil Conditioner, C/N

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Effect of Different Phosphorus Doses on Corn (Zea Mays L.) Root Growth and Carbon Content

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Abstract

Plants take up mineral nutrients and water from the soil through roots systems. Healthy root growth means healthy plant growth. Since plant roots have a high surface area, the roots take up mineral nutrients for better nutrient absorption and growth. Furthermore, after harvesting, an important proportion of root biomass (as residual plant parts) is remaining in the soil which is the main source of soil organic carbon (SOC). Soil fertility and soil quality are directly related to SOC content. In this respect, plant root systems are very important not only for plant growth also important for soil deployment and soil sustainability. Plant root growth is an effect of soil phosphorus concentration. Plant root is very sensitive to soil P concentration especially for root and mycorrhizae development. The purpose of this study is to understand the effects of different phosphorus doses on plant root growth parameters. The tested hypothesis is the increasing phosphorus (P) doses can increase root growth. A long term field experiment was established in 1998 and since then regularly each year control (0), 50, 100 and 200 kg P_2O_5 ha^{-1} P fertilizers were applied as triple superphosphate. For this work, maize seeds were sown in June 2017 as a second crop after wheat and maize were harvested at October 2017. At harvest for each plot unit, per square meter area's all roots were collected at 0- 40 cm soil depth with three replicates. All the collected roots were washed and fresh root was recorded. Plant roots growth parameters such as length, diameter, volume and surface were analyzed by WinRhizo. Specific root surface area also was calculated by using root day meter and total surface area. Also total plant root dry meter was determined. Root concentration and total carbon uptake were calculated. The obtaining data are shown that with increasing P doses, plant root length, surface and volume was increased. Root C uptake increase with P fertilizer doses increase. I have been concluded with P doses application a considerable P remained in the soil. And the remained root increased SOC content. For sustainable and eco-friend production it is important to enrich soil organic carbon content through root residual in the soil.

Key Words: Phosphorus, Fertilizer, Root growth, Corn.

1. Introduction

Soil plant nutrition amount directly affect root growth (Zhang, Zhang, et al., 2016) parameters like (length, surface, volume and diameter) and root growth directly affect the ability of a plant to take up nutrition and water. There was relationship with soil P content and root growth (Frossard, Bünemann, et al., 2016). In addition to, root growth is controlled by actively photosynthesizing leaves (Rayburn and Sharpe, 2019).Knowledge of the sources of C and their decomposition to form soil organic matter (SOM) is crucial for understanding the terrestrial C cycle (White, Coale, et al., 2018).It was known roots could fixation to C (Vuorinen and Kaiser, 1997) by photosynthesis metabolism. It means that roots can increase soil Organic Matter (OM) as plant residual.

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It could be used for CO_2 mitigation. The atmospheric CO_2 concentration has increased to approximately 410 ppm (Anonymous, 2019) from the pre-industrial level of 280 ppm and it is estimated to reach 490–600 ppm and 730–1020 ppm by the middle and end of this century (Wang, Feng, et al., 2013). Soils have the largest carbon storage of the terrestrial carbon cycle (Kumar, Pandey, et al., 2006). The important wayto mitigation atmospheric CO_2 has SOM(Paustian, Cole, et al., 1998). We must increase SOM by residual roots.

In this respect, it can be a farm strategy that roots can use for mitigation of atmospheric CO_2 Green House Gas (GHG) emission. We must mix the plant parts especially roots to soil to store carbon the soil. The purpose of this study is to understand the effects of different phosphorus doses on plant root growth parameters. The tested hypothesis is the increasing phosphorus (P) doses can increase root growth.

2. Material and Method

2.1 Material

A long term field experiment was established in 1998 and since then regularly each year control (0), 50, 100 and 200 kg P_2O_5 ha^{-1} P fertilizers were applied as triple superphosphate. For this work, maize seeds were sown in June 2017 as a second crop after wheat and maize were harvested at October 2017. At harvest for each plot unit, per square meter area's all roots were collected at 0- 40 cm soil depth with three replicates. All the collected roots were washed and fresh root was recorded.

2.6 Methods

Plant roots growth parameters such as length, diameter, volume and surface were analyzed by WinRhizo. Specific root surface area also was calculated by using root day meter and total surface area. Also total plant root dry meter was determined. Root concentration and total carbon uptake were calculated.

3. Results and Conclusion

3.1. Root Growth Parameters

As shown in Table 1, there was statistical significant ($P<0.05$) different to root length. Increasing doses P were increase root length. In addition, there were no statistical difference but on average, different P doses were increased root surface area and root volume. When we look root diameter in table 1 there was no statistical difference. Because of root diameters can change, it was normal.

Table 1. Effects of different P doses on root growth parameters.

Application	Root Length ($km\ da^{-1}$)	Root Surface ($m^2\ da^{-1}$)	Root Volume ($m^3\ da^{-1}$)	Root Diameter (mm)
P0	1961 b	2260	0.21	0.37
P50	2114 b	2808	0.26	0.44
P100	2928 ab	3361	0.27	0.36
P200	3406 a	3550	0.30	0.33

There are many studies describing the relationship between soil nutrient content and root development (Zhang, Zhang, et al., 2016). It is known that the relationship between phosphorus fertilization and plant roots growth.Plants can use their root systems to reach a large soil volume for Pabsorption(Frossard, Bünemann, et al., 2016). The morphology and size of roots were alsoaffected by soil P available (Paulsen, Köpke, et al., 2016).

3.2. Root Carbon Fixation

As shown Figure 1, increasing P doses were improved root carbon fixation.Increasing P level application increased P fixation. On average, P 200 application given the highest C fixation. The lowest C fixation was obtained with control application. Since atmospheric CO_2emission has effects on climate change and consequently have effects on ecosystem and human life, it is important to fix CO_2 through photosynthesis.This fixed carbon can be storage in the soil as a soil organic C storage(Kumar, Pandey, et al., 2006).

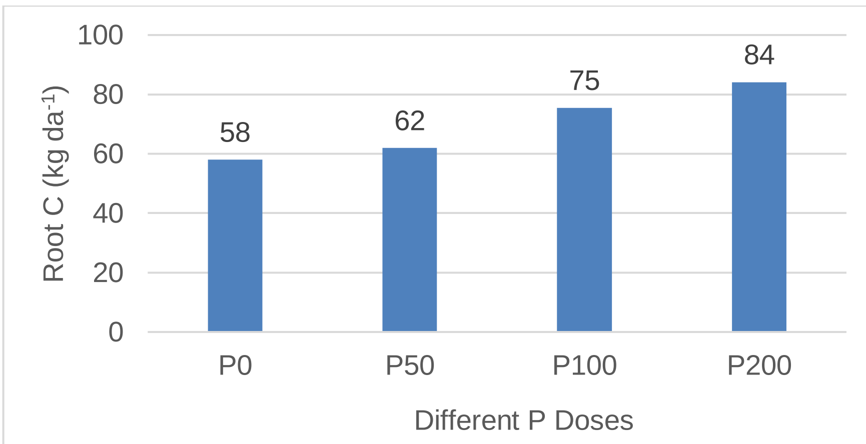

Figure 1. Effect of different P doses application on root C fixation.

Relationship in between root parameters and carbon fixation was searched. It seems that there is a significant correlation in between root length root carbon content (Table 2). Also there is a positive relationship in between root surface are and C content. This relationship is very important for sustainable carbon management through P fertilization.

Table 2. Spearman's rho Correlations among root growth parameters and C

n=12	Root Length (km da^{-1})	Root Surface (m^2 da^{-1})	Root Volume (m^3 da^{-1})	Root Diameter (mm)	C (kg da^{-1})
Root Length (km da^{-1})	1.00				
Root Surface (m^2 da^{-1})	0.82^{**}	1.00			
Root Volume (m^3 da^{-1})	0.36	0.78^{**}	1.00		
Root Diameter (mm)	-0.55	-0.11	0.32	1.00	
C (kg da^{-1})	0.61^{*}	0.49*	0.18	-0.49	1.00

**:p<0.01, *:p<0.05

Consequently, in order to mitigatethe atmospheric CO_2, we must use plant species have high root leant and surface area which have a relation with carbon fixation. Also it is important to keep roots residuesin soil to increase soil organic carbon content. In this respect, it is clear with increasing P fertilizer application C fixation throughphotosynthesis is increase and this increase is related with root length and root surface increased.

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Biochar Production From Maize (Zea Mays) and its Physico-Chemical Characterization

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Abstract

The work was conducted at Çukurova University, Rhizosphere laboratory and is based on physico-chemical characterization of biochar, which was produced from Maize at 700 °C for time period of 2 hours in a muffle furnace having deficient oxygen and was crushed mechanically using a mortar and pestle, passed through 2 mm mesh sieve. Different morphological characteristics and physico-chemical properties were analyzed by determining the pH and Electrical conductivity of biochar which was 7.6 and 2.1dS/m respectively, Scanning Electron Microscopy (SEM) analysis showed different pores in biochar surface indicating the internal water contents and volatile hydrocarbons which were evaporated lost during carbonization. Inductively coupled plasma mass spectrometry (ICP-OES) was performed to quantitatively determine the macro and micro nutrients such as P, Ca, K, Mg, Cu, Mn, Zn, Fe. Besides these, EDX showed the 76 % Carbon along with (O, Au, K, Ca). The same 76/1.54 % age of C and N was also investigated by CN analyzer.

Our results recommend that biochar produced from maize (Zea Mays) having insoluble both macro and micro nutrients as well as CN make them plant-available and can be used as ecofriendly fertilizer for the plant growth and have the potential to remediate the contaminants naturally or artificially present in the soil. The produced biochar is porous in nature which can increase water holding capacity of the soil and act as refuge for the microorganisms.

Key Words: Biochar, Maize, SEM, ICP-MS, characterization, XRD, contaminants.

1. Introduction

Climate change is one of the most important challenges faced by the modern world. In many developing countries efforts are taken to reduce avoidable greenhouse gas emissions or off-setting unavoidable emissions through sequestration of C(Lehmann, Gaunt, et al., 2006).Biomass is the world's fourth largest energy source and the first in developing countries representing 14 and 35 %of primary energy (Hall, Rosillo-Calle, et al., 1992). Globally, biomass has an annual primary production of 229 billion oven-dry tons (Hall and Rosillo-Calle, 1998) and India produces nearly 370 million tons of agricultural. Forest/biomass wastes per year(Pappu, Saxena, et al., 2007). Among all the available lignocellulosic biomass, agricultural wastes such as corn Stover, wheat straw and rice straw are produced in huge amounts globally (Loow, Wu, et al., 2015). Biomass stands a greater chance of prevailing as a good source for the production of biochar, which in turn can be a solution for waste management. The abundance and availability of agricultural by-products make them good material for biochar production and excellent source for waste management(Sugumaran and Seshadri, 2009).

Biochar is a fined-grained, black, solid, carbon-rich (70-80 %) porous substance produced from thermal decomposition of biological wastes (e.g. wood waste, agriculture biomass waste and manure) in the absences of oxygen at relatively low temperature (< 300°C) (Lehmann, da Silva Jr, et al., 2002). Biochar has a large surface area and high porosity, tending to increase with increasing pyrolysis temperature until around 850

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°C (Brown, Kercher, et al., 2006, Lua, Yang, et al., 2004). Many biochar products have alkaline pH(Gaskin, Steiner, et al., 2008). which can decrease soil acidity, creating a more favorable habitat for many plants and microbes. biochar has high capacity to absorb cations and anions from solutions, including a variety of polar and nonpolar organic compounds. Wood derived biochar have a cation exchange capacity (CEC) up to 490 cmol C/Kg (Radlein, Piskorz, et al., 1997)and anion exchange capacity (AEC) of 88.2 cmol C/KG (Fujita, Tomooka, et al., 1991). Biochar application to the soil has been reported to boost soil fertility and improve soil quality resulting in increased crop yields.Soil benefits include raising soil pH increasing water holding capacity, improving cation exchange capacity (CEC) and retaining nutrients (Glaser, Haumaier, et al., 2001) Biochar is a low-cost product and has been tipped as an excellent soil amendment for sequestering carbon, for increasing organic carbon, water retention and to provide a preferred habitat for soil microbes(Stavi and Lal, 2013).

In the present study, perishable wastes such as pea pods, cauliflower leaves and orange peel wastes were used for the production of biochar and both the biomass and biochar were characterized biochemical, pH, EC, CEC, SEM-EDX, Micro and macro nutrients, elemental analysis,

2. Material and Methods

2.1 Biomass collection

Biomass (Maize waste) was collected from the research land of soil sciences and plant nutrition department, Cukurova University, Adana, Turkey, for the production of biochar.

2.2 Biochar Production

The dried Maize sample (2–3 mm particle size) was placed in a cylindrical stainless steel fixed bed reactor of 43 mm height and 60 mm internal diameter. The reactor was placed inside a tubular electric furnace connected to a temperature and heating control system, the reactor temperature was regulated using a temperature controller. The char sawdust samples were collected for analysis.

2.3 pH and Electrical Conductivity

The Electrical Conductivity, as well as the pH of the biochar, was determined by soaking the biochar with deionized water at a 1∶5 solid/water ratio for 24 h.

2.4 Moisture, Volatile Matter and Ash Contents

The moisture, volatile matrix (VM) and an ash content of biochar were evaluated following the standard ASTM D1762 – 84 methods (ASTM, 2007). 5g of mechanically crushed biochar sample was weighed into a pre-heated crucible and heated at 500°C for 5 hours. The crucible was then cooled to room temperature and weighed again followed by calculating the ash content by the following formula.

Ash content (%) = weight of ash content (g)/ dry mass of the biochar (g) × 100.

2.5 Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-OES)

Extraction in the acid medium was performed to quantitatively determine the micro Nutrients (Fe, Zn, Cu, Mn) as well as macronutrients such as (Ca, K, Mg and P) according to the methodology of Amaral Sobrinho. biochar sample obtained at 700 °C were studied by ICP-OES to determine their elemental characteristics,

2.6 Scanning Electron Microscopy (SEM)

In order to examine the surface morphology, porosity etc. the biochar sample was analyzed by high resolution scanning electron microscopy (HRSEM) in a JEOL 7600F electron microscope with an acceleration of 30 kV and a theoretical resolution of 1 nm. For this analysis, a solid sample was homogeneously dispersed in pure ethanol was deposited on a Cu grid, previously covered with a thin layer of biochar.

2.7 Carbon-Nitrogen Ratio

The elemental composition of C and N was determined against 2 gm Aspartic Acid (Bremen- Germany $C_4H_7NO_4$) having 36.09 % C and 10.52 % N as standardusing an elemental analyzer (Thermo Finnigan EA-1112, Thermo Fisher Scientific Inc, MA, USA

3. Results and Discussions

3.1 Biochar Production

Biochar was produced at 700°C in muffle furnace and was mechanically crushed to finely powdered form and was stored for further observations. Some figures of the produced biochar are given below.

Figure 1. Images of biochar produced at 700 °C.

3.2 pH and Electrical Conductivity

pH and electrical conductivity was determined by above mentioned protocol and it was found that the pH of the produced biochar is 7.6. It is because of the different cations which were released from the feedstock during processing at high temperature. In the same way EC was also measured which ranged up to 2.4. This is also optimum for the growth of plants. Because plants can tolerate the EC above than 4 dS/m.

3.3 Moisture, Volatile Matter and Ash Contents

Moisture, volatile matter and ash contents are determined by placing the finely-grained biochar sample in furnace having temperature 500 °C. So the moisture contents of biochar ranged from 6 to 13 %, ash ranged from 3 to 19 % and VM ranged from 50 to 78 %.

3.4 Inductively Coupled Plasma Mass Spectrometry (ICP-OES)

As biochar was produced from agricultural waste so its micro and macro nutrients were quantitatively determined through ICP-OES. The results are graphically represented bellow. These all macro-nutrients are important for the growth of plants and increase the final yield up to 20 %. In the same way the micro-nutrients were analyzed which are mentioned in the following Figure 2.

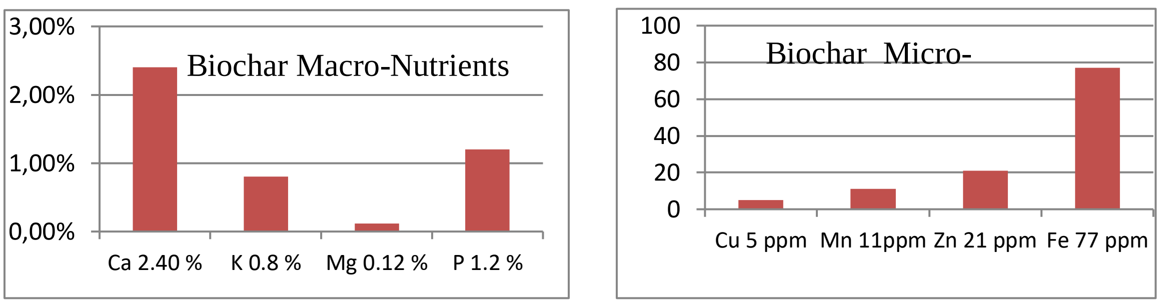

Figure 2. Graphical Representation of Macro-Nutrients

3.5 SEM- EDX Analysis

The SEM image of biochar in Figure3 and 4 were like a molded skeleton with small pores and uneven surface structure. But in op SEM image, the biochar had broken edge with tarry deposits on the surface. Generally, these biomass wastes contain low lignin and high volatile matter content which affects the pore creation in biochar (Lehmann, et all. 2011). The energy dispersion X-ray of the biochar sampleFigure3 and 4 indicatedthat sample had more minerals (C,O, K, Ca, Au).

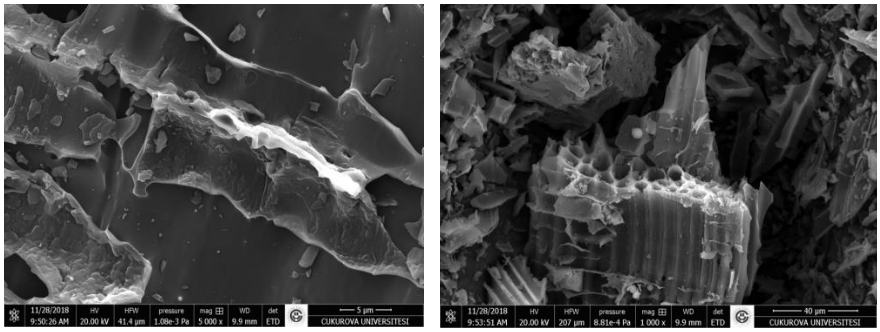

Figure 3 and 4. Scanning electron microscopy of biochar.

3.6 Elemental Analysis

Elemental analysis such as C and N was carried out by elemental analyzer at 900 °C. In which biochar sample (3.5 to 5.5 mg) was taken and was run against aspartic acid as a standard and the results of elemental analysis are indicated below in Figure5.

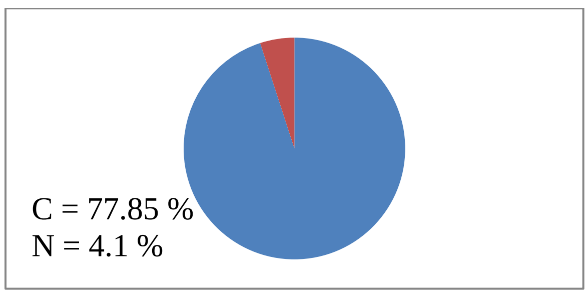

Figure 5. Graphical representation of C and N of biochar

4. Conclusion

A laboratory study was conducted to characterize the biomass waste viz maize plants which were carbonized at 700°C. The biochar had higher values of organic carbon, total surface anions, water holding capacity and mineral content for use as a best soil amendment. This finding is important to establish the biochar as an effective medium for increasing soil carbon, irrigation effectiveness, runoff mitigation and reducing non-point source agricultural pollution, apart from this, the reduction of voluminous waste biomass to produce biochar through pyrolytic process provides possible ways to solve the management and disposal of the waste biomass in an efficient manner.

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Effects of Some Organic Materials and Inorganic Fertilizers on Germination Parameters of Fenugreek (*Trigonella Foenum Graecum*) and Some Soil Properties of Growth Media

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Abstract

In this study determination of effects of tea waste (TW), spent mushroom compost (SMC) and inorganic fertilizers (IF) on germination parameters of fenugreek (Trigonella Foenum Graecum) and some soil properties of growth media was aimed. The experiment was carried out according to factorial experiment and with three replications in 54 pots.

The lowest germination rate (62.22%) was determined at TW_2xIF_2 application. The highest germination rate (93.33%) was found at TW_0xIF_1 and SMC_0xIF_0 applications. The shortest germination time 4.77 day was observed at TW_0xIFG_0 application while the longest germination time 6.81 day was observed at TW_2xIF_2 application. The shortest germination time 4.77 day was observed at TW_0xIFG_0 application while the longest germination time 6.81 day was observed at TW_2xIF_2 application. The highest pH and EC means were found as 7.39 and 2.01 dS m^{-1} at SMC_0xIF^2 and SMC^2xIF_2 applications while the lowest pH and EC means were determined as 6.49 and 0.10 dS m^{-1} at TW_0xIF_0 application. Generally, increasing pH and EC levels growth media negatively affected germination parameters. The lowest and highest organic matter contents of growth media were obtained as 1.22 % and 6.79 % at TW_0xIF_2 and SMC_2xIF^1 applications. Waste mushroom compost was found more effective on organic matter content of growth media among applied materials.

Keywords: Wastemushroom compost, tea waste, fenugreek, germination, soil properties

1. Introduction

Chemical fertilizers used in high amounts cause determination of soil health. Heightened environmental awareness has lead to organic revolution. The scientists focused on the researches related with using of organic materials as comprehensive strategy to save soils from further degradation and convert of organic wastes to environmentally safe manner. Regular additions of organic materials such as animal manures, crop residues, sugar industry waste, and municipal bio-solids are important for sustainability of productivity and fertility of agricultural soils (Solaimalai et al., 2001). Adding organic material into soil is beneficial for maintaining soil quality by improving physical, chemical, and biological soil conditions (Kızılkaya, 2005; Özdemir et al., 2009; Fischer and Glaser, 2012). Many researchers reported that different organic materials applied into soils such as crop residue (Verhulst et al., 2011) or compost (Chalkos et al., 2010) has been shown to be a useful way to increase soil fertility, available nutrient contents, cation exchange capacity and soil water holding capacity (Fixon and West, 2002). Applying inorganic fertilizers with organic materials widely at in last times because of their negative effects on the environment and their future cost. Kolodziej (2006) reported that integrating

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nutrient management with organic manures and inorganic fertilizers increased yield and chemical constituents in *Plantago arenaria*.

Tea waste can be used in agricultural systems as soil conditioners. Tea wastes contain plant nutrients and organic matter, they may be used to supplement or replace inorganic fertilizers in crop production (Gülser and Pekşen, 2003; Siddiqui et al., 2011). Using the spend mushroom compost as organic manure is solution to utilize this spend organic matter in a better way. It is converted into quality manure for crops because of its rich organic matter content, near natural pH and beneficial microbial population (Gülser and Pekşen, 2003).Fenugreek (*Trifonella foenum graecum*) is annual crop, usually used as a spice in many parts of the world but also used as a forage crop, in some areas (Acharya, 2006). It is known as one of the oldest medicinal plants and has long been recognized as a traditional medicine in Asia, Africa, and Mediterranean countries (Acharya, 2007).

In this study effects of tea waste and spend mushroom compost on germination time of fenugreek and some soil properties of growth media were investigated.

2. Materials and Methods

This study was carried out according to factorial experimental design with three replications in 54 pots under controlled conditions at 25±1°C in chamber room of Soil Science and Plant Nutrition Department in Agricultural Faculty of Van Yuzuncu Yil University. Three different doses of tea waste (TW_0: 0% Tea Waste, TW_1: 2.5% Tea Waste, TW_2: 5.0% Tea Waste) spent mushroom compost (SMC_0: 0% Spend Mushroom Compost, SMC_1: 2.5% Spend Mushroom Compost, SMC_2: 5.0% Spend Mushroom Compost,) were applied as organic materials to plastic pots when seeds were sown. Fenugreek (*Trigonella Foenum Graecum*) was used as plant material in this study. Fifteen fenugreek seedlings were sown each plastic pot having 3 kg growing media. Then the seedlings were thinned to five after one week following sowing. Inorganic fertilizers doses as Ammonium sulphate (21% N), Triple Super Phosphate (44% P_2O_5) and Potassium Sulphate (50% K_2O) were used after germination (IF_0: 0-0-0 (N-P_2O_5-K_2O), IF_1: 125-50-75 mg kg^{-1} (N-P_2O_5-K_2O), IF_2: 250-100-150 mg kg^{-1} (N-P_2O_5-K_2O)). The experiment was ended after eight week following sowing. Germination time was estimated using the following equation (Ellis and Barrett, 1994).

Organic matter contents, pH and EC values of experimental soils were determined by using standard soil analyses methods reported by Kacar (2009).

$$\textbf{Germination time} = \frac{\Sigma n\ (\text{germ. seed numb. at the counting day})\ x\ d\ (\text{counting date(day)})}{\Sigma n\ (\text{Total germinated seed number})}$$

Statistical analyses were done using SPSS package programs to show difference among the mean values of obtained data from the different applications (SPSS, 2018).

Physical and chemical soil properties of experimental soil had loamy in texture, slightly alkaline, non saline, moderate limely, insufficient in organic matter phosphorus, potassium and zinc contents.

3. Results and Discussion

The variance analyses results belong effects of applications on germination parameters and some soil properties of growth media were given in Table 3.

Table 2. F values of the variance analyses for the germination parameters and soil properties

	DF	pH	Salinity	O.M.	G.R.	G.S.
SMC, TW and IF applications	53	3.57**	77.47**	11.97**	1.70 ns	3.86**

SMC, Spend Mushroom Compost; TW, Tea waste; IF, Inorganic Fertilizer; **, %5; ns, non significant

The changes in pH values obtained in different applications were found significant ($P<0.01$) statistically (Table 2). The pH values decreased while TW and SMC doses increased in without chemical fertilizer applications. In SMC applications with chemical fertilizers, pH values generally shown the increases compared with SMC applications without inorganic fertilizers.

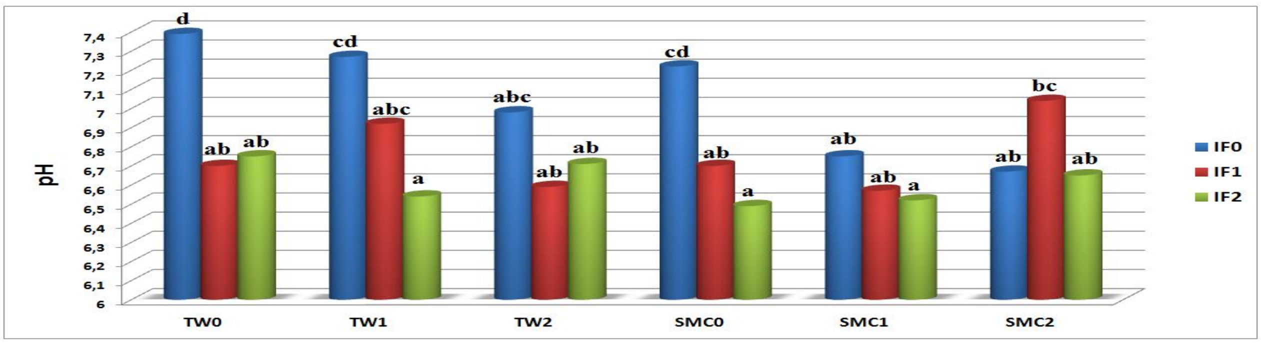

Figure 1. Effects of organic and inorganic fertilizers on soil pH,

Conversely pH values decreased while the IF doses increased compared with in TW applications without inorganic fertilizers (Figure 1).Generally increasing IF doses increased salinity of growth media both TW and SMC applications significantly ($P<0.01$) (Table 2).The salinity values obtained in SMC applications were higher than those in TW applications. Increasing IF doses were increased salinity in both of TW and SMC applications. The lowest salinity values were determined as 101.99 µS cm^{-1} and 2009 µS cm^{-1} in TW_0xIF_0 and SMC_2xIF_2 applications. The TW and SMC applications increased organic matter contents of growth media. If additions also increased organic matter contents in both of TW and SMC applications. In SMC applications organic matter contents obtained in IF_2 doses were lower than those in IF_1 doses (Figure 3). Increasing IF doses lead decreases in organic matter contents in applications without TW and SMC (Figure 3). These changes of organic matter content of growth media were found significant ($P<0.01$) statistically (Table 2).

Increasing TW doses without IF increased germination ratio while the increasing SMC doses without IF caused the decreases in germination ratio.The IF additions decreased germination ratio in TW applications. The IF_1 doses also decreased germination ratio in SMC applications while the IF_2 doses increased germination ratio. The differences among germination ratio were not found significant (Table 2).

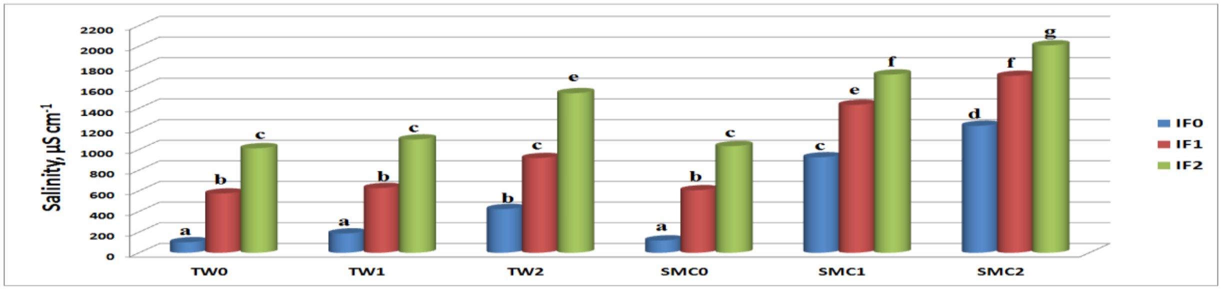

Figure 2. Effects of organic and inorganic fertilizers on soil salinity

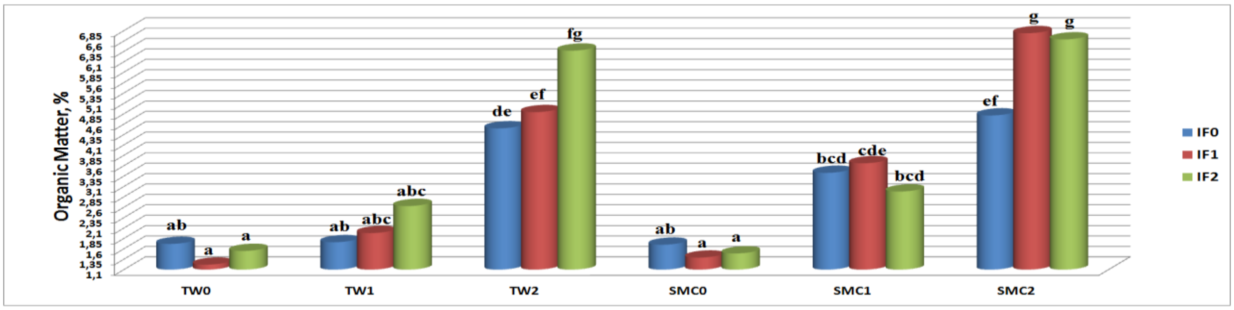

Figure 3. Effects of organic and inorganic fertilizers on soil organic matter,

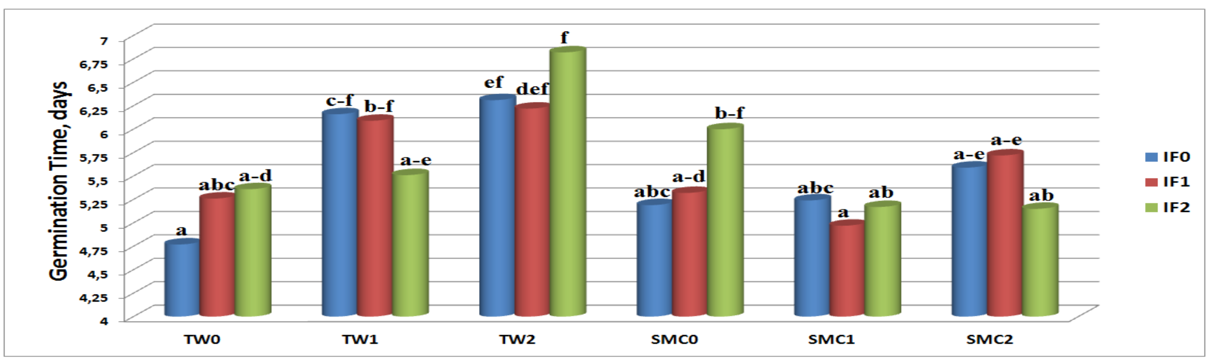

Figure 4. Effects of organic and inorganic fertilizers on germination time

The germination time obtained in TW applications were longer than those in SMC applications in both of with and without IF applications. IF_1 additions extended the germination time in SMC applications while IF_2 additions shortened the germination time (Figure 4). Generally IF additions extended germination times in TW applications. The changes of germination times were found significant ($P<0.01$) statistically (Table 2). In this study increasing TW and SMC doses increased organic matter content and salinity while TW and SMC applications decreased pH value of growth media. Increasing IF doses also increased salinity of growth media and increased pH in SMC applications. Germination ratio and germination time were negatively affected by increasing TW, SMC and IF doses. Similarly Gülser and Pekşen (2003), reported that addition of organic materials such as tea waste, spend mushroom compost etc. increased soil organic matter content and supplied near neutral pH. On the other hand, Mugwel et al. (2009) reported that potential high salt concentration of spent mushroom substances restricted their using as a growing media for salt sensitive plants. Medina et al.

(2009), Vinod et al. (2012) reported that germination ratio decreased because of increasing of relative proportion of spend mushroom compost in growth media. When taking into account results of referred researches and our study it was thought that using of tea waste and spend mushroom compost is a useful way to increase organic matter content and to decrease pH value of growth media. But, these materials may be lead high salinity and may be applied as alone or combined inorganic fertilizers may be negatively affected plant germination parameters.

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Determination of Adaptation of Some Plant Species in the Salt Affected Soils of Malya-Tigem

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Abstract

The classical methods (leaching, drainage, chemical additive etc.) which are used in the improvement of salt affected lands are given up nowadays due to the reasons such as non-affordable increasing costs, taking too much time and emergence of reclamation processes that would require new improvements. In order to solve this problem some countries such as Pakistan, India, Australia and Canada have been implementing the "Agricultural Technology Based on Biosalinity" which is one of the alternative methods. Here, the purpose is to perceive the saline ecosystem as an effective source. This study was conductedin two chosen locations in Malya, Kırşehir which are saline and very saline (o rhaving different salinity levels). The seedling soft a marix (Tamarixramossisima), mahaleb (Cerasusmahaleb, four wing salt bush (Atriplex canescens), knotweed (Polygonaceae) and oleaster (Elaeagnus angustifolis) were planted on thefieldwith3-metergapsontherows having 2.5-meter pitches.Three applications were madewhich are the control, zeolite + leonardite and farmyard manure applications. The analyses were revealed that the soils of the fields were problematic soils originating from gypsum and salinity, the soil characteristics were not homogenous and they changed even in short distances. This situation was more evident in the salinity (1.04-52.60 dS/m) and gypsum (quantitatively low to very) contents. The values of pH (7.02-7.74), organic matter (1.23-3.29%) and lime (9.85-23.9%) demonstrated wide ranges. Considering the plant adaptation, it was observed that the plants found an opportunity to growin the study are a number 1 and demon strated different survival percentages, and the plants did not survive in the study are a number 2 for the duration of the study. According to the percentage of plant adaptation, the best adapted plant was Atriplex canescens in terms of survival percentage (100%) in the study area number 1 at the end of the study period. The survival rates of the plants such as tamarix (98%), mahaleb (39%), oleaster (31%) and the wild apricot (23 %) were revealed. Ephedradistachya, (0%) did not survive. Generally, a positive correlation was determined between the height and the canopy of the plant. The highest value of the plant height was measured in the zeolite application of atriplex (130.33 cm) and the lowest value was measured in the organic fertilizer application of tamarix (67.67 centimeters). Depending upon the applications, the most

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significant difference on the diameter of plants again was determined on atriplex. The canopy of atriplex varied between 120 and 218 centimeters. It was observed that atriplex wasalsores is tant to boron as well as salt. It was determined that atriplexes have maintained their leafage for a long time, formed seeds and that area was a suitable to obtain atriplexseeds.

Keywords: Reclamation, atriplex, ecosystem, saline land management, adaptation.

Temporal Endophytic Bacterial Dynamics of Cucumber; A Culture Dependent and Independent Approach

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Abstract

Microbiological diversity of plants brings forward the level of interaction between the both besides increasing the understanding of endophytic environment. This study was conducted with the premise to determine trend of culturable and non-culturable endophytic bacteria in two different stages encompassing four consecutivest ages of cucumber. Lowest healthy leaves of cucumber were sampled starting from ready-to-be transplanted nursery (stage 1), 1-month (stage 2), 2-month (stage 3) and 3-month (stage 4) after transplanting. For culturable endophytic bacteria, the leaf-stalk was subjected to isolation through standard protocols and obtained colonies were compared by Restriction Fragment ength Polymorphism (RFLP). Different RFLP-types were identified to their nearest neighbor through 16S rRNA sequencing and compared. The non-culturable endophytic bacterial diversity was obtained through next generation sequencing. Results indicated similar trend among culturable and non-culturable bacteria for observed operational taxonomic units and diversity indices. Shannon-Weiner and Simpson Diversity Indices showed increase for first three stages for site1, hence forth decreased. However, for the site 2, diversity kept on increasing until last stage sampled. For instance, site 1 resulted into lower culturable diversity but higher non-culturable diversity when compared to site 2. Temporal persistence of certain culturable and non-culturable bacteria was also observed. Concluding, the endophytic bacterial diversity in cucumber increased with the growth and decreases later in the age. Secondly, plants regulate the density and diversity of endophytes while certain bacteria persist throughout the lifecycle of plants.

Keywords: Temporal, endophytic bacteria, diversity, cucumber

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High Salt Tolerant Plant Growth Promoting Rhizobacteria from the Common Ice-Plant *Mesembryanthemumcrystallinum* L.

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Abstract

Prevalent salinity hinders the plant growth, and efforts for vegetation are limited due to excessive concentration of salts. The microbiome associated with extreme habitats has the potential of inducing stress avoidance, tolerance, and resistance strategies in the host plants for energy requirements. Manipulation of such interactions offers the potential revegetation, and utilization of saline soils, and with the similar objectives, the rhizosphere of Common ice-plant was explored for incident bacteria helping the plant grow better. The isolation resulted in 152 isolates, and above 50% isolates were observed tolerant to 513 mM of NaCl, and the two, PR-3 and PR-6, most promising even showed tolerance up to 1250 mM salinity. Both the strains showed indole acetic acid production, and 1-aminocyclopropane-1-carboxylate deaminase activity, but neither of them had nitrogen fixation ability. Phosphorus solubilization, and siderophore production was shown by either of them. Plant growth promoting (PGP) assay showed significant root elongation when compared with control, which was further confirmed by the pot experiment where the above-ground part of the Common ice-plant also showed significant growth over control. Concluding, rhizosphere bacteria from the halophyte plant showed different PGP abilities, and thus can be applied for improving the growth of associated plant in saline conditions.

Keywords: Salinity, common ice-plant, plant growth promoting rhizobacteria

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Effects of Pyrochars and Hydrochars Obtained from Various Organic Wastes on Soil Bacterial Diversity in Rhizosphere of Maize (*Zea mays*)

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Abstract

Biochar is the product of thermal degradation of various organic materials in the absence of oxygen (pyrolysis), or in the presence of water and high pressure (hydrothermal carbonization). Biochar application to soils can increase the concentration of soil organic matter, especially water-extractable organic carbon and stimulate soil microbial biomass and their activities. As the residence time of biochar in soil is expected to be hundreds to thousands of years, the changes in microbial community structure and functions could persist for a long period of time. Despite increasing attention on the use of biochar as soil conditioner all over Turkey and around other countries, there are limited research activities and knowledge about the supportive effects of biochar in clayey, saline-alkaline and highly degraded soils of Turkey with low organic matter and nutrient content. In addition, there is a lack of knowledge about what kind of biochar would be adequately effective in such soils. Moreover, yet there is no information about biochar effect on soil microbial diversity in Turkish Soils.

Apot experiment was therefore carried out to determine the effects of different biochars (pyrochars and hydrochars), obtained from various organic wastes namely (sewage sludge, poultry manure and olive waste) on soil bacterial diversity, mineral nutrition and growth of maize in greenhouse conditions. Bacterial diversity of all pyrochar and hydrochar applied (1, 2 and 4 t/da^{-1}) soils were investigated using High-throughput sequencing.The PCR-amplified partial 16S rRNA genes in soil were sequenced after biochar treatment in order to assess the change of bacterial diversity and community structure utilizing MiSeq. In total, approximately 1.8 million bacterial sequences were identified. The most dominant bacterial genies were Actinobacteria, Alphaproteobacteria and Thermoleophilia.The results showed that different carbonization methods have affected different bacterial groups in the highest application dose of biochar i.e. Hydrochar increasedAlphaproteobacteria and Actinobacteria, whilePyrocharincreased Beta- and Gammaproteobacteria. Further research efforts should focus on the resolution of the effects of thesebiochars under natural field conditions.

Keywords: Pyrochar, Hyrochar, Bacterial community structure, High-throughput sequencing

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Effects of Sugar Beet Factory Disposal of Vinasse on Some Chemical and Biochemical Properties of Soil During Incubation Period

Çağla ATEŞ[1], Ayten NAMLI[2]

Abstract

In this study, the effects of different doses of vinas on some chemical and biochemical properties of soil have been evaluated with 6 months incubation. Four different types of vinas (2 public, 2 private company products) were applied to 300 kg pots at 0, 2, 4, 8, 20 L da^{-1} doses. On the 15-30-60-120 and 180th days of incubation β-glucosidase enzyme activity, alkaline phosphatase enzyme activity, soil respiration (CO_2 output) and microbial biomass were measured in soils. On the 15th and 180th days of incubation, pH, EC, total N, organic matter, available P_2O_5 and K_2O, KDK, lime, available Fe, Cu, Zn, Mn and total Cd, Pb, Ni, Cr and Hg analyzes were performed. Depending on the increasing dose, CO_2 output increased and decreased due to incubation time. The biomass carbon content of the vinas treated soil was higher than the control soil. Beta glucosidase enzyme activity of the soil increased compared to control at the beginning of incubation but the difference between control and applications was not significant due to progressive incubation time. Beta glucosidase activity was significantly decreased at all times in 20 L da^{-1}application, which is the highest dose of all vinas varieties ($P < 0.05$). Vinas applications have increased the organic matter, phosphorus and potassium content of soils and it has not been effective on lime and KDK. It was noteworthy that vinas, which had different effects on the total and extractable amounts of macro and micro elements and heavy metals, led to an increase in Ni contents. The pH of the vinas used in the experiment is 5.5-6.0, and the EC is 7.60-13.64 dSm^{-1}, so the pH values of the soils have decreased depending on the increasing dose, the EC values are increase dependent on the dose and time. It is worth noting that it is necessary to pay attention to the use of vinasse in irrigated agriculture applications especially in the region where the water balance is negative.

Key Words: Vinasse, liquid organic fertilizer, soil, enzyme activity, microbial biomass.

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The Effect of Biochar Applications on the Development of Rocket Plant, Soil Enzymes and Microbial Biomass

Esra KUTLU SEZER[1], Çağlar Özkan SEZER[2], Ayten NAMLI[3]

Abstract

High carbon and mineral content products obtained as a result of pyrolysis process in the absence of oxygenorin the presence of small amounts ofoxy genarecalled Biochar. The use of organic materials, which have a high potential of waste, after being converted into biochar is very beneficial in terms of the evaluation of wastes, soil health and plant development. Theimpact of biodiversity on soil fertility and plant growth is determined by the interactions among characteristics of biochars and amended soil, application rate and requirements of crops grown. For this purpose, the effects of biochar on the rocket plant, microbial biomass and soil enzymes were investigated. Biochar material alone was administeredat100, 200 and 400 kgda^{-1}doses and in addition to doses with nutrient solution. At the end of the application, rocket plant harvested age and dry weight were determined and microbial biomass, alkaline phosphatase and beta glycosidase enzyme analyzes were performed from fresh soil samples. The best result was obtained from the application of 200 kg da-1 biochar + nutrient solution on the wet and dry weight development of the rocket plant at the applied doses. The best results for both soil enzymes and microbial biomass were obtained from the application of 400 kgda^{-1} biochar + nutrient solution. In addition to nutrient solution in soil, biochar application has contributed significantly to both soil enzymes and microbial biomass as well as plant growth.

Keywords: Biochar, microbial biomass, soil enzyms

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The Effect of Pyrochar and Hydrochar Application on Arbuscular Mycorrhizal Fungi Associated with *Zea mays*

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Abstract

Biochar obtained by the thermochemical conversion of various biomass under unaerobic conditions is often used as soil conditioning material. Majority of the existed knowledge about stimulatory effects of biochar applications on soil quality has been provided from pyrolytic biochars (obtained from traditional pyrolysis). As an alternative to pyrochars, those obtained from hydrothermal carbonization (hydrochars), have recent become popular and currently been investigated by many different authors. The synergetic effect of pyrochar applications on plant symbiotic microorganisms such as arbuscularmycorrhizal (AM) fungi and their combined effect on plant growth has also been documented by several researchers. However, considering the fact that pyrochar and hydrochar have different physico-chemical characteristics, AM fungi may react with hydrochar application to soil differently depending on biomass type used for char production and there is almost no information on this matter. Here, we compared AM fungal community compositions in Zea mays root after application of pyrochar and hydrochar obtained from three biomass sources.

In this research, olive waste (OW), poultry manure (PM) and sewage sludge (SS) were used as biomass sources to provide pyrochars and hydochar. The pot experiment with *Zea mays* were established with seven different biochar treatments with three application dose (1, 2 and 4 t/da): without application (CT), pyrochar (P-OW, P-PM and P-SS) and hydrochar (H-OW, H-PM and H-SS). Unsterilized soil was usedas AM fungal inoculum. Root DNA was extracted after 8 weeks. AM fungal 18S rRNA gene was amplified and the amplicons were sequenced using high-throughput sequencing system, MiSeq.

In total, approximately 2.9 million AM fungal sequences were identified. The most dominant AM fungal genus was *Glomus*, followed by *Claroideoglomus*and *Scutellospora*. Genus *Diversispora* appeared only in pyrochar treatments. Genus *Paraglomus* and *Acaulospora*showedrelatively higher abundance in the pyrochar and hydrochar treatments, respectively. Genus *Claroideoglomus* tended to have relatively low abundance in P-SS and H-SS treatments. Application rates had little impact on the AM fungal community. Based on the beta diversity analysis, pyrochar and hydrochar shifted AM fungal community differently. Our results suggest that difference of carbonization process and biomass source could make different impact on AM fungal community.

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Molecular Diversity of Soil Microbial Community in Arid Grassland in Central Anatolia

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Abstract

Soil microorganisms play important roles in soil functions such as plant productivity and nutrient cycling. In addition to rhizospheric bacterial communities, arbuscularmycorrhizal (AM) fungi are important soil microorganisms, forming symbiotic associations with roots of most terrestrial plants, and enhance host plant nutrient acquisition. Therefore, investigations of indigenous microbial diversities of rhizobacteria and AM fungi are important for the restoration of degraded soil and for sustainable agriculture in desertified arid ecosystems and understanding the relationship between rhizobacteria and AM funjiare strongly required. In this study, we investigated rhizobacterial and AM fungal communities in arid perennial grassland under desertification stress in Turkey using a high-throughput sequencer.

To evaluate the effect of soil degradation on microbial community, we selected six natural grassland sites with different desertification potentials from the Hasanoglan-Ankara Region and the Kalecik-Kırıkkale Region in Central Anatolia, Turkey. Rhizospheric soil and root samples were collected from seven plant species. Soil bacterial community was evaluated based on 16S rRNA genes amplified with soil DNA as the template, and AM fungal community was evaluated based on 18S rRNA genes amplified with root DNA. All amplicons were sequenced by using Illumina MiSeq platform.

In total, 4.2 million and 1.2 million sequences were identified for rhizospheric bacterial and root AM fungal community, respectively. The most dominant bacterial phylum was Actinobacteria, followed by Proteobacteria and Firmicutes. AM fungal community was dominated by the genus Glomus (approximately 80%), followed by Scutellospora and Acaulospora. The degree of soil degradation was reflected in the beta diversity of soil bacterial community but not in that of AM fungal community. Co-ocurrence network analysis indicated soil degradation-sensitive communities and keystone species in bacterial community but not in AM fungal community.

Keywords: arbuscularmycorrhizal fungi, bacterial community, MiSeq, high-throughput sequencing

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Use of Shrubby Legumes and Their Rhizobial Symbionts in Soil Amelioration After Heavy Contamination

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Abstract

Soil degradation limits the potential for crop production and even the re-establishment of native vegetation after a heavy event of pollution. Most land restoration practices typically concentrate on the recoveryof soil physical properties and plant establishment, while neglecting the recovery of soil microbiota. Most Mediterranean areas undergo heavy drought periods, when plant growth is limited. In such environments, wild leguminousshrubs substitute and meet the same ecological functions as trees. For these reasons, leguminous shrubs are excellent candidates for use in land reclamation, as they are drought tolerant, and improve soil fertility through biological nitrogen fixation (BNF)

In this study, we used the legumes *Genistacinerea*,*Echinospartumbarnadesii and Retamasphaerocarpa*, in a long-term trial to recover a degraded soil in southwestern Spain. We investigated to what extent the introduction of shrubby legumes inoculated with their own rhizobial symbiontscan improve the properties and associated vegetation of a degraded soil. The results showed that the inoculation of legumes withnitrogen-fixing bacteria enhanced plant survivorship and biomass production in all four legumes. In the absence of the inoculated legumes, soil fertility and plant community recovered at a much slower pace and the accompanying plant community and soil bacterial activities were significantly lower than in the areas with inoculated plants.

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Light Availability and Rhizobial Strains as Soil Related Factors Critical for Mediterranean Flora

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Abstract

Since temperatures keep rising as a result of climate change it becomes critical to assess whether plants can survive. Rhizobium are known to support plants' growth by fixing atmospheric nitrogen. However, there are very few studies evaluating how the presence of symbionts modulate plant performance under different light stresses. We hypothesized that microorganisms can support plant growth under light stresses. For that purpose, we exposed plants of *Coronilla juncea* L., *Ornithopus compressus* L., *Trifolium repens* L. and *Vicia sativa* L. to three levels of irradiance in the presence and in the absence of their rhizobial counter-partners. Significant differences were detected between treatments and among plant species, where inoculated plants, in most cases, increased biomass androots complexity. Nitrogen was fixated by nodulated and non nodulated plants which means, in the case of non nodulated plants, that endophytic associations were formed. Rhizobial strains can support and enhance plants' growth and fitness, as in the case of O. compressus. This is the first study conducted to elucidate the effect of rhizobial inoculation on plant performance, when plants are forced to grown under low, intermediate or high radiation level, differing from the optimal for the plant species, and possible for the rhizobial strain. We have proven that the mutualistic interaction due to rhizobia goes beyond its implication in the cycle of nitrogen and helping the plantto cope with extreme environments, like low or excessive radiation.

Keywords: Legumes, light, inoculation, fitness

1. Introduction

Drought and high temperatures in the summer season are characteristic of Mediterranean ecosystems. According to the latest IPCC report the weather inSpain in the next 20 year will suffer from increased temperatures and exacerbated drought in summer as a result of warms and cloudless days coupled with increased radiation, affecting all living beings (IPCC & IPCC5 WGII, 2014). However, plants might adapt to climate changes, changing their irradiance preferences. Adaptation or lack of it to light irradiance can be critical to plant's reproduction and survival.

The family Leguminosae is the botanical family with most representatives in almost all known ecosystems (Yahara & al., 2013). Their ability to establish symbiotic associations with microorganisms known as rhizobia, allowing plants to obtain nutrients, such as nitrogen by biological fixation, can be essential for their growth and critical for their reproduction (Newbold, 1989).

Root colonization with plant growth promoting rhizobaceria(PGPR), like those in the genus Rhizobia generally have positive effects on plant growth and soil fertility (Chalk et al., 2006). This includes increases in plant height (Safapour et al., 2011), biomass (Ramana et al., 2010), shoot:root ratio (Veresoglou et al., 2012), production of flowers (Li and Zhu, 2005), and seed yield in crop plants (Safapour et al., 2011). Furthermore, bacteria promote root growth but also inoculation can avoid damages in plants from environmental stresses,

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such as dessication, radiation intensity or even mitigate plant-plant competition by increasing biomass in native species benefiting them instead invasive plants (Ipek et al., 2014).Although the associations plant-bacteria are usually positive, it might result in unpredictable costs for the plants (Mortimer et al., 2008). In natural ecosystems, light availability is often one of the most relevant limiting resources able to modulate competition among plant species (Chirko et al., 1996). As far as we know, there are no studies investigating the vegetative growth of plants in association with bacterial inoculants and light limitation on reproductive growth and plant fitness.

The main goal of this study is to evaluate the extent to which rhizobateria affect plant performance in terms of development, dry weight as growth rates and fitness, under different light stress conditions. We predict that responses can differ depending on the plant species used, their ecology and the presence and absence of rhizobial inoculants. Light stresses are prone to become one of the major consequences of global climate change, anticipating to deleterious effects and testing if microorganisms are the answer to overcome temperature and light stresses..

2. Material and Method

A total of 20 tanks, 45x32x40 cm, were set up in the laboratory of Ecology at the University of Pablo de Olavide. Sixteen of them in a light and temperature-controlled room which had a 12 hour of light- dark regime, the rest (four tanks) were placed near the window with natural light- dark regime. Two of the selected species *Cornilla juncea*L., *Vicia sativa*L., come from environments with low levels of irradiance, whereas the other two,*Ornithopus compressus* L. and *Trifolium repens*L. arecommonly found in well irradiated ecosystems. All of them are native in the Mediterranean region. Those plant species were inoculated with *Rhizobium leguminosarum* (Frank 1879), *Rhizobium leguminosarum* USDA2370T(Frank 1879), *Rhizobium fredii* (Scholla and Elkan, 1984), *Rhizobium leguminosarum subsp trifolii* ATCC1440 (Frank 1879),respectively. Bacteria were chosen according to affinity to plant species found in bibliography.Prior to germination, seeds were surface-sterilized with NaClO at 50% for 5 minutes, followed by six rinses with distilled H_2O. The seedlings were suspended over distilled water and nutrient solution by autoclaved square sponge rubber and each one introduced in plastic cylinder. Every tankreceived Hoagland's nutrient solutions at 5% and were filled with distilled water. Plants were treated with high radiation (900 µsiemens/m^2s), intermediate radiation (600µsiemens/m^2s) and natural radiation (250 µsiemens/m^2s). Half of the tanks received nutrient solution containing one species of rhizobacteria inoculum and the others were kept as control ones. Bacterial inoculants were grown in a solid YMA culture, after that they were taken to YMA broth. Plants were harvested for the first time 35 days after they were inoculated. The second harvest occurred after 35 days approximately.

Rate of biomass production= $\frac{(Log\ biomass\ harvest2)-(Log\ biomass\ harvest1)}{Days\ harvest2-harvest1}$

Inflorescences and the length of them were counted and measured to calculate fitness as number of inflorescences multiplied by mean length of inflorescences. Dry weight were obtained from nodules, shoots and roots along.

Statistical analysis

All the statistical analysis performed with R programme (R Core Team, 2018). Using parametrical U-Mann Whitney for comparisons within the same radiation and anova tests between radiation treatments.

3. Results and Conclusion

3.1 Biomass growth rates

Average values of biomass growth rates in*C. juncea* grown under high radiation shows were greatly higher in control plants than in the inoculated ones (Figure 1a). Under intermediate values of radiation, significant differences were detected between control and inoculated plants within the same radiation treatment and between different radiation (Figure 1a).*T. repens* plants showed significant differences for most of the variables under high and intermediate radiation treatments. However, under natural radiation no significant differences were observed in any of the studied variables (Figure 1b).Growth ratesof shoots, roots and total plant mass of *O. compressus* in both high and intermediate radiation were significantly greater in inoculated plants than in non-inoculated ones; significant differences were found within radiation treatments and between different radiation (Figure 1c).Plants of *V. sativa*under high radiation showed significant differences for dry shoot and total plant growth rates. Under intermediate and natural radiation *V. sativa*plants showed similar behaviour to that in*C. juncea* (Figure 1d). Significant differences were found between control and inoculated plant among different radiation treatments and with the controls.

We hypothesized that there would be an enhancing effect of growth and reproduction by rhizobial strains under different levels of radiation that would result in increased biomass growth rates along with reproduction. Leguminous plants grown inoculated under intermediate radiation level were expected to increase their performance due to the presence of the mutualistic bacteria; we have detected a noticeable decrease in plant biomass growth rate, particularly in *V. sativa*. This behaviour can only be due to the fate of the bacteria acting as a parasite under the light limited environment, as it has been observed in other leguminous species(Bethlenfalvay & Pacovsky, 1983).

We have observed that inoculated plantsof *O. compressus* and *T. repens* showed increases in biomass growth rates under intermediate radiation inoculated treatment (Figures 1b, 1c) as it has been demonstrated in plants inoculated with mycorrhiza (Ballhorn et al., 2016). We propose that the extra input of nitrogen coming from the biological nitrogen fixation, leads to an increase in biomass growth rate.When irradiance is excessive and the plant is stressed, the rhizobial symbionts hinder plant performance,acting as a parasite in the inoculated plants (Ballhorn et al., 2016).However, *T. repens*under natural radiation treatments showed similarbiomass growth rates in inoculated and non- inoculated plants; growth in this species is slower than in others.As *T. repens* usually grows in environments high radiation it is likely to expect that the symbiosis between this species and their rhizobia have evolve in such a way that both are tolerant to high radiation, aiding the plant to overcome the high irradiance-induced stress.

3.2 Plant Fitness

Fitness was only calculated in *O. compressus*plants grown underintermediate radiation treatments as they were the only ones to flower and fruit. Significant differences were detected when compared to control treatment in the second harvest (Table 1). As hypothesized rhizobio increases fitness in plants. Rhizobia can support plants' reproduction or behave like parasites decreasing their fitness (Ballhorn et al., 2016). As shown in *O. compressus* under intermediate radiation, the inoculated plants benefited from the presence of microorganisms. However, we do not have an explanation on why *V. sativa* and *C. juncea* did not flowered, which needs further study.

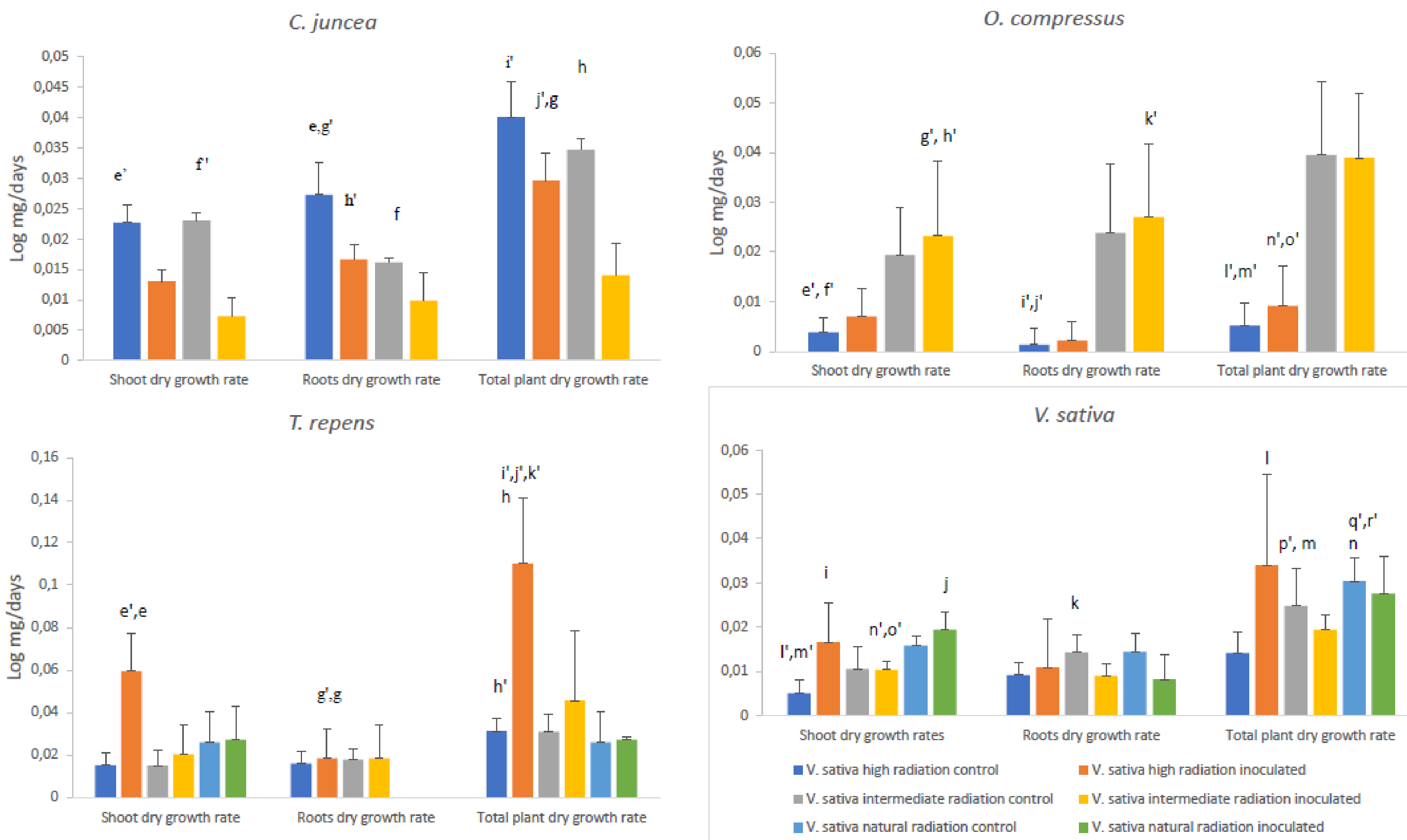

Figure 1. Biomass growth rates of four legumes, plants were grown under three light regimes grown under inoculation and no inoculation (□+ SD; values are means in gnotobiosis). Letters above bars indicate significant results after performed U Mann Whitney's test and anova comparison between treatments marked with ' . *C. juncea*: e'=0.001, e= 0.0021, f '= 0.001, f= 0.002488, g'= 0.023, g= 1.083e^{-5} h'= 0.041, h= 6.956e-6, i'= 0.001,j'= 0.041. *O. compressus*: e'=0.001, f'=0.002, g'=0.006, h'=0.006, i'=0.003, j'=0.001, k'=0.005, l'= 0.002, m'=0.001, n'=0.019, o'= 0.005. *T. repens*: e'= 0.001, e= 1.73e^{-5}, g'= 0.001, g'= 0.0001494, h'= 0.001, h= 1.497e^{-5}, i'= 0.001, j'= 0.004, k'= 0.001. *V. sativa*: l'= 0.004, m'=0.001, i= 0.0003248, n'= 0.001, o'=0.001, j= 0.03546, k= 0.003886, l= 0.0133, p'= 0.049, m= 0.01469, q'=0.001, r'=0.009, n=0.0089. Note Different scales on Y axis.

3.3 Conclusions

To conclude rhizobial strains can support plants' growth and fitness on high radiation treatments enhancing them, as in the case of *O. compressus* and *T. repens*, which will benefit plants in climate change as temperatures rises. Although rhizobial strains support plants' growth in many cases, results from our study reveals that *V. sativa* and *C. juncea*, from low radiation range, did not react as good as *T. repens* and *O. compressus*, from high radiation range. As some microorganisms react as parasites that could be the case of *C. juncea* in high radiation. Further research should be done in *V. sativa* using different rhizobial strains and evaluating the interactions between plant-rhizobio and light radiation. Evaluating plants' species behavior to high radiation treatments can be critical as climate change becomes the cause of plants' populations decrease.

To our knowledge, this is the first study conducted to elucidate the effect of rhizobial inoculation on plant performance, when plants are forced to grown under natural, intermediate or high radiation level, differing from the optimal for the plant species, and possible for the rhizobial strain. Although more research is needed on this direction, we have proven that the mutualistic interaction due to rhizobia goes beyond its implication in the cycle of nitrogen and helps the plant to cope with extreme environments, like short or excessive radiation.

Table 1. Fitness rated of *O. compressus*, plants were grown under intermediate radiation under inoculation and no inoculation for 45 days and 90 days in the first harvest and second, respectively.

Harvest	Treatment	$\bar{x}$ (number of inflorescences x cm)	SD
First	Control	0	0
First	Inoculated	1.9	6.3
Second	Control	0	0
Second	Inoculated	20.9 a	19.7

Letter next to average values indicates significant differences after performed U Mann- Whitney's test, a= 7.588e-06

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Effect of Kombu Tea (Kombucha) and Mix Microorganisms Culture of Kombu Tea Production Waste on Soil Respiration and Microbial Biomass Carbon Content of Soils

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Abstract

The aim of this study was to investigate effects of the kombucha and lyophilized waste of kombucha culture on Soil Respiration and Microbial Biomass Carbon Content of soils. In the experiment, sandy loam and loamy soils were used. In the experiment, kombucha was used as an organic material, and culture of kombucha available in the market as a product obtained from a manufacturing plant in Samsun was used by utilizing lyophilization. In the flower pot experiment performing in the green house, each flower pot were filled by the weight of 4 kg soil, and the amount of 0, 10, 20, 30 ml/pot of kombucha and 0.25, 0.50, and 0.75ml/pot of lyophilized waste of culture of kombucha were put into the each flower pot. Greenhouse experiment lasting totally 138 days. After the 138th day, the effects of kombucha and lyophilized waste of culture of kombucha on Soil Respiration and Microbial Biomass Carbon Content of soils. On the soil respiration, it was determined that the waste given by lyophilization of the sandy loam soil was 0.75 gr / pot of potted plants and the soil respiration increased by 18,5% compared to the control. When the kombu tea was applied directly to the soil as a product, the maximum effect was obtained in loamy soil and in a 30 ml application dose per pot, and 15.8% of the increasecomparedtothecontrol. In Sandy loamy soil. 0.75 g waste per pot Microbial biomass carbon content of soil was found to be increased by 33.9% compared to the control of kombu tea cultivar, and by the microbial biomass carbon content of soil compared to 55.4% control by direct application of kombu tea at 30 ml / flowerpot.

Keywords: Soil Respiration, Microbial Biomass Carbon, Soil, Kombu Tea

Seasonal Variations in Microbial Biomass of Algerian Steppe Soils

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Summary

Our study consists of showing the evolution of the microbiological soil of the Algerian steppe under different ecosystems, characterized by aridity almost perennial. All results have strongly demonstrated the presence of bio reactivity whatever it is restricted but real and that these soils are not sterile even in disadvantageous conditions. In fact, variations in microbial biomass are, strongly linked to climatic variations and particularly to seasonal variations where the effect of temperatures is direct on their fluctuation, making the biotope limiting which resulted in « partial sterilization» which tends mainly towards the microbial decay which remains the only fragile pedosphere bioreactor of the arid ecosystems.

In this perspective, a prerogative is useful for the purpose of conservation and soil improvement to limit the negative plague of desertification for a sustainable development**.**

Key words: arid, microbial biomass, steppe, partial sterilization, seasonal variations.

1. Introduction

Soil microorganisms play a fundamental role in the degradation of organic matter as they supply essential nutrients that can be used by plants.

The main objective of this work is to study the microbial fluctuations governing climatic variations, in general, and seasonal, in particular, where no one doubts that the choice made on this study in the steppe areas of Algeria is not fortuitous Since the fragility of such an environment, the degradation of natural resources, climate change and irregular rainfall are elements that should be studied to understand the functioning and dynamics of microbial populations in these areas.

2. Material and methods

2.1 Choice of the Site

The study sites are chosen according to four different stations namely (Stitten (Soil1), Rogassa, (Soil2) Brezina (Soil3) and El-Bayadh (Soil 4), of which five samples are taken according to the diagonal method, at 30 cm deep on a one hectare surface that are subsequently mixed to give an average sample for each site, samples were taken in December P1, April P2 and July P3 under stipa, tenacissima, Atriplex parviflora retama and lygeum spartum

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Physicochemical analysis of soils was carried out in the soil science laboratory, Faculty of Agricultural Sciences, University of Tiaret.

For microbiological characterization of steppe soils, technique of indirect method was used (Pochon and Tardieux 1962)

Statistical analysis

The results are subject to a two-way analysis of variance, namely the effect of soils and seasonal periods on microbial levels. (ANOVA)

3. Results and Discussion

Granulometric analysis shows that samples of soil have a sandy-loamy texture. Indeed the sandy fraction dominates. The physicochemical analysis of the four soils showed that they have a low water content, explained by their coarse texture reflecting relatively appreciable porosity and permeability. Characterized by a weakly alkaline pH (7.32-8.52). In addition, the analysis revealed that these soils are relatively poor in organic matter and salts. Microbiological characterization of the four sites studied shows that the steppic soils have a heterogeneous and variable microbial distribution, both qualitative and quantitative, depending on the weather governing climate change and the irregularity of precipitation, which is translated by seasonal variations.

3.1 Seasonal Evolution of Aerobic Bacteria in Steppe Soils

The average results of the evolution of aerobic bacteria show that:

During the winter period P1 the density of aerobic bacteria, is relatively important in Sol2 (24x106 ± 3.46 germs / g of soil), the lowest rate is recorded in Sol3 (18x106 ± 6 germs / g of soil)

During the spring P2 period the highest number of aerobic bacteria is 33.33x106 ± 11.01germs / g of soil recorded in Sol2, while the lowest is marked in Sol3 (17.33x10 6 ± 4.04 germs / g of soil)

During the summer period P3 the rate of aerobic bacteria oscillates between 20,33x106 ± 10,40 germs / g of soil in Sol2 and 14 x10 6 ± 2,5germs / g of soil in Sol3.

The analysis of the results obtained shows that the density of aerobic bacteria is dependent on the nature of the soil sampled ($p < 0.05$) and the sampling period ($p < 0.05$).

Moreover, the interaction between soil type and sampling period has no significant variation on these germs ($p > 0.05$) Evolution saisonnières des champignons des sols steppiques

The results of the fluctuations of fungi recorded in show that:

Soils collected at P1 have a relatively high fungi level (4.66x106 ± 2.88germs / g soil) in Soil4 the lowest rate is reported in Sol2 (3.33x106 ± 2.08 germs / g soil). Soils collected in P2 show a drastic increase in the fungi level, especially in Soil1, estimating with an average of 244x10 6 ± 8 seeds / g of soil and the lowest rate with an average of 64x10 6 ± 23.06germs / g of soil in Soil3 . Soils taken in P3 have a fungi rate of between 3x106 ± 2.64 germs / g of soil and 2.33x10 6 ± 1.52 germs / g of soil.

The analysis of variance of the number of fungi from different soils shows that this density is considerably dependent on the nature of the soil taken ($p < 0.05$), as well as the sampling period ($p < 0.05$). More, an interaction is established between the soil type and the different seasons with a remarkable variation in fungi ($p < 0.05$). A heterogeneous microbial distribution that varies according to the sampling period

3.2 Seasonal Evolution of Steppe Rock Nitrogens

The results reveal that soils collected at P1 have a particularly high level of Sol2 nitrogen (26x106 ± 12.16 germs / g soil). The lowest rate is recorded in soil 1 (7.33x10 6 ± 1.52 germs / g of soil).)

In P2, the rate of azotobacters oscillates between a maximum value (102.66x106 ± 61.46 germs / g of soil) in Soil2 and a minimum value (36x10 6 ± 12.16 germs / g of soil) in Soil1.

In P3 the intense rate (18.66x106 ± 7.02 germs / g of soil) is reported in Soil2 against the weakest is reported in Soil1 (6x106 ± 2.64 germs / g of soil.)

The treatment of the results obtained indicates that the number of germs / g of soil is strongly conditioned by the nature of the soil samples ($p < 0.05$). The measurement period has a highly significant effect on the rate of azotobacters ($p < 0.05$).

3.3 Seasonal Evolution of Actinomycetes in Steppe Soils

The results of the evolution of actinomycetes show that soils collected at P1 have a relatively high value of actinomycetes in Soil2 (6x10 6 ± 1.73 germs / g of soil) and a minimum value in Soil 1 (2.66x10 6 ± 1.15germs / g of soil

In P2, the density reaches a maximum of 106.66x10 6 ± 21.38germs / g soil reported in Soil4 and a minimum value 58, 66x10 6 ± 10.06 seed / g soil reported in Soil1.

In P3, the fall is sharp the rate of actinomycetes varies between 4.66x10 6 ± 2.08 germs / g soil in Soil2 and 1.66x10 6 ± 1.15 germs / g soil Soil1.

The analysis of the results shows that the number of actinomycetes is strongly dependent on the sampling time ($p < 0.05$). On the other hand, the interaction of the nature of the soil and the sampling period seems to have no appreciable effect ($p > 0, 05$).

3.4 Seasonal Evolution of Ammonifiers from Steppe Soils

The results of the proliferation of ammonifiers (Tab 8) show that:

Soils taken at P1 show a level of ammonifiers of (0.6x10 6 ± 0.17 germs / g in Soil 2, and 0.3x106 ± 0.17 germs / g of soil in Soil3.

Soils collected P2 have a rate of 1.1x10 6 ± 0.17 germs / g soil in Soil2 against a rate of 0.4x106 ± 0.17 germs / g of soil in Soil3.

The summer period P3 is marked by a relatively high level of ammonifiers in Soil2 (0.4x106 ± 0.26 germs / g of soil) the low rate of 0.3x106 ± 0.1 germs / g of soil is recorded in Soil 1 with an average of 0.3x106 ± 0.17 germs / g of soil in Soil3 and Soil 4

The analysis of the results shows that the ammonifiers rate is strongly influenced by the two factors: the nature of the soil ($p < 0.05$) and the sampling period ($p < 0.05$). There was also a significant interaction between the nature of soils studied and sampling periods ($p < 0.05$).

3.5 Seasonal Evolution of Nitrifiers in Steppe Soils

The average results obtained show that soils taken from P1 have a nitrifying rate of between 0.6x10 6 ± 0.2 germs / g of soil in Soil2 and 0.3x10 6 ± 0.1 germs / g soil Soil1. During the spring period P2, the highest relative nitrifying rate is marked in Soil2 with an average of 0.7x106 ± 0.26 germs / g of soil and in Soil4 with an average of 0.7x10 6 ± 0.17. germs / g of soil. The low rate of the season is recorded in Soil3 with an average of 0.4x106 ± 0.2 germs / g of soil.

Soils taken from P3 have the same nitrifying density, equal to 0.3 106 ± 0.17 germs / g of soil in Soil1, 0.3 106 ± 0.26 germs / g of soil in Soil2, 0.3 106 ± 0.2germs / g of soil in Soil3 and 0.30 ± 0.1 germs / g of soil in Soil4.

Average seasonal evolution of nitrifiers in The analysis of the results shows very large variations between the different soil samples ($p < 0.05$). However, this parameter strongly depends on the sampling period ($p < 0.05$). The interaction between soil type and the different sampling periods has a significant variation ($p < 0.05$) on nitrifiers.

3.6 Seasonal Evolution of Denitrifiers in Steppe Soils

The average results obtained show that soils taken from P1 have a relatively low denitrifying rate (0.73x10 6 ± 0.35 germs / g soil) in Soil1 and (0.3x10 6 ± 0.2 germs / g soil) in Soil 2.

In P2, the highest relative rate is recorded in Soil1 (1.1x106 ± 0.43 seed / g soil) and (0.6x106 ± 0.26 seed / g soil) in Soil 2.

In P3 a denitrifying rate of 0.66x106 ± 0.32 germs / g of soil is reported in Soil1 and (0.3x10 6 ± 0.1 germs / g of soil) reported in Soil2.

The analysis of the results shows that the denitrifying rate is strongly dependent on the sampling period ($p < 0.05$). On the other hand, no interaction is reported between the nature of the soil and the sampling periods on the variation of denitrifying germs ($p > 0.05$).

4. Conclusion

The study conducted on the microbiological evolution of the steppe soils, has highlighted that in such ecosystems the microbial population is far from being a homogeneous whole but whose growth is linked not only to physicochemical characteristics but also to climatic variations. As a result, biological activity remains an essential component of soil fertility. (Ambouta et al 1996) related to the ecological adaptations of each species. Indeed, the results obtained have shown that the fluctuations of the microbial biomass are strongly linked to seasonal variations, in particular, where the effect of temperatures is direct on their growth making the biotope limiting which resulted in «partial sterilization Which tends essentially towards microbial decay, Similar results have been reported by Bourahla 1998 unknown (Killian et al 1939 ; Ali H 1980 ; Dellal et al 1992)which showed that this decay is the only fragile pedosphere bioreactor of arid ecosystems. Among these micrometric constituents, the microbiological course which by its role, either as a source of nutrients after mineralization, or as an agent of organization and formation (protection and genesis of the organo-mineral complex where microbiological and simulation studies therefore remain insufficient in arid ecosystems (Bourahla 1998) (Mikol 1987).

In this perspective, a prerogative is useful for the purpose of conservation and soil improvement to limit the negative plague of desertification in a sustainable development framework.

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Effects of Bacterial Preparation on Quality of Sugar Beet (Beta Vulgaris L.) Lider Variety in Konya Province

Nurgül KITIR[1]

Abstract

In this study, it is aimed to determine the efficiency and quality effects of a bacterial preparation containing a consortium of Tricoderma afroharzianum and Bacillus thuringiensis strains on Sugar Beet (Beta Vulgaris L.) Lider variety for this purpose, in the Çumra Sugar R & D field in the province of Çumra, Konya, different dose trials of this bacterial preparation in controlled conditions according to the trial design of randomized plots are carried out at 3L ha^{-1},6L ha^{-1}, 9L ha^{-1}, in the growth season and each 20 day period totally 3 applications of bacterial preparation were made. According to the results of the study, 22.7% increase in productivity was recorded in the Lider variety at 3L ha^{-1} according to control group and this increase was found statistically significant at $p < 0.02$ level.

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An Evaluation of the Effects of Hydrothermal and Pyrolytic Biochars on Soil Quality Assessed by Physico-Chemical and Biological Indicators

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Abstract

The aim of this study was to investigate the effects of hydrolytic and pyrolytic biochars generated from different organic wastes on selected soil characteristics in an incubation experiment. Pyrochars and hydrochars derived from sewage sludge, poultry manure and olive oil solid waste through pyrolysis and hydrothermal carbonization were mixed with clay soil on a dry weight basis in three different doses and incubated at 25 °C for 120 days. In order to reveal how different pyrochars and hydrochars affect soil quality and fertility a range of physical, chemical and biological soil characteristics were analyzed at the end of the incubation period. The results indicated that pyrochar applications increased total nitrogen (N) better compared to those of different hydrochars while soil organic matter seemed to increase better in hydrochar applied soils. The highest total N determined under sludge derived pyrochar and organic matter under hydrochar of olive oil solid waste. In general, hydrochar seemed to increase soil pH but decreased electrical conductivity. No clear differences were observed in available P, lime content, aggregate stability and cation exchange capacity under different pyrochar and hydrochar applications. However soil enzyme activities, especially β-glucosidase, were very responsive to hydrochar with increasing application rates. These findings indicated that the hydrochar obtained by hydrothermal carbonization is more effective on the biological properties of soil compared to the pyrochar obtained by pyrolysis. Briefly, pyrochar applications increased total nitrogen (N) better compared to those of different hydrochars.

Key Words: Hydrothermal Carbonization. Pyrolysis. Pyrochar. Hydrochar. Soil health

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Effect of Different Biochar Doses and Mycorrhiza Application on Soil CO_2 Flux, Under Field Condition

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Abstract

Today climate change is one of the serious problem which is caused by atmospheric gasses such as CO_2. Before the industrial revolution atmospheric CO_2 concentration was 270 ppm and at present is above 411 ppm. If this increase continues, many disasters such as drought, flood, earthquake etc. would happen. The best way of atmospheric CO_2 mitigation is to use plant photosynthesis mechanisms. In addition to carbon (C) fixation and many positive management properties such as biochar can be used as a soil amendment. Biochar is a byproduct of pyrolysis system and remains in the soil for many years. It is an important soil organic carbon sources. The aim of this study is to search the effect of different doses of biochar and mycorrhiza on CO_2 released from soil. The hypothesis of this study is biochar and mycorrhiza mitigates the atmospheric CO_2.

The experiment was set at Cukurova University, Research and Implantation Area. The field experiment was set up 2018 and control %0, %1, %2 and %4 doses of biochar and mycorrhiza (G. Mosseae) was applied. Maize (Zea Mays L.) seeds were sown in May 2018 and harvested in October 2018. After 4 weeks from germination, soil CO_2 flux was detected with Li-COR 8100A machine. And every two weeks measurements were done until harvest. Data showed that increasing biochar doses application increased soil CO_2 release and mycorrhiza inoculation increased soil organic pool.

Keywords: Maize, CO_2 imitation, Carbon, Mycorrhiza

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Tea Bag Index (TBI) of Cranberry (*Vaccinium macrocarpon* Ait.) Agroecosystems

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Abstract

One of the biggest contemporary challenge is how to maintain or increase soil carbon stocks to reduce GHG emissions? Carbon sequestration in cranberry soils can contribute mitigating climate change. The measurement of carbon sequestration requires the development of indices. The size of the organic particles, the biochemical composition (lignin-cutin content, cellulose, hemicellulose, soluble substance) and pH influence the rate of organic matter decomposition. Fractal kinetics provides a decomposition rate related to the biochemistry of organic matter (k) and a physical protection index (0 <h <1). The tea bag (TBI) index makes it possible to compare the decomposition rates among terrestrial ecosystems. The TBI uses standardized bags of two kinds of tea (rooibos tea and green tea) and cranberry residues. The decomposition (k) and stabilization (S) parameters of teas depend on temperature, moisture content, pH and other factors. Experimental sandy cranberry soils are located on 4 sites (3 conventional and 1 organic) in central Quebec. Preliminary results indicate that cranberry residues decomposes more slowly compared to other terrestrial ecosystems documented so far.

Keywords: Carbon sequestration, Tea Bag Index, Fractal kinetic

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THEME 5:
Soil Pollution

Determination of Heavy Metal Risk and Their Enrichment Factor in Intensive Cultivated Soils of Tokat Province

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Abstract

Heavy metal contamination has caused serious environmental and health-related problems around the world. This research was conducted in arable lands of some basins located on Tokat province. The aim of this present study was to determine I-) some physico-chemical properties of soils, ii-) to find heavy metal (HM) content and their enrichment factor (EF) and iii-) to detect relationship between some physico-chemical properties and HM concentration. To identify the concentrations and sources of heavy metals, 280 soil samples (0-20 cm) were collected from the study area. Subsequently, in order to evaluate natural or anthropogenic sources of heavy metal content and their EF in agricultural fields, the concentrations of some HMs (Cd, Co, Cu, Cr, Ni, Pb and Zn) and some physico-chemical properties of soil samples were analysed. The results showed that mostly the concentration of Ni followed by Cr exceeded their threshold levels. The local pollutions from Ni and Cr were attributed to the natural influences (particularly due to parent material). The concentrations of the other HMs are relatively lower than the critical values. The mean values of the HMs contents arranged in the following decreasing order: Ni > Cr > Cu > Zn > Co > Pb > Cd in the studied soil sample. In addition, it was found significantly positive relation between Pb and OM while the same relation was also found clay content and Cd and Pb. On the other hand, according to EF of HMs in total soil samples, Cd, Ni and Cr have found 16%, 10% and 6% soil samples as moderate enrichment class, whereas 55% and %1 of the total soil samples were determined significant enrichment class in terms of Cd and Ni elements. Besides, all other HM elements did not exceed minimal enrichment level. However, in some regions of the study area, the Cu, Cd and Pb contents were also slightly raised, this case possibly stems from anthropogenic effects such as excessive P fertilization, field traffic and pesticide using.

Key words: Heavy metal risk, enrichment factor, micro basin, Tokat

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Estimation of Diffuse Pollution Loads of Pesticides in Tersakan Sub-Basin of Yeşilırmak River Basin, Turkey

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Abstract

Tersakan Creek is one of the highly polluted tributaries of Yeşilırmak River because it receives pollution loads both from discharges of the industrial facilities and run-off water of the agricultural areas in the sub-basin. A monitoring program was implemented to determine the water quality status of the sub-basin in accordance with the EU Water Framework Directive (WFD). Monitoring program involved collections of water samples form the creek at 14 points and from the effluents of industrial plants at 12 points for up to 8 times each representing different seasons over a 2-year monitoring period. Each sample was analyzed for pesticides that are classified as "specific pollutants" and "priority pollutions" by the EU WFD. The results of the water sample analyses revealed that concentrations of 22 pesticides, out of the detected 55 pesticides, exceeded the pre-defined environmental quality standards (EQSs). Some of the pesticides are discharged by industries; however, mass balance calculations showed that their contribution to the pollution was relatively insignificant. This implied that main contribution to pesticide load to the Tersakan Creek was attributable to diffuse loads from agricultural lands. This study aimed to estimate the agricultural non-point pollution loads to the Tersakan Creek of these pesticides, concentration of which exceeded their respective EQSs. For this purpose, firstly the estimation of sediment yields from drainage areas delineated in association with each water sampling point in the sub-basin was required. Sediment yield was estimated using a GIS based model, Dynamic Erosion Model and Monitoring System (DEMİS) developed by the General Directorate of Combating Desertification and Erosion. This model relies on Revised Universal Soil Loss Equation and also yields sediment delivery ratio specific for each drainage area of the sub-basin. Secondly, estimation of pesticide concentration remaining in the agricultural soil after its application for a specific crop was required. Soil concentration of pesticide was estimated using a pesticide fate and transport model PESTRANS which requires detailed input data on soil and pesticide fate and transport characteristics. Diffuse pollution loads for pesticides exceeding EQSs in the Tersakan Creek were then simply calculated through multiplying the sediment yield by pesticide soil concentration. Results showed that such pesticides as Cypermethrin, Dichlorvos, Ethalfluralin, Prothiofos contribute diffuse pollution loads to the Tersakan Creek. Furthermore, to propose control measures for these pesticides regarding their application rates in the sub-basin, additional calculations were also performed to estimate the required maximum pesticide application rate not to exceed EQSs.

Keywords: Pesticides, diffuse pollution load, Tersakan sub-basin, Yeşilırmak river basin

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Effect of Mining Activities on Soil Quality

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Abstract

Soil quality is an important parameter in terms of soil type, physical, chemical and biological properties and ecosystem health and sustainability. As a result of the mining activities, changes in topography and soil characteristics cause the degradation of the vegetation and increase the land degradation. This study was carried out at the Diatomite Quarry, which is grassland in Orta province of Çankırı, in the central Kızılırmak region of Central Anatolia. In determining the soil quality, DIS4ME (Desertification Indicator System for Mediterranean Europe) was used. A total of 30 points were sampled from 0-30 cm depth and 15 sampling points were taken from the vicinity of the mine area while the other 15 sampling points were taken from the unspoiled area around the mine area. Texture, bulk density, soil reaction (pH), electrical conductivity (EC), lime ($CaCO_3$) and organic matter (OM) content analyzes were performed in soil samples. The data obtained from the study were evaluated together and the damage caused to the environment was revealed if the restoration works of the mining applications were not carried out.

Keywords: Mining Application, Diatomite, Soil Quality, DIS4ME

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Emerging Contaminant Pollution in the Paddy Soils of Ergene Watershed

Feride Öykü SEFILOĞLU[1], Işıl BALCIOĞLU[2]

Abstract

Pollution of agricultural soils by persistent organic contaminants is a global issue in terms of human health, management of nonrenewable resources and ecological sustainability. Various organic pollutants enter to arable lands by the extensive application of agrochemicals for pest control, the use of manure and sludge as fertilizers and irrigation of fields with polluted water. Since soil acts both as a sink and source of the contaminants through various fate and transport mechanisms, monitoring of soil contamination is essential for the evaluation of environmental risks and development of remediation options. From this point of view, a multiresidue analytical method was developed and applied to soil and rice samples collected from paddy fields located southwestern Thrace region adjacent to Ergene River to screen the 170 emerging pollutants. Simultaneous extraction of the target contaminants from soil samples and their quantification were performed with acetate buffered QuEChERS (quick, easy, cheap, effective, rugged, and safe) method and liquid chromatography coupled with tandem mass spectroscopy (LC-MS/MS), respectively. High concentrations of emerging contaminants as well as pesticides clearly revealed the persistence of various pollutants in soil exposed to industrial pollution. The sources of contaminants and the fate and transport processes in the region were thoroughly discussed. The pesticides from triazole, neonicotinoid and strobilurin groups and the surfactants were the most frequently detected contaminants while the concentration of oxadiazone and benzydimethyldodecylammonium reached to mg/kg level in the region. The intensive rice production in this highly polluted watershed arouses a suspicion in terms of food safety.

Keywords: Agricultural soil, Rice, Pesticides, Emerging contaminants, QuEChERS, LC-MS/MS

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Agricultural Soil Contamination by Organic Pollutants

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Abstract

Environmental contamination by persistent organic pollutants is a global concern regarding the ecological sustainability, biodiversity, human health and food safety. In this respect, pollution of soil is a significant consideration, since soil acts both as a sink and source of contaminants regarding to the various fate and transport mechanisms. Anthropogenic contaminants can enter to the agricultural soil by the application of manure or biosolid as fertilizer, irrigation with reclaimed wastewater and application of agrochemicals for pest control. Based on the characteristics of soil, physicochemical properties of chemicals and environmental conditions; contaminants can be accumulated in the soil, uptaken by the edible parts of the plants, leach to groundwater or surface waters, which can damage the aquatic and terrestrial life, contaminate freshwater resources and affect the human health via food chain. Considering the increasing food demand globally, the continuous input of chemicals to enhance the crop yield resulted in the accumulation of various contaminants in the agricultural fields including pesticides, antibiotics, pharmaceuticals, PAHs, PCBs, PAEs and other emerging industrial compounds. In this study, the sources of these organic pollutants, their detected concentrations in agricultural soils and the remediation options are reviewed.

Keywords: Agricultural soil, Organic pollutants, Contamination, Remediation

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Comparison of Enrichment Factor of Heavy Metal Concentration in Micro Catchments Located on Çarşamba Delta Plain and Upland Positions

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Abstract

The aim of the this study was carried out to determine i) some physico-chemical properties ii) heavy metal (HM) content and their enrichment factor (EF), and iii) detection relationships between some physico-chemical properties and EF values of HMs in arable lands of micro catchments located on two different physiographic positions that area Çarşamba Delta Plain and Upland in Samsun province. For that reason, total 126 soil samples were collected from surface (0-20 cm). Analysis of some basic physico-chemical parameters such as soil texture, pH, EC, $CaCO_3$, organic matter, nutrient element concentrations (total nitrogen (TN), available phosphorus (AvP), extractable calcium (ExCa), extractable magnesium (ExMg), extractable sodium (ExNa), extractable iron (ExFe), extractable zinc (ExZn), extractable manganese (ExMn) and extractable cupper (ExCu)) and some potential toxic HM elements such as cupper (Cu), lead (Pb), cadmium (Cd), nickel (Ni), chrom (Cr) and cobalt (Co) were done in selected soil samples. In addition in order to assess accumulation of HM, EF was estimated. It was found that 34.9% medium texture, 52.4% heavy texture and 12.7% course texture in soil samples. Besides, pH values vary between 4.68 and 7.67 and there is no any salinity problem. $CaCO_3$ and organic matter content of samples were detected as 0.0-14.1% and 1.05-6.91%, respectively. 81% of total soil samples was found high Ni concentration while, 26% of it was determined Cr concentration which is over the threshold level. Other HM concentrations were detected as lower than maximum permissible concentration level. When compared their sampled positions, 89% of high Cr and 95% of high Ni concentrations were determined on micro catchments located on Çarşamba Delta Plain due to alluvial deposited parent material. As for EF, the highest value of EF was found for Cd (19.73), whereas only Cu has lower EF values. In addition, most of the EF values of HMs (except for Cu) spatially distributed on delta plain.

Keywords: Enrichment factor, heavy metal, soil physico-chemical properties

Introduction

The importance of organic agriculture, whose aim is to obtain healthy and nutritional quality products, to preserve water quality and quantity, to reduce the negative effects of chemicals on organisms and environment and to prevent erosion, is increasing day by day. Maintaining the productive and dynamic structure of agricultural land is among the targets of organic agriculture. In recent years, the excessive use of chemicals, the accumulation in the surface soil as well as the penetration of deep contaminated pollutants into the profile of the water resources, pose a threat to the sustainability of agricultural areas. Therefore, it is necessary to determine the organic farming basins and to ensure their sustainability through measures to be taken.

Heavy metals, which form an important source of inorganic pollutants in groundwater, are also defined as metals with a density higher than 5 g/cm^3 and contaminated and toxic properties (Duffus, 2002; Kahvecioğlu et al., 2009). Heavy metal accumulation is not only endangering agricultural areas and its environment, but also poses a danger to human and animal health due to food consumption (Chen, 1996; Zheng et al., 2002;

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2003). In our country, there is not much scientific study on the effect of heavy metals on organic farming areas, which constitute an important threat in soil accumulation.

The aim of the present study was carried out to determine i) some physico-chemical properties ii) heavy metal (HM) content and their enrichment factor (EF), and iii) detection relationships between some physico-chemical properties and EF values of HMs in arable lands of micro catchments located on two different physiographic positions that area Çarşamba Delta Plain and Upland in Samsun province.

Material and Method

Field description

This study was carried out in eight micro catchments sited on two different phsyographic positions. Two of them is sited at Çarşamba and Terme districts located on alluvial delta plain and another is found on Salıpazarı district located on upland position in the Central Black Sea region of Turkey. The study area lies at an elevation above the sea level from 0 to 1268 m. The region has topographically very heterogeneous topographic features such as mountainous, hilly and rolling positions in upland areas, whereas almost flat position in delta plain. Therefore, commonly high slope degree particularly located at Salıpazarı district, on the other hand gently slope degree (0-2%) and flat physiographic units are commonly located on delta plain in the study area.

The climate can be described as sub-humid and according to long term meteorological data (1974-2017), average annual precipitation and temperature of the study area are 1023.1 mm and 14.4 ºC, respectively. According to Newhall simulation model (Van Wambeke, 2000), soil temperature and moisture regimes are Mesic and Dry Tempudic, respectively.

Soil Sampling and analysis

Field study was conducted in 2017. Soil samples were collected from mostly Eutric Fluvisols and Chromic Cambisols in Delta plain, while some soils were also taken from Alisols-Acrisol-Pozols soil units (FAO/WRB, 2014) located on upland position. All soils were represented for agricultural lands. The sampling was carried out after harvest in the autumn and before start of the next cropping season in order to avoid the influence of agricultural practices during the crop growing season, i.e. fertilization. 126 soil samples were taken from soil surface layer (0–20 cm). In addition, their coordinates were recorded using global positioning system (GPS) tool.

Samples were air-dried and sieved through a 2 mm sieve to be prepared for analyses. Soil requirements for organic farming including soil physico-chemical properties, nutrient elements and heavy metal concentration were determined based on literature (Lindsay and Norvell, 1978; Kloke, 1980). Table 1 shows the selected analytical protocols.

Some physico-chemical characteristics of soil such as the organic matter, pH, and lime contents, and the particle size fractions are of great importance in the heavy metal toxicity of soils. The calculation of the enrichment factors (EF) for the heavy metals was made using an equation suggested by Sposito (1989) and Agbenin (2002)

$$EF = (HM_{soil}) / (HM_{earth})$$

where HM_{soil} is the total heavy metal concentration in the soil sample, and HM_{earth} is the mean heavy metal concentration in the earth's crust, which is 0.11 mg kg^{-1} for Cd, 50 for Cu, 100 for Cr, 20 for Co, 80 for Ni, 14 for Pb, and 75 mg kg^{-1} for Zn (Sposito, 1989).

Table 1. Protocol measurements for some soil physical and chemical properties

Parameters	Unit	Protocol	Reference
Texture (Clay, Silt and Sand)	%	hydrometer method	Bouyoucos (1951)
pH	1:1	(w:v) soil-water suspension	Soil Survey Laboratory (1992)
EC	dSm^{-1}	(w:v) soil-water suspension	Soil Survey Laboratory (1992)
Ca2CO3 (CaCO3)	%	Scheibler calcimeter	Soil Survey Staff (1993)
Organic Matter	%	Soil organic carbon by a modified Walkley-Black method	Soil Survey Laboratory (1992)
$NaHCO_3$–P	mg kg^{-1}	Bray-Kurtz and Olsen	Kacar, 1994
Total N	%	Kjeldahl	Bremner and Mulvaney (1982)
NH4OAC–K, Ca, Mg, Na	mg kg^{-1}	Ammonium acetate extraction, flame spectrometry detection	Soil Survey Laboratory 1992
DTPA–Cu, Fe, Mn, Zn	mg kg^{-1}	DTPA extraction, AAS detection	Lindsay and Norvell (1978)
Total heavy metal (Cu,Cd,Cr,Pb,Co,Ni,Zn)	mg kg^{-1}	According to EPA 3051 sing ICP-OES detection	Kloke (1980)

Based on the EF value, five categories of pollution were distinguished by Sutherland (2000): the absence of enrichment (<2), moderate enrichment (2–5), high enrichment (5-20), very high enrichment (20–40), and extremely high enrichment (>40).

Results and Discussions

Soil physico-chemical properties and heavy metals

The physico-chemical characteristic selected in this study showed variability as a result of dynamic interactions among natural environmental factors (topography, parent material, climate and vegetation) including soil development degree, leaching process, and cultivation activities such as tillage systems or fertilization (Dengiz et al. 2015). The descriptive statistical parameters such as mean, maximum, minimum, and coefficients of variation (CV) of the some basic physico-chemical properties related to 126 soil samples taken from surface (0-20 cm) of the crop lands in 8 micro catchments in Çarşamba, Terme and Salıpazarı districts of Samsun were given in Table 2. In order to determine variability of some physico-chemical soil properties, many researchers offer to investigate coefficient of variation (CV). According to CV values, it was classified as low (<15%), medium (15-35%) and moderate (> 35%) (Mallants et al. 1996). In this case, variables of sand, silt of physico-chemical soil properties and Zn have moderate CV. On the other hand, the variables of sand, clay, EC, $CaCO_3$ content, micro and macro nutrient elements of soil physico-chemical properties. In addition to that, the values of pH in soil samples have low variability and ranged from strong acid to slightly alkaline (4.68 and 7.67), whereas electrical conductivity had a mean value of 0.41 dS m^{-1}. The mean values of organic matter and $CaCO_3$ content (%) were 3.00 and 1.84.

As for the concentrations of heavy metals (HM) in the surface soils given in Table 3, it was determined that variables of heavy metal concentration of soils had a high level of variability. In the soils studied, the concentrations of Cu amounted to 18.19–99.3; Cr, 4,15-245; Pb, 6.97-45.0; Cd, 0.00- 2.17; Co, 10.51-59.8; and Ni, 11.56-241.0 mg kg^{-1}. The heavy metal contents such as C0, Ni and Cr were higher than those given in Table 2. On the other hand, Pb, Co, and Cd concentration not exceeded their permissible threshold level in all of the soil samples. 81% of total soil samples was found high Ni concentration while, 26% of it was determined Cr concentration which is over the threshold level. Other HM concentrations were detected as lower than maximum permissible concentration level (Figure 5). When compared their sampled positions, 89% of high Cr and 95% of high Ni concentrations were determined on micro catchments located on Çarşamba Delta Plain due to alluvial deposited parent material.

Table 2. Descriptive statistical analysis of physico-chemical properties and heavy metal of soil samples

Parameters	Mean	SD	*CV	Varians	Min.	Max.	**Skewness	Kurtosis
Surface (0-20 cm, *n:126*)								
Sand (%)	28,6	19,2	67	367	7,32	92,0	1,26	0,907
Clay(%)	38,9	16,5	42	271	2,69	68,4	-0,429	-0,536
Silt (%)	32,5	9,25	28	85,5	5,12	54,8	-0,112	-0,017
pH (1:1)	6,52	0,82	13	0,671	4,68	7,67	-0,453	-0,984
EC (dS m^{-1})	0,41	0,22	54	0,050	0,11	1,86	2,44	13,0
CaCO3(%)	1,84	3,07	167	9,415	0,00	14,1	2,15	4,08
OM (%)	3,00	0,99	33	0,980	1,05	6,91	0,650	0,961
AvP (mg kg^{-1})	12,7	21,2	167	448	0,400	113	3,10	10,2
exNa(mq$100g^{-1}$)	164	200	122	39984	0,07	692	1,23	0,189
exCa (mq$100g^{-1}$)	2239	2104	94	4427612	9,56	8108	0,68	-0,320
exMg(mq$100g^{-1}$)	360	347	96	120171	1,83	1101	0,457	-1,32
TN (%)	0,18	0,07	37	0,004	0,06	0,45	1,25	1,99
B (mg kg^{-1})	1,98	1,43	72	2,03	0,22	8,39	1,78	4,14
AvFe (mg kg^{-1})	52,2	34,3	66	1174	6,39	186	1,57	2,99
AvCu (mg kg^{-1})	5,08	2,12	42	4,48	0,34	10,3	-0,139	-0,194
AvZn (mg kg^{-1})	1,02	0,90	88	0,812	0,05	4,45	2,00	3,68
AvMn (mg kg^{-1})	24,1	18,1	75	328	3,22	103	1,97	4,88

SD: Standard deviation, Min.: Minimum, Max.: Maximum, n: sample number, *CV (Coefficient of Variation**)**, **skewness:< │∓0.5 │= Normal distribution, 0.5- 1.0 = Application of character changing for dataset, and > 1,0 → application of Logarithmic change, #:

Maximum permissible concentration.OM: Organic matter, TN total nitrogen, AvP: Available phosphorus, ExCa extractable calcium, ExMg extractable magnesium, ExNa extractable sodium, AvFe Available iron, AvZn Available zinc, AvMn Available manganese and AvCu Available cupper.

Table 3. Some statistical characteristics for the total heavy metal contents and maximum permissible concentration in the soils studied, mg kg^{-1}

Heavy Metals	Mean	SD	*CV	Variance	Min.	Max.	**Skewness	Kurtosis	MPC ppm
Surface (0-20 cm, *n:126*)									
Cu	46,1	17,7	38	315	18,19	99,3	1,04	0,985	100
Cd	0,80	0,61	77	0,377	0,00	2,17	-0,07	-1,26	3
Cr	72,5	39,7	55	1577	4,15	245	1,30	3,04	100
Pb	19,1	6,49	34	42,1	6,97	45,0	0,376	1,18	100
Co	23,2	9,80	42	96,0	10,51	59,8	1,57	2,65	50
Ni	94,4	61,9	66	3830	11,56	241	0,401	-0,96	50

MPC: Maximum permissible concentration.

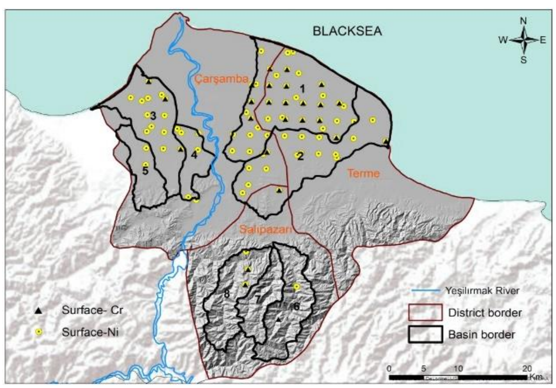

Figure 5. Exceeded heavy metals their maximum permissible concentration in representative micro catchments

A correlation analysis was done for the determination of the relationships between the physico-chemical properties of the soils and heavy metals and given in Table 4. Puschenreiter and Horak (2000) stated that the basic soil characteristics, such as the pH and texture, are of great importance in the availability of heavy metals in the soils. It was found that a significant negative correlation was revealed between the content of sand and the Pb concentrations, whereas a positive correlation was determined between the clay content and the heavy metal content such as Cd, Ni and Pb. This result confirmed the data of Temmerman et al. (2003). In addition, no significant relation was found between the content of silt and the heavy metals which are Cr, Pb, Co and Ni (except for Cu and Cd). The soil's pH and the $CaCO_3$ content have significant role related to the heavy metals accumulation in the soils. Negative linear correlations were found between these soil properties and some heavy metals such as Cu, Ni and Co in surface soil depth.

Table 4. Relationships between some physico-chemical properties of the soils and the heavy metals in the surface and subsurface soils

Heavy Metals (mg kg^{-1})	Sand (%)	Clay (%)	Silt (%)	pH	EC (dS m^{-1})	$CaCO_3$ (%)	OM (%)
Surface (0-20 cm, *n:126*)							
Cu	0,130	-0,045	-0,233**	-0,302**	-0,317**	-0,229**	0,183*
Cd	-0,312**	0,238**	0,190*	0,286**	0,276**	0,484**	-0,083
Cr	-0,329**	0,402**	-0,097	0,339**	0,284**	0,284**	0,080
Pb	-0,317**	0,253**	0,144	0,030	0,191*	0,308**	0,126
Co	-0,030	0,015	-0,027	-0,248**	-0,159	-0,025	0,023
Ni	-0,518**	0,559**	0,023	0,503**	0,397**	-0,446**	0,013

*:p<0,05;**: p<0,01

In addition to obtain real heavy metals' values, all the elements were additionally grouped into five levels by Sutherland (2000) in order to estimate their relative accumulation according to the enrichment factors (EF) values for surface and subsurface soil samples. Some statistical characteristics of the EF for the surface and subsurface soils are given in Table 5. In surface soil samples, the EF values for Cd attest that the soils were enriched with these elements as compared to their mean background value. The highest value of EF was found for Cd (19.73), whereas only Cu has lower EF values. In addition, most of the EF values of HMs (except for Cu) spatially distributed on delta plain (Figure 6).

Table 5. Some statistical characteristics of the enrichment factors (EF) for the surface and subsurface soils, mg kg^{-1}

Heavy Metals	Mean	SD	*CV	Varians	Min.	Max.	**Skewness	Kurtosis
Surface (0-20 cm, *n:126*)								
EF-Cu	0,92	0,36	38	0,126	0,36	1,99	1,04	0,92
EF-Cd	7,28	5,58	77	31,2	0,01	19,7	-0,07	7,28
EF-Cr	0,72	0,40	55	0,158	0,04	2,45	1,30	0,72
EF-Pb	1,37	0,46	34	0,215	0,50	3,21	0,37	1,37
EF-Co	1,16	0,49	42	0,240	0,53	2,99	1,58	1,16
EF-Ni	1,18	0,77	65	0,598	0,14	3,01	0,40	1,18

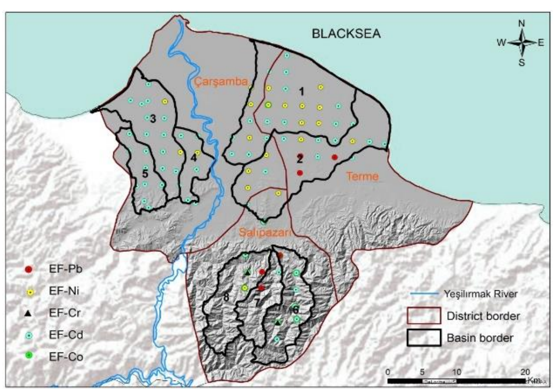

Figure 5. EF heavy metals in representative micro catchments

Conclusion

This present study was conducted in some intensive cultivated lands in eight micro catmints located at delta plain position and upland position in order to determine heavy metals content and their enrichment factors. For this purpose, 126 soil samples were collected form surface soil. The results showed that mostly the concentration of Ni followed by Cr exceeded their threshold levels. The local pollutions from Ni and Cr were attributed to the natural influences (particularly due to parent material such as sediment deposit and volcanic rocks). The concentrations of the other HMs are relatively lower than the critical values. The mean values of the HMs contents arranged in the following decreasing order: Ni > Cr > Cu > Co > Pb > Cd in the studied soil sample. In addition, it was found significantly positive relation between Pb and OM while the same relation was also found clay content and Cd and Pb. On the other hand, according to EF of HMs in total soil samples, particularly Cd and Ni have been found more than 2 level on delta plain.

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Urban Soil Quality Assessment – a Comprehensive Case Study of Urban Gardens in Eastern Slovenia

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Abstract

Soil sealing is one of the major threats to urban gardening. More than 100,000 hectares of mainly agricultural land are taken annually for urbanization purposes in the EU member states. Driving forces of sealing relate to the need for new housing, business locations and road infrastructure for the socio-economic development of urban areas. On the other hand urban gardening is becoming more popular each year, due to its social, economic and health benefits.

To preserve healthy home-grown products within the city, urban gardens must be a first priority of the municipalities and their inhabitants. In Slovenia each city poses a land reserved for urban gardens. Lately more and more local initiatives are being established which are fighting against soil sealing and protect old as well as build new urban garden areas. Within the project we checked the soil quality at selected urban gardens in Eastern Slovenia. During the years 2017 and 2018 several urban gardens were examined. All soil samples were analysed using ICP MS and the average contents are: V – 103.5 mg/kg, Cr – 102.9 mg/kg, Ni – 57.0 mg/kg, Cu – 71.7 mg/kg, Zn – 442.5 mg/kg, As – 18.4 mg/kg, Mo - 1.7 mg/kg, Cd – 1.7 mg/kg, Sb – 1.8 mg/kg, Ba – 620.4 mg/kg and Pb – 124.7 mg/kg. Chemical analyses show that many of sampled soils contain hazardous elements which are above allowable limits. Thus further assessments and toxicological studies are needed to prevent the hazardous effects for end users.

Keywords: Soil, urban garden, pollution

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Use of Plant Activator in Phytoremediation: Example of Ni

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Abstract

In this study, Rhodobacter capsulatus DSM1710 was used as plant activator in Malabar spinach (Basella alba L.) cultivation and the nickel (Ni) content of the soil was investigated. The study was designed according to randomized block design with three replicated of the conditions which were control, only bacteria (10 mL), only chromium (Cr) (30 mgkg-1), Cr+bacteria (10 mL+30 mgkg-1). The plants were planted into 5L pots as 1 plantpot-1 25 days after sowing. Applications of bacteria were carried out during the transplantation of the 3 true leaf phase plants to their pots. Plants were harvested 45 days later. According to the analysis results the Ni contents of the plants were 4.42, 3.50, 527, 5.49 mgkg-1 and Ni contents of the soil were 7.75, 7.70, 7.28, 8.67 mgkg-1 in the mentioned order of conditions. It was revealed that Ni contents of both plants and soil were the highest in Cr+bacteria condition. Rhodobacter capsulatus, which was an activator, increased the solubility of the heavy metal Ni in the soil. The Malabar spinach has the highest Ni content in the same condition as this plant acted as a hyperaccumulator.

Keywords: Phytoremediation, nickel, bacterium, Basella alba L.

1. Introduction

The excessive use of chemical fertilizers in traditional agriculture systems decreases soil productivity and biological diversity and brings about new pests and diseases. The sustainability in agriculture cannot be provided because of the ongoing use of agricultural chemicals in amounts that ecosystems cannot handle. As a result, there is a significant decrease in soil fertility and product quality. There is a need for applications that will increase the soil quality and fertility in order to obtain high quality products. Increase in the beneficial microbial population in the rhizosphere by biological and organic fertilizers is required. The biological and organic fertilizers applied to the soil increase soil productivity. Therefore, the need for chemical fertilizers decrease, the organic wastes can be degraded and pollution upon chemical use can be minimized. Organic fertilizers have a vital role for soil microorganisms beside remediation of physical structure of the soil (Karaman et al., 2012). Utilization of biological applications instead of chemicals focusing of sustainability in agriculture has gained priority (Merdin, 2009). Beneficial microorganisms have been started to be used to increase the resilience of plants to biotic and abiotic stress conditions. Biofertilizers used in agriculture are applied to composts, seeds, soil or vegetative parts of the plants and are live or latent microorganisms that can fix nitrogen, convert phosphate and some other elements into bioavailable form, promote plant growth by secondary metabolite production or protect plants against some diseases (Armstrong 2001; Postma et al., 2001; Deniel et al., 2006; Mahdi et al., 2010). Rhodobacter capsulatus is a photosynthetic, gram negative, purple no sulfur bacterium that can fix nitrogen and produce hydrogen by the help of its nitrogenase enzyme and showed

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to be utilized as a biofertilizer (Weaver et al., 1975; Adiloglu et al., 2018). The Malabar spinach (Basella alba L.) is fast growing, creeping vegetable belonging to Basellaceae family which can be grown in high temperatures (Grubben and Denton, 2004; Rathee et al., 2010; Deshmukh and Gaikwad, 2014). This vegetable has originated in Indonesia and India and can naturally be grown in tropical Asia (Saroj et al., 2012). It is also named as vine spinach, climber spinach, Ceylon spinach and Indian spinach (Roy et al., 2010; Sen et al., 2010). Malabar spinach can easily be grown on different soils and climates (Palada and Crossman, 1999). The above ground stem, leaves and young flower buds can be consumed as vegetable. It has high vitamin C, vitamin A, flavonoid, saponin, carotenoid and amino acid contents and substitutes the true spinach (Spinacea oleracea L.) in the countries which are produced. It also has androgenic, antidiabetic, anti-inflammatory, anti-oxidant, anti-ulcer and antibiotic properties (Deshmukh and Gaikwad, 2014). Heavy metal tolerance of plants is determined by physiological and molecular mechanisms. Hyperaccumulators take up high amounts of toxic materials such as metals or metalloids and can hold them in their bodies during normal growth and reproduction. Heavy metal contamination in soil has effects on soil fertility and ecosystem, and also on animal and human health through food chain. High expenses of cleaning procedures of the contaminated soil limited the applications of classical removal technologies. Therefore, there is a need for new technologies that are low cost and efficient in remediations of the contaminations. As a result, phytoremediation methods which are more aesthetical and of low cost compared to other methods have been developed (Adiloglu et all., 2018). In this study, the interaction of nickel heavy metal with chromium heavy metal contamination and utilization of Malabar plant as a hyperaccumulator in phytoremediation of heavy metal chromium. The alteration of the functional element and heavy metal nickel in soil and plant has been determined.

2. Methodology

This research was conducted in the labs of the Department of Soil Science and Plant Nutrition, Faculty of Agriculture, Tekirdag Namik Kemal University, Tekirdag, Turkey. The ambient temperature was 25°C and humidity was about 80% in the climate-controlled lab. (Eryilmaz Acikgoz and Adiloglu, 2018). The plant material was green standard variety of Malabar spinach (Basella alba L.) (Zengarden Firm, Turkey) (Figure 1). The seeds were sown in multipods as three duplicates. Peat was used as the production environment (Klasmann-Deilmann, Potground H, Germany). Some specifications of the peat were: 160-260 mg/L N, 180-280 mg/L P2O5, 200-150 mg/L K2O, 80-150 mg/L Mg, pH 6, 70% organic matter and 35% C. The research was designed according to random block design where the trials were control, only bacterium application (10 mL), hexavalent chromium (CrO3) 30 mgkg-1, bacterium+chromium (10 mL and 30 mgkg-1) as triplicates. The plants were transferred to 5L pots as 1 plantpot-1. Bacteria were applied during transplantation of plants of three true leaves to the pots. Plants were harvested 45 days after planting and immediately washed with distilled water and dry weights of the plants were determined after keeping at 65°C for 48 hours until the weight changes were stabilized. After that, analyses of soil and plant samples were carried out (Kacar and Inal 2010; Kacar 2016). Rhodobacter capsulatus DSM1710 used in this study was photosynthetically grown on peptone yeast extract medium MPYE which is a rich medium. The cells were collected during the exponential phase of growth with centrifugation, washed twice with sterile distilled water and suspended in sterile physiological saline solution to be 5x107 cellsmL-1 applied to the root area of the plants during plantation as 10 mL. Then the results of the experiment were evaluated by the use of SPSS 21 statistics software. ANOVA variance analysis and Duncan multiple comparison tests were conducted on the research results. In addition, no pesticides were used during the growing period.

Figure 1. Photos of the Malabar spinach (a) during the experiment (b). (Original).

3. Results and Conclusion

Chemical and physical characteristics of the soil used in this study are given in Table 1. The soil pH was neutral with no salinity before the experiment. The organic content of the soil was low. The texture was clay loam with medium amount of lime. The soil was insufficient in terms of iron and manganese and sufficient in terms of copper and zinc.

Table 1. Some chemical and physical properties of the soil sample

Analysis	Results	Analysis	Results
pH	7.04	Mn (mg kg $^{-1}$)	0.70
EC (µscm^{-1})	1620	Cu (mg kg $^{-1}$)	1.83
$CaCO_3$ (%)	5.65	Fe (mg kg $^{-1}$)	0.40
Organic matter (%)	1.88	Zn (mg kg $^{-1}$)	0.87
Texture	Clay Loam(CL)	Cr (mgkg^{-1})	0.45
P (mg kg $^{-1}$)	36.40	Ni (mgkg^{-1})	7.75
K (mg kg $^{-1}$)	253.80		0.70

Table 2. Effects of plant activator on nickel content of the Malabar spinach and the soil *, **

Trials	Soil (Ni) $mgkg^{-1}$	Plant (Ni) $mgkg^{-1}$
Control	7.75± 0.01 b	4.42 ± 0.03 b
Bacterium	7.70 ± 0.03 b	3.50 ± 0.06 c
Chromium	7.28 ± 0.02 c	5.27 ±0.06 a
Chromium+Bacteria	8.67 ± 0.07 a	5.49 ± 0.39 a

*: The values are mean of three replications; **: Each parameter was evaluated individually and values in the same column with different letters are statistically significant at the level of 5 %.

The nickel content of the plant and soil in the trial where bacteria were applied were different numerically, however they were statistically insignificant (Table 2). The lowest nickel in the plant was observed in only bacterium application. This suggests that bacteria utilized nickel in the soil. Nickel is an essential element for many bacteria and cofactors of the enzyme's hydrogenase and urease (Kacar and Katkat 2010). The highest nickel contents in the soil and plant were when chromium was applied together with bacteria. This may suggest the presence of a synergistic relationship between heavy metal chromium and nickel. The nitrogen fixing bacterium Rhodobacter capsulatus (Masepohl and Hallenbeck 2010), has supported the green Malabar spinach and protected it from chromium contamination as revealed from the nitrogen content of the plant. The first physiological event affected by the toxic levels of chromium in the plant is the seed germination. This element inhibits seed germination by decreasing amylase activity, transport of sugar to the seed and increasing protease activity. At the same time, it inhibits root development by hindering elongation and multiplication of root cells. By this way, it prevents plant growth and development by decreasing plant nutritious elements and water uptake from soil (Khan et al., 2000; Jain et al., 2000). Hence, quality and yield significantly decrease. Malabar spinach has been shown to be a hyperaccumulator in this study as toxic level of chromium contamination did not show the effects mentioned above in this plant. It is an obligation to remediate heavy metal contaminations for the sustainability of agriculture and production of healthy products for healthy generations. Soils should be remediated in an economic way for sustainable agriculture and in order to feed the increasing world population and protect the public health. The effects of the nitrogen fizzing bacterium Rhodobacter capsulatus and chromium contamination on functional nickel contents of the soil and the plant Malabar spinach were evaluated in this study. The results showed that besides nitrogen which is vital for green plant cultivation, nickel, which is a heavy metal, is also a functional element that needs to be evaluated with soil and plant analyses in microbial fertilizer applications. The nickel levels were found to be the lowest in the trial where only bacteria were applied as the bacteria utilized the nickel element. The highest nickel amount was found to be in chromium + bacteria application which suggests that there is a synergistic relationship between nickel and chromium. The soil bacterial population is declining day by day due to conventional agriculture applications. Use of biofertilizers should be encouraged in order to prevent this negative situation. Majority of agricultural soils in Turkey are devoid of organic materials. Dissemination of use of such organic fertilizers would positively affect the organic content of soil and also help inhibition of further pollution of soil and water sources due to excessive use of chemical fertilizers. A vast majority of agricultural lands are lost in terms of healthy agricultural production because of the pollutants. In order to prevent this hyperaccumulator plants and pollutants on which their efficiency is the highest should be determined and phytoremediation should be applied for sustainable agriculture.

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THEME 6: Plant Nutrition

Influence of Fresh and Composted Broiler Chicken Manure on the Contents of Some Micro Elements in the Root and Above Ground of Corn Plant

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Abstract

In the study, the effect of fresh chicken manure and chicken manure of composted with rice husk on some micronutrients of corn plant (Zea mays L.) was investigated.The study was carried out under greenhouse conditions as four replicates in randomized plot design.Comprised of fresh chicken manure chicken manure of composted with rice husk were filled with four different doses (0%, 1%, 2% and 4%) by mixing with clay loam soil (2000 g). Three corn seeds were planted in each pot and water was applied until the field capacity.The concentrations of B, Fe, Zn, Cu, Mn of above and below soil (root) parts of the plant were determined after 3 months of development in each pot.

Application of fresh and composted chicken manures at different doses were found statistically significant in Cu, Zn values of above ground parts of corn plant.The highest Cu value was obtained in a dose of 2% of fresh chicken manure and the highest Zn values were obtained in 2% of fresh chicken manure and 4% of composted chicken manure.When the root parameters of the corn plant were examined, it was observed that the manure and dose applications on the Zn contents were statistically significant and the manure factor on the Mn contents was a statistically significant effect and the composted chicken manure was more effective in increasing the Mn concentration. The effects of the applications on other measured parameters were not statistically significant.

Key Words: Chicken manure, composting, micronutrients, corn

1. Introduction

The most important aim in sustainable agriculture and soil management practices is to reestablish the deteriorating natural balance while receiving high efficiency and to use the resources effectively. Increasing world population, unplanned urbanization and industrialization lead to misuse of the land, which is one of the most important natural resources of a country. The most basic problem of the soil is that it can be easily lost or degraded in a short period of time despite the occurrence in many years. The main reasons for the degradation are inappropriate soil and water management. It is important to increase the soil organic matter, which is an indispensable element of sustainable agriculture practices, and to evaluate the wastes effectively in doing so. Organic matter which affects the physical chemical and biological soil properties extremely positively; There

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is inadequate in the soils of Turkey. In successful land management, soil fertility should be improved and crop yields should be increased and maintained at this level.

Although many agricultural practices have been effective in increasing soil fertility, all these practices are aimed at increasing and maintaining the amount of organic matter in the soil. On the other hand, farm fertilizers and their composts that we can use as a source of organic matter are not used sufficiently and consciously. Composting; It is the process of converting organic material into humus by microorganisms. In other words, the process of biodegradation and stabilization of organic substances under controlled environmental conditions.Compost materials applied to the soil may vary. In the selection of composting materials wastes, which cause serious environmental problems, are regarding the large amounts, are important resources. Plant residues, farm residues, stable manure, urban wastes, industrial wastes and post-harvesting materials can be used to increase the organic matter content of soils directly or after composting. (Entry vd. 1997; Pascual vd. 1997; Madejón, vd. 2001; Kütük vd. 2003; Bhattacharya vd. 2003).

Fresh or composted chicken manures have positive effects on plant growth with contents of macro and micro nutrients. In particular, organic fertilizers play an important role in eliminating micro-element deficiencies that are currently ignored by chemical fertilization.

The aim of this study is to determine the changes in some micro element contents in the aboveground and root parts of corn during early development period.fresh and composted broiler chicken manure applications which are exposed in large quantities in our country.

2. Material and Method

The experiment was established on the basis of dry weight in 2 kg soil pots under controlled conditions in the greenhouse of Ankara University, Faculty of Agriculture, Department of Soil Science and Plant Nutrition. Fresh chicken manure and composted chicken manures were filled with soil with at the rate of 0%, 1%, 2% and 4% and then incubated for approximately 1 month. The experiment was carried out with four replications according to the trial design of randomized plots and the irrigation was done according to the field capacity. In the experiment, urea (250 kg ha-1), phosphorus, TSP (80 kg ha-1) and potassium nitrate (200 kg ha^{-1}) were used as fertilizers. Some physical and chemical properties of experimental soil are given in Table 2.1.

Fresh chicken manure with rice husk is provided from a farm producing broiler chicken in Bolu. The compost material was obtained at the end of the three months composting after the temperature stability of the fresh chicken manure with the rice husk. The C / N ratio of fresh chicken manure- ricehusk mixture at the beginning is intended to be about 25 for the rapid maturation of the compost material. In order to increase the carbon content of mixture, 125 kg of rice husk was added to100 kg fresh chicken manure (Demir, 2012).

On 04.06.2015, the plants were harvested by cutting off the soil surface and the roots in the pots were washed carefully. The above ground parts and roots were washed with distilled water, dried at 65 ° C, dry samples was milled.Milled plant samples were burned with wet oxidation method (Kacar and Inal, 2008) and total Fe, Mn, Zn, Cu and B were determined by ICP-OES device.

Table 2.1. Some physical and chemical properties of experimental soil

Properties of Experimental Soil		Unit	Quantity
Texture (clay loam) (Bouyoucos, J. 1951)		% Clay	40
		% Silt	34
		% Sand	26
pH (U.S.Salinity Lab. Staff, 1954)		1:2,5	7,92
Electrical Conductivity (EC) (U.S.Salinity Lab. Staff, 1954)		dS m^{-1}	0,29
Lime ($CaCO_3$) (Hizalan ve Ünal, 1966)		%	6,08
Organic Matter(Nelson ve Sommers, 1982)		%	1,38
Total Nitrogen (N) (Bremner, 1982)		%	0,09
Plant-available nutrients	Iron(Fe) (Lindsay ve Norvell, 1978)	mg kg^{-1}	6,50
	Zinc (Zn) (Lindsay ve Norvell, 1978)	mg kg^{-1}	0,71
	Copper (Cu) (Lindsay ve Norvell, 1978)	mg kg^{-1}	0,10
	Manganese (Mn)(Lindsay ve Norvell, 1978)	mg kg^{-1}	5,58
	Boron (B) (Lindsay ve Norvell, 1978)	mg kg^{-1}	1,50
	Phosphorus (P) (Olsen ve Dean 1954)	mg kg^{-1}	4,98
	Potassium (K) (Jackson, 1958)	mg kg^{-1}	447

Table 2.2 Some properties of fresh chicken manure, composted chicken manure and soil

Materials	Organic carbon (%)	Total Nitrogen (%)	pH (1:2,5)	EC (dS m^{-1})	Free Carbonates (%)
Fresh chicken manure	44,00	4,27	8,93	8,38	3,29
Composted chicken manure	25,20	1,26	7,84	2,83	2,28

3. Result and Discussion

When manure materials and application rates evaluated together, manure*doseinteractions were statistically significant ($p<0.05$) on the content of copper (Cu) and zinc (Zn).The highest Cu concentration was determined as 6,44 mg kg^{-1} in 2 % dose of fresh manure and the highest Zn concentration was determined in 4 % of compostedmanureand 2 % dose of fresh manure (Table 3.1, Fig. 3.1 and Fig. 3.2). Aynacı and Erdal (2016) stated that, they used urban waste for maize plant cultivation and also they pointed out taht as the amount of applied compost increased, Fe, Zn and Mn concentrations increased and the effect on Mn concentration was found statistically significant.

Table 3.1 Effects of fresh and composted chicken manure applications on some micro element contents of the aboveground cornplant

Material	Dose	Fe mg kg^{-1}	Mn mg kg^{-1}	Zn mg kg^{-1}	Cu mg kg^{-1}	B mg kg^{-1}
Fresh Manure	% 0	55,95	6,12 C	6,18 Ca	3,17 DEa	0,27
	% 1	67,74	1,59 D	6,16 Cb	3,51 DEb	0,42
	% 2	98,24	19,37 A	14,31 Aa	6,44 Aa	0,39
	% 4	44,03	1,77 CD	5,17 Cb	2,97 Eb	0,25
Composted Manure	% 0	55,95	6,12 C	6,18 Ca	3,17 DEa	0,27
	% 1	46,19	16,8 AB	11,54 Ba	3,79 Da	0,24
	% 2	118,89	14,76 B	12,16 Bb	4,58 Cb	0,34
	% 4	63,44	16,86 AB	14,23 Aa	5,37 Ba	0,30
	LSD	ns*	4,389	1,562	0,698	ns*

P<0,05 The difference between the means indicated in separate case is statistically significant. Upper case have been used to compare application rates in material subgroups. Lower case is used in comparison of materials in dose subgroups.*ns: Not significant

When manure materials and application rates were statistically not significant on the Fe and B contents. When manganese (Mn) contents were statistically evaluated, it was seen that manure factor was significcant and compostedmanurewas more effective in increasing manganese concentration compared to fresh manure (Table 3.1). In the studies, it was determined that as the contents of the organic materialsin soil, Ca, Mg, Fe, Mn and Zn contents increased as well (Lopez-Mosquera et al., 2000). Similarly, Pinamonti et al. (1997), Bozkurt et al. (2000a), Bozkurt et al. (2000b) and Çimrin et al. (2001) reported that the micro element concentrations of the plant increased with increasing organic material applications.

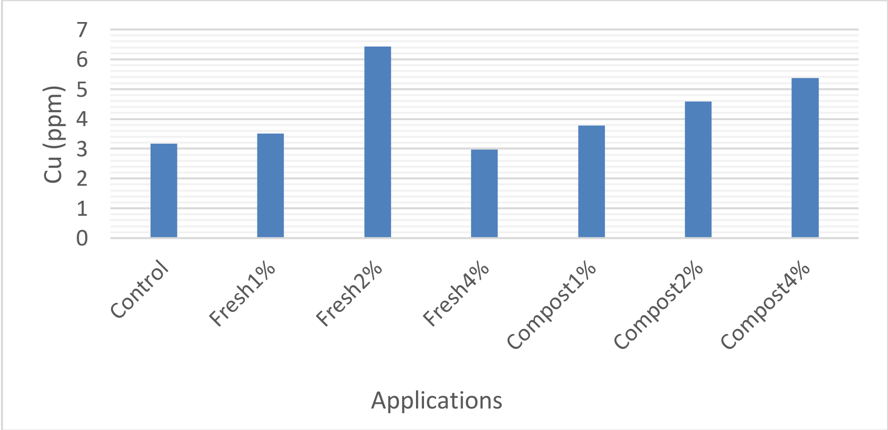

Figure 3.1 The effect of different doses of manure materials on the copper (Cu) content of the aboveground of the plant

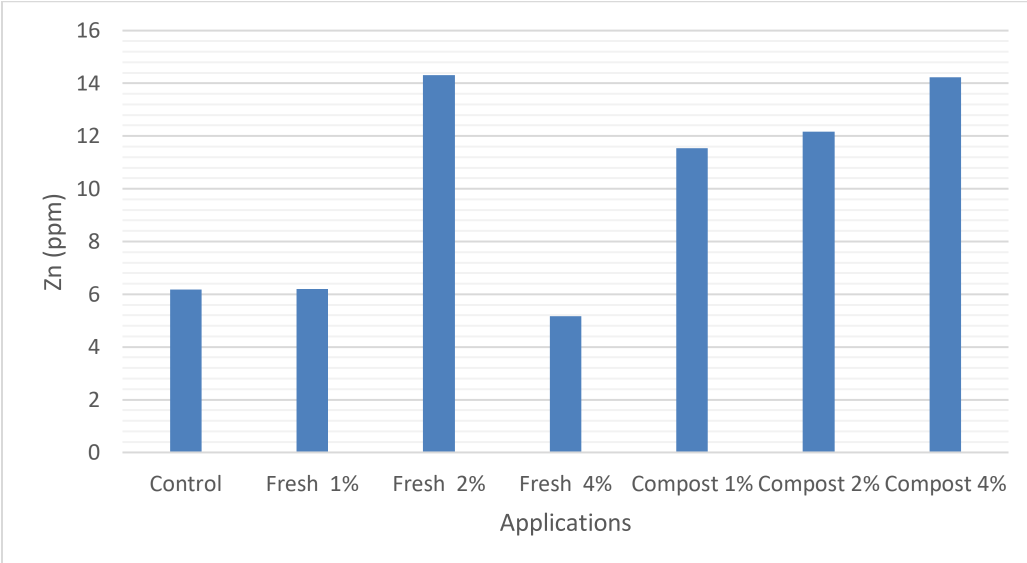

Figure 3.2 The effect of different doses of manure materials on the zinc (Zn) content of the aboveground of the plant

Table 3.2 Effects of fresh and composted chicken manure applications on some micro element contents in root of corn plant

Material	Dose	Fe mg kg^{-1}	Mn mg kg^{-1}	Zn mg kg^{-1}	Cu mg kg^{-1}	B mg kg^{-1}
Fresh Manure	% 0	1595,82	61,94 C	24,81 D	40,21	45,45
	% 1	1745,09	67,18 C	32,97 CD	33,05	6,21
	% 2	2741,01	97,99 B	44,29 B	36,30	8,99
	% 4	659,09	59,94 C	38,54 BC	21,81	24,23
Composted Manure	% 0	1595,82	61,94 C	24,81 D	40,21	45,45
	% 1	2123,46	114,47 B	55,11 A	32,88	3,75
	% 2	3022,81	111,89 B	61,11 A	28,14	2,50
	% 4	4308,27	159,17 A	60,52 A	25,64	17,15
	LSD	ns*	26,17	8,66	ns*	ns*

P<0,05 The difference between the averages indicated in separate case is statistically significant. Upper case have been used to compare application rates in material subgroups. Lower case is used in comparison of materials in dose subgroups.*ns: Not significant

In the root of the corn plant, when different manure materials and application rates were evaluated statistically together, manure*dose interactions were not found significantly ($p<0.05$) on the content of Fe, Cu and B.It was determined manures and application rates on Zn contents were statistically significan.The highest Zn concentrations were found in 1 %, 2 % and 4 % of compostedmanure.It was observed that manure factor was statistically significant effect on Mn contents and it was revealed that composted chicken manure was more effective in increasing Mn concentration (Table 3.2). Yürük and Bozkurt (2006) revealed that, increasing rates (0%, 10%, 20% and 40%)caused to increase in the roots of plants, proportional to the dose increase in waste sludge applications for bean (*Phaseolus vulgaris*) and chickpea (*Cicer arietinum*) plants, They stated that waste sludge applications caused increases in Zn and Cu contents. They reported that the increase in heavy metal contents was significant in the roots when compared to the abovegroundpart of the plant.

4. Conclusion

It has been observed that fresh and composted chicken manures and different dose applications caused changes in iron, copper, manganese, zinc and boron contents in the aboveground and root components of corn plant. When the results of the study are examined, the effect of different application rates of fresh and composted chicken manure on the contentsof Cu and Zn in the aboveground of the corn plant was statistically significant. The highest Cu content was obtained at the rate of 2% fresh chicken manure, the highest Zn content were obtained in 2% fresh chicken manure and 4% of composted chicken manure as consider the root of the corn plant, manure and application rateson Zn contents were statistically significant, while it was observed that only manure factor had a significant effect on Mn contents. Further composted chicken manure was found to be more effective in increasing Mn concentration of plant root than fresh manure. The effects of the applications on other micro element concentrations were not significant. As a result of the study, the fresh and composted chicken manure increases the micro element content of the root and aboveground of corn plant with increasing application rates due to the enrichment of organic matter and micro element content.

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Variation of Aggregate Stability and Mean Weight Diameter of Soils Developed on North-western and South-eastern Toposequence

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Abstract

The aim of this study is to examine the changes and water resist aggregate stability (WRAS) and mean weight diameter (MWD) of soils developed on the different parent materials (marl, colluvium and alluvial), land form (flat on hill, back slope, footslope and flood plain), elevations, land cover and land use under semi-humid climatic conditions. In this context, four soil profiles were selected on northwestern and southeasterntoposequence and examined. According to Newhall simulation model, soil moisture and temperature regimes of the study area are Typic Xeric and Mesic, respectively. The study results showed that the lands located on back slope and flood plain were classified in the Lithic Xeroorthents and VerticXerofluvent subgroup of the Entisol order, while the lands on the flat on hill and footslope fields were classified as TypicHaplustert, and TypicCalcixerept, belonging to the Vertisol and Inceptisol orders. The formation of different soils on the northwestern and southeastern direction transect in the study area in other words, young and mature soils existing in a local area suggests that topography or local relief and parent material have a significant impact on the material and time involved in the soil formation process. It is seen that in the maturation of the soil and in the process that keeps the soil young, the soil transport and sedimentation, especially in the soils located on the back slopes due to water movement, is as effective as the formation that occurs on the spot. A significant difference was determined between the upper layer WRAS and MWD values of four soils used as dry and irrigated agricultures and this difference is thought to be caused in particular by agricultural use of the soils and by their organic matter and their pedogenic development. The soil classified as TypicHaploxerert has the highest WRAS and MWD values, whereasVerticXerofluvent has the lowest WRAS MWD values in surface horizons.

Keywords: Water Resist Aggregate Stability, Mean Weight Diameter, Toposequence

1. Introduction

The rapidly growing population has not only increased demand for herbal products, but also increased the pressure on agricultural areas. On the one hand, the human being must ensure the reliable food and ensure sustainability in agricultural production. The desire to obtain high yield from the unit area, it causes the exploitation of the soils and changes their the physical and chemical properties,as well as affects negatively on the quality of the soil.

Soil quality is an important criterion for evaluating the management practices, land degradation or improvement of land use sustainability. Because of soil quality, depending on factors such as soil management practices, ecosystem, environment, socio-economic and political priorities, it is defined as the umbrella

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characteristic of the soil (Doran and Parkin, 1994, Canbolat, 2006,Altıkatvd, 2009, Cebel, 2011, Kadıoğlu and Canbolat, 2014). Unconscious or out of purpose of land uses cause loss of functions associated with important physical, chemical and biological properties of soils, this case leads to land degradation.

The main objective of sustainable land management is to protect the fertility of the land and to transfer it to future generations. That's way, it is necessary to supply sufficient and detailed data about soil and land resources for protection practices. In other words, the most important step in the development of different strategic plans and management practices for the protection of the soil is the collection of information on the soil (Yakupoğluat all, 2012).

The majority of our geography position or topographic positions havehigh and steep slope degree. Therefore, it should be taken some precautions or measurements and fulfilment under control for cultivation which has slope land position. Because, shope has significantly role on pedogenetic development of soil in itssuit. Therefore, topography or relief is the most important factor for soil formation and affects how water and energy were added to and was lost from soil.Aggregates can be called as the smallest parts of the soil which can form by means of clay, silt and sand fractions mixed withorganic materials and living organisms create the most suitable condition for plant life(Ergene, 1982).It should be stimulate for aggregates formation particularly in cultivated land due to resist for field traffic and erosion

Aggregate stability that is an important parameter in determining of resistance against to environmental factors that deterioration (Hillel, 1982; Yılmaz and Alagöz, 2005), is often closely related to the soil's organic matter and clay content (Haynes and Swift, 1990; Chenu at all, 2000; Yakupoğlu at all, 2012). The effect of organic matter on aggregate formation is more pronounced in soils including low clay content (Hillel, 1982).Organic matter improves aggregation in fine texture, providing better airation and also helping to store more water (Lal, 1979). In addition, the average weighted diameter, expressed as a measure of the water resistance of soil aggregates, is also an indicator of the grain size distribution.

The aim of this study is to examine water resist aggregate stability (WRAS) and mean weight diameter (MWD) of soils developed on the different parent materials (marl, colluvium and alluvial), land forms (flat on hill, back slope, footslope and flood plain), elevations, land cover and land use under semi-humid climatic conditions.

2. Materials and Methods

2.1. Site description

The study area is located at the Vezirköprü district of Samsun province in the Central Black Sea Region and coordinated between 35º 01-35º 48 east longitudes and 41º 00 V- 41º 19 'north latitudes. Vezirköprü district covers 1713 km² and 115 km away from Samsun province

Vezirköprü differs from the climatic conditions of the coastal zone in terms of the humid climate type of the coastal zone and the terrestrial climate of the inland, with its specific thermal and moisture characteristics of the transition zone. The winters are colder than the coast and the summers are warmer (Average monthly temperature in August is 22.3 ºC). Annual rainfall over 500 mm per year. With rainfall is increasing in high places, snowfall appears to be effective (Anonymous, 2019).Soil temperature and moisture regimes were determinedby Turanat all, (2018) as Mesic and Typic Xeric using the Newhall simulation model

2.2. Soil sampling and analysis

The research was carried out atfour different topographic locations including foots, slopes, hill flats and floor terrains. In addition, in the study area formed on different parentmaterialwere defined four soils profiles developed under the same climate and land use (arable lands). Soils have been studied on along transect with representative four profiles illustrated in Figure1.

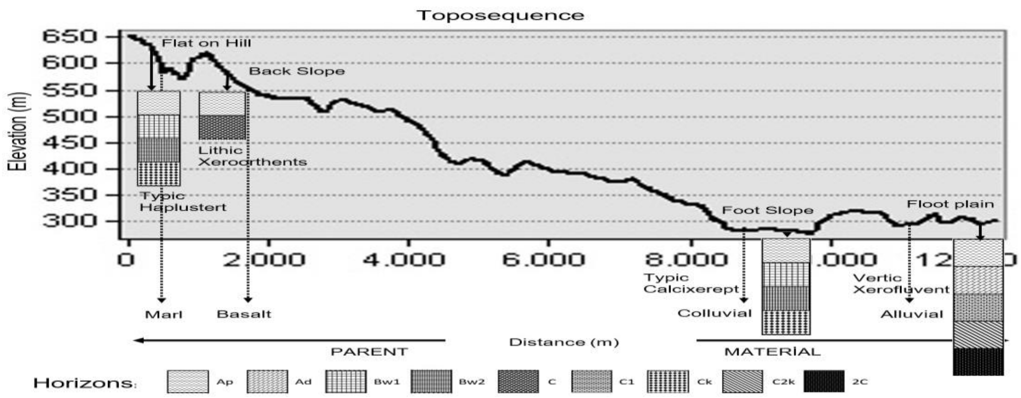

Figure 1. Transect of the four different soil pedons on different parent material and topographic positions.

Morphological properties of these 4 profiles in the field were identified and sampled by genetic horizons and classified according to Soil Survey Staff (1993 and 1999). 15 soil samples were taken to investigate for their physical and chemical properties at the laboratory. Disturbed soil samples were then air-dried and passed through a 2 mm sieve to prepare for laboratory analysis. After soil samples were then air-dried and passed through a 2 mm sieve, particle size distribution was determined by the hydrometer method (Bouyoucos,1951). Organic matter was determined using the Walkley-Black wet digestion method (Nelson and Sommers, 1982). pH, EC-electrical conductivity (ofthe saturation) by method of the (Soil Survey Labrotory, 1992). Lime content by Scheiblercalsimeter (Soil Survey Staff, 1992). Exchangeble cations and cation exchange capacities (CEC) were measured using a 1 N NH4OAC (pH 7) method (Soil Survey Labrotory, 1992).Aggregate Stability: According to the wet screening method, it was measured in the yoder type screening set (Kemper and Rosenau, 1986). Weighted Average Diameter: Air dried soil samples were found by sieving on sieve set with different sieve openings (Demiralay, 1993).

3. Results and Discussion

3.1. Morphological Properties and Classification

Morphological properties and classification of pedons was given Table 1. Soils in the study area exhibit difference with regard to particle size distribution, color and surface horizon depth. These differences represent the obvious effect of erosion, whereby surface soils have been carried from the shoulder slope to the foot slope, their accumulation leading to progressively darker, deeper and finer-textured soils with decrease in elevation. Soil colour is significantly related with the parent material, marlstone, with a value-croma ratio of 6/3on the flat on hillposition, darkening progressively to reach a maximum value of 4/3 on the footslope. The accumulation of calcium carbonate in Pedon I, II and IV is indicative of pedological developments reflected in the variations in color, particle size distribution and surface horizon depth. These three profiles has also carbonate nodules and micelles in Ck horizon. For all profiles included a strongly or moderately developed A horizon with a granular structure; a strongly or moderately developed B horizon with an angular blocky structure (except for profile II which has no subsurface horizon); and a C horizon with a massive or graded structure. Particularly, Profile I has strong, coarse blocky structure in Bss horizon due to high clay content leading to slickenside formation

Table 1. Morphological properties and classification of pedons.

Horizon	Depth (cm)	Color (dry)	Color (moisture)	Structure	Boundary	Special features
PI (TypicHaplustert, coordinate: 710510 E-4550925 N, elevation: 648 m)						
Ap	0-27	10 YR 4/3	10 YR 3/3	3cgr and 2mabk	ac	cracks
Bss1	27-72	10 YR 3/2	10 YR 2/2	3cabk	gw	slickenside
Bss2	72-116	10 YR 3/2	10 YR 2/2	3cabk	gw	slickenside
Ck	116+	10 YR 6/3	10 YR 5/3	mas	-	carbonate nodules and micelles
PII (Lithic Xerorthents, coordinate: 711075 E-4552105 N, elevation: 594 m)						
Ap	0-29	10 YR 4/4	10 YR 3/4	2mgr	aw	-
C	29-60	10 YR 3/4	10 YR 3/3	mas	-	-
PIII (TypicCalcixerept, coordinate: 707929 E- 4559170 N, elevation: 270 m)						
Ap	0-24	10 YR 4/3	10 YR 3/3	2fmgr	as	-
Bw1	24-52	10 YR 3/3	10 YR 4/3	2mgr	cw	structure development
Bw2	52-70	10 YR 3/3	10 YR 4/3	2msbk	gw	structure development
Ck	70+	10 YR 4/4	10 YR 3/3	mas	-	carbonate nodules and micelles
PIV (VerticXerofluvent, coordinate: 710574 E-4558674 N, elevation: 254)						
Ap	0-25	10 YR 4/4	10 YR 3/4	2mgr	aw	cracks
Ad	25-55	10 YR 3/3	10 YR 3/4	3mgr	cw	Density layer
C1	55-90	10 YR 3/3	10 YR 3/4	mas	gw	-
C2k	90-123	10 YR 3/3	10 YR 3/4	mas	gw	carbonate nodules and micelles
2C	123+	10 YR 4/3	10 YR 4/4	mas	-	-

Abbreviations: Boundary: a = abrupt; c = clear; g = gradual; d = diffuse; s = smooth; w = wavy; i = irregular. Structure: 1 = weak; 2 = moderate; 3= strong; sg = single grain; mas = massive; vf = very fine; f = fine; m =medium; c = coarse; gr = granular; pr = prismatic; abk = angular blocky; sbk = subangular blocky.

Descriptions and classification for soil profiles investigated from different topographic positions in the study area were conducted according to Soil Survey Staff (1999). Two of the profiles were classified as Entisol order due to low pedological process while, others fall into Inceptisol order due to their cambic horizon development.

3.2. Physical and Chemical Characteristics

The basic physical and chemical properties of the soils in each profile in the study area are given in Table 2. In the profiles investigated in the study area, their surface soils show significantly difference each other in terms of particle distribution, horizon depth, organic matter, lime content and soil reaction. According to Soil Taxonomy 1999, the profile classified as TypicHaplustert in flat on hill has clay texture. While the organic matter is 2.80% on the surface layer, it decreases along the profile depth and it becomes 0.76% in Ck horizon. In addition, while the pH content is slightly acid with 6.30 value on the surface soil, it reaches 8.17 and becomes slightly alkaline in Ck horizon due to basic ions leaching process. On the other hand, the lime content is less limy with 0.89% on the surface whereas, the Ck horizon contains 41.85% due to accumulation of calcium carbonate and parent material. The WRAS values were found between 54.72% and 31.84%. Besides, MWD which is a measure of the resistance of soil aggregates to water erosion varies between 0.85 and 0.71mm.

Table 2. Physical and chemical properties of soils formed on different parent material, topographic position, elevation and land use in the study area.

Horizon	Depth (cm)	pH (H2O) (1/2,5)	EC (dS/cm)	CaCO3 (%)	O.M (%)	Exchangeable Cations (cmolc·kg-1)				P.S.D (%)				WRAS (%)	MWD (mm)
						Na	K	Ca	Mg	C	Si	S	Class		
Profiel I, TypicHaplustert / Flat on hill / Agriculture / 648 m / Marl															
Ap	0-27	6,30	0,14	0,89	2,80	0,23	0,51	30,35	11,30	50,36	20,62	29,01	C	54,27	0,74
Bss1	27-72	7,43	0,34	0,73	0,98	0,36	0,28	39,10	3,90	53,62	18,97	27,41	C	54,72	0,80
Bss2	72-116	7,89	0,25	1,86	0,68	0,27	0,38	56,45	7,75	57,71	21,11	21,18	C	53,86	0,85
Ck	116+	8,17	0,29	41,85	0,76	0,20	0,22	52,75	8,80	64,43	18,68	16,89	C	31,84	0,71
Profile II, Lithic Xerorthents / Back slope/ Agriculture / 594 m / Basalt															
Ap	0-29	7,78	0,03	1,53	2,25	0,26	0,49	30,00	19,45	43,00	26,57	30,43	C	57,51	0,81
C	29-60	8,05	0,25	12,04	0,63	0,33	0,25	35,75	27,15	31,24	27,44	41,32	CL	27,64	0,73
R	60+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Profile III, TypicCalcixerept / Foot slope/ Agriculture / 270m / Colluvial deposit															
Ap	0-24	7,95	0,26	13,25	2,22	0,33	1,09	17,35	31,50	31,90	30,09	38,02	CL	14,21	0,69
Bw	24-52	8,20	0,24	13,65	1,17	0,25	0,43	24,20	24,05	35,98	36,32	27,69	CL	30,97	0,72
Bw2	52-70	8,26	0,26	13,98	1,31	0,33	0,42	23,30	28,05	36,42	38,09	25,49	CL	38,12	0,70
Ck	70+	8,30	0,26	14,95	0,30	0,58	0,26	29,50	24,65	30,72	42,12	27,16	CL	25,11	0,63
Profile IV, VerticXerofluvent / Flood plain/ Agriculture / 254 m / Alluvial deposit															
Ap	0-25	8,15	0,26	10,83	1,21	0,37	0,91	21,60	30,45	25,71	34,92	39,36	L	14,63	0,62
Ad	25-55	8,15	0,29	12,84	1,27	0,68	0,57	23,75	26,25	54,44	24,78	20,77	C	42,74	0,77
C1	55-90	8,03	0,73	14,54	0,79	1,1	0,49	25,45	40,30	58,74	22,45	18,80	C	56,55	0,85
C2k	90-123	7,99	1,46	15,35	0,25	1,96	0,39	31,95	34,90	47,59	24,42	27,99	C	46,45	0,77
2C	123+	8,14	1,18	14,22	0,24	1,79	0,26	43,45	11,20	33,77	28,30	37,93	CL	18,29	0,66

Profile II was classified as Lithic Xerorthent. Slope was considered as one of the most significant factors controlling the pedogenic procedures in this pedon, which is located on a high back slope. Slope contributes to greater runoff, as well as to greater translocation of surface materials downslope through surface erosion and movement of soil. Soil horizons in Profile II were identified as surface soil symbolized as A, C (parent material) and R (rock), with no diagnostic subsurface horizons and low pedogenetic development, indicating it to be a young soil. While the organic matter is in the medium level with 2.25 on the surface, it is very small in the sub-surface horizon (0.63). Its pH value is 7.8 in surface and 8.05 in subsurface. The lime content is 1.53 limy in the upper soil and 12.04 in parent material. The WRAS value of the surface soil is 57.51% and its MWD value is 0.81 mm.

Profile III formed on the colluvial parent material has structural development and was classified as the TypicCalcixerept.This soil has dominantly clay loam texture along the profile depth and its soil reaction is slightly alkaline and changes pH values between 7.95 and8.30. Lime content varies also between 13.25-14.95% described as moderately limy. In addition, organic matter content of this soil changes between 2.22% in the surface and 0.30% in the Ck horizon. In this profile which located on low slope position, its WRAS value is 14.21% on the surface while, the MWD value is 0.69.

As for profile IV, Soil formed on the fine alluvial deposit and on flood plain has no any structural development and pedogenetic process was classified as VerticXerofluvent. Texure of this soil, dominantly clay loam texture in surface layer whereas, commonly clay texture becomes in subsurface soils. Its pH ranges between 7.99-8.15and the lime content varies between 10.83-15.35%. The WRAS value in the surface soil is 14.63% and the MWD is 0.62 mm.

4. Conclusion

In this current study, the four profiles in the study area were evaluated based on their pedological development, classified according to Soil Taxonomy and investigated in terms of their water resistant aggregate stability and weighted average diameter under the same climate and land use but different topographic positions and parent materials. Soil erosion was found to be the main negative factor in soil formation on hillside positions (shoulder and back slope) in the study area. The determination of the water resistant aggregate stability of soil, there are important for determining the sensitivity of towards to erosion. Usually, soils which have well aggregated and high aggregates stability are also more resistance to abrasion. It is observed that the aggregate stability is 50% and more than it in the study area. On the other hand, water resistant aggregate stability values were found low values in soils formed on colluvial deposit and foot slope (low slope degree). This case can be explained due to cultivation practice and field traffic leading to negative influence for aggregate formation. Therefore, land management practices are significantly important to keep their stability against to soil erosion.

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Effects of Iron and Zinc Chelates on Leaf and Shoot Growth in Apple Trees

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Abstract

This study was carried out to determine the effects of iron and zinc chelates on leaf and shoot growth of Starking apple trees in a randomized completely experimental design as four replication at the Fruit and Sapling Production Station of Van Provincial Directorate of Agriculture. In the experiment, 250 g N, 250 g P_2O_5 and 50 g K_2O per tree were applied to each plot as a basic fertilization. In soil and foliar fertilization, Bolikel Fe (Fe EDDMa, 6% Fe) and Sanzink (6% Zn) organic compounds were used as chelate forms of iron and zinc, respectively.

The highest leaf surface area (24.33cm^2) and dry leaf weight (0.269g) were obtained in combine applications of iron and zinc chelates while the highest shoot length (27.07 cm) and dry shoot weight (2.573g) were in alone zinc chelate application. The lowest means belong leaf surface area (20.80 cm^2),shoot length (16.00 cm), dry shoot weight (0.969 g) were determined in control while the lowest dry leaf weight (0.258 g) was determinate in zinc chelate application. It was determined that zinc and iron chelate applications positively affected growth of apple trees.

Keywords: Apple tree, iron, zinc, chelate, growth

1. Introduction

Micronutrients are needed in relatively small quantities for adequate plant growth and fruit production. Their deficiencies lead important disturbances in the physiological and metabolic process in the plant (El Gazzar, et al., 1977).

Micronutrients have important roles in the fruit set and retention, as well as in the fruit yield and quantity (Khan et al., 1993).Iron has many essential roles in plant growth and development including chlorophyll synthesis, thylakoid synthesis, enzyme activities, and chloroplast development (Chohura et al., 2009). Fe deficiency is wide spread occurring in about 30 – 50% of cultivated soils.. Iron content in soil is generally high, but a large proportion is fixed to soil particles (Bindraban et al. 2015) especially in aerobic soils and high pH levels. Fe is mainly in the insoluble form as ferric iron (Fe^{+3}). Mortvedt et al. (1991) reported that in calcareous soils less than 10 % of the Fe is available to plants. Therefore these soils are usually deficient in the available form, ferrious iron (Fe^{+2}) (Bindraban et al., 2015, Ye et al., 2015).In calcareous soil, the high HCO_3 concentration and pH are two main factors leading to low Fe availability in soil and Fe efficiency in plant (Mengel, 1994). Tagliavini et al., (2000) reported that Fe chlorosis is more complex occurrence in fruit trees than in annual crops.

Zn deficiency is also common in many crops (Marschner, 2012). Zn plays role in the different enzymes activities including dehydrogenases, aldolase, isomerases, RNA and DNA polymerases, cell division, photosynthesis, polen function and fertilization, production of biomass (Marschner, 2012).

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Kenbaey and Sade (1987) reported that 30% arable areas in the world and 50% of the agricultural soils in the Turkey suffer from Zn deficiency. The Van region is among the areas most severely affected by Zn deficiency (Çamaş et al., 1998).

Fe and Zn fertilization is still the most effective way to amend Fe and Zn efficiency in plants. The chelates increase Fe solubility and function as transports through solution to plant. Fe EDDHA is belong the most effective synthetic Fe chelate under natural and alkaline soil conditions (Zekri and Obreza, 2019).Similarly Aggarwal and Sastry (1999) reported that the binding of Zn synthetic chelates increased the metal solubility and mobility in soils thus enhancing Zn availability to plants. Apple is considered one of the major and the most deciduous fruit crop in the world. Apple is one of the sensitive plants to the Fe deficiency such as avocado, banana, barely, citrus, oat, soybean, peanut, potatoes, and various green house flowers.

In this study, determination of effects of Fe and Zn chelates on leaf and shoot growth on apple trees was aimed.

2. Materaials and Methods

This study was carried out at the Fruit and Sapling Production Station of Van Provincial Directorate of Agriculture. The experiment was conducted according to completely randomized experimental design with four replications in 28 parcels. In this research, 15- 20 years old starking delicious apple trees were used as basic fertilizations 250 g N (as Ammonium Sulphate: 21% N), 250 g, P2O5 (as Di Ammonium Phosphate: 18% N, 46% P2O5) and 50 g K2O (as Potassium Sulphate: 50% K2O) were applied to each trees accepted one parcel.

Chelated Fe (Botikel, Fe EDDHMa, 6% Fe) and Zn (Sanzink, 6% Zn) fertilizers were applied to soil and leaf as separately, or combine of those for each randomly chosen tree.In the different soil applications 50g Fe chelate and 400 ml Zn chelate were separately solved in 30 L water and were applied to embossed soil surface under tree projection far away from stem in ratio of $^{1}/_{4}$ of tree crown projection radius. In the different leaf applications 16 g Fe chelate and 125 ml Zn chelate were separately solved in 10 L water. Total doses of leaf applications were applied in two period by 20 days interval before flowering time.

Some soil properties of garden soil were given in Table 1. The soil physical and chemical analyses were done by using standard soil analyze methods reported by Kacar (2012).

Table 1. Some physical and chemical results of the test area soil

Soil depth, cm	**Texture**	**pH**	**Salinity, %**	**Lime, %**	**O.M., %**	**Total N, %**
0-20	Sandy loam	7.39	0.053	7.8	0.6	0.056
20-40	Sandy clay loam	7.58	0.043	13	0.5	0.047
Soil depth, cm	**P, mg kg^{-1}**	**K, mg kg^{-1}**	**Fe, mg kg^{-1}**	**Zn, mg kg^{-1}**	**Cu, mg kg^{-1}**	**Mn, mg kg^{-1}**
0-20	22.14	111.3	7.52	0.62	8.08	7.35
20-40	6.4	89.9	6.68	0.99	8.38	5.87

Physical and chemical soil properties of garden soil had sandy loam, sandy clay loam in texture, slightly alkaline, slightly saline, moderate limely, insufficient in potassium and zinc contents (Table 1).

Twenty shoots and twenty leaves were picked from each tree for physical measurements. Statistical analyses of obtained data were done by using SAS package program (SAS, 1998). Application means were compared with Duncan's test.

3. Results and Disscusion

At the end of two-year fertilizer applications leaf and shoot growth of starking apple trees were determined. The variance analysis results belong effects of applications on leaf surface area, dry leaf weight, shoot length and dry shoot weight were given in Table 2.

Table 2. F values of the variance analyses for the leaf and shoot growth of apple trees.

VS	DF	LSA	DLW	SL	DSW
Chelated Fe and Zn applications	3	1735^{ns}	0.219^{ns}	7.183**	108.282**

** Significant at 0.01 level, ns: non significant, LSA: Leaf Surface Area, DLW: Dry Leaf Weight, SL: Shoot Length, DSW: Dry Shoot Weight

All of the applications increased leaf and shoot growth. These increases were not found significant for leaf growth statistically.Alone Sanzink application had more positive effect on shoot growth than the other applications. But Sanzink application took place with combine application in shoot length means while the alone Bolikel Fe application was in the same group with control in shoot growth means according to Duncan's multiple repair test Figure (1, 2, 3, 4).

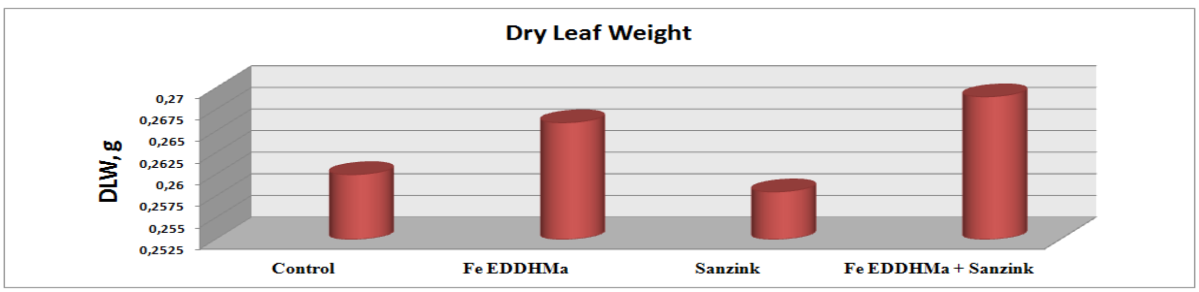

Figure 1. Effects of Fe chelate and Zn chelate applications on dry leaf weight.

Barker and Pilbeau (2006) reported that addition of fertilizers to supplement the natural soil fertility is essential for modern crop production and price management of nutrients is essential for sustainable agricultural production.Iron deficiency occurs in calcareous soil where chemical iron availability to plant root is very low (Sharma et al., 2004). Komosa et al., (2005) reported that application of chelate forms promoting water solubility and low value of dissociation constant is a basic way to preventing of reduce iron availability in a growing media.

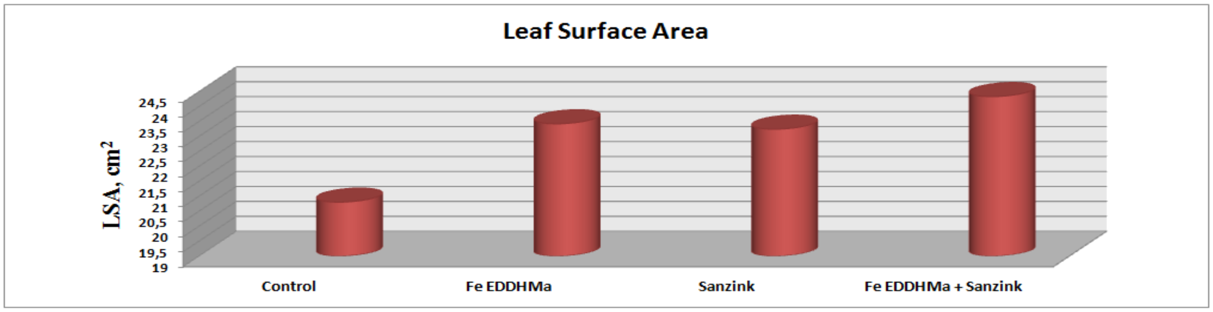

Figure 2. Effects of Fe chelate and Zn chelate applications on leaf surface area.

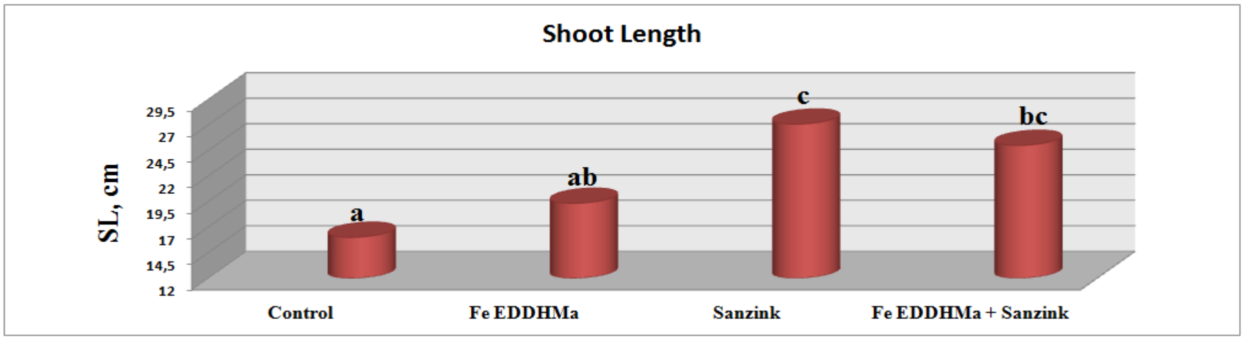

Figure 3. Effects of Fe chelate and Zn chelate applications on shoot length, (P< 0.01).

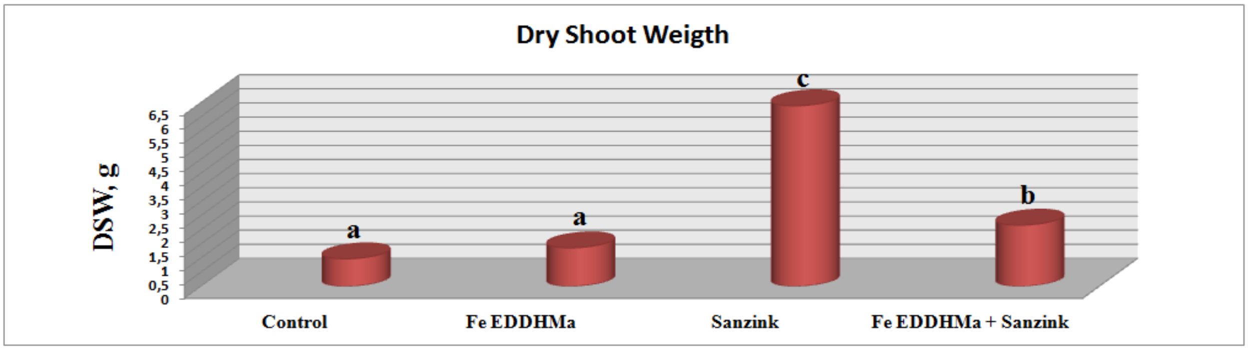

Figure 4. Effects of Fe chelate and Zn chelate applications on dry shoot weight, (P< 0.01).

The binding of Zn with synthetic chelates increases its solubility and mobility in soils, thus Zn availability to plants (Aggarwal and Sastry, 1999). El Shazly and Dris, (2004), Asaad (2014) reported that cheleated Fe, Zn, and Mn applications increased shoot length, shoot number and leaf area in Anna apple trees.The increases of vegetative growth of trees fertilized micronutrient might be attributed accumulation of carbohydrates resulted by improving tree condition and ameliorate of micronutrient deficiency.

Results obtained in this study are corresponding with those of similar researches and literature knowledge. At the end of this study it was concluded that application of iron and zinc chelates can be useful to ameliorate vegetative growth of apple trees in calcareous soils.

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Addition of Vermicompost to Soil Influences Total Phenolic Content of Sweet Basil

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Abstract

Sweet basil (*Ocimum basilicum* L.), a medicinal and aromatic plant possesing rich phenolic and terpenoid content, is commonly utilized for culinary and medicinal purposes around the world sinceancient times. Vermicompost (VC) products were categorized as biostimulants along with the humic exracts andare utilized for organic fertilizer as well asconsidered as an organic soil amendment material.Use oforganic fertilizers preserves the essential oil yield and natural aroma of basil. In present study, the effect of increasing doses of vermicompost additions (0%, 10%, 20%, 30%, and 40%) on total phenolic content (TPC) inthe leaves of sweet basil were investigated. The highest TPC was determined at 10% VC applicated group as 90,02 mg/g leaf and the lowest TPC was determined at 30% VC applicated group as 50,72 mg/g leaf in dry weight expressed as gallic acid equivalents (GAE). Plant biostimulants are *de novo* products and have proved efficiency in medicinal and aromatic plant cultivation due to their possible inducing activities on the synthesis of secondary metabolites.

Keywords: Basil, Phenolic, Vermicompost,

1. Introduction

Naturalcompounds from Sweet Basil (*Ocimum basilicum* L.), a well-known member ofthe Lamiaceae family, have been utilized toflavor foods, in oral care productsand as an ornamental herb as well (Simon et al., 1984; Morales and Simon, 1996). Phenolic acid and other aromatic compounds impart basil withantioxidant, antimicrobial and antitumor activities (Gutierrez et al., 2008; Hussain et al., 2008).The application ofvermicompost or theother biofertilizers seems to reduce the use of chemical fertilizers and their adverse effects andhence they may play an important role toobtain the purposes of sustainable agriculture(Shokooh et al., 2013).

Organic fertilizer application on basil cultivation preserves the natural aroma and increases the essential oil yield (Hiltunen and Holm,1999).Vermicompost products were categorized as organic fertilizers by du Jardin (2015) in a regulatory study which was supported and then adopted by relevant EU Commissions. Plant biostimulants are *de novo* products and have proved efficiency in medicinal and aromatic plant cultivation due to their possible inducing activities on the synthesis of secondary metabolites(Raffieet al., 2016).

The aim of this study was to investigate the effects of solid vermicompost applicationon TPC of basil leaves. Thus, an important contribution to very limited knowledge and prospective researches about the use of organic fertilizers on medicinal and aromatic plant cultivation were aimed as well.

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2. Methodology

Basil seedswere acquired from a farming equipments supplierin Kırsehir/TURKEY. Seeds were sown in 3 seeds per 50 cc containers in a greenhousein October. At the 3rd week of the germination, one individual in each container was selected andthe others were eliminated. The application groups were consisted of 10 basil individuals.Vermicompost applications were carried out by mixing solid vermicompost with soil for the rates of 0%, 10%, 20%, 30%, and 40% to bring final volume of each container to 50 cc.

Figure 1.A view of basils at the 3rd week of development.

Upper leaves at similar positions of each individual basil plant were harvested as 15 g, dried at shadow and room temperature, and then subjected to total phenolic content analysis. Total phenolic concentration of the extracts was determined spectrophotometrically according to the Folin-Ciocalteu method (Singleton et al. 1999).Data were analyzed by ANOVA and means were separated by Duncan's Multiple-Range Test at P<0,05. Statistical analysis was performed with SPSS statistic software package (1999).

Figure 2. View of basils at the greenhouse

3. Results and Conclusion

3.1 Results

It was determined that the vermicompost addition to soil increased TPC 19% at 10% application group whereascaused a decrease in 33% TPC at 30% application group (Figure 3).

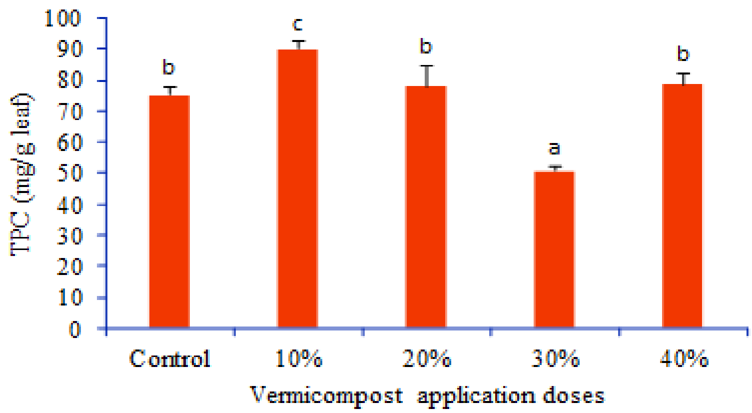

Figure 3. The effects of vermicompost solid applications on total phenolic content of basil.

The results from the rest of the groups,20% and 40%, were not statistically significant in terms of TPC when compared with control group.

3.2 Conclusion

The existence of humic acid in the content of vermicompost, along with the plant growth hormones auxin and cytokineand their related compounds, were reported as having positive effects on plant growth and development (Scaglia et al., 2016). The results of a recent study (Türkay et al., 2018) which was carried out with solid vermicompost application to the root zone of basil individuals with increasing doses up to 24%, were similar and in concordance with the results of present study (Figure 4).

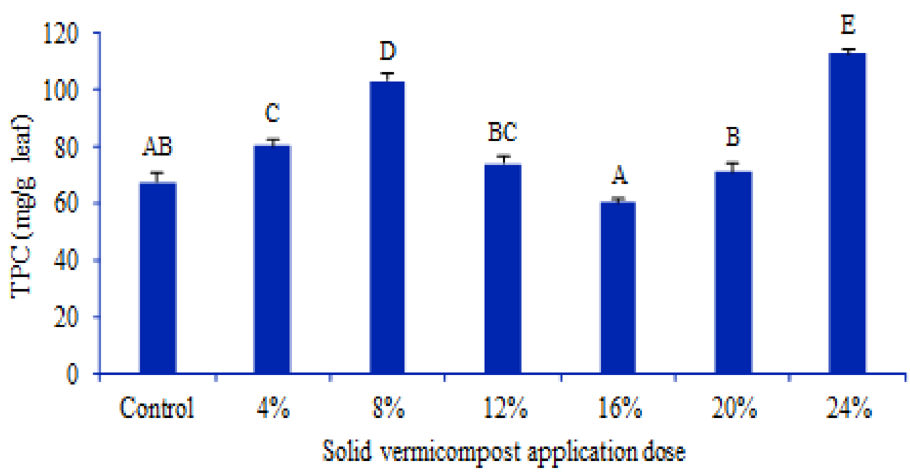

Figure 4. The effects of vermicompost solid applications on total phenolic content of basil (Türkay et al., 2018).

The results of present study and the study carried out by Türkay et al. (2018) were demonstratedtogether in Figure 5with the aim ofevaluate the effects of vermicompost addition on TPC in basil leavesprecisely.

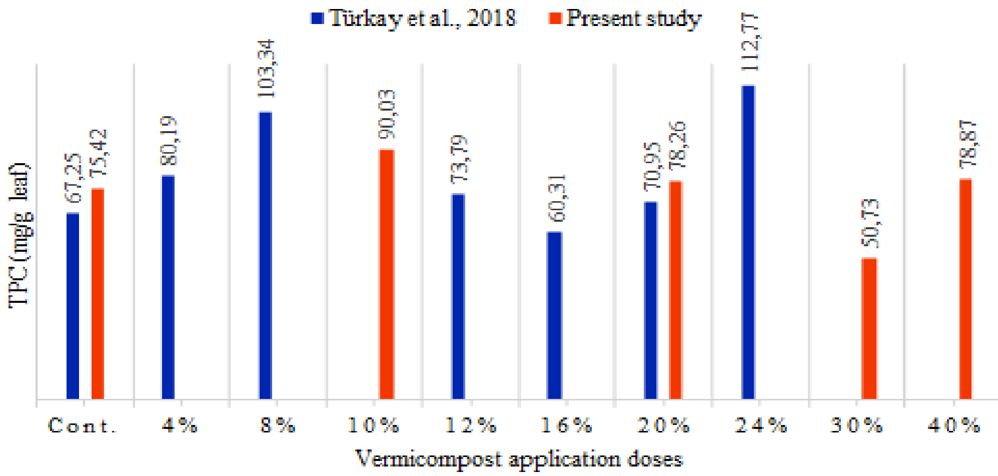

Figure 5. Comparison of the results of two independent studies aimed to determine the effects of various vermicompost solid application doses on total phenolic content of basil.

According to the results of present study, 10% solid vermicompost addition to soil caused an increase in TPC as 90,03 mg/g leaf and the change was 19% compared to control. This value was consistent withthe results of 8% and 12% vermicompost applications in the studypreviously reported by Türkay et al. (2018). The entire results obtained from present study were substantially in accordance with those relevant results, except a remarkable increase in TPC at the dose of 24% vermicompost application. Vermicomposts acquire very high microbial population as well as having humic acid and plant growth hormones such as auxin and cytokine and their related compounds (Edwards et al., 2011). Besides, it is well known that plant phenolics are defense compounds being incrementally synthesized as a response to the environmental stress conditions both abiotic and biotic(Öztürk & Demir, 2002). The increase in TPC at 24% solid vermicompost application, conceivably was correlated with the higher microbial activity at the root zone of basil individuals.

In present study 30% vermicompost addition to soil in resulted with the lowest TPC amount in the basil leaves.Main classes of secondary metabolites,including plant phenolics,are derived from primary metabolites.Therefore, increasing doses of vermicompost application above 24% to the root zone presumably have negative effects on the synthesis of precursor metabolites of phenolic compounds. Although, there was some increase in TPC at the dose of 40% compared to 30% vermicompost application, the higher vermicompost existence above 24% at the root zone of basil individuals caused presumable adverse interactions among the factors of soil.

Vermicomposts and derivated products are novel in agronomy and further research is needed for thoroughly evaluate its effectiveness on medicinal and aromatic plant cultivation.

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Analysis of Phytate Phosphorus Accessibility for Barley Plants in Soilless Culture

Özge ŞAHİN[1]

Abstract

Agriculture is one of the most important components for all society. Adding fertilizer is one important way to keep agricultural production systems sustainable. In nature, plants use soil nutrients, and then they die and are decomposed by microorganisms. This returns the nutrients to the soil. In present and future some people, climate and etc. are caused to soil pollution, losses etc. In this way people will need to other medium for plant growing. One of this medium is soilless culture. Soilles culture offers and an alternative to soil culture when serious soil and water problems. And phosphorus (P) is another major limiting nutrient for biological systems in the terrestrial environment. Paradoxically, many soils contain a relatively large amount of P which, if totally available, would exceed requirements for growth of both plants and soil microorganisms. However, much of this soil P is in forms that are not directly available for use. Because *P* availability is controlled by three primary *factors*: *soil* pH, amount of organic matter, and proper placement of fertilizer P.Aim of this study to determine of effect of different P sources on barley (*Hordeum vulgare*Golden Promise cv.) plant growth, P concentrations and phytase activity in pH 5 in soilless culture. In this study, after germination plants were transplanted to 2liters nutrient solution and one seed were sown per pot. All nutrients were supplied as modified Hoagland's solutions with different P concentrations.Nutrients solutions were changed every week and added organic and inorganic P with P deficiency level (-P), phytate level (Phy); phosphorus demand level (+P, KH_2PO_4). The plants were grown greenhouse under natural light and natural temperature condition. Results showed that dry and fresh weight of shoot and root and lenght of shoot where plants were grown in +P and Phy were higher than the where plants where grown in –P condition. Phosphorus concentrations and phytase activity of roots in +Pand Phy condition were higher than the –P condition.Phosphorus and phytase activity of shoots were higher than the Phy and –P condition, respectively. These results show us, organic phosphorus resource can be used in P deficiency for plant growing in soilless culture.

Keywords: Phosphorus, Phytate, Barley, Phytase activity

1. Introduction

Phosphorus (P) is a major limiting nutrient for biological systems in the terrestrial environment. Paradoxically, many soils contain a relatively large amount of P which, if totally available, would exceed requirements for growth of both plants and soil microorganisms. However, much of this soil P is in forms that are not directly available for use. Up to 80% occurs in organic forms (Richardson et al., 2005), of which inositol phosphates constitute the largest (50%) fraction (Anderson, 1980; Turner et al., 2002).The largest amounts of P available to plants grown on soilless culture are present in nutrient solutions that are slightly acidic (pH 5.0)(Dyœko et al. 2008).

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Phytate is the salt form of myo-Inositol-hexakisphosphate and the major storage form of P in seeds. In soil 20 to 50 % of organic P is bound to inositol (Dalal, 1977; Anderson, 1980). It is a chelator of divalent cations such as Ca^{2+}, Mg^{2+}, Fe^{2+}, Cu^{2+}, Mn^{2+} and declines the availability of such ions for plants and animals (Harland andOberleas, 1999).

Enzymes, which are able to hydrolyze phytate, are widespread in nature and are found in bacteria, fungi, animals and plants. Even though plants possess phytases themselves, mostly expressed in seeds during germination, they are not able to make phytate P accessible from soil. Heterologous expression of phytase genes in plants could solve the problem.

This study aims to investigate the effects ofthe utilization of phyate P by plants can be increased barley plant in soilless culture.

2. Materials and Methods

Before sowing, all barley seeds(the *Hordeum vulgare* cultivar Golden Promise) were put on the $CaSO_4$ solution for a night (2 x 10^{-4}M, $CaSO_4.2H_2O$). All seeds were sown dilute solution and thinned to one seedling after germination. The cultivars were grown in greenhouse under natural light and natural temperature condition.

We used PVC pots (2 liters) for this experiment. Nutrients were supplied as modified Hoagland's solutions with different P concentrations for all pots (Table 1). The pots were arranged in a completely randomized block design with 10 replicates of barley (nutrient solution is to be adjusted to pH 5 to 5.5 for barley).One of the group were kept as –P group. To the second group, to ensure the demand P condition, +P was applied. And the last group, to ensure organic P condition, phy was applied. Experiments were performed on barley seedlings grown in nutrient solutions of the following composition: (in mM) K, 1.5; NO_3^-, 3.5; Ca, 1.0; NH_4^+, 0.6; P, 0.6; Mg, 0.25; S, 0.25; (in µM) Cl, 50; B, 12.5; Mn, 3; Cu, 2; Mo, 0.1; Ni, 0.1; Fe, 20. Regularly every week nutrient solution was changed and added new P amountswith Mes Buffer to regulate pH. Everyday; pH was mesaured to arrange the pH 5.0-5.5.

After the 7 weeks of growth in the greenhouse, the shoots and roots were harvested and fresh weight were recorded. Some fresh samples from roots and shoots were taken to determine the phytase activity. Shoots and roots were dried in an oven at 65ºC. After the determination of dry weights,concentrations of P were determined.

Table 1. Phosphourus concentrations of weeks

Week	-P (KH_2PO_4)	Phytate ($C_6H_6O_{24}P_6Na_{12}$)	+P (KH_2PO_4)
1.	0	0.010 mM	0.010 mM
2.	0.004 mM	0.070mM	0.070mM
3.	0.220 mM	0.443 mM	0.443 mM
4.	0.139 mM	2.78 mM	2.78 mM
5.	0.139 mM	2.78 mM	2.78 mM
6.	0.139 mM	2.78 mM	2.78 mM
7.	0.139 mM	2.78 mM	2.78 mM

2.1 Measurement of Phosphorus

Plant samples were heated in a muffle furnace at 550° C for 6 h, the ashes dissolved in 10 ml of 2 N HNO_3 and diluted to 50 ml with reverse osmosis water. Extracts were filtered and stored in plastic vials until analyzed. Phosphorus was determined by spectrophotometrically following the method of Barton (1948).

2.2 Measurement of Phytase Activity

Leaf and root samples of barley were taken 7 weeks after transfer to the nutrient solution. Leaf tissue was homogenized in 50 mM TrisHCl buffer, pH 6.8 containing 0.4% of protease inhibitor cocktail for plant cell and tissue extracts from Sigma (P9599). The homogenate was centrifuged for 5 min in centrifuge and than the supernatant was collected. Sample solutions were assayed for phytase activity by incubating 25 µM of the solution with 125 µl of substrate solution [0.4% (w/v) sodium phytate (Sigma, St Lois, MO, USA) in 0.1 M sodium acetate buffer, pH 5.0] for 15 min at 37 ºC (Shimizu, 1992). The reaction was stopped by adding 150 µl ammoniummetavanadate the free phosphate determined according to. Results were compared to a standard curve prepared with inorganic phosphate (K_2HPO_4).The soluble protein content of this crude extract was determined (Bradford,1976). One unit of phytase is the activity that liberetes 1 µmol of phosphate from phytic acid in 1 min (Engelenet al., 1994*)*.To determine the specific phytase activity the soluble protein content of this crude extract was determined (Bradford,1976).

2.3 Statistical Analysis

Analysis of variance was performed on the data, and significant differences among treatment means were calculated by least significantdifference (LSD) test ($P < 0.05$) and also compared by descriptive statistics (±SE).

3. Results and Conclusions

The data in Table 2 show the differences between shoot dry weight, root dry weight and root lenght of the P treatments. There are significant differences ($P<0.05$) between the inorganicand organic P (phytate) treatment, but none between the Phy and the -P treatment. The biomass of plants grown on -P and Phy are similar, whilst the biomass of plants grown on inorganic P is significant higher. Our results on fresh and dry weight and lenght of plant are in accordance with those of Cheung and Boon (2006).

Table 2. Fresh and dry weight of shoot and and lenght of shoot and root

Treatments	Fresh Weight (g plant-^{1})		Dry Weight (g plant-^{1})		Lenght (cm)	
	Shoot	Root	Shoot	Root	Shoot	Root
Phy	31.6±1.98 a	10.9±0.47 b	2.91±0.26 b	0.56±0.07 a	56.5±0.50 a	11.5±0.35
- P	7.66±0.17 b	6.71±0.64 c	1.02±0.05 c	0.70±0.02 b	47.5±0.87 b	11.7±0.81
+ P	33.9 ±2.66 a	13.1±0.26 a	3.63±0.27 a	0.62±0.01 a	58.0±1.08 a	9.22±0.83
F value	57.4**	46.2**	37.8**	8.54**	44.7**	3.90 ns
LSD value	6.13	1.54	0.70	0.14	2.72	-

The values are means of ten replicates standard error (±SE). *$P < 0.05$, **$P < 0.01$, ns: non significant.

Effect of P applications are statistically important on concentrations of P and phytase activity of shoot and root. The highest concentrations of P and phytase activity of shoot and root were determined +P application and then Phy applications, the lowest concentrations and activity were determined with –P application (Table 2). And also concentrations of P and phytase activity of roots are higher than the concentrations of P and phytase activity ofshoots.Our results like Cheung and Boon (2006).

Table 3. Phosphorus concentrations and phytase activity of shoot and root

Treatments	P concentration (mg kg-^{1})		Phytase Activity (U mg^{-1})	
	Shoot	Root	Shoot	Root
Phy	86.8±3.25 b	109±2.95 a	0.44±0.009 b	205± 2.56 b
- P	73.7±4.12 c	91.2±4.61 b	0.10±0.004 c	140±2.74 b
+ P	107±2.90 a	105±3.81 a	0.66±0.02 a	615±60.7 a
F value	24.2**	6.15*	361**	53.8**
LSD value	11.1	12.3	0.05	112

The values are means of ten replicates standard error (±SE). *P < 0.05, **P < 0.01, ns: non significant

We determined the significance of difference among the P applications on barley plant. pH is important on P efficiency in soil.Especially to increase the usefulness of organic phosphorusin different soilless condition(Cerozi and Fitzsimmons,2016).Soil pH less than 5.5 typically reduces availability of P in soil solution by 30 percent or more and soil pH more than 7.5 reduces availability of P in soil solution. Soil is important ongrowing ofhuman and increased population some needs such as housing, eating and etc. All these needs are reasons of contaminations of soil and reduction of used unit field for people, plant, animal and etc.Mined phosphate rock is increasingly considered a strategic resource whose supply could become severely limited in the future and there are no substitutes for P in agriculture. Utilization of P from the applied commercial P fertilizers by plants is very low due to its complex chemical reactions in soils. The efficiency of applied P fertilizer is assumed as low as about 20% depending on soil properties (Taskin et al. 2018). These reasons lead us to search for alternative resources to soilless agriculture in order to produce the food that people need to survive.Another important reason for soilless culture is that it can be done in areas not suitable for agriculture.Because the herbicide is not used in soilless systems, the foods produced in these systems are considered to be much safer than the foods grown in soil.pH is important restrictive factor on P efficieny for plant(Dyœko et al. 2008). In our study pH is important effect on the availability availabity of organic P of barley. Organic P can be use in deficiency of P for an alternative P resources in soilles culture.

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The Importance of Legume Forage Crops As Green Manure

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Abstract

The soil exploitation for intensive agricultural production such as tillage, chemical fertilizer and pesticide uses, monoculture cropping and continuously crop cultivation (without fallowing system) caused soil degradation and resulted some environmental pollutions. The application of green manure can be one of the alternatives in order to minimize the negative effects of some applications in intensive agriculture practices on the soil and the environment. The application of green manure increases soil organic matter and nitrogen and keeps the availability of other soil nutrients. The use of legume forage crops as green manure can increase the amount of nitrogen in the soil by atmospheric nitrogen fixation. This makes it more economically efficient than other green manure and chemical fertilizers. The legumes have a taproot that can absorb the nutrients from the deeper soil and improve the physical structure of the soil. For these reasons, this study discusses the importance of legume forage crops as green manure crops for the soil sustainabilities.

Keywords: Environment, organic fertilizer, organic matter, soil properties, sustainability.

1. Introduction

The growing food demands due to ever-rising human populations forced world farmers to adopt intensive and unsustainable agricultural practices that increased both economic and environmental costs. Intensive agriculture, which aims to achieve maximum efficiency in a unit area, has generally focused on monoculture and this application has revealed many negative results in terms of environmental protection (Demirci et al., 2002). Chemical fertilizers and pesticides are used to increase the yield, but the use of these chemicals often unconscious combining with intense and inappropriate soil tillagecaused the damage of the physical structure of the soil and has led to the emergence of important environmental problems such as unproductive soils and salinity (Göktekin & Ünlü, 2016). The rapid deterioration of organic matter in the damaged soil consequently affected soil health, soil water holding capacity, surface and groundwater pollution and soil nutrient deficiencies have been reported (Meena et al., 2018). The organic matter content of the soil in 89% of the agricultural lands in Turkey(2014) varies from less than 1% (very low level) and around 1-2%(low level) (Gezgin, 2018). The most basic sources of soil organic matter are stubbles, animal manures, composts and green manures (Karaöz, 1992; Akkaya & Kara, 2018, Gezgin, 2018).For this reason, in this study, the importance of legumes as a green manure plants, which is less effective than chemical fertilizers, has been emphasized in terms of maintaining sustainability and productivity in agricultural lands epecially in term of soil organic matter and soil nitrogen content improvments.

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2. The Advantages of Legumes as a Green Manure Plant in Term of Soil Organic Matter and Soil Nitrogen Content Improvement

The amendment of plants to the soil especially in a certain period of the development of plants with plenty of leaf while the plants are green (Karaöz, 1992; Karakurt, 2009) in order to provide the necessary organic matter in the soil, to improve the physical, chemical and biological properties of the soil (Florentín et al., 2010) and to form soil cover for erosion control (Florentín et al., 2010; Rosenfeld & Rayns, 2011) is called "green manure" and the plants used for this purpose are called "green manure crops". As can be understood from the definition that the purpose of green manure before the main crops being grown which has the greatest benefit in improving the soil organic matter (Karakurt, 2009; Rosenfeld & Rayns, 2011; Talgre, 2013) is for soil loosening, soil structure improvement and soil nitrogen increase (Özyazıcı& Manga, 1998).As reported by Rosenfeld& Rayns (2011), soil organic matter from crop reduces in the range of 2-5% per year. The sufficient organic matter in the soil improves the physical, chemical and biological properties of the soil and ensures that this condition is stable. As a result; improves soil health by positively affecting the properties of the soil, the strength of the aggregate, water holding capacity and nutrients (Çepel, 1988; Karakurt, 2009; Talgre, 2013; Gezgin, 2018). Nitrogen is a key element in the development of plants and their high-quality yield, (Rosenfeld & Rayns, 2011; Talgre, 2013). Soil organic matter is the source of nitrogen, as well as all nutrients (Karakurt, 2009).

Table 1. Soil rganic matter yield of several legume green manure crops

Green Manure Plant	Scientific Name	Organic MatterYield (kg ha^{-1} $year^{-1}$)	Reference
Common vetch	*Vicia sativa*L.	2500	Astier et al., 2006
Hairy vetch	*Vicia villosa*	1395	Florentin et al, 2010
Pigeon pea	*Cajanus cajan* L.	5153	Florentin et al, 2010
Black-seed mucuna	*Mucuna pruriens*	3911	Florentin et al, 2010
Jack bean	*Canavalia ensiformis* L. DC.	3863	Florentin et al, 2010
White lupine	*Lupinus albus* L.	1925	Florentin et al, 2010
Field Pea	*Pisum sativum* L.	3590	Piotrowska & Wilczewski, 2012
Alfalfa	*Medicago satvia*L.	2410	Guan et al., 2016
Bush clover	*Lespedeza davurica* S.	1990	Guan et al., 2016
Milk vetch	*Astragalus adsurgens* Pall.	1460	Guan et al., 2016
Yellow lupine	*Lupinus luteus* L.	1355	Pietrzykoski et al., 2017

While the use of non-leguminous plants as green manure increases only the amount of organic matter in the soil, legumes do not only increase soil organic matter but also increase the amount of nitrogen in the soil by fixating the atmospheric nitrogen (Çengel et al., 2009; Rosenfeld & Rayns, 2011; Talgre, 2013; Akkaya & Kara, 2018). Table 1 and 2 present the organic matter and nitrogen yield of legume green manure crops application. The plants are not able to fully utilize nitrogen from chemical fertilizer application due to some reasons such as nitrogen leaching by rain and irrigation water and are taken away from the soil by denitrification event. However, nitrogen produced from green manure application, provides nutrients for a longer period of time for the plants, provides the opportunity to the plantsto use nutrients during the whole development period and constitutes the source of the N form which is not easily washed in the soil (Özyazıcı

& Manga, 1998; Karakurt, 2009; Talgre, 2013).Biological nitrogen fixation is the process of converting atmospheric N_2 into ammonia (NH_3) or other molecules in the soil which can be easily accessed by plants (Rosenfeld & Rayns, 2011; Meena et al., 2018), and is carried out by symbiotic relationships with *Rhizobium* bacteria living in the root nodules of plants of leguminous family (Karaöz, 1992; Florentín et al., 2010)as shown in Figure 1. As a result, leguminous forage crops leave a nitrogen-rich soil to the plants that come after, and they can meet a significant amount of the nitrogen needed by this plant (Açıkgöz et al., 2005). Meena et al. (2018) reported that legumes can contribute to 40% of total N fixation in the world as a result of their symbiotic relationship with *Rhizobium* bacteria, and can meet 50-80% of their N requirement with biological nitrogen fixation.

Table 2. Approximate soil nitrogen yield of several legume green manure crops

Green Manure Crop	Scientific Name	Nitrogen Yield (kg ha^{-1} year^{-1})	Reference
Alfalfa	*Medicago satvia*L.	125-600	Widjajanto, 1996; Rosenfeld & Rayns, 2011;Bilgili, 2018
Red clover	*Trifolium pratense*	73-460	Rayns &Rosenfeld, 2008; Rosenfeld & Rayns, 2011
Crimson clover	*Trifolium incarnatum*	100-150	Rosenfeld & Rayns, 2011
White lupine	*Lupinus albus*L.	75-300	Rayns &Rosenfeld, 2008; Florentin et al, 2010
Common vetch	*Vicia sativa*	90-250	Rosenfeld & Rayns, 2011;
White clover	*Trifolium repens*	50-450	Rosenfeld & Rayns, 2011
Pea	*Pisum sativum* L.	80-160	Widjajanto, 1996; Bilgili, 2018
Yellow sweet clover	*Melilotus officianalis*	15	Rosenfeld & Rayns, 2011
Soybean	*Glycine max* L. Merr.	65-200	Widjajanto, 1996; Bilgili, 2018
Persian clover	*Trifolium resupinatum*	100	Rosenfeld &Rayns, 2011;
Hairy vetch	*Vicia villosa*	40-208	Rayns &Rosenfeld, 2008; Florentin et al, 2010
Fanugreek	*Trigonella foenum-graecum*	30	Rosenfeld & Rayns, 2011
Lentil	*Lens culinaris*	13	Bilgili, 2018
Forage bean	*Vicia faba* L.	97-152	Widjajanto, 1996
Subterranean clover	*Trifolium subterraneum*	4-320	Rayns &Rosenfeld, 2008

In order to provide the desired benefit from the green manure crops and to prepare a suitable environment for the next crop, it must be rapidly decomposed from the soil after mixing. One of the substances involved in the decomposition rate of organic matter is nitrogen(Çepel, 1988). The C:N ratio can be used to indicate the type of material used and the ease of decomposition. In general, when leguminous green manure plants are abundant, they should be mixed in the soil during the flowering phase, since they have a lower C:N ratio in the leaves, roots and stems(Meena et al., 2018). N fixation by the legumes is maximum during flowering and begins to decrease during the seed development(Talgre, 2013).

Green manurecrops, especially legumes, have a well-developed deep-rooted pile root system. Legumes with developed tap root systems can provide the nitrogen and other nutrients that have been infiltrated (or washed) into the deep soil layers that are not available for the plants. Thus, tap-rooted legumes play an active role in keeping some of the nutrients, preventing their washing and returning them to the top soil layers(Brown, 1913;

Florentín et al., 2010; Talgre, 2013; Meena et al., 2018). The deeper the roots of the green manurecrops, the more air in the soil is provided. As the activity of bacteria will increase in parallel with increasing aeration, higher plant nutrient production will be provided in soil. (Brown,1913).Organic matter amended into the soil by green manure is a source of nutrients for soil microorganisms that play an important role in the decomposition process of organic residues, the recycling of plant nutrients and provides the carbon (C) and required energy for them(Rayns & Rosenfeld, 2008; Talgre, 2013; Rosenfeld & Rayns, 2011; Meena et al., 2018). Green manure crops cover the top surface of the soil form the shade canopy increases the activity of bacteria in the upper layer of the soil (Karakurt, 2009).

Figure 1. *Rhizobium* bacterial nodosities in Hungarian vetch roots (origninal documentation)

3. Conclusion

One of measures that can be taken in order to minimize the damage of the soil and environment because of intensive agricultural practices in the green manure application.The application of green manurecrops for a rotation cropping system, increase the organic matter and other nutrient content of the soil, prevent the existing plant nutrients from being lost for various reasons. Leguminous forage crops as green manure crops which have a pile root system, can form a better surface cover, can be rapidly decomposed in the soil, as well as increase the soil organic matter, these crops are also able to build a symbiotic relationship with *Rhizobium* to add free nitrogen to the soil, and can be used as a good quality raw fodder during hard years, are more advantageous than grasses.

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Complex Assessment of Winter Wheat Growing Conditions in Northwestern Bulgaria

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Abstract

The objective of the study is to make a complex assessment of the winter wheat (*Triticum aestivum* L.) statusin case of two commonly used varieties in Bulgaria - „Annapurna" and „Enola", grown on Chernozems inNorthwestern Bulgaria. Thirty elementary sampling units (ESUs) have been located on the field units' territory for performing the observations on phenological stages, presence of weeds, crop disease and pests and for collecting of soil and plant samples for laboratory analyzes. The following indicators were used to evaluate the growing conditions of the crop during the phenophases: sum of precipitation; land evaluation; soil nutrient supply; soil moisture supply; number of emerged plants per area; height of plants; weight of the aboveground dry biomass; number of stems per area; number of productive tillers per area; Nitrogen uptake by plants; presence of weeds;crop damage caused by diseases and pests.A three-stage ranking of the crop conditions was defined: 3 - high, 2 - average and 1 - low. The complex evaluation of the development of the crop throughout the growing season is presented as an arithmetic mean of the indicators estimates for each phenological phase. The complex assessment for the studied field Units ranges from average to high according to the conditions and the state of the crop during the whole growing season.

Keywords: winter wheat, growing conditions, ranking, Chernozems

1. Introduction

Crop productivity depends on the specific interactions between the genetic traits of plant, soil properties, weather conditions, and the farming practices. The ranking of the environmental variable is often used for assessment of the complex interaction of several variables. The ranking can be done either by means of statistical characteristics of the variable or using threshold values for distinguishing limiting and optimal conditions or in relation to the potential risk for damages, such as loss of yields or other environmental consequences. Among the most popular procedures applying ranking of several variables are the land evaluation methodologies (Sys et al., 1991; Petrov et al, 1988). The operational crop monitoring is usually performed by the local experts and last decades also by the

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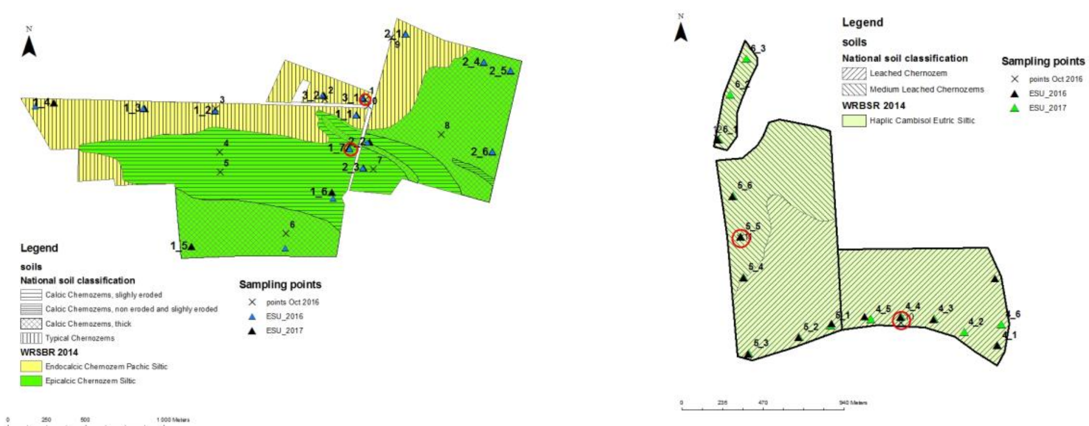
satellite observations. The actual growing conditions can be relate to the ground-based observations of the crop status and the driving environmental variables.

The aim of this study is to make a complex assessment of the growing conditions of winter wheat (*Triticum aestivum* L.) in case of two commonly used varieties in Bulgaria - „Annapurna" and „Enola" using ranking of the environmental and crop variables.

2. Methodology

2.1 Study area

The study was conducted during the 2016/2017 agricultural year on six agricultural field Units, located in the Northwestern planning district of Bulgaria, Pleven region, Municipality of Knezha. Two varieties of winter wheat (*Triticum aestivum* L.) were grown on the selected six Units. Units 1, 2, and 3 were sown with Annapurna variety, while Units 4, 5, and 6 were sown with Enola variety. The studied 30 elementary sampling units (ESU) are presented on soil map (Fig. 1).



1a) 1b)

Figure 1. Location of ESUs during Field Campaigns 2016/2017 on the soil map of the studied area: a) Units 1, 2 and 3 (winter wheat variety Annapurna); b) Units 4, 5 and 6 (variety Enola).

2.7 Meteorological conditions

The main driving factor for duration of phenological phases of winter wheat is the sum of the effective temperatures. The shortage of water is best pronounced in June 2017. The water budget of late spring season (April-June) which is the most important for winter wheat yields is assessed as slightly dry in 2017 (-75 mm at Epicalcic Chernozems and -45 mm – at Haplic Cambisols).

2.8 Parameters and ranks for estimation of winter wheat growing conditions

The phenological observations were conducted in several basic phenological phases according to the Zadok's growth scale. The evaluation of the winter wheat growing conditionsis based on the indicators which are important for the development of the crop in the particular period(Table 1). Some indicators are doubled in order to underline their importance for yield formation.

The final complex value for each ESU is calculated by averaging the above listed indicators and ranking as low (≤2.0), average (2.1-2.5) and high (2.6-3.0).

The evaluation of soil fertility is based on the land evaluation methodology (Petrov et al., 1988) updated according to the FAO land evaluation principles (Sys et al., 1991) and the nutrient status criteria. Ranking criteria are presented in Table 2.

The soil moisture status was evaluated as: Poor when the soil moisture content (W) was below the wilting point (water retained at suction1500 kPa); Fair – when it was above the Field Capacity (water retained at suction 33 kPa) as the plant could suffer from low content of oxygen in the rootable zone; Good when W was between wilting point and field capacity (Table 3).

Table 1. Indicators for evaluation of the crop conditions per phenological phases.

Evaluated indicator	**Z 20** 3rd leaf	**Z 23-24** tillering	**Z 31-34** stem elongation	**Z 65-69** anthesis	**Z 91** ripening
Land evaluation	2x	2x	2x	2x	2x
Soil nitrogen (N) supply	x				
Soil phosphorus (P) supply	x				
Soil potassium (K) supply	x				
Emerged plants	2x	2x			
Number of fruit bearing stems			2x	2x	2x
Number of grains in a single wheat-ear					2x
Height of the plants	x	x	x	x	x
Weight of aboveground dry biomass	x	x	x	x	x
Sum of rainfall between phenophases	x	x	x	x	x
Soil moisture	2x	2x	2x	2x	2x
Nitrogen uptake by plant	x	x	x	x	x
Presence of weeds	x	x	x	x	x
Presence of plant disease	x	x	x	x	x

Table 2. Criteria for assessment of soil fertility conditions based on soil categories and content of soil nutrients – nitrogen (N), phosphorus (P) and potassium (K).

Soil category	Field rank	Content of nutrients		
		$N\text{-}NH_4$+$N\text{-}NO_3$ mg/kg	P_2O_5 mg/100g	K_2O mg/100g
1 (low)	0-40 (N_2; N_1)	<20	<10	<18
2 (average)	40-85 (S_3; S_2)	20-60	10-20.6	18-35
3 (high)	85-100 (S_1)	>60	>20.6	>35

Table3. Ranking of soil moisture content (W, % per mass) for winter wheat.

Rank	Estimation	Soil moisture (W, %)			
		Epiclacic and Endoclcic Chernozems		Haplic Cambisol Eutric Siltic	
		0-25 cm	0-100 cm	0-25 cm	0-100 cm
1	Poor	<20	<20	<20	<22
3	Good	20-28	20-28	20-27	22-28
2	Fair	>28	>28	>27	>28

Available soil water storage in 0-25/30 cm soil layer is insufficient when it is below 18-20 mm for Epicalcic Chernozems or 23-25 mm for fine texture soils such as Haplic Cambisols. Available water content stored in 1 m soil layer is considered as critical if it is below 55-60 mm. Taking into account the increasing of the root zone and the crop water requirements during vegetation, the precipitation in different phenological phases is ranked accordimg to Koedjikov et al. (1971) (Table 4).

Table 4. Modified scale for ranking the influence of precipitation (P, mm) during the phenological phases of winter wheat (after Koedjikov et al., 1971)

Phase	Minimum P (mm)	Rank	Optimal P (mm)	Rank	Excess P (mm)	Rank
Germination	<20	1	55-65	3	>65	2
Tillering	<20	1	30-40	3	>100	2
Heading	<30	1	30-60	3	>120	2
Grain formation	<50	1	50-110	3	>110	2

1 – Poor; 2 – Fair; 3 - Good

The measured biometric data during the phenological stages of the winter wheat are ranked depending on the level of development of the crop in the particular phase (Tables 5, 6, 7).

Table 5. Rank of the height (cm) of the winter wheat plants per phenological stages.

	Phenological stage of development/ Height of plants(cm)				
Category	**Z-20**	**Z 23-24**	**Z 31 - 34**	**Z 65 - 69**	**Z -91**
1 (low)	<7	<15	<40	<70	<80
2 (average)	7-12	15-18	40-50	70-80	80-90
3 (high)	>12	>18	>50	>80	>90

Table 6. Scale (category) for the measured weight of the dry aboveground biomass (AGBd) (g/m^2) per phenological phases of the winter wheat.

Category	Phenological stage of development /Dry biomass (AGBd) (g/m^2)				
	Z-20	**Z 23-24**	**Z 31 - 34**	**Z 65 - 69**	**Z -91**
1(low)	<10	<100	<500	<1000	<1200
2(average)	10-15	100-140	500-700	1000-1200	1200-1400
3(high)	>15	>140	>700	>1200	>1400

Table 7. Scale (category) for counted crop indicators.

Category	% of emerged plants on m^2 compared to the sowing norm	Total number of productive tillers formed in phase stem elongation (Z 32-34) and anthesis (Z 65-69) / m^2	Number of grains in a single wheat-ear
1(low)	<60	≤ 450	10-30
2(average)	60- 80	450-550	30-50
3(high)	80-100	≥550	>60

The evaluation of plant illnesses and pest is made according to the scale presented in Table 8.

Table 8. Modified scale in categories for evaluating the presence of weeds and damages incurred by illnesses and pest on the wheat plants in % (Kozarev, et al., 1972.)

Category	Presence of weeds	Damages incurred by illnesses and pest
1	Weeds are more than wheat plants and suffocate them	average - 25-50%; substantial - over 50%
2	Weeds are common, but still are less than wheat plants	low damages - 10-25 %
3	Lack of weeds, only presence of single weeds	lack or very little damages < 10%

The ranks for nitrogen uptake by plants is based on the optimal content of nitrogen in the wheat in the phases of tillering, stem elongation and ripening: low (<1.0), average (1-3) and high (>3).

3. Results and Conclusion

The basic soil characteristics for all studied units are very suitable for wheatgrowing. The total land assessment of the soils ranks them as good and very good. The soil category varies from 82 to 93.The distribution (%) of ESUs according to the estimations of selected indicators is presented in Fig.2(a÷g) and according to the complex evaluation in Fig.(2h).The complex assessments of winter wheat growing conditions at the studied field Units range from average to high according to the driving factors and the status of the crop during the whole growing season.The presented methodology for complex assessment of the winter wheat growing conditions summarizes the estimations of more than 10 indicators per individual phenological phases. The integrated information allows to trace the development of the crop and to detect the spatial and temporal changes. The results can be used for comparison with satellite derived information for crop status.

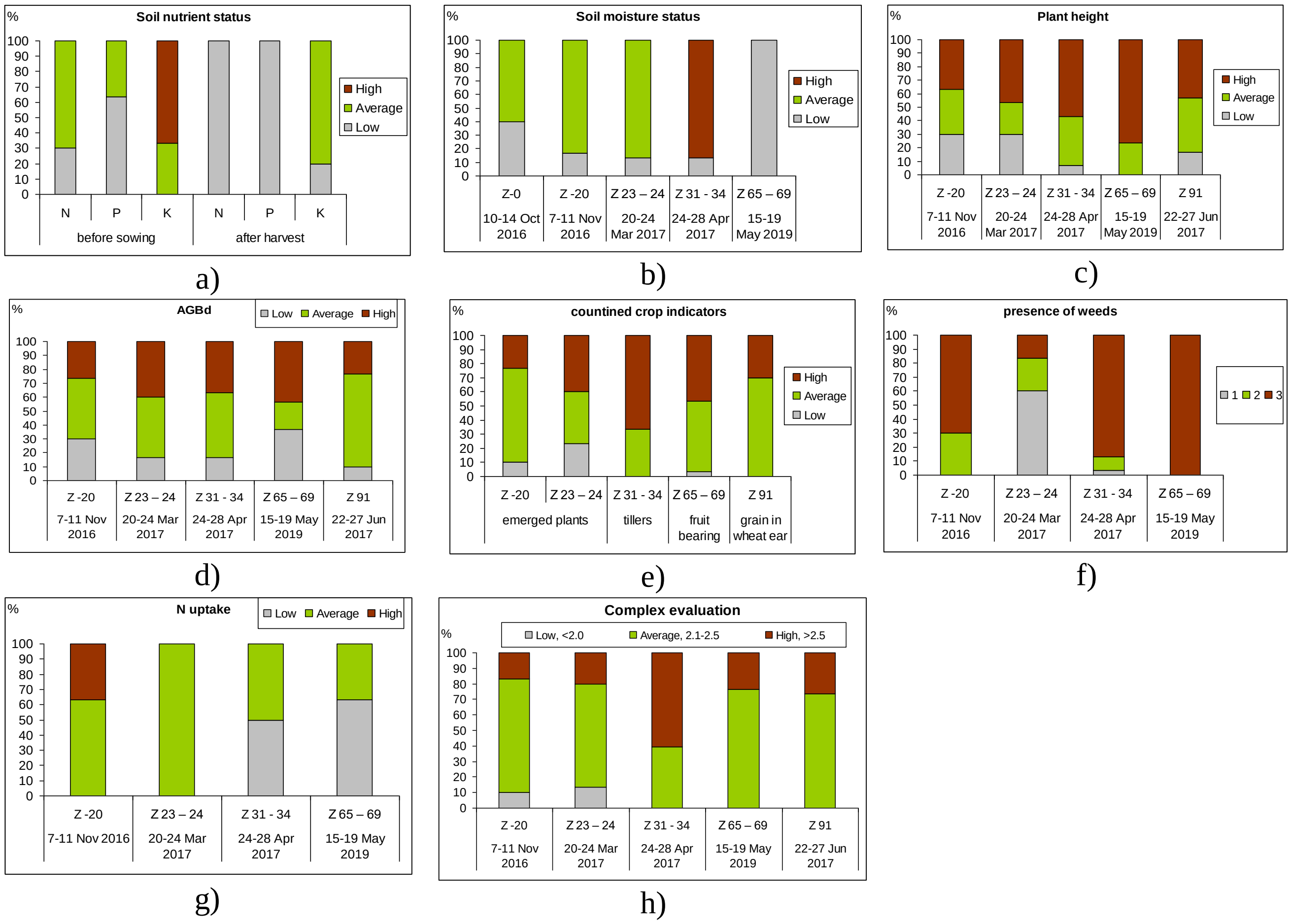


Fig.2 Distribution (%) of ESUs according to the estimations of selected indicators (2a÷2g) and according to the complex evaluation (2h).

4. Acknowledgments

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Effects of Nitrogen Application and Weed Management on Rice Yield under AWD Irrigation System

MdZakaria Ibne BAKI[1],[2] , MKA BHUIYAN[3], Kazuki SUZUKI[4], Naoki HARADA[5]

Abstract

Rice (*Oryza sativa* L.) is one of the most important cereal crops in the world. Fertilization and weeding practices are very important factors for harvesting potential yield in rice. The efficient N management can increase crop yield and reduce the production cost.Alternate wetting and drying (AWD) method can save water by about 38% without adversely affecting rice yields.We investigated the response of different levels of nitrogen and methods of weeding on weed abundance and grain yield of bororice under alternate wetting and drying (AWD) irrigation condition.

The experimentwas carried out at the experimental field of Bangladesh Rice Research Institute, (Gazipur, Bangladesh) from December 2016 to May 2017. The treatments consisted of five N levels (0, 60,120,180 and 240 kg-N ha^{-1}) and four different weed control methods:Pre-emergence herbicide application followed by 1 hand weeding (HW), pre-emergence herbicide application followed by post-emergence herbicide application (HH), three times hand weeding (3HW) and unweeded (control). The experiment was laid out in factorial RCB design with three replications.

The application of HW and HH effectively controlled weed emergence (78-93%). Based on summed dominance ratio (SDR), the most dominant weed species could be arranged in the order of *Echinochloa crus -galli*>*Scirpusjuncoides*>*Cynodondactylon*>*Syperusdifformis*>*Marseliaminuta*>*Monochoriavaginalis*.
Interaction of nitrogen levels and weeding methods had significant response on rice yield components. The highest (7.61 t ha^{-1}) grain yield was obtained from combination of180 kg-N ha^{-1}application with 3HW treatment. Comparable higher grain yields 7.48 and 7.56 t ha^{-1},were obtained from the combination of HW with 180 kg-N ha^{-1} and the combination of HH with 180 kg-N ha^{-1}, respectively. The optimum dose of nitrogen for HW, HH and 3HW were estimated to be 173.0, 189.1 and 189.4 kg-N ha^{-1}for boro rice under AWD irrigation system, respectively.

Keywords: Nitrogen, Grain yield, Weed control

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Effects of Rice Husk Compost Application on Macro Element Nutrition and Yield of Tomato in Organic Growth

Zeynep DEMIR[1*], Coşkun GüLSER[2]

Abstract

Effects of rice husk compost (RHC) on tomato yield and total ash, macro element contents of leaves were investigated in organic growth. Rice husk was composted with farmyard manure under aerobic conditions for 13 months until decreasing C:N ratio from 123.62 to 38.32. Experiment with RHC was conducted in a randomized plot design with four application doses of RHC (0, 3, 6 and 9%) into surface soil (0-20 cm) with three replications in the greenhouse of Soil Science and Plant Nutrition Department of Agricultural Faculty in OndokuzMayıs University, Samsun. F1-RN Sumela variety of tomato plant was grown in the plots without pre-plant fertilization during the experiment for 4 months. While RHC applications significantly reduced total ash contents of leaves, they increased the total N, P, K, Ca and Mg contents according to the control. Effects of RHC applications on total ash, P, and K contents of the tomato leaves were statistically significant at 0.01 level and their effect on total N, Ca and Mg were significant at 0.05 level. The total ash values of the tomato leaves significantly reduced by the application doses of RHC in the following order; control (20.1%) > 3% (18.1%) > 6% (17.8%) > 9% (16.3%). The total N, P and K contents of the tomato leaves generally increased according to the control with the application of RHC dosses in the following order 9% > 6% > 3%. The Ca and Mg contents of the tomato leaves increased according to the control with the application of RHC dosses in the following order; 3% > 9% >6%. Total N, P and K contents of the tomato leaves significantly increased from 2.15%, 0.25% and 1.64% for the control to 3.96%, 0.45% and 3.40% for the 9% RHC application, respectively. Ca and Mg contents of the tomato leaves significantly increased from 2.76% and 0.46% for the control to 3.89% and 0.56% for the 6% RHC application, respectively. The highest tomato yield (7.77 t/da) was obtained with the 9% of RHC application. The positive correlations were found between total N and P (0.790**), total N and K (0.897**), P and K (0.899**), K and Ca (0.681*), K and Mg (0.659*), Ca and Mg (0.647*). The total ash content gave significant negative correlations with total N (-0.898**), (-0.947**), and K (-0.893**). Using RHC in organic tomato growth under greenhouse conditions generally improved macro element nutrition and yield of tomato.

Keywords: Rice husk compost, Tomato, Macro Nutrients, Yield

1. Introduction

Tomato is one of the most popular and versatile vegetables in the world. Organic production with a high yield and desirable quality is a target of many producers.Although chemical fertilizers have been claimed as the most important contributor to the increase in world agricultural productivity over the past decades (Smil, 2001), the negative effects of chemical fertilizer on soil and environment limit its usage in sustainable agricultural systems (Peyvast et al., 2008). Organic fertilizers, which mainly come from agricultural waste residues, are often identified as suitable local organic fertilizers. These contain high levels of nutrients for example,N, P and high amounts of organic matter (Shabani et al., 2011).In case of uncontrolled storage of

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residues and wastes produced as a result of agricultural practices in our country or their application into soils, the benefit expecting from them is not provided. Application of these wastes into agricultural fields after composting them aerobic or anaerobic conditions is important both waste management and to increase soil fertility with natural ways. Composting is a biological decomposition process in which microorganisms convert organic materials into relatively stable humus like material. During decomposition, microorganisms assimilate complex organic substances and release inorganic nutrients. A large amount of soilsin Turkey, like 75%, contains very low and low organic matter content (<2%). One of the basic ways to deal with this situation is to increase organic matter content of soils. Organic matter is known to improve soil fertility by changing its physical, chemical and biological characters (Candemir and Gülser 2010); vegetable production requires continuous applications of organic matter (Richter 1997). Organic fertilizers or compostsoffer many benefits for horticulture. Firstly, they release nutrients slowly, which means that plant nutrition occurs over a long period. Secondly, this slow release avoids over-nutrition thus avoiding providing too much nitrogen, phosphorous or potassium, all of which can be harmful in too high doses. Thirdly, they create a good environment for beneficial soil organisms, such as earthworms, which improve the soil structure by incorporating organic matter well down into the topsoil creating drainage and air tunnels while so doing (Stein 2009). Especially in organic farming, the use of compost is one of the methods to increase the organic material contents of processed and unprocessed soil. With the use of compost, organic substances lost from soils in various ways are again given in to soils and thereby nutrient loss is reduced. In this study, effects of rice husk compost on yield and macro element contents of leaves were investigated in organic tomato growth.

2. Materials and Methods

Rice husk was composted with manure under aerobic conditions in the greenhouse of Agricultural Faculty in OndokuzMayıs University for 13 months. Rice husk was composted with farmyard manure under aerobic conditions for 13 months until decreasing C:N ratio from 123.62 to 38.32. Some properties of the organic residues used in the compost process were given in Table 1.

Table 1. Some properties of the organic residues used in the study

	C, %	N, %	Natural Moisture, %	C/N
Rice Husk	46.303	0.376	15.0	123.146
Manure	33.146	2.789	73.0	11.884
Rice Husk Compost	21.138	0.552	35.8	38.320

The study was conducted in the greenhouse of Agricultural Faculty of OndokuzMayısUniversity between June 1, and August 31, 2010. The rates of 3, 6, 9% of rice husk compost (RHC) were applied to the plots (2.0 x 1.0 x 0.2 m) in a randomized plot design with three replications. Sümela F1-RN (*Solanumlycopersicum* L.)tomato variety was used in the experiment as a plant material. Eight tomato seedlings were planted in each plot. F1-RN Sumelavariety of tomato plant was grown in the plots without pre-plant fertilization during the experiment for 4 months.The 5th and 6th most recent mature leaves from the plant growing point were sampled for macro nutrient analyses (Geraldson et al. 1973). After drying the leaf samples at 65ºC, they were ground and placed in a furnace at 550ºC to get ash content (Kacar, 1994).Total nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg) contents of the leaf samples were determined according to the Kacar and Inal (2008).Experimental results were subjected to ANOVA with SPSS Version 16.0 statistics software.

Treatment means were compared with Duncan's multiple range test and correlations were performed to express the relationships between experimental parameters (Yurtsever, 2011).

3. Results and Conclusion

Effects of RHC treatments on total ash values and macro nutrients of the tomato leaves were found to be significant at $p<0.01$ level (Figure 1). While total N, P, K, Ca, Mg values of the leaves increased with RHC application according to the control treatment, total ash values of the leaves decreased with RHC application. The highest total ash value (20.1%) was in the control treatment and the lowest value (16.3%) was in the 9% of RHC treatment (Figure 1A). The total ash values of the tomato leaves significantly reduced by the application doses in the following order; control (20.1%) > 3% RHC (18.1%) > 6% RHC (17.8%) > 9% RHC (16.3%).

The lowest total N content (2.15%) inthe leaves was obtained in the control treatment while the highest N content (3.96%) was in the 9% RHC treatment (Figure 1B).According to the limit values given by Alpaslan et al. (1998), total N content in the leaf samples of 6% RHC (3.38%) and 9% RHC (3.96%) applications were found in the sufficient level. Nitrogen is the most limiting nutrient for tomato growth and is required for optimum production because tomato removes large amount of N from the soil (Needham, 1973). There was nitrogen deficiency in tomato plants grown in the control and 3% RHC treatments.

Table 2. Limit values for some macro nutrients in tomato leaf (Alpaslan, 1998).

	Deficient	Sufficient	Excessive
Total N (%)	2.80-3.19	3.20-4.50	>4.50
P (%)	0.40-0.49	0.50-1.20	>1.20
K (%)	4.30-4.99	5-10	>10
Ca (%)	1.10-1.49	1.50-2.40	>2.40
Mg (%)	0.26-0.31	0.32-0.80	>0.80

The lowest P content (0.25%) in the leaf samples was determined in the control treatment while the highest P content (0.45%) was in the 9% RHC treatment (Figure 1C).The P values of the leaf samples significantly increased by the application doses in the following order; control (0.25%) < 3% RHC (0.35%) < 6% RHC (0.38%) < 9% RHC (0.45%). According to Table 2, even if P contents of the leaf samples increased by the doses of RHC application, P levels of the tomato leaves were less than 0.5% and determined as deficient. Deficiency in P results in stunted growth of tomatoes with thin stems and dark green color on the upper surface of leaves containing purpling veins. Older leaves show premature senescence with yellow and purple tints (Needham, 1973).

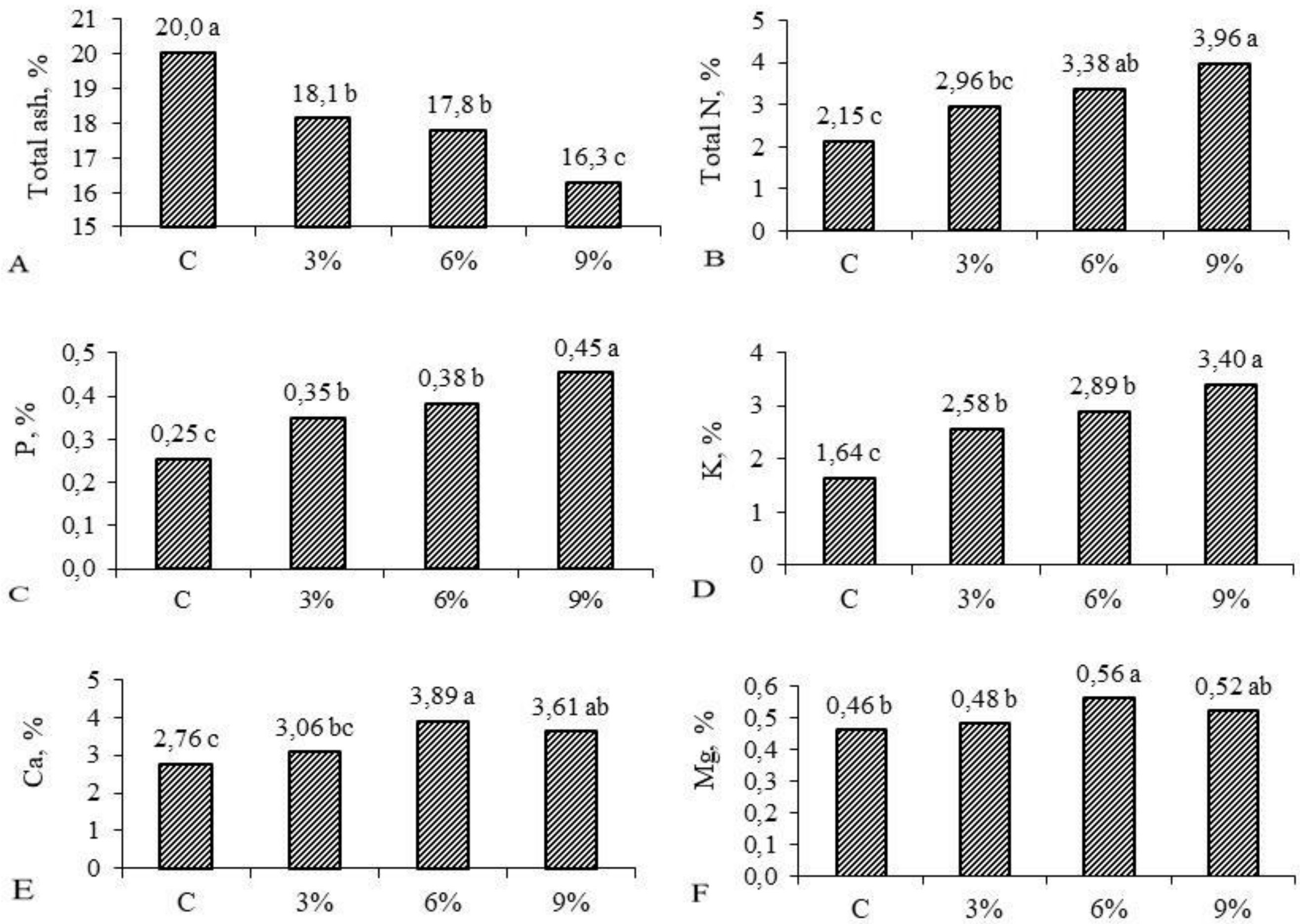

Figure 1. Effect of rice husk compost treatments on total ash and macronutrient contents in leaves.

The lowest K content (1.64%) inthe leaves was obtained in the control while the highest K content (3.40%) was in the 9% RHC treatment (Figure 1D).The K values of the tomato leaves significantly increased by the application doses of RHC. Potassium contents of the leaf samples in all treatments were lower than the critical range (5-10%) of sufficient level (Table 2). Potassium deficiency results in brown marginal scorching with interveinal chlorosis and yellowing in tomato leaves (Needham, 1973) and shortened internodes.The lowest Ca content (2.76%) was obtained in the control treatment while the highest Ca content (3.61%) was in the 9% RHC treatment (Figure 1E).Calcium has three major functions in plants: it is essential for the cell walls and the structure of the plant, it acts as a factor that maintains cohesion cells together (Acosta-Durán, 2007) and it maintains the structure of the plant tissue (Fageria et al., 2001). Ca contents of the leaf samples in all treatments were higher than the excessive level (2.40%) given in Table 2. The lowest Mg content (0.46%) was determined in the control treatment while the highest Mg content (0.56%) was in the 6% RHC treatment (Figure 1F).Mg is a central atom of chlorophyll and thus plays a significant role in plant photosynthesis. Since it is a mobile element in plants, chlorophyll of the plants is first reduced in old leaves and the remaining amount of Mg in old leaves is transferred to younger leaves (Hermans et al., 2010). The Mg contents of the leaf samples in all treatments were within the range (0.32-0.80%) of sufficient level (Table 2).

Although 3% and 6 % doses of RHC applications reduced tomato yield compared with the control, tomato yield value (7.77 ton/da) in 9% RHC application significantly increased according to the control (4.90 ton/da) treatmentby the 58.56% ratio (Figure 2).Anaç et al. (1999) reported that tomato yield increased by 20% using agricultural waste compost in the cultivation. Tu et al. (2006) reported that the increases in fruit yields could also be due partially to large increases in soil microbial biomass after organic fertilizer applications, leading to production of hormones or humates in the composts acting as plant-growth regulators independent of the nutrient supply.

The correlations among the tomato yield, ash content and macro nutrients are given in Table 3. The ash content values showed negative correlations with all parameters, but the correlations with N, P and K contents were significant statistically at 1% level. There were significant positive correlations among the N, P and K contents. K content also showed significant positive correlation with Ca and Mg content of leaf samples. Although they were not significant, all macro nutrients had positive correlation with tomato yield.

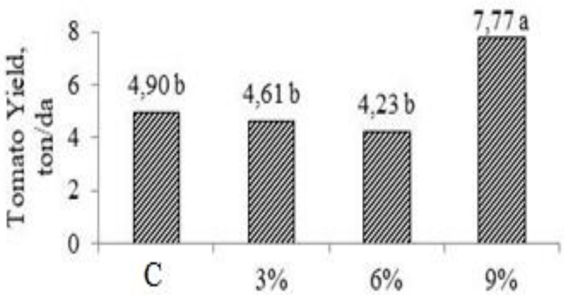

Figure 2. Effect of rice husk compost treatments on tomato plant yield, ton/da

Table 3. Correlations amongyield, total ash and macro nutrients in tomato.

	Total N	P	K	Ca	Mg	Yield
Tot. ash	-0,898**	-0,947**	-0,893**	-0,465	-0,444	-0,549
Tot. N		0,790**	0,897**	0,487	0,527	0,529
P			0,899**	0,549	0,569	0,544
K				0,681*	0,659*	0,572
Ca					0,647*	0,295
Mg						0,076

As a result, macro nutrient contents of the tomato leaves grown under greenhouse condition increased by the RHC applications. While the P and K levels of the leaf samples were found as deficient, total N, Ca and Mg contents of the leaves were in the range of sufficient level. Using RHC in organic tomato growth generally improved the level of macro nutrient, but P and K should be added to soil from different organic sources to reach successful organic tomato growth.

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THEME 8: Soil Philosophy

How is Soil Philosophy and Ethics Possible?

Burçin ÇOKUYSAL[1]

Abstract

Since last decades many of the researcher, philosopher and environmentalist have focus on the land management problems. Philosophical consideration of soil management systems and perspective on land degradation, and application of this theories to global moral issues such as preservation on soil ecology, world population, gender equality, world hunger and poverty, water and air pollution are the main target of this article. Soil philosophy, ethics in particular makes a great difference in usage of the soils and producing food for human and animals. Agricultural philosophy and ethics have many forms, but this article pointed out recognize ethical issues and dilemmas in agriculture and soil management decision-making.

How should human beings relate to the soil and ecosystem? Why is gender an issue access to land? Do we have moral obligations toward non-human animals, microorganisms and other parts of soil? And what do we to other including future generations, with respect to the soil and its environment? Who will decide about what is right? Article will examine such questions in light of some of our current ethical theories.

Keywords: Soil philosophy, Soil ethics, Ethically problematic issues on soil management

1. Introduction

In essence, philosophers who realized human life is not able to go on without nature, especially soil, state that humans are responsible for deranging the natural neutrality and destroying the potential of soil's agricultural production thanks to philosophy and ethics. By the help of philosophy and ethics, they express different kind of aspects on soil, nature and environment and offer several solutions from different view point (Hartel et. all. 1994; Burkhardt et. all. 2000; Chrispeels and Mandoli, 2003; Dundon, 2003; Weston, 2009;Korthals, 2017)

Industrial production modified the last two centuries, and consumption system, created correspondingly, affected the agricultural system and agricultural production system seriously. The positive and negative effects of economy on soil and productivity are being argued. The reasons such as bartering the production areas off for several reasons, ignoring the animal rights, destroying the soils to not being in a recyclable way, being unfair to share of agricultural products, are the important factors to cause a "global ecologic crises". Overlooking the necessity of solving the issues or discussing the solution suggestions make difficult to settle on sharer of subject. Since the necessity of philosophy and ethics base, in the solution of soil productivity of global ecological crises and issues relating to agricultural production, the question whether the nature is aim or tool is still being an object for discussion (Weber, 2009; Ip, 2009; Singer, 2011; Toprak, 2012).

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2. Materials and Methods

Material and methods of this article is shaped by author mental models and frames of references that used to organize aim, reasoning and observations. The method of this article involves the logical process of reasoning. This reasoning process was used for drawing inference from the finding of a study or arriving at conclusion of this article.

2.1 Aim

The aim of the article, constituting sustainable soil management system, balancing the land degradation neutrality, healing the soil health, examining the sustainable value chain in regard to sustainable value chains for land degradation neutrality are being argued thanks to philosophy. More clearly, the main aim of the article is to discuss how soil philosophy and soil ethics can be possible. In this context, it is observed that community, private sector, universities and non-governmental organizations, which provided several solution suggestions, create a paradox to neutralize and sustain the land degradation neutrality. The question “how can we evaluate the paradox?” is aimed to evaluate by the help of philosophy and ethics. Besides that, the other questions that we need to evaluate are: How should human beings relate to the soil and ecosystem? Why is gender an issue access to land? Do we have moral obligations toward non-human animals, microorganisms and other parts of soil? And what do we to other including future generations, with respect to the soil and its environment? Who will decide about what is right? Article will examine such questions in light of some of our current ethical theories.

The last and above all, it is aimed to discuss whether the soil philosophy and ethics are possible or not. If it is possible, is it matter to philosophizing about land degradation neutrality? What is the effect to philosophizing about it to the communal living? These are the questions tried to be evaluated. Even to ask these questions are vague, it is showed that the soil philosophy might be possible. However, is the idea true or not? Is it realistic or not? These are the questions of debate.

3. Is Soil Philosophy and Ethics Possible?

From my standpoint, philosophy, proprietarily soil philosophy and ethics, should be discussed in two manners. Firstly, soil philosophy is historical and individual formations. In time, it is observed every philosopher described the relation between human-nature, human-soil and human-human-environment in a different way. More precisely, it can be said that every philosopher has freedom to redefine these relations. What makes them philosophers is the freedom to redefine at the end.

Secondly, individuals, that we call as philosophers are the human at the end, (it is so important, in a sense philosophy is the thing that human do in the world) do it under these historical and social conditions. And the individuals, called as philosophers, chase their minds in time because they influence by the historical and social conditions. For instance; Ancient Greece Philosophy, Middle Age, Environment Philosophy (Jardins, 2006; Kılıc, 2008),Eco-philosophy (Ecosophy) (Fox, 1994; Drengson, 1997; Shea, 2014), Deep Ecology (Naess, 1973; Cuomo, 1994, Light, 1996), Ecofeminism (Dobscha, 1993; Christ, 2006; Anonymous, 2015) . Thereby, it should be evaluated both philosophers and their ideas by considering the period and its conditions.

When we think about the relation of philosophy especially nature, environment, agriculture and soil philosophy, and philosophical thoughts within living reality and goings-on, it rises an important result. It is seen that philosophy is in a struggle for analyzing the period, understanding, interpreting founding and converting. In effect, philosophy by its fact is the act, which is able to take every subject freely, inquire into, unlimited itself with any permission, discuss critically and consistently. When considered from this point of view, soil philosophy and soil ethics seems possible. For a long while, ethically problematic issues are restricted with relations of human and society. However, the ethical studies, shaped in recent times, bring forward to the problematic issues on sustainable soil management system, land degradation, soil health and examination of gender equality's role. Thus, discussing about the problematic issues, specified thanks to philosophy and ethic, makes both practical and theoretical aspects possible to approach. The discussions came to light thanks to soil philosophy and ethics, and possible solution suggestions started to be questioned in every aspect. As well as science and technology are important sources to provide soil productivity and sustainability, a significant part of the discussions will remain incomplete without soil philosophy and ethics. Today, the problematic issues about soil and environment might be occurred because of this deficiency. Science and technology, using the issues in soil as a base, with the common study of soil philosophy, centering upon the values, constitute the main study area of soil ethics. Paradigm shift seems inevitable in the near future because of the responsibility that we need to take against world from anthropocentric ethical approach to ecocentric ethical approach.

4. Issues of Values on Land Degradation Neutrality

Is it possible to mention about the value of ecosystem and soil independently from human or vital for human? To answer the question, it should be defined the meaning of "value" firstly. Without this definition, it seems impossible to answer the questions on value of soil and land degradation neutrality. In conclusion, ethics are ground with the meaning of "value" (Zelezny and Shultz 2003).

As an important concept of economy, the "value" is the measurement of currency, which cash on a good or service. Although the concept of "value" come to ethic from economy, it has different kind of meaning in ethical approach. For instance; in economy, the concept of soil is used for the definition of "usage" and "exchange value", it is the value that we appraised, not the value that soil has characteristic of.

In this situation, commodification of soil is inevitable. If the natural asset carries a value of usage for human from the point of soil and soil ecosystem, there will be no value to protect the soil in anyway. At this point, the protection of soil and creatures, depending on it, seem impossible. Soil and ecosystem, depending on it, have an individual value, and it is not a tool to gain favor for human. An important reason of ecological crisis will be solved, when human stop to use soil and the creatures as an owner and see them as a part of ecosystem. It seems that the solved reason is such as to influence the crisis, which causes a negative effect, directly.

Regardless of serving the purpose of soil or ecosystem for human, accepting their own values, in a sense to accept their existence as a value itself, enable to solve several ethical issues. The examples of "value" concept are also available in human living. Although a plow which reminds us of an old soil tillage system has not a usage value for today, is still a value. What makes the plow valuable is its existence and connection to the former generations. Its existence is a value by itself. It is so important to adopt the idea to preserve the soil. Admitting the soil's existence as a value itself will be a progress in preservation of environment and nature. Thus, it will help us to improve the results of global ecological crisis.

On the basis of the earth, environment and the issues that arise due to it, it is observed that the own value of soil and environment get lost and instrumental value comes into prominence more. Soil ethics that teach us how to behave not only the human, but also the soil and nature, is the main starting point to protect the soil.

As another ethical issue in the matter of soil's value, it is thought that all the efforts, giving to protect the soil, will gain favor to only human both economically and ecologically. People consider the creatures, haven't a place in nutrient cycle and life cycle, valueless. If human is a basic member of ecosystem, regardless of having a place in nutrition cycle or not, it needs to be seen as worth living. Aldo Leopold (1887-1948) states that when the action protects the biotic community integrity, neutrality and beauty will be true, unless it is false one, he underlines that ecosystem should be considered as a whole and living creatures and non-living assets have their own values.

When all the issues, encountered in the soil, are evaluated generally, evolution in ethics, in other the values of soil ethics, should be adopted to reach an agreement in future and to protect the soil wealth, will be main goal of this symposium.

5. Who Will Decide About What Is Right to Do in Soil Protection?

The variety of issues on creating a sustainable soil management system, land degradation neutrality, soil health, examining the role of gender equality, sustainable value chains for land degradation neutrality and the continuous increase correspondingly; political, social, financial, scientific and social movements show an increase. At this point, when every partner provides solution suggestions from their perspective, finding a common ground and reaching an agreement is being a problem. Besides, the issues, causing new issues, create a need for moral and cultural dimension. And, it makes the issues more complicated.

The point to focus on here firstly is that individuals need to make their own choices to provide solutions on soil management and make a moral choice. The producers, who have financial difficulties, have no chance to choose the balanced-fertilization programs or chemicals, which are unqualified and create soil pollution. The countries, have lost soil fertility and soil health, have no chance to import or not import the agricultural products. Poor producers, who have a need for labor force, have no chance to consider or not consider the child labor or gender inequality. It doesn't show that they have a right to behave unethically, but how we need to expect from them (who are not able to make their own choices) to develop the soil and environmental consciousness better for the future generation. At this point, although soil sustainability and environmental issues seems luxury along poverty of human, it occurs because of the insusceptible management models to protect the soil and environment, lead to come through.

6. The Chipko Movement and The Female Role to Develop the Environment Consciousness

Environmental consciousness to refer to specific psychological factors related to individuals' propensity to engage in pro-environmental behaviors (Zelezny and Shultz 2000; Sanchez and Lafuente, 2010; Sharma and Bansal, 2013)"The Chipko Movement" shaped in 1970 in India (Jain, 1984; Shiva and Badyopadhyay; 1986; Shiva, 1988; Kedzior, 2006). It was the social and ecological and movement, which hadn't containing any violent, put forward the impulse to present the female role to develop the environment consciousness. The floods and landslides observed in the destructed jungles make the women involved in it and Chipko Movement spread on countries and regions in the later years. Ecofeminists, who argued on the majority of observed environmental disaster and the equality of pressure applied on gender, defend that environment and gender equality issues don't come to a solution unless the present pressure will continue. The issues on agricultural production, soil protection and social gender equality will be solved, only if they break the taboos in society, discuss philosophically and ethically and place the oppressive behaviors into equalitarian one. Soil, environmental and equality issues influence everyone regardless of woman, man, adult and child. Hence, not solving these issues until today make essential to provide solutions suggestions with new approach. Being informed about the dilemma such as female-male, human-nature, human-soil, objectivity-subjectivity is the first step to being influenced by mindscape and realization of word. Besides, the step will be the basic steps to be taken into world which is equalitarian and protecting the nature.

There are more questions that need to be answered by steps in the word: “How should human beings relate to the soil and ecosystem?” “Why is gender an issue access to land?” “Do we have moral obligations toward non-human animals, microorganisms and other parts of soil?” And “what do we to other including future generations, with respect to the soil and its environment?” These questions, regarding who will decide about what is right to do, can be answered by three different perspectives.

The first perspective is the defender of "Anthropocentric Ethics” approach. According to the anthropocentric soil and environment ethics, living creatures and non-ling assets such as plants, animals, soil and environment have not their own values. They exist as long as they serve and gain favor for human and hence, they have value. From this perspective, soil and nature seems as a tool. The defenders believe that human protect to soil and nature to gain favor economically, ecologically and esthetically. Reaching global and local dimeson of soil and environment issues, reaching threatened dimension of irrevocable issues that human will be influenced in our planet caused to be questioned the "Anthropocentric Ethics” approach in every aspect. “Biocentric Ethics” come to the forefront by coming to the forefront of the concept of protection of soil and environment, gender equality, equal share, animal rights gradually. According to the “Biocentric Ethics”, the value of human seems more precious than nature. It is stated that all existing organisms, living in nature, regardless of their development level, have moral value. The mainstay of Biocentric Ethics” is shown as life itself. With this approach, it is accepted that every person, animal, plant and microorganisms have the same right against natural order. Since It is thought that life will continue in nature without human being, nature is considered as valuable independently from a value that every existing creature will give on.

Thirdly and lastly, defender of “Holistic Environmental Ethics (Ecocentric)” approach accepted that both living creature in nature and non-living things such as soil and environment are the subject of ethics. According to holistic approach, it is accepted that non-living things such as soil and environment exist in nature, and it is enough to have a right. In the base of this ethical approach, they underlie in ecosystem. Consequently, it should answer the issues from this perspective that encountered in the ethical area.

7. Conclusion

Although some people think that ethical decisions are in theory, not work in practice, ethical judgements, which not work in practice, have a fault also in theory. Since the aim of all ethical judgments lead the way of practice. In this respect, philosophy and ethics seem possible to apply in every division in life.

It is obvious that study of soil philosophy and soil ethics will develop the soil consciousness and sensitivity ambidextrously in time. When considered from this point of view, it can be said that ethics have a problematic issue with human himself firstly and then with other human and his environment.

It is observed that the perspective of three cruces points needs to be examined, despite the diversity and extensity of ethically problematic in the soil sciences.

Firstly, soil material that we perform the agricultural production, and ecosystem which is tied to the soil are not the material that people get economic benefit from, it is the part of the ecosystem. Secondly, people neither are the owner of the nature, nor have a right to use and convert the soil as they want, they are the part of entire ecosystem. Thereby, all the unethical behaviors make them guilty. Thirdly, it is the necessity to approach the entire living and non-living system. In this way, they can understand the position and value of themselves and other parts of ecosystem.

In conclusion, we need to consider the perspective of 'ecocentrism' more which shows that people come to existence and sustain their life with nature, than the perspective of 'anthropocentrism' which see the nature as a material for people and a raw material using in production by people.

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THEME 8
Land Degradation Neutrality from Local to Global Scale (Youth Forum Session)

How Agricultural Sector Can Contribute to Land Degradation Neutrality in Pakistan; Perspective of Farmers' Participation and Integrated Land Use

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Abstract

Agriculture is vital for Pakistan's economy and plays major role in livelihood of majority of the population. The continuous rise in Country's population has put pressure on agriculture sector and demand for food is on the rise. In contrast, cultivable area is decreasing with the bulging issue of land degradation. Land degradation in the Country is caused by socio-economic factors, loss of soil fertility, grazing pressure, erosion, deforestation, water-logging, salinity and soil pollution. Besides, emerging problems include those of decreasing river and canal flow, utilization of agricultural area for housing and industries and irregular shifts in weather. Pakistan as land degradation neutrality (LDN) signatory needs to address such problems on immediate basis to attain the targets. A National Action Programme was initiated almost 17 years ago, yet not much has been achieved due to lack of implementation and non-participation of all stakeholders among other reasons. Therefore, quick education of all the stakeholders about the worth of soil and threats of land degradation is needed. The strategies and policies should include the farming community, and only through the participatory approach, land degradation can be decreased if not reversed. Also, cautious and integrated land use is advised to achieve LDN in Pakistan and other developing countries. The targets achieved locally would contribute globally leading towards the Sustainable Development Agenda.

Keywords: land degradation neutrality, Pakistan, farmer education, integrated land use

1. Introduction

Pakistan is predominantly agricultural country; with this sector contributing up to 18.9% in gross domestic product (GDP) and employing around 42.3% of the labor force (Ministry of Finance 2018). This contribution can be attributed to several natural resources including particularly those of arable land, fresh water availability and well-established irrigation system. The arable land of Pakistan is estimated 31.1 m ha constituting 39.1% of the total area, and is irrigated by more than 58000 kms of canals (Pakistan Bureau of Statistics 2017). Pakistan has long been successfully relying on these resources for food production with the exceptions of certain commodities. However, several factors are severely affecting the food self-sufficiency of the Country.

Pakistan has seen constant population bulge which is estimated at 2.4% per annum currently, thus there is increase in food requirement. Next biggest threat to food security in Pakistan is changing climate which has led to abrupt changes in rainfall and weather patterns; the most visible parameter accepted by masses. Severe rainfall and hailstorm, for instance, was very rare during wheat harvest and mango flowering season (mid-April), but happened this year and damaged large area throughout Pakistan. Similarly, Monsoon rainfall remained a blessing for both surface and groundwater reservoirs, but its increased intensity leads to flooding

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almost every year for the last two decades (Hunt et al. 2018; Khalid et al. 2018). The other extreme effect of climate change is the decrease in fresh water resources which is facing continuous decline and estimated at 9% lower in 2017-18 compared to previous year (Ministry of Finance 2018). It also leads to dry spells and severely affects cropping especially in rainfed areas. Next, cropping area is not utilized fully as cultivated area is only 22.7 m ha when compared with that of arable land (31.1 m ha) (Pakistan Bureau of Statistics 2017). Notably, energy crisis limiting the use of automated pumps for lifting groundwater, lack of agricultural mechanization, post-harvest losses, small and scattered land holding, supply and application problems with agricultural inputs, marginal ad subsistent land-use, yield gap issues, socioeconomic influences and depletion of soil resources are leading factors towards decreased crop yields asking for import of food instead of its export. The decreasing crop yield circumstances ask for efficient use of resources, especially that of the soil to fulfill increasing food needs. The extent of inefficient land use can be estimated as Pakistan stands 59th in yield per unit area of wheat (FAOSTAT 2017) among other countries. The case of other crops is also not different.

2. Land degradation in Pakistan

Estimated 85.4% of the soils of Pakistan are prone to degradation and desertification (Khan et al. 2012) through multitude of processes: 1) policy related 2) land managemental, 3) climatic, and 4) socioeconomic. Certain policy measures have been introduced for soil resource management including that of National Action Programme to Combat Desertification in Pakistan, 2002 following the ratification of Land Degradation Neutrality (LDN) initiative in 1997 by Pakistan. However, the implementation largely remains preemptive due to lack of specific organization, legislation and execution (Khan et al. 2012). Continuous change in administrative setups, lack of proactive application-targeted legislation, no or minimum participation of stakeholders, and lack of an authority for forcing the policies have been adding to the problem. This is also joined by meager extension activities, which have not incorporated the new problems. Similarly, soil is still considered personal resource rather than national which is one of the main reasons behind blunted execution of the policies.

Majority of farming community in Pakistan prefers conventional farming practices which have led to soil degradation throughout the country. For instance, flood irrigation, extensive tillage practices and incautious agricultural inputs application are common among the farmers. Similarly, unlined water channels and the incautious irrigation practices lead to soil loss. Besides, disposal of solid waste and effluent of industries to the soil, municipal waste dumping sites, and on-the-rise soil pollution add to the problem on managemental level causing damage to soil. There are certain land-use related issues too which have led to decline in soil resources. For example, marginal and subsistent land use is dominant which deteriorates the soil fertility.

Most parts of Pakistan receive minimal rainfall, and face high evapotranspiration, leading to soil salinity (Qureshi 2011). Similarly, irrigation using saline groundwater has also led to increase in saline soils throughout the country. This disturbed soil chemistry also leads to waterlogging problem in some areas. Further, the Monson rainfall has long been serving as source for water reservoirs, but recent trend has been drastic because of high intensity rainfall leading to flooding. The flooding and/or intense rainfall has often led to erosion particularly in the areas with more slope. The changing climate trends have started affecting the biodiversity and water availability which are having dire effects on soil.

Socioeconomic factors intermingled with those of policy, managemental and climatic issues are leading towards land degradation and depletion due to a) use of agricultural lands for housing, b) transportation of top layer for infrastructure, c) economic extremes leading to non-cultivation, d) dumping of domestic waste, e) family land division, and f) small and scattered land holding. Combined, all these factors have led to land degradation in Pakistan which is estimated 61% of the agricultural area (Hassan and Arshad 2006).

3. What can be done to achieve land degradation neutrality?

Very few localities in the world enjoy the luxury of vast agricultural land, but the realization of value of this resource is also very rare. The circumstances of ever-increasing food requirement and changing climate ask for efficient utilization of deteriorating soil resources and recovery of already degraded soils. The Land Degradation Neutrality (LDN) initiative under these circumstances is immediate need especially for the countries where soil loss has not yet been addressed. For Pakistan, few policy measures, management techniques and reclamation strategies have been devised for achieving LDN targets. First program set was The National Action Programme to Combat Desertification in Pakistan 2002 focuses on better crop and animal husbandry, soil and water conservation, reclamation of problem soils and afforestation. The progress on this and later programs has been slow and minimal, therefore immediate action is needed for the 2030 Agenda for Sustainable Development.

The reasons behind slow progress of such policies happen to be lack of participation of all the stakeholders especially that of the farming community who have to execute major part of the target. Therefore, the farming community needs to be educated about the worth of soil, and soil as national or global resource rather than personal. A survey of available resources, and periodic review of soil resources of each farmer can be started which can check the status of land degradation and suggest accordingly. Certain incentives can be coupled with achieving the targets. Furthermore, systemized knowledge dissemination regarding land degradation, soil conservation, links between climate change and soils, reasons behind soil fertility loss, and declining irrigation water dynamics can be done to the public. Similarly, farming community can be supported not only for the problem identification, but also for the solutions. Finally, awareness about soils as carbon sink rather than source, utilizing the soil's microbiological potential in reducing chemical inputs, and soil's importance for food security thus is a must and immediate need.

Another important aspect can be the integrated land-use which is quite the practice in rural farming communities, however, not being practiced up to its potential. The integrated farming encompassing all the three i.e. crop husbandry, animal husbandry and poultry farming, besides fisheries and agroforestry has the potential to address the problem of land degradation. There can be certain agronomic approaches under integrated land use: a) marginal lands can be utilized better through planting fodder crops incorporating legumes, b) crop residues or stubbles which are usually burnt can be used for housing or feed for the animals, c) utilization of animal and poultry manure as nutrient source, and d) grazing in agroforestry area will not only enhance biodiversity, but also can ensure security in case of environmental adversities damaging one crop, which can be applied. The agroforestry system besides, would not only prevent erosion, but also enhance soil nutrient status through nitrogen fixation trees and leaf litter. Finally, monsoon season receiving almost 70% of the annual rainfall within 2-3 months leading towards erosion, flooding, and sometimes crops lodging can be used for fisheries besides reservoir for water scarce periods. The integration although on smaller levels would be more secure than that of single crop stands, or sole rearing of animals. This system will also address the problem of deforestation in the Country. Another approach can be reclamation of problem soils initially through animal grazing. For example, a local palatable Kallar grass (*Leptochloa fusca*) can grow well in saline and waterlogged areas, thus is an excellent candidate for reclamation of such soils. Similarly, microbe-assisted phytoremediation can be employed for recovering such soils which will also replenish the nutrients in the soil.

The soil loss is ultimately the loss of livelihood (Erfurth 2019) for the farming community throughout the world. The soils besides providing food to all the creatures are also potential carbon reservoirs, and under changing climate scenarios, their worth must be documented and understood. This realization on the part of public especially that of land owners thus is immediately needed besides policy formulation and implementation. The participatory approach and cautious land use in agricultural sector are the key to Land Degradation Neutrality which will help achieve Sustainable Development Goals (SDGs) locally as well as globally.

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Integrated Planning Approaches for Sustainable Use of Land/Soil Resource İstanbul Metropolitan Youth Assembly

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Abstract

Today, the dependence of the agricultural sector on technology is increasing.High-tech developed countries produce high-yield products.These countries are blocking the continuity of production by marketing low-cost genetically modified products to developing countries.As a result, the competitive power of developing countries in agriculture is decreasing.Hence, the gap between developed and developing countries is gradually expanding.This situation further impoverishes developing countries.Agriculture in different geographic regions of the world and Turkey has a great potential.The global problems mentioned above are an obstacle to the equal development of the agricultural sector in the world.Although Turkey has high agricultural potential, it can not reach a sufficient yield.These difficulties vary according to the region's geographical features and spatial relationships.

In this study, the following items will be examined.

-Improving the quality of agricultural products,

-Productivity growth in smart agriculture and sustainable agriculture

-Technological progress,industry and trade in smart agriculture and sustainable agriculture

-Issues soil quality and efficiency in agriculture as a result of methods industry and trade.

In order to develop smart agriculture and sustainable agriculture in Turkey problems will be presented with their solutions.

Key Words: Developing Countries, Agriculture, Sustainable Agriculture, Organic, Soil, Degradation, Sustainable

1.Introduction

The concept of degradation is regression soil structure of the agricultural or forest area and the result of this process; the erosion of the soils and in the area where have soil completely corroded, continued the main material on the corroded land.In many regions of the world, soil erosion is one of the main land degradation processes that reduce the soil productivity by removing fertile topsoil layers, thus decreasing levels of organic matter and the nutrients.Natural, anthropogenic, socio economic and political factors are effective on degradation. The significance of agricultural sector which has a crucial role in development of countries and societies had been increasing as a result of globalized economic system, competition environment and rapidly changing market conditions.The necessity for convenient use of soil, rises due to the population increase. Therefore erosion researches are important researches for sustainable agriculture.Turkey has very important geopolitical status. Turkey considerate extensive coastlines on the Aegean and the Black Sea and the Mediterranean.The geographic status provides watercourses and ecological diversity.

2.Methods

Environmental issues have been priority issues for both developed and developing countries' sustainable development. Environmental issues has been rather important topics and given priority in the public agenda of both developed and developing countries.Agriculture of developed countries has highly industrialized. This leads to a lot of problems on environment such as soil degradation, pesticide pollution etc.It is a fact that in developed countries highly industrialized agriculture based on intensive input use creates a lot of problems on environment such as soil degradation, pesticide pollution etc.Rural-urban migration began with the shrinking of agricultural areas and the lack of food supplies, the pollution and reduction of water sources, the deterioration of the quality of fields and the decline of livestock farming.

Industrialisation saw the earth's climate begin to undergo changes caused by the gasses released into the atmosphere, and extreme weather conditions, droughts, floods and avalanches started to occur.Thus, degradation of environmental resources has the potential for being more highly destructive of productive assets in developing countries.In industrial countries, environmental quality issues hinge primarily on matters of human health and the aesthetic quality of the environment.In developing countries, on the other hand, environmental issues are related to human health and productivity and also to the degradation of the future productivity of the natural resource base on which many people are directly dependent.

3.Results and Conclusions

Agriculture, economy and environment has to be researched as comlementary issues in academic studies.The basic principle of sustainable agricultural production and natural resources is to utilize lands based on their current potentials. Therefore, the present soil sources should be determined firstly.

Geographic Information Systems should be used effectively and successfully by academics, scientists and researchers.Additionally, the characteristics and problems of soil series should used determine and problem solutions should be used recommend.

Inappropriate use of agricultural lands and erosion threat these important agricultural centers.Factors such as the area of the land, ecological conditions, the agricultural technique used, the crops grown and the yield power of the soil are the issues to be considered together with the land assets of the enterprise.We can give an example of a 4 ha land which is located in the Mediterranean seaside belt and has high market value.This land is more valuable than the 30 hectare dry land located in Eastern Anatolia and Central Anatolia Region.

Recently, organic agriculture has developed rapidly in the world and global organic food market has been growing.Therefore, demand is increasing in organic agriculture. Most of the current organic production is exported mainly to the EU countries and the domestic market has been growing(Table 1). Although, Turkey has suitable ecologic conditions and export potential for organic production, the share of Turkish organic products in the world market is significantly low.

Table.1 Development of Turkey's Organic Product Exports

Years	Price (FOD,$)
1998	15,879,571
1999	19,370,599
2000	22,756,297
2001	24,563,892
2002	26,230,259
2003	27,242,407
2004	27,260,473
2005	27,504,928
2006	28,236,617
2007	29,359,321
2008	30,877,140
2009	33,076,319
2010	36,932,955

Bibliography:TÜGEM

The methods such as good agricultural practices in Turkey (GAP) should be used in sustainable agriculture. The methods should be used for soils. Therefore, soils will not have lost its naturalness.In this aspect, by avoiding the use of unnatural inputs like chemicals or synthetical fertilizers; preferring the organic agriculture technics (methods) for quality, health and environmental standards will be key factor. Organic agriculture has become more important in terms of the application of sustainable agriculture in to practice. By developing the environment consciousness, organic agriculture become a necessity.The methods such as good agricultural practices in Turkey (GAP) should be used in sustainable agriculture. The methods should be used for soils. Therefore, soils will not have lost its naturalness.

These kind of applications such as use of unnatural inputs like chemicals or synthetical fertilizers cause a vital danger infecting on human-beings and in fact all living organisms through food linkage.The development of the main issues affecting the organic agriculture for Turkey should be presented.Good agricultural practices in Turkey (GAP) should be identify.Good agricultural practices in the basic principle of sustainable agricultural production and natural resources is to utilize lands based on their current potentials.Turkey should be presented recommendations for developing.Alternative sectors should be presented in order to solve problems, improve policy programmes.Soils current potentials should be utilized to sustainable agricultural production.Therefore, the determination of the existing soil resources should be done first.Today's changing economic competitive conditions expose constraints for obstacle of sustainable development such as“Transgenic Organisms” (GMO).Sustainable development represents a structure which tries to solve the problems of modern economic development that are linked each other such as ecological destruction, social inequality and ignorance of future generation.It is possible to say that the contribution of the firms in the formation of these problems is very high.Today's changing competitive conditions exposed that; there should be a parallel structure between company's business and the company's efforts to be sustainable.Considering these situations, state policies should be developed and academic studies should be continued.The important thing is that; the preventive actions should be identified , solutions should be found and taken in progress to solve the problems.

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Unlocking the Potential and Opportunities for LDN Integration in Lebanon

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Scope 1: Data-driven land management and planning for successful LDN transformation process: Perspectives from Lebanon

The Land Degradation Neutrality concept (LDN) has undoubtedly transformed the notion of land degradation and its treatment measures, and has emerged as one of the most effective means for facing land degradation thereby accelerating the implementation of the UN 2030 SDGs. However, the need to shift LDN from its theoretical to its operational aspect has also raised the need for several transformational processes within. As highlighted by the UNCCD, successful LDN implementation is controlled by many factors of which data quality and availability play a significant governing role. The availability of accurate continuously representative data is needed to have proper LDN implementation by providing the building-block for the LDN indicators which in turn allow the establishment of baseline conditions for comparison and subsequent monitoring and reporting. Thus, the power of data to inform and improve processes, gives it the potential to re-orient the decision making process in what is known as Data-Driven Decision Making (DDDM). However the presence of powerful data alone is not enough for achieving DDDM for LDN implementation, but instead requires a comprehensive linking framework in order to develop adequate strategies and action plans for a concrete application of the LDN concept. In Lebanon one of the East Mediterranean countries, LDN is still in its early stages, and the process of DDDM is contested by the lack of land planning, restraints and regulations despite the presence of fine scale up-to-date data and information. A prominent national land use land cover (LU/LC) time series, a rigid soil database, a national land capability classification map and a comprehensive soil organic C map for LDN implementation exist, but little approaches have been implemented at the national scale. DDDM for LDN in Lebanon can be achieved by compiling the existing datasets, namely the national land capability classification (LCC) map following the USDA's classification, the national LU/LC and soil maps. The combination of these layers allows a successful implementation of the LDN concept through sustainable land planning as highlighted by the UNCCD. The LCC layer provides a concise understanding of land productivity by revealing the productive capacity of the Lebanese soils thus allowing the establishment of a proper understanding regarding their ecosystem functions and services. Based on the latter, a broad option for adequate land cover based on land suitability can be made available to land planners. Further, interrelating related geospatial data under Geospatial Environments allows to shed light on land loss hotspots, nature, type and extent of mismanagements and inadequate land occupation that led to land degradation. Through dataset coupling, a land degradation mapping and a decision making tool is obtained, thus putting the LDN concept into practice by promoting sustainability through land use planning obtained from data-driven land management in response to the UNCCD's LDN transformation checklist.

Scope 2: Integrated planning approaches for sustainable use of land/soil resources: Perspectives from

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Lebanon

Land occupation changes in Lebanon are mostly translated under the form of urban development at the expense of agriculture, forests, grasslands and natural resources. In addition to increasing urbanization under a situation of lack in planning restraints and regulations, landscape unsustainable evolution has further aggravated due to continuous war episodes, intensive internal displacement and lack of political stability. Concerning land planning, despite the existence of protection and zoning legislations, random land dynamics are observed thus raising the need to review or reconsider existing regulations. Globally, under a context of complex geopolitical and demographic pressures, a state of increasing unsustainable land use and land cover distribution in the country is observed. This state has led to a significant pressure on natural resources, particularly on soil that has become subjected to intensive soil erosion and mismanagement that may have led to a regression in Lebanese soils' quality and productivity. Consequently, integrated planning approaches for sustainable management and use of the land/soil resource are urgently needed in Lebanon. For that purpose, land use-planning or even land resource planning are central points of focus for promoting sustainability at this state. In order to achieve proper integrated land planning, suitable representative tools must be presented for decision makers for a participatory approach not only addressing current conditions, but also extending further towards building future resilient ecosystems. By implementation of appropriate land use planning based on soil capability and land suitability, a comprehensive plan for selection and zoning based on placing land occupation classes of mutual beneficence in proximity to each other and accounting for the trade-off between sustainable conservation and population needs can be achieved. Therefore, a clear understating of soil capacity is needed to provide insights regarding land planning decisions. Further, through identification of the different levels of land suitability, the potential to prospect adequate corrective and preventive measures for ensuring soil continuity and sustainability can also be tackled. Such a step is considered crucial for successful LDN implementation given the integral role the UNCCD confined land planning for the application of the LDN concept. Despite its importance, land use planning is often contested by several factors in Lebanon namely land tenure, rights, regulations, urban planning, markets and the socio-economic difference between rural and urban contexts. Therefore, a participatory approach englobing legislative, economic, scientific and local backgrounds is needed to account for the several governing factors associated with proper land use planning in order to promote the sustainable continuity and ecosystem services of Lebanese soil resources.

Scope 3: Towards the transformation of the Lebanese agricultural sector for LDN

As a result of rich and diverse agro-ecosystems, pedo-climatic conditions and abundance of water resources, Lebanon is characterized by an extensively diversified agricultural sector that covers more than 60 percent of its territory, making it an exception within its surrounding. However, throughout the years, land degradation has severely affected the Lebanese agricultural sector. National studies show that 40 percent of the country is under risk of desertification, 60 percent under land degradation; in addition, 7 and 15 percent of arable and irrigated lands have been lost, and soil erosion rates have significantly surpassed those of Mediterranean climate pedogenesis. Recent reports show that due to soil erosion and land degradation alone, the Lebanese agricultural sector forming 3 percent of Lebanon's Gross Domestic Product (GDP) (US$47.537 billion) suffers from a 74 million US$ loss/year, thus extending from an environmental constraint to an economic loss. Such losses are further exacerbated by uncontrolled land occupation dynamics and inherited traditional soil management and farming practices. In order to cope with this problem, in the hope of achieving the related 2030 sustainable development goals (SDG), the country is in need of implementing LDN particularly with respect to the SDG2 aiming to ensure food security and promote sustainable agriculture and SDG6 to ensure the sustainable management of water resources. The Lebanese government has already pledged through the

Ministry of Agriculture (MoA) to adopt official voluntary LDN targets for the year 2030 through improving land productivity and soil organic C stocks along with improving landscape mosaic and limiting land use/cover conversion. Furthermore, the Lebanese Ministry of Environment in turn has set two targets for enhancing the agricultural sector by 2030, by promoting sustainable practices and use for agriculture. An additional MoA strategy for the year 2015-2019 for ensuring sustainable management and use of natural resources, lists several courses of action that include improving the governance and sustainable use of natural resources, in addition to responding to climate change impacts, that can indirectly be linked to successful LDN transformation. Despite the attempts for ensuring the integration of LDN into the Lebanese agricultural sector and the extensive efforts of the Lebanese MoA and FAO cooperation, the listed targets are still aspirational and are in their embryonic stages of implementation mainly due to problems arising from difference in points of view of farmers regarding conservational versus modern practices, productive land availability, land tenureship and lack of agricultural system crediting. Accordingly, no concrete or significant indicator for LDN assessment is presented particularly those concerning proper knowledge of soil properties and reporting sustainability. Nevertheless, the presence of a prominent National Database, and the ongoing agricultural oriented land planning projects may be the solution for promoting soil conservation, correcting soil properties, integrating conservation agriculture, practices and climate adapted species for shifting the Lebanese agricultural sector towards LDN goals of promoting food security.

In conclusion to the three presented scopes, application of LDN in Lebanon is no longer an option, but rather a necessity in order to safeguard its land resources and to address land degradation as one of its most stressing geo-environmental threats. A rapid LDN implementation is no longer an environmental need only, but has extended further to become an economic necessity since the costs of land degradation in the country have become much higher than those needed to prevent it. By integration of LDN through the discussed scopes, a short term neutral anthropogenic impact on land is sought as a precursor for an aspirational positive human impact on lands at the long term in an aim to promote the sustainable development of the country.

Recent Drought Assessment of Interannual Rainfall of Gadag District, Karnataka India

Stasha K BALKISSOON[1], P.L. PATIL[2]

Abstract

India is an agrarian nation which depends heavily on rainfall and in Karnataka state 64% of agriculture is rainfed with area covering 11,400,000 hectares (KSA,2015). During the period of 2009-2016, there were 3 recorded droughts which resulted in crop failure and loss of farmers income. Drought occurrence in the south western state is due to the mild monsoon or decline in the monsoon rains. Gadag District is part of a physiographic area of the Deccan Plateau which has a recent 8- year average of 569.7mm of rainfall and is classified as a semi-arid region. This paper intends to investigate the interannual rainfall distribution of the recent drought years and compare drought years to a normal year using daily rain gauge rainfall data from 10 stations across Gadag District. During the monsoon months (June -September) there is a notable decline in the monthly contribution to the annual precipitation whereby in drought months consisting of on average 58 % contribution of monsoon rains towards annual rainfall while in the normal year there is around 72 % contribution to annual rainfall resulting in average 8 % decline in monsoon rainfall contribution in drought years for the ten rain gauged stations. Lakshewar and Ron rain stations shows the greatest decline of 21% and 14% respectively while Betagei shows the lowest decline of 2.34%. For the month of June all stations indicated a decline in monthly rainfall although there is no visible trend in number of rainy days. For example, interestingly some stations number of rainy days increases during the drought period as compared to the rainy period in June. However, September shows a visible trend of increased rainy days for normal year as compared to the drought year. A typical drought year showed a decline in the primary peak in the bimodal interannual rainfall pattern. Also, within Gadag District the rainfall pattern follows the bi modal rainfall but the number of rainy days differ for each station that is rainy days is station dependent while the monthly rainfall is more readily predictable variable among stations.

Keywords: Drought, semi-arid, rainfall pattern

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Salinity Problems of Agricultural Land in Turkey

Veysi AKŞAHİN[1], İbrahim ORTAŞ[1]

Abstract

The increasing human population in the world brings with it a number of problems. One of these problems is the demand for adequate and healthy food. In order to fulfill this demand, mankind is implementing an intensive agricultural strategıes. The maincomponent in agriculture is the plant and the plant has a number of necessessıttıes. In agriculture, mankind unconsciously ırrıgateland excessıvely to suck up more crops whıch has severe consequences such as salinization and formation of barren soils.

Soil salinity is mostly seen in irrigated lands. Salinity occurs when the ground water approaches the soil surface in hot and low rainfall areas. Under normal conditions, plants need salt to grow. However, it causes damage to plants when excess salt accumulates in the soil. Barley, cotton and wheat complete their growth without any damage from moderate salt. However, vegetables, fruits and some other field crops suffer yield losses even from light salt in the soil. Salt-resistant barley, wheat and cotton crops also decrease yields with increasing salinity intensity.

Excess salt damages the plant cells and prevents the water intake from the soil. In addition, no cultivated plant grows in alkaline lands because the whole structure of the soil is degraded.

Salinity is one of the important problems that reduce plant diversity and agricultural productivity in our country as well as in the world. Especially in arid and semi-arid climate regions, inadequate rainfall and high evaporation, insufficient drainage, agricultural processes and soil properties are the main causes of salinity and affect large areas.

Turkey is also present in semi-arid regions, irrigation unconsciously due to be held in Turkey

The formation of saline soils is increasing especially in Harran plain, Konya plain and Iğdır plains. Nowadays, these increasing saline soils restrict the cultivation of agriculture and cause fertile soils to replace inefficient and dry soils. The Iğdır Plain is located in the semi-arid climate zone and 1/3 of the total usable areas are affected by salinization and only 24.194 hectares of land can be cultivated (Temel and Şimşek, 2011).

Especially in arid and semi-arid regions, about half of the irrigated lands have various levels of salinity problem in approximately 2% of our country's land and 4% of agricultural land. Good protection of limited resources and especially agricultural lands is a necessity against the geometrically increasing world population The distribution of barren soils in Turkey has reached 264958 ha Area and this constitutes 17% of the problematic areas (Karaoğlu and Yalçın, 2018). Also in Turkey, there are problems of salinity and alkalinity of about 1.5 million hectares. This corresponds to approximately 32.5% of the land suitable for irrigation (Kanber et al., 2005).

Keywords: Irrigation, salinity, semi-arid

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Land Degradation Neutrality from Local to Global Scale: Research Activities in Ankara University, Turkey

Selen DEVIREN SAYGIN[1]

One of the most important threats to Sustainable Soil Management (SSM) and land degradation is soil erosion. Especially in our part of the Globe, degradation due to the soil erosion on soil ecosystem functions and services has been a serious problem and it seems will be so after the outcomes of substantial assessments on worldwide soil and land degradations by Global Soil Partnership (GSP), United Nation Convention to Combat Desertification (UNCCD), United Nation Climate Change (UNCC) and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in respect to the food security.

Similarly, Sustainable Development Goals (SDGs) aim to achieve a better and more sustainable future for all by maintaining and restoring land resources. In this way, combating climate change, conserving biodiversity and maintaining crucial ecosystem services can be achived by investing in the future of the land.

I am here today as the representative of my university. I would like to briefly talk about some of the work that I and my team members have done in the last 15 years regarding soil and land degradation processes at the parcel, regional and national scales.

In this time span, we have carried out several research projects on the prediction of soil losses, evaluation of dam life, investigation of the effects of land use changes on soil erodibility by RUSLE model, national-scale rainfall erosivity estimation with RUSLE, and wind erosion risk assessment by WEPS model, sediment trap efficiency analyses for wind erosion measurements, sediment- supported organic material transport, eroded sediment size modeling, process-based soil erodibility estimation with WEPP model, mechanical soil cohesion measurements and its relationships with other water erosion processes.

Each of these studies has brought new research and projects with it to be applied on a larger scales. For example, after RUSLE projects we have chance to make collaborations with General Directorate of Combating Desertification and Erosion (CEM) for the applicability of the RUSLE model at the national scale and the water erosion risk map was produced for Turkey. Similarly, the national wind erosion risk assessment was conducted by CEM with the scientific support provided by our team and a national wind erosion risk map was prepared. Herewith, Turkey is getting well-prepared taking key steps towards preventing erosion processes in order to sustainably manage soil resources. At this point, I would like to express my thanks on behalf of my team to the valuable CEM employees who contributed to the organization of these important works on behalf of our country.

Conclusively, there is a close relation between ecosystem functions and the sustainability of natural resources based on the conservation-utilization balance. At this point, the reliability of the methods, models and approaches applied in the management of natural resources is extremely important. For this reason, the studies that are planned to be conducted in the future periods require the formation of new researches in order to validate the models / methods and approaches for our arid and semi-arid country conditions. And researches on these issues are continuing within our team.

It's been a pleasure being with all of you today, thank you.

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A Research on the Alfalfa Varieties with Resistant Leguminous Fodder Plant Growing in Vineyard Areas with Boron Toxicity

Fulya KUŞTUTAN[1], Fadime ATEŞ[2], Özen MERKEN[3], Ebru TOPRAK ÖZCAN[4]

Abstract

Our country is located in the most favorable climate zone of the world in terms of viticulture and at the intersection of gene centers of the vine. Vine is one of the oldest fruit species in the world. It shows that high boron levels cause significant deficiencies in physiological, quality and yield of plants. Alfalfa variety is a perennial plant, in particular it is resistant to boron toxicity, it can be planted as a green manure or a soil breeding plant and its roots are very deep. Due to the fact that it is highly tolerant to boron, it is aimed that the grapevine is affected at least from the boron toxicity. This study was carried out to determine the effect of boron on the reduction of intake by the vine, the effects of the blessing alfalfa variety on the reactions to boron toxicity. As a result of the study, it was found that the capacity of the alfalfa variety was high.

Keywords: Vineyard, alfalfa, boron, fodder plant, toxicity

1. Introduction

Our country is located in the most favorable climate zone of the world in terms of viticulture and at the intersection of gene centers of the vine. At the same time, our country is in the geography where the vine was first cultured (Oraman 1970, Mullins et al. 1992, Çelik et al. 1998).

Grape is among the most sensitive plants against boron toxicity according to other fruit species. When the level of boron in the soil exceeds 1 ppm, signs of mild toxicity start in vines, and when the concentration exceeds 4 ppm, signs of severe toxicity appear. The presence of high levels of boron in irrigation water or soil causes product losses due to boron toxicity. According to the World Agriculture Organization (FAO), the use of water with more than 1 ppm boron content in irrigation can cause problems in plants and soils. Our country is the center of the alfalfa gene and reported that 3300 years ago the oldest recorded information is used as a fodder crop alfalfa in Turkey (Hanson et al., 1988).

The clover, which is called the queen of forage crops, is distinguished from other forage crops due to its high adaptability, a long-lasting, high yielding, high nutritional value, and grazing of some varieties in a vegetation cycle.

Turkey mostly alfalfa naturally seen and agriculture is increasing in every region in recent years. In addition to the existing clover varieties, it is necessary to investigate and adapt the new varieties suitable for our country and region, and it is also important in the determination of pasture-type clovers that can be used in the breeding of the region pastures (Kır and Soya, 2008).

Alfalfa (*Medicago sativa* L.) is a feed plant that gives a wide adaptability and is used in many different ways. Alfalfa is a plant with a pile root system that can be drilled deep in the soil. But there is usually little branching

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in the roots. Under appropriate conditions, the root length of the plant is 8-10 m. The effective root depth of the alfalfa is 1,2-1,8 m. The root thickness of the plant is about 2,0-2,5 cm.

Boron toxicity is a nutritional problem that limits plant breeding in the agricultural lands of arid and semi-arid regions around the world (Cartwright et al., 1986). Boron toxicity can occur naturally in soils, especially in the case of high boron containing waters (Nable et al. 1997), or as a result of the use of compost fertilizers or in the case of cultivation around thermal power plants using lignite coal. In addition, boron levels in salty and sodic soils may be toxic to plants (Bergmann 1992; Marschner 1995).

The effect of boron on the reduction of intake by the vine, the effects of alfalfa fodder crop on boron toxicity and the effect of alfalfa growth on the nutritional balance of vine plant were made in the land conditions.

2. Methodology

The study was carried out between the years of 2017-2018 in the vineyard with a high-wire finishing system, irrigated with 10 year old vine in the age of yield of Sultani seedless grape varieties at the producers land in the Alaşehir district of Manisa. Sultani seedless grape variety (*Vitis vinifera* L.) and clover variety (*Medicago sativa* L.) were used in the study. Sultani is the most common variety used in the production of raisins and is also consumed fresh. According to preliminary observations, the plantation of the grape plantation at the research site was as follows; Alfalfa seed was used as trial material. Alfalfa seeds were obtained from the agricultural dealer in Manisa province.

3. Results and Conclusion

Table 1. Analysis of variance values.

Uygulama	2017 Flowering Period Vine Leaf Boron Content (ppm)	2018 Flowering Period Vine Leaf Boron Content (ppm)	2017 Alfalfa Boron Content (ppm)	2018 Alfalfa Boron Content (ppm)
1	170b	113bc	123ab	110b
2	152bc	140ab	105b	137ab
3	120b	90c	142a	155ab
4	149bc	113bc	112ab	181a

$p < 0.01$ level is important

As a result of this study, it is a very important development of alfalfa which is applied to Sultani seedless grape varieties which has important economic value for our region. It was concluded that their use in the control of weeds is possible and weed exits during this trial. In addition, clover as a green manure or soil improvement plant in the yield and quality of grapes are expected to provide positive contributions.

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Determination of Kocakır Forests (Eskişehir) Some Soil Properties and Soil Mapping

Nejat ÇELİK[1], Hakan D.DURMUŞ[2]

Abstract

In Turkey, investigation and mapping of the soil was started in 1952 by aid of FAO. So, the first soil map of Turkey with 1/800.000 scale was prepared. Kocakır Forests are one of the application forests of Eskişehir Forest Soil and Ecology Research Institute. In this area will be (nearly 2000 ha) determined.

The Project will contain tree stages: preliminary studies including collection of basic data (I), implementing of survey and collecting other data relating with qualitative variables (II), evaluating of results and preparing of reports (III).

For those purposes, totally 198 sample plots will be taken from the study area. Project has been applied on total 100 sample areas. Species of tree sand shrubs on each the sample area were identified with their height and diameter measurements. Soil samples were taken from horizons of the soil profiles. A soil pit will be dug in each sample plot and some soil characteristics, like soil horizons, soil depth, stoniness, structure, root density, moisture conditions in the soil, main rock, will be determined. Soil samples will be taken from the horizons by using 1 liter soil core sand analyzed for texture, pH, total carbonates, organic matter in the laboratory.

All the dataobtainedfromgraphs, tablesandmapsarerelatedtoeachothers. Topography of the region affects the local climate, vegetation and soil characteristics. Furthermore, the parent materials that constitute from the geological structure play an important role on the distribution of vegetation.

Project team will accomplish the study in 48 months with a Project leader and two researchers. Proposed Project budget is 45.750 Turkish Liras. This Project will provide useful tools for forest planner sand forest manager sand scientists interested in forest soil map and multi-functional forest planning. Also it will be an original study in Turkish scientific literature.

Keywords: Eskişehir, Kocakır, researchforest, soil, site, classification

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Changes in Some Soil Properties of Hazelnut Orchard Soils with Fertilization

Rıdvan KIZILKAYA[1], Coşkun GÜLSER, Caner GÖKÇE, Abdurrahman AY

Abstract

The aim of this study was to determine the effects of the alkaline characterized fertilizer (19:10:10) produced for hazelnut plant on some soil properties of hazelnut orchards located on different topographic positions in Ordu and Giresun provinces of Turkey. The fertilization from soil was made for 40 hazelnut ocak (a bunch of about 12-14 hazelnut bushes) in each orchard. The fertilizer was applied to soil surface as 1 kg per hazelnut ocak at the end of February and 0.75 kg per ocak at the end of May 2018 at 25 different orchards. Surface soil samples (0-20 cm) were taken at the beginning of the field studies before soil fertilization (February, 2018) and the after harvesting (September, 2018) from the orchards. According to the soil test results, the most of the soil samples was in fine textural class. The mean values of pH, EC OM content in soil samples increased from 5.99 to 6.20, from 0.192 to 0.327 dS/m, and from 4.30 to 5.12% by the fertilization, respectively. The mean available P_2O_5 content of the soil samples increased from 4.01 ppm to 6.02 ppm by the fertilization. The mean values of exchangeable K, Ca and Mg contents in the soil samples also increased from 0.61 to 0.86 cmol/kg, from 18.55 to 18.74 cmol/kg and from 13.63 to 17.00 cmol/kg by the fertilization. It can be concluded that using alkaline characterized fertilizer in hazelnut orchards improved soil chemical properties with increasing nutrient contents and regulating the soil pH. Therefore, alkaline characterized fertilizers should be used in acidic soils of the hazelnut orchards located on the Black Sea Region of Turkey.

Key words: Hazelnut, fertilization, soil pH, organic matter, nutrients

1. Introduction

Hazelnut easily grows in the northern part of Turkey until 750-1000 m altitude. According to the current data, hazelnut production area in the world is 950 thousand hectares and 700 thousand hectares (about 75%) of this land is in Turkey. Turkey is the biggest hazelnut producer in the world with approximately 600 thousand tons of hazelnut production (Anonymous, 2018). Hazelnut growing areas in Turkey is divided into three groups as follows; 1st region Ordu, Giresun, Trabzon, Rize and Artvin provinces, 2nd region Samsun, Sinop, Kastamonu, Zonguldak, Bolu, Düzce, Bartin, Sakarya and 3rd region covers other 25 provinces mainly Istanbul and Bursa (Anonymous, 2017). The majority of hazelnut farming in Turkey is made in the Eastern Black Sea region. Because of the general structure of the region is hilly and abundant rainfall, does not suitable for the cultivation of other crops. Hazelnut agriculture due to vegetative characteristics of the region to prevent erosion of the soil and has a very important economic value (Ünal et al., 2010). Hazelnut is a culture plant with fringe roots, although the roots do not go too deep, they can reach up to 80 cm depth on sloping land. The plant is not selective for soil request, but the soils having rich nutrients, loamy-humus structure with a pH of about 6, and deep soil profile are suitable for hazelnut growth (Karadeniz et al., 2008). The Central and Eastern Black Sea Region of Turkey (I. Standard Region) has an average production capacity of 70% in the hazelnut cultivation (Anonymous, 2014). Major problems of hazelnut cultivation in Ordu and Giresun provinces are generally

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hazelnut orchards are old and the mistakes made in the pruning process and fertilization practices. Generally the most important point in hazelnut growth, effective fertilization practices based on the soil analyses are not applied by the farmers in the region. This is very important subject in terms of the economic aspect of hazelnut production and the sustainable agricultural management. In recent years, production of plant-specific fertilizers and fertilizer consumption in Turkey has shown a great increase. However, this increase has not been reflected much in efficiency and has been left behind as yield in many countries (Şahin, 2016). Turkey has a significant place in the world with a high value-added production of hazelnut. Although it is wrong to expect an increase in productivity with only fertilization, it is still one of the most effective applications. This study was carried out to determine the effects of alkaline characterized fertilizer application on some soil properties of hazelnut orchards located on different topographic positions in Ordu and Giresun provinces of Turkey.

2. Material and Method

This study was carried out in 25 hazelnut orchards located at Ordu and Giresun provinces, Turkey. Forty ocak (a bunch of about 12-14 hazelnut bushes) are marked from each hazelnut orchard and the alkaline characterized fertilizer (19:10:10) was applied to soil surface as 1 kg per hazelnut ocak at the end of February and 0.75 kg per ocak at the end of May 2018. Surface soil samples (0-20 cm) were taken at the beginning of the field studies before soil fertilization (February, 2018) and the after harvesting (September, 2018) from the orchards. After the soil samples were air dried, they were sieved by 2 mm sieve and prepared for physical and chemical analyzes.

Soil samples were analyzed for sand, clay and silt contents by hydrometer method (Demiralay, 1993); soil reaction (pH) 1: 1 soil-water solution with pH meter, electrical conductivity (EC) values measured in the same solution with EC meter (Richards, 1954). Soil organic matter content was determined by the modified Walkley-Black method (Nelson and Sommers, 1982). Exchangeable cations (K, Na, Ca and Mg) of soil samples were determined by extracting soil samples with 1 N ammonium acetate (pH = 7.0) solution (Kacar, 1994). According to the pH of soil samples, phosphorus analysis was performed by either Bray Kurtz (1945) or Olsen method (Olsen et al., 1954). The lime content ($CaCO_3$) was measured by Scheibler Calcimeter method (Nelson, 1982).

3. Results and Conclusion

According to the soil test results, descriptive statistics for the changes in soil properties at 25 hazelnut orchards are given in Table 1. Clay contents of the orchard soils varied between 12.14% and 59.61% with a mean of 30.78%. The most of the soil samples was in fine textural class.

The mean pH values increased from 5.99 in control samples to 6.20 by the fertilization (Table 1). According to the soil survey staff (1993), the pH values of the 25 control soil samples were classified as 8% in very strong acid, 16% in strongly acid, 36% in moderately acid, 20% in slightly acid, 12% in neutral and 8% in slightly alkaline. After fertilization, soil pH values generally increased and were classified as 4% in very strongly acid, 40% in moderately acid, 36% in slightly acid, 16% in neutral and 8% in slightly alkaline. Although there was a slight change (2.7%) in mean pH values after fertilization over the control (Figure 1B), fertilization changed the most of soil pH classes from very strongly acid and strongly acid to moderately acid and slightly acid classes. The mean EC values increased from 0.192 dS/m in control samples to 0.327 dS/m in the soils sampled after the fertilization (Table 1). Although there was a high increase (69.8%) in mean EC values after fertilization over the control (Figure 1B), EC values of the soil samples were less than 2 dS/m and classified as non-saline (Soil Survey Staff, 1993).

Fertilization treatment increased mean soil organic matter content from 4.31% in control to 5.12% (Table 1) with a rate of 19% (Figure 1A). The soil OM contents of the hazelnut orchards were lower than 2%, classified as low in 8 samples (32%), and higher than 4% classified as high in 12 samples (48%). After fertilization, OM content of soils increased in the orchards. Soil OM classification changed as low in 4 samples (16%) and high in 16 samples (64%).

Table 1. Descriptive statistics of the soil properties before (C-control) and after fertilization (F).

Soil properties	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Clay, %	12.14	59.61	30.78	12.71	0.71	0.42
Silt, %	15.78	79.78	46.22	16.06	0.10	-0.06
Sand, %	8.09	33.68	23.00	7.02	-0.68	-0.33
C-pH (1:1)	4.80	7.78	5.99	0.76	0.67	0.15
F-pH (1:1)	4.56	7.89	6.20	0.70	0.43	1.48
C-EC, dS/m	0.04	0.41	0.19	0.10	0.26	-0.78
F-EC, dS/m	0.03	0.87	0.33	0.19	0.94	1.50
C-OM, %	1.62	8.30	4.31	1.78	0.50	-0.72
F-OM, %	1.68	10.50	5.12	2.10	0.63	0.27
C-N, %	0.18	0.40	0.29	0.06	-0.15	-0.32
F-N, %	0.27	0.64	0.40	0.10	0.86	0.34
C-P, mg/kg	1.11	11.24	4.02	2.94	1.04	0.14
F-P, mg/kg	2.03	18.00	6.03	4.10	1.31	1.47
C-K, cmol/kg	0.08	1.42	0.61	0.41	0.88	-0.40
F-K, cmol/kg	0.14	2.35	0.86	0.53	1.20	1.81
C-Ca, cmol/kg	1.88	38.25	18.56	10.38	0.28	-0.54
F-Ca, cmol/kg	3.06	47.13	18.74	9.48	0.93	2.13
C-Mg, cmol/kg	1.64	40.88	13.64	12.42	0.92	-0.56
F-Mg, cmol/kg	0.39	46.95	17.01	13.58	0.71	-0.71
C-Na, cmol/kg	0.29	1.52	0.71	0.30	0.90	0.73
F-Na, cmol/kg	0.21	3.05	0.59	0.55	4.01	18.21
C-$CaCO_3$, %	0.62	25.54	2.71	4.80	4.85	23.93
F-$CaCO_3$, %	1.41	51.98	6.58	12.67	3.27	9.75

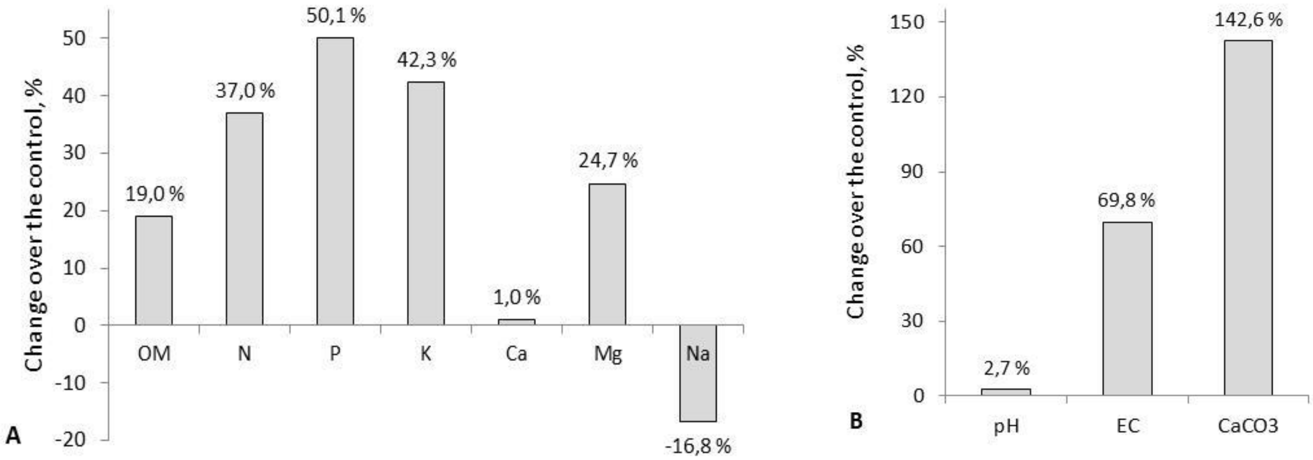

Figure 1. Percentage changes in mean values of soil properties after fertilization over the control.

Total N and P content in the hazelnut orchard soils also increased by the fertilization. The mean values of total N and P contents increased from 0.29% to 0.40% and from 4.02 mg/kg to 6.03 mg/kg, respectively (Table 1). Increments in the mean value of total N and P contents by the fertilization over the control treatments were found as 37.0% and 50.1%, respectively (Figure 1A). Total nitrogen contents of the soils were generally higher than 0.25% and classified as high (Hazelton and Murphy, 2007). While the P contents in non-fertilized soils were lower than 10 mg/kg classified as low, the P contents in fertilized soils were classified as low in 72%, moderate in 25% and high in 3% of the soils (Hazelton and Murphy, 2007).

After the fertilization, the mean values of exchangeable K, Ca and Mg contents in the hazelnut orchard soils increased from 0.61 to 0.86 cmol/kg, from 18.55 to 18.74 cmol/kg and from 13.63 to 17.00 cmol/kg while the mean value of exchangeable Na content decreased 0.70 to 0.59 cmol/kg (Table 1). Increments in the mean value of K, Mg and Ca contents by the fertilization over the control treatments were found as 42.3%, 24.7% and 1.0%, respectively (Figure 1A). The K contents of the control soil samples (68%) lower than 0.7 cmol/kg were classified as moderate, after fertilization the K contents of soils (56%) higher than this limit value were classified as high (Hazelton and Murphy, 2007). Soil Ca and Mg contents in 21 samples (84%) of the hazelnut orchards were higher than 10 cmol/kg and 3 cmol/kg, respectively, and classified as high for both cations (Hazelton and Murphy, 2007).

Fertilization treatment increased mean $CaCO_3$ content from 2.71% in control to 6.58% (Table 1) with a rate of 142.6% (Figure 1B). Generally lime contents of the soil samples taken from hazelnut orchards were lower than 5% and classified as low. After the fertilization, lime contents of the orchard soils increased and the lime content of 20% samples were found higher than 5% and classified as moderate.

As a result, fertilizer application in hazelnut orchards located in Ordu and Giresun Provinces generally increased soil OM, total N, P, exch. K, Mg and Ca contents and decreased exch. Na content. It can be concluded that using alkaline characterized fertilizer in the hazelnut orchards helps to improve soil physical and chemical properties due to increasing OM, nutrient contents and regulating the acidic soil pH. Therefore, alkaline characterized fertilizers can be suggested to use in acidic soils of the hazelnut orchards located on the Black Sea Region of Turkey.

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THEME 9:
Sustainable Soil and Land Management (FAO Session)

Importance of Integrated Land use Planning for LDN: An Overview of FAO-Turkey Technical Cooperation

Hakkı Emrah ERDOGAN[1], Soledad BASDIDAS[1], Bulent GÜLÇUBUK[1], Yi PENG[1], Sara Marjani ZADEH[1]

Abstract

On the remaining land, users with different socioeconomic status and power compete to achieve food security, economic growth, energy supply, nature conservation and other objectives. Therefore, the land demands for cropping, grazing, forestry, wildlife, infrastructure, outdoor recreation, landscape as well as industrial and urban development are greater than the land resources available. Integrated land use planning is an important tool to find a balance among these different demands and assure agricultural production, while conserving the natural environment. Many countries are recognizing the need for a more integrated approach, making the connection between spatial planning, land degradation, biodiversity and climate change. However, this nexus is not yet reflected in spatial planning regulations or policy. Therefore, the UNCCD Conceptual Framework encouraged to the ILUP and highlighted that land neutrality needs to be maintained over time; through land use planning that anticipates losses and plans gains. In Turkey, The Ministry of Agriculture and Forest (MAF) is responsible to find balance into the competition of different land uses while improving national agricultural production with considering environmental protection and SDGs. Thus, they effort to develop policies and implementation tools for sustainable use of land resources. The General Directorate of Agrarian Reform (DGAR) is primarily responsible for the coordination and management of agricultural land resources and provide infrastructure services as an operational arm. In this regard, DGAR has conducted Land-Use Planning Program (LUPP) in agricultural landscape since 2012. However, the MAF`s LUPP considered only the biophysical criteria (soil, climate, topography) focusing to environmental constrains for food production. The competition between different land use and socio-economic drivers of land degradation come up a strong need to expand LUPP scope by considering the socio-economic parameters, adding a multi-stakeholder engagement process, capacity development program for small-scale farmers, establishing link with rural development policies, and integrating women's economic empowerment considering ecosystem management, environmental protection and climate change resilience. Within this regards, the FAO and MAF have developed a Technical Cooperation Project on Integrated Land Use Planning (ILUP) for food security by enhancing climate resilience and ecosystem management. The overall objective is to develop an ILUP approach through capacity development of relevant institutions, to establish stakeholder engagement process, and to strengthen the relevant land information infrastructure in a cost-effective way.

Keywords: Land Degradation Neutrality, Land Use Planning, SDGs, Clímate Change and Biodiversity

[1] Food and Agriculture Organization of United Nation

Enhancing Soil Governance at the Global, Regional and National Level: GSP Experiences in Turkey Towards Sustainable Soil Management

Hakki Emrah ERDOGAN[13], Liesl WIESE[1], Zineb BAZZA[1], Ronald VARGAS[1] Gunay ERPUL[2]

Abstract

Sustainable soil management (SSM) was defined in the revised World Soil Charter (WSC) as: a set of activities that maintain or enhance the supporting, provisioning, regulating, and cultural services provided by soil without significantly impairing either the soil functions that enable those services or biodiversity. Therefore, SSM strongly contributes to collective efforts towards tackling land degradation neutrality (LDN), climate change adaptation and mitigation, promoting biodiversity and several other benefits that are directly related to the achievement of the Sustainable Development Goals (SDGs). As a result, SSM has specific relevance to the United Nations Convention to Combat Desertification, the United Nations Framework Convention on Climate Change, and the United Nations Convention on Biological Diversity. To move from definition to implementation, a guidance document or protocol has been developed by the Intergovernmental Technical Panel on Soils (ITPS) of the Global Soil Partnership (GSP) to assess whether management practices are sustainable according to the revised WSC definition of SSM. Through the activities contained in the GSP global and regional implementation plans, this protocol will facilitate the assessment of SSM practices according to local, national and regional priorities and contexts by the Regional Soil Partnerships. Using the assessment protocol, a database of SSM management practices or good practices will be compiled, drawing from existing databases, as well as relevant practices not currently catalogued. The global implementation plan for SSM further proposed to identify the appropriate SSM practices and systems at regional and national levels using existing databases. Subsequently, the barriers preventing SSM application and the recommended SSM practices at regional and national levels will be identified, disseminated and tackled. In this regard, the regional implementation plans were built in harmony with the global Plans of Action for the five GSP pillars in order to enhance synergies across pillars. As an active member of the GSP, Turkey has played an active role in the establishment of the regional and sub-regional partnerships for Europe and Eurasia and the development of associated regional implementation plans. Recently, Turkey started to develop its national action plan for SSM under the FAO technical support program.

Keywords: Sustainable Soil Management, LDN, SDGs

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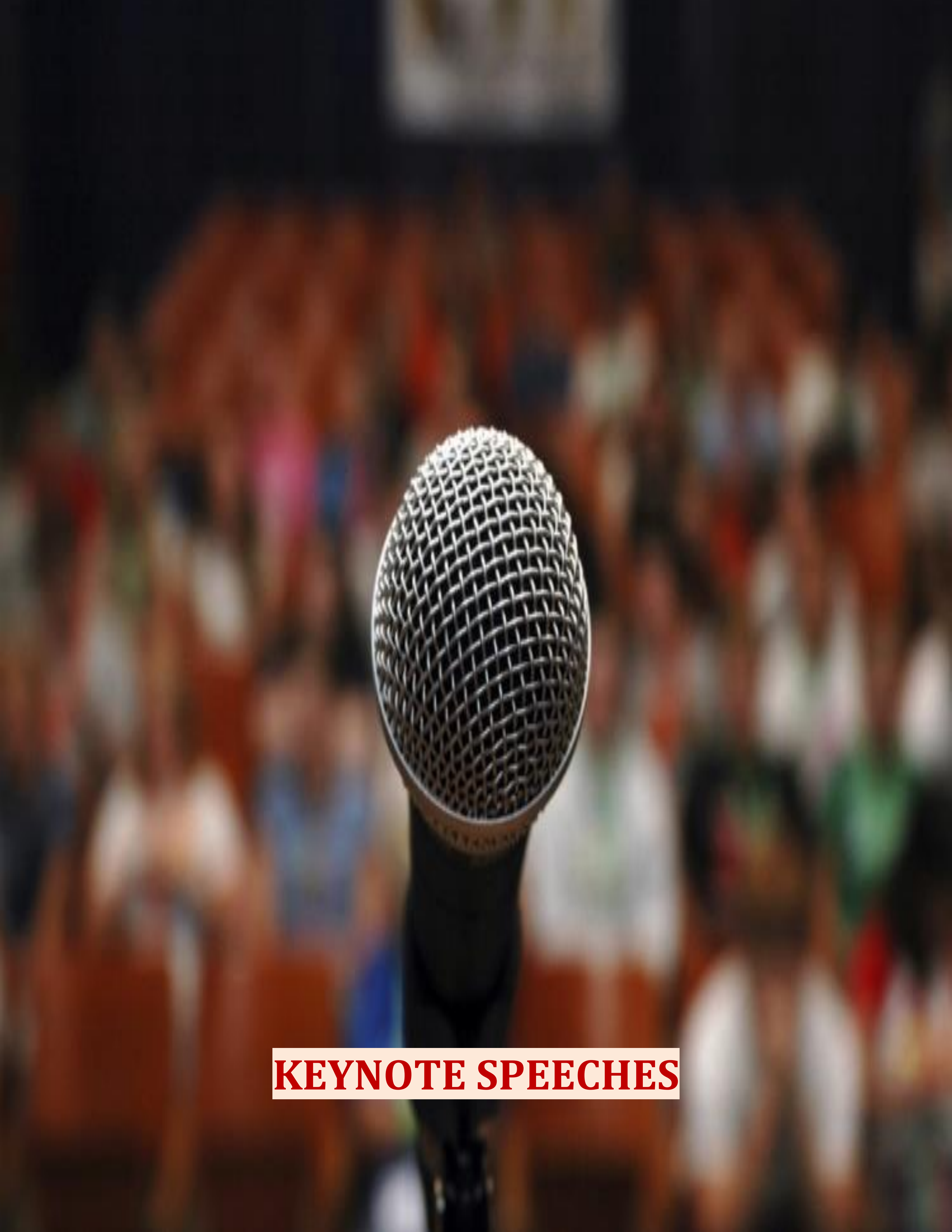


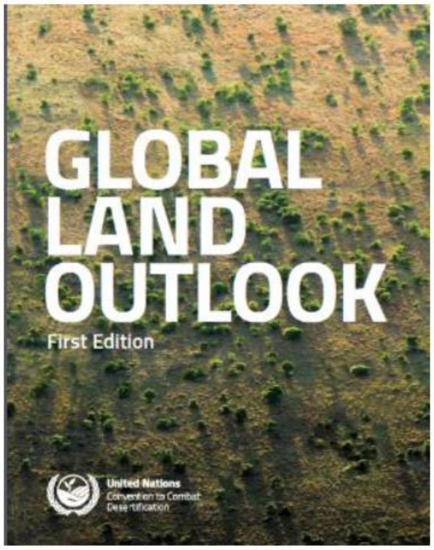
KEYNOTE SPEECHES


25 YEARS
United Nations
Convention to Combat
Desertification
How can Land Degradation Neutrality contribute to positive transformation?
Barron Joseph Orr, Lead Scientist
INTERNATIONAL SOIL CONGRESS
2019
10th International Soil Congress 2019
cessful Transformation toward LDN: Future Perspective
Ankara, Turkey | 18 June 2019


Transformation
The IPCC (2014) has defined transformation as a change in the fundamental attributes of natural and human systems.

Why do we need *positive* transformation?

- **Land is finite** in quantity. Competing demands for its goods and services are increasing pressures on land resources in virtually every country.
- **Over 1.3 billion people trapped** on degrading agricultural land
- **Land transformation** in **rural areas** is **unprecedented** in terms of both speed and scale
- **70 per cent of agricultural land** is now used to grow **feed crops and livestock production**
- **Consumption** of natural resources **doubled in 30 years**
- **3 planets to meet 2050 natural resource demands**



https://www.unccd.int/actions/global-land-outlook-glo

…because land (and time) are running out

- **1 million species** are threatened by extinction largely because **75% of the land surface has been altered**
- These **(negative) transformational changes** are creating the conditions for a biological evolution **so rapid**, it is **visible just over a few years**.

- The **conversion of land** for agriculture is the leading driver of land-use change, with **meeting the demand for food, feed, fibre and bioenergy** production in the lead. **Forests, wetlands and grasslands and savannas are paying the price.**

https://www.ipbes.net/news/ipbes-global-assessment-

Land can accelerate many SDGs...

...but SDGs compete for the same land resources.

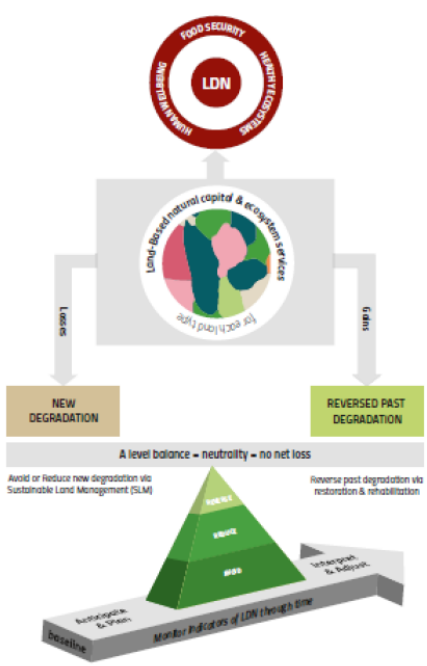
How can navigate the inevitable SDG trade-offs?

A balanced approach is needed.

- One that **anticipates new degradation** even as we plan to reverse past degradation
- One that **considers tradeoffs** among competing interests across the landscape

LDN provides the framework for this.

Land Degradation Neutrality (LDN)



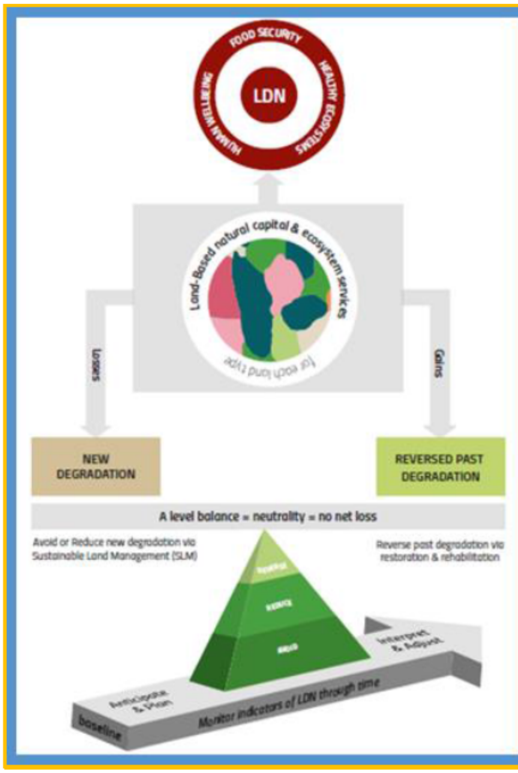
"A state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems"

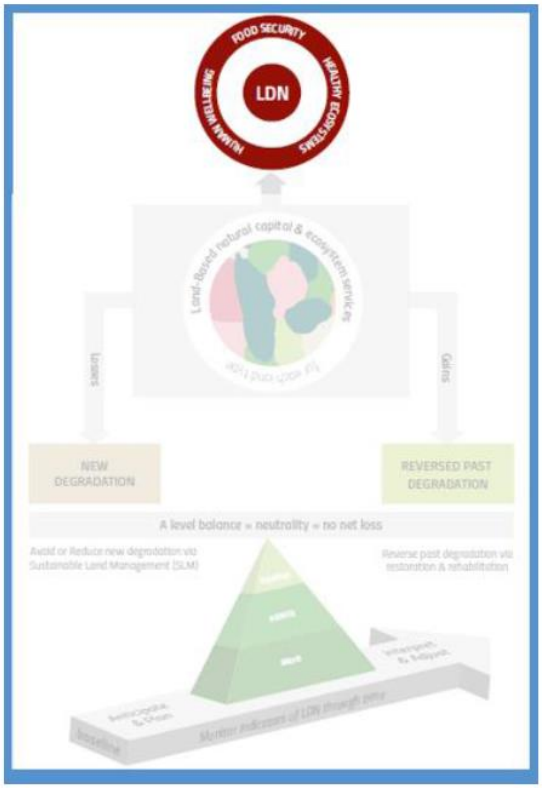
UNCCD COP12 October 2015

Land Degradation Neutrality

- LDN seeks to **maintain natural capital** and the **ecosystem services** that flow from it
- LDN is about keeping **land in balance**
- Keeping land in balance provides the basis for **keeping food, carbon and biodiversity in balance** as well.
- LDN is about achieving **multiple benefits**
- LDN provides a framework with **multiple entry points** which facilitate **optimizing the synergies** among the Rio Conventions (Climate Change, Biodiversity, Land Degradation)

https://knowledge.unccd.int/publication/ldn-scientific-conceptual-framework-land-degradation-neutrality-report-science-policy





The Vision of LDN

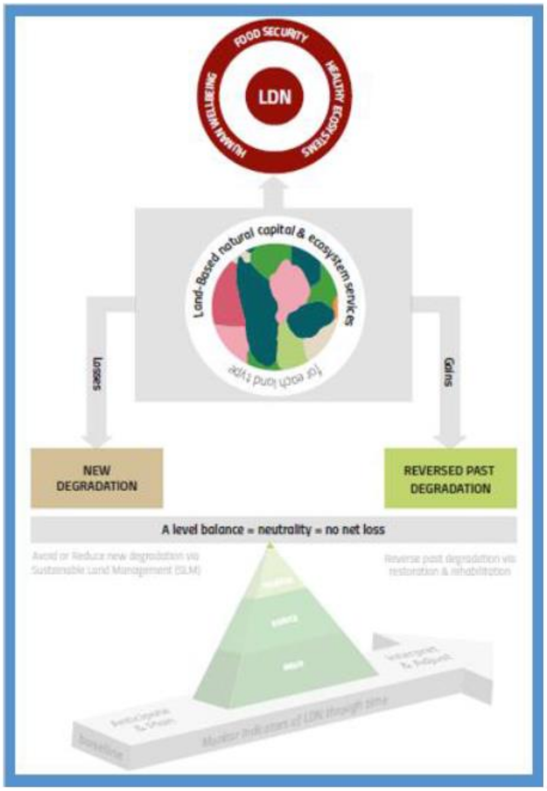
United Nations
Convention to Combat Desertification

Human wellbeing

Food security

Healthy ecosystems

The goal of LDN is maintaining or enhancing the land resource base - in other words, the stocks of **natural capital** associated with land resources and the **ecosystem services** that flow from them



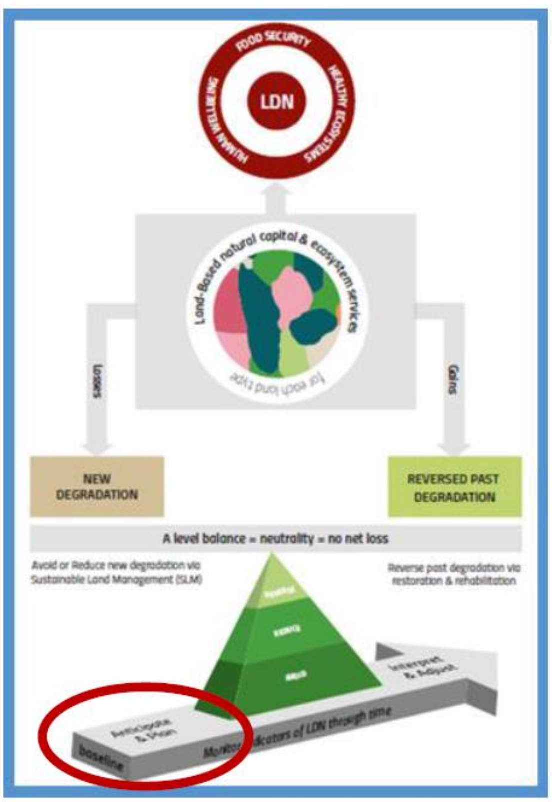
Mechanism for achieving neutrality

Neutrality = ***no net loss*** compared to the reference state (baseline)

Baseline is NOW (current condition)

Counterbalancing future land degradation (anticipated **losses**) through planned measures to achieve equivalent **gains** elsewhere within the same **land type**

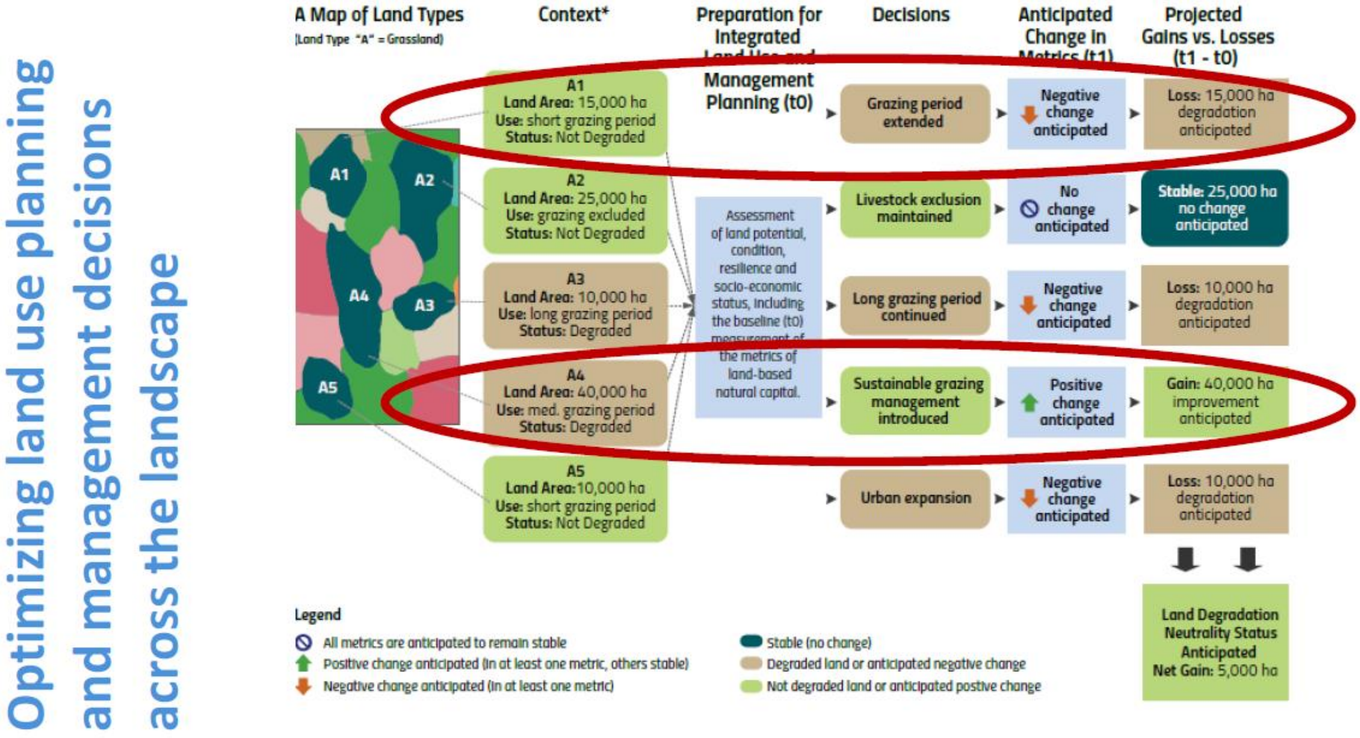
“like for like”

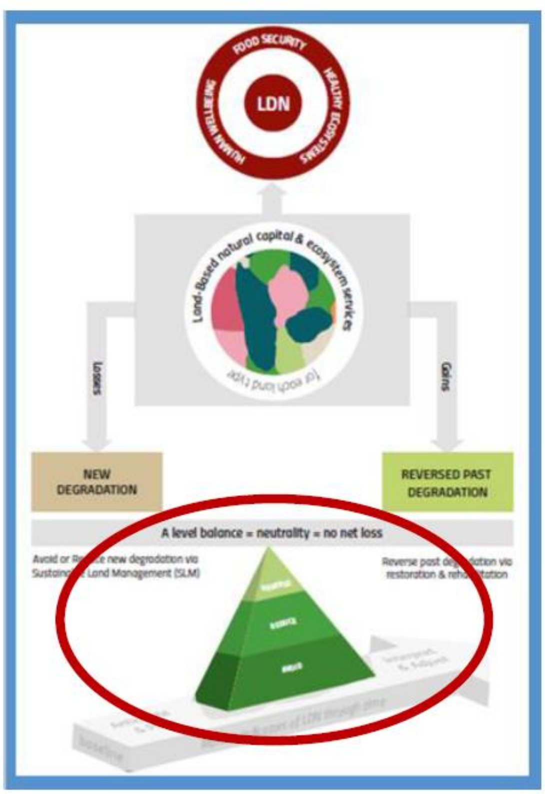


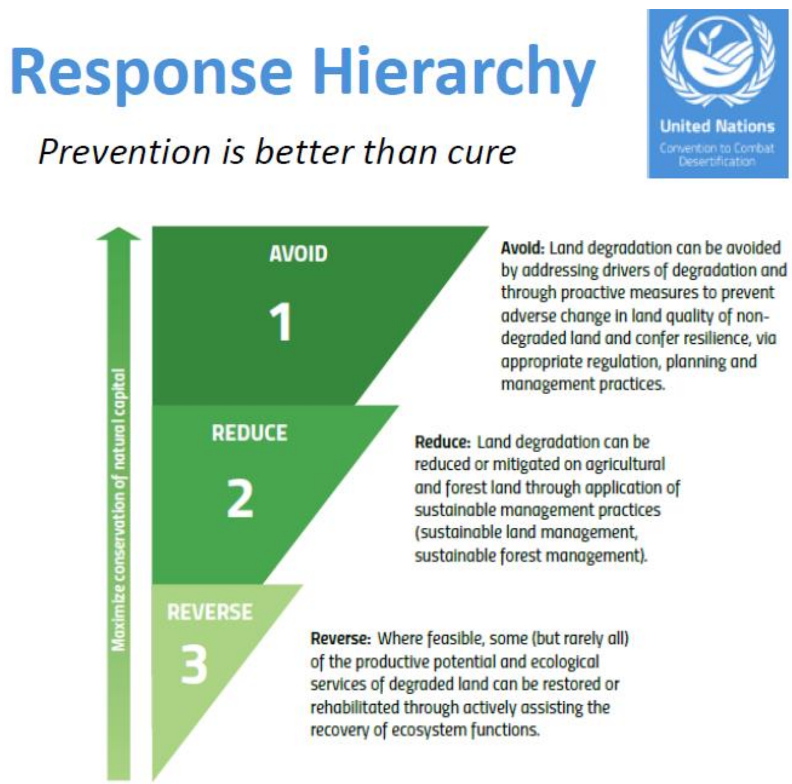
Integrated land use planning

LDN planning (which begins with target setting) involves anticipating where degradation is likely so that the optimal mix of interventions across the landscape to achieve neutrality can be pursued.

- Occurs at multiple levels
- Leverages existing land use planning

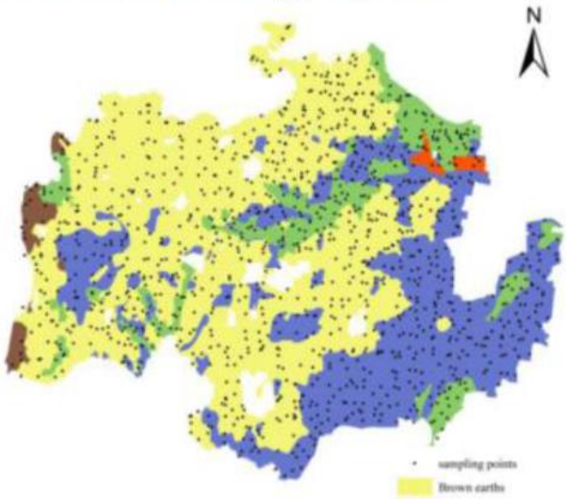

Optimizing land use planning and management decisions across the landscape
A Map of Land Types
(Land Type "A" = Grassland)
Context*
Preparation for Integrated Land Use and Management Planning (t0)
Decisions
Anticipated Change in Metrics (t1)
Projected Gains vs. Losses (t1 - t0)
A1
Land Area: 15,000 ha
Use: short grazing period
Status: Not Degraded
A2
Land Area: 25,000 ha
Use: grazing excluded
Status: Not Degraded
A3
Land Area: 10,000 ha
Use: long grazing period
Status: Degraded
A4
Land Area: 40,000 ha
Use: med. grazing period
Status: Degraded
A5
Land Area: 10,000 ha
Use: short grazing period
Status: Not Degraded
Assessment of land potential, condition, resilience and socio-economic status, including the baseline (t0) measurement of the metrics of land-based natural capital.
Grazing period extended
Livestock exclusion maintained
Long grazing period continued
Sustainable grazing management introduced
Urban expansion
Negative change anticipated
No change anticipated
Negative change anticipated
Positive change anticipated
Negative change anticipated
Loss: 15,000 ha degradation anticipated
Stable: 25,000 ha no change anticipated
Loss: 10,000 ha degradation anticipated
Gain: 40,000 ha improvement anticipated
Loss: 10,000 ha degradation anticipated
Land Degradation Neutrality Status Anticipated
Net Gain: 5,000 ha
Legend
All metrics are anticipated to remain stable
Positive change anticipated (in at least one metric, others stable)
Negative change anticipated (in at least one metric)
Stable (no change)
Degraded land or anticipated negative change
Not degraded land or anticipated postive change


LDN
FOOD SECURITY
HEALTHY ECOSYSTEMS
HUMAN WELLBEING
Land-Based natural capital & ecosystem services
Losses
Gains
NEW DEGRADATION
REVERSED PAST DEGRADATION
A level balance = neutrality = no net loss


Response Hierarchy
Prevention is better than cure
United Nations
Convention to Combat Desertification
Maximize conservation of natural capital
AVOID
1
REDUCE
2
REVERSE
3
Avoid: Land degradation can be avoided by addressing drivers of degradation and through proactive measures to prevent adverse change in land quality of non-degraded land and confer resilience, via appropriate regulation, planning and management practices.
Reduce: Land degradation can be reduced or mitigated on agricultural and forest land through application of sustainable management practices (sustainable land management, sustainable forest management).
Reverse: Where feasible, some (but rarely all) of the productive potential and ecological services of degraded land can be restored or rehabilitated through actively assisting the recovery of ecosystem functions.

Integrated land use planning is the key to achieving LDN

United Nations
Convention to Combat Desertification



Using the best information available

- Land degradation status
- Land potential
- Resilience
- Socio-economic data
- Gender considerations

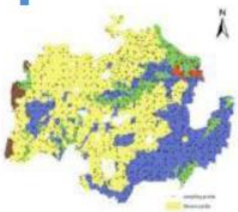
In order to

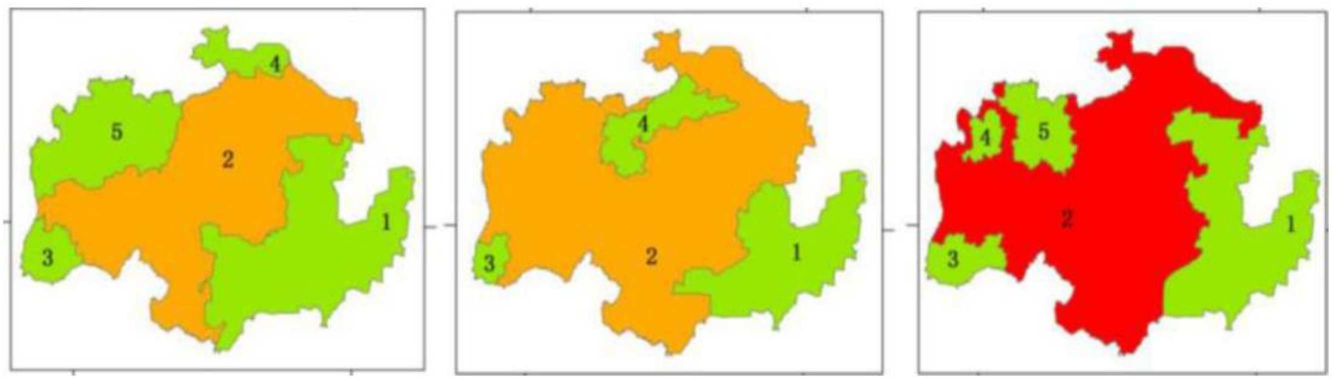
- Optimize the spatial mix of possible interventions
- Navigate trade-offs

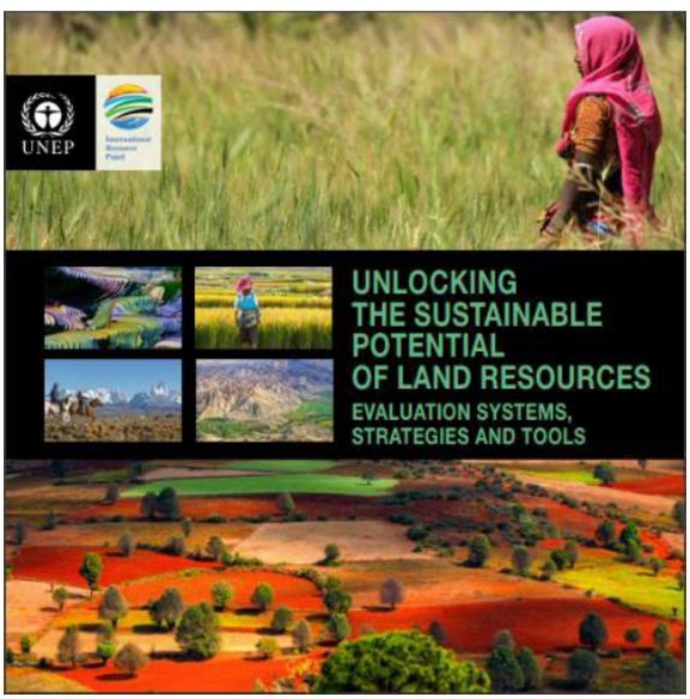
United Nations
Convention to Combat Desertification

It is about having the right information...

…to do the right thing in the right place at the right scale





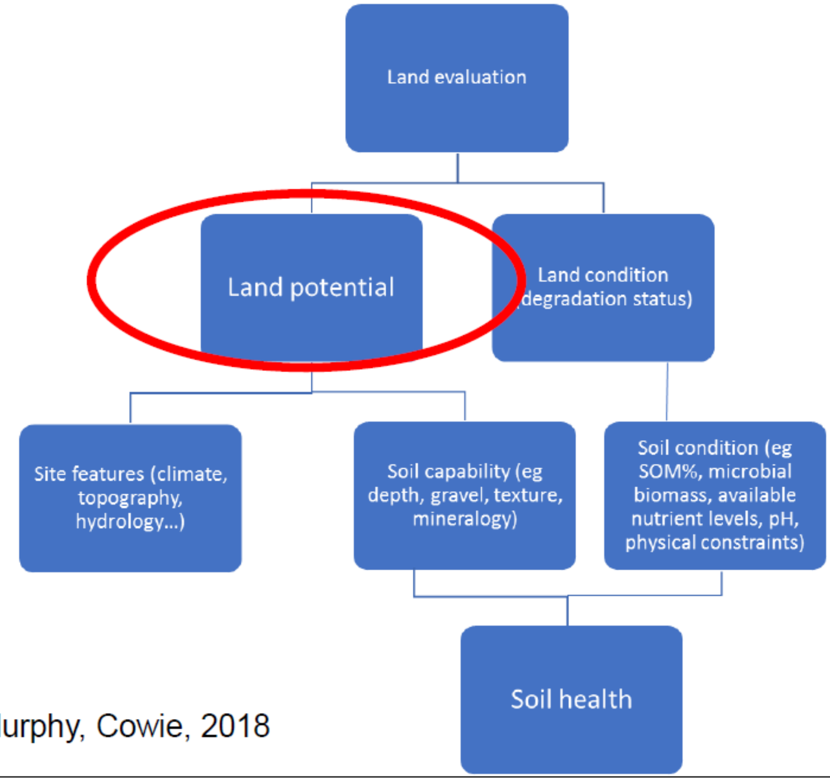


Land potential is the inherent, long-term potential of the land to sustainably generate ecosystem services, which reflects the capacity and resilience of the land-based natural capital, in the face of ongoing environmental change.

Land potential

http://www.resourcepanel.org/reports/unlocking-sustainable-potential-land-resources

Assessing land potential is part of most land and soil evaluation methodologies.



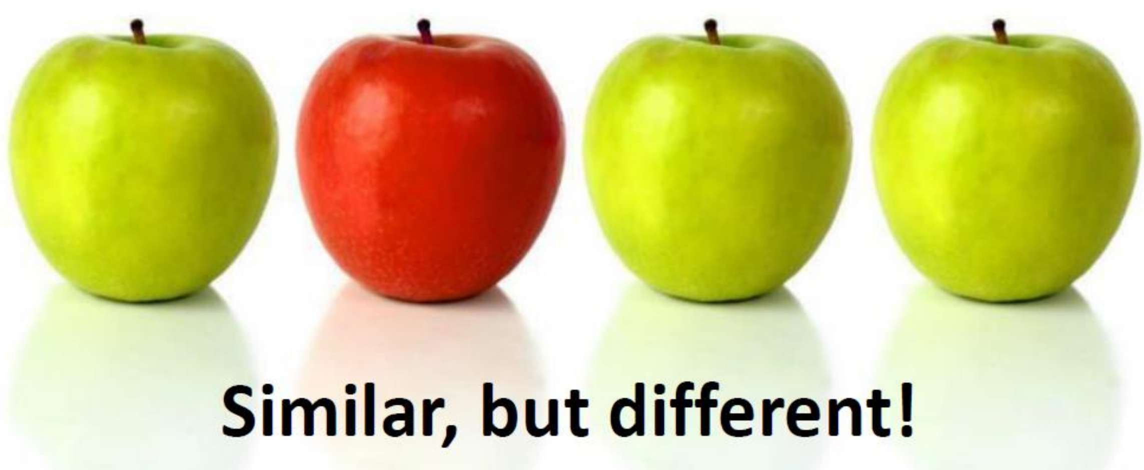
United Nations Convention to Combat Desertification

Henry, Murphy, Cowie, 2018

Appropriate land use depends on the underlying land potential

United Nations Convention to Combat Desertification

WARNING: Similar soils in similar climate conditions may not mean similar land potential



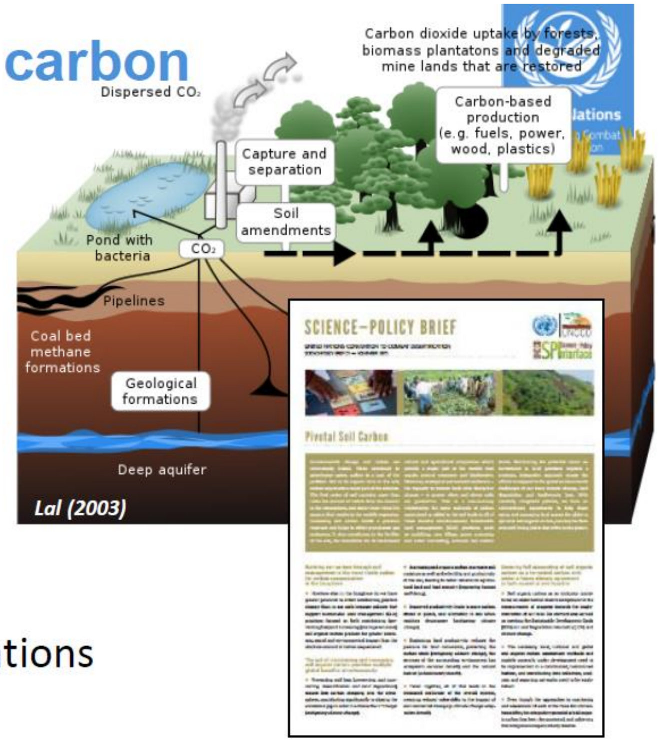
The SLM cornerstone of LDN

Sustainable Land Management can be defined as the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions.

Source: WOCAT

Multiple benefits of soil carbon

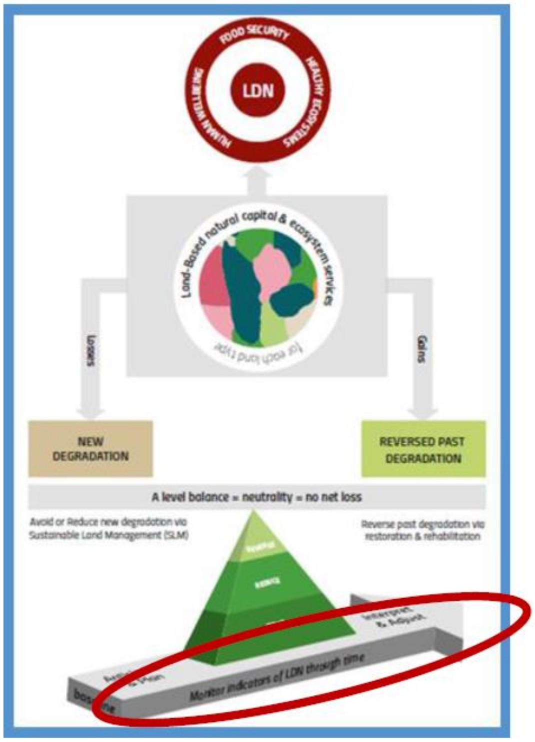
- Stores atmospheric C
  - Cost effective climate mitigation measure
- Improved water holding capacity
  - Buffer against drought
- Improved soil fertility
  - Nutrient store and supply
  - Improved productivity / yields
- Improved soil structure
  - Improved workability
- Improved soil habitat soil organizations
  - Improved biodiversity



What should we measure?

For harmonization of LDN monitoring, 3 essential variables are measured in all countries.

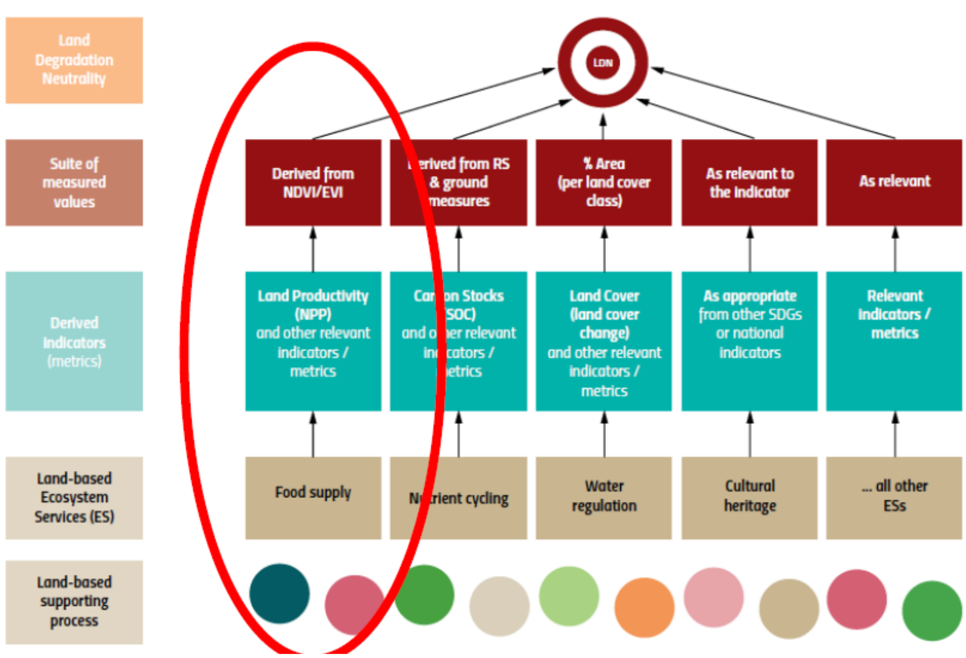
Countries also measure any other relevant indicators



Monitoring and learning

- Global indicators: Land cover, land productivity and soil organic carbon
- "One out, all out", area basis
- Complemented by:
  -Locally-relevant indicators
  -Process indicators
  -Outcome indicators
- Verified using local knowledge (multi-stakeholder platforms nested across scales)

Selection of indicators based on ecosystem functions that provide ecosystem services

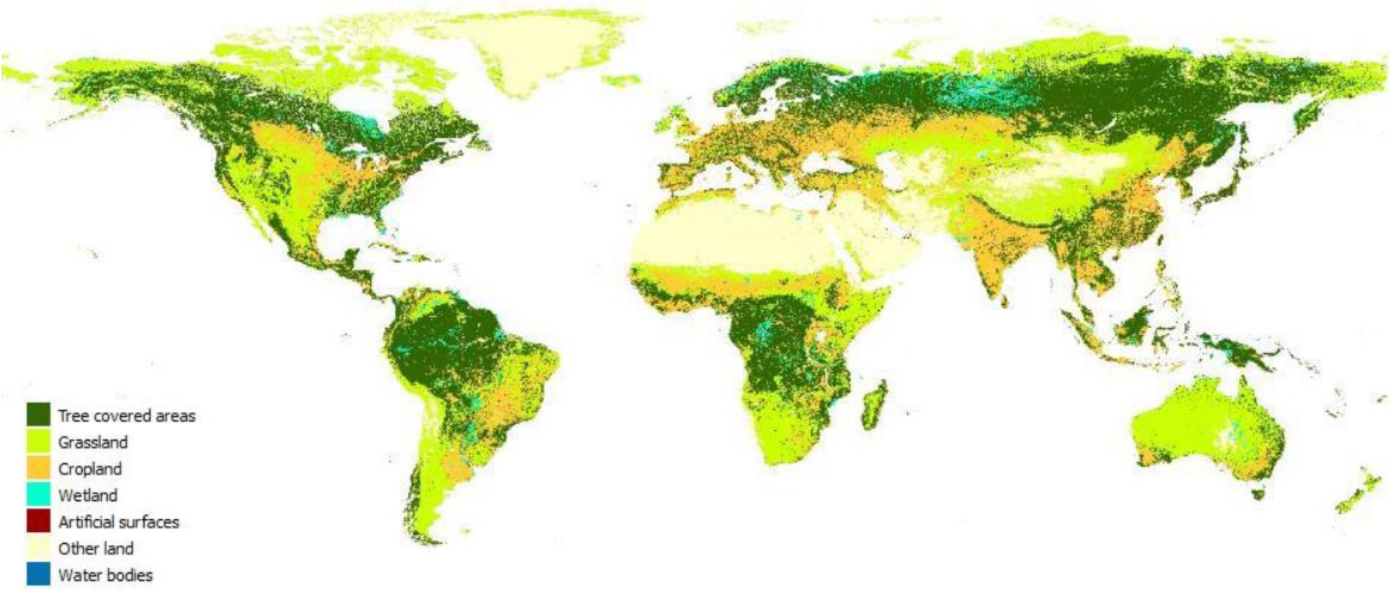


The framework does not prescribe how to measure the indicators.

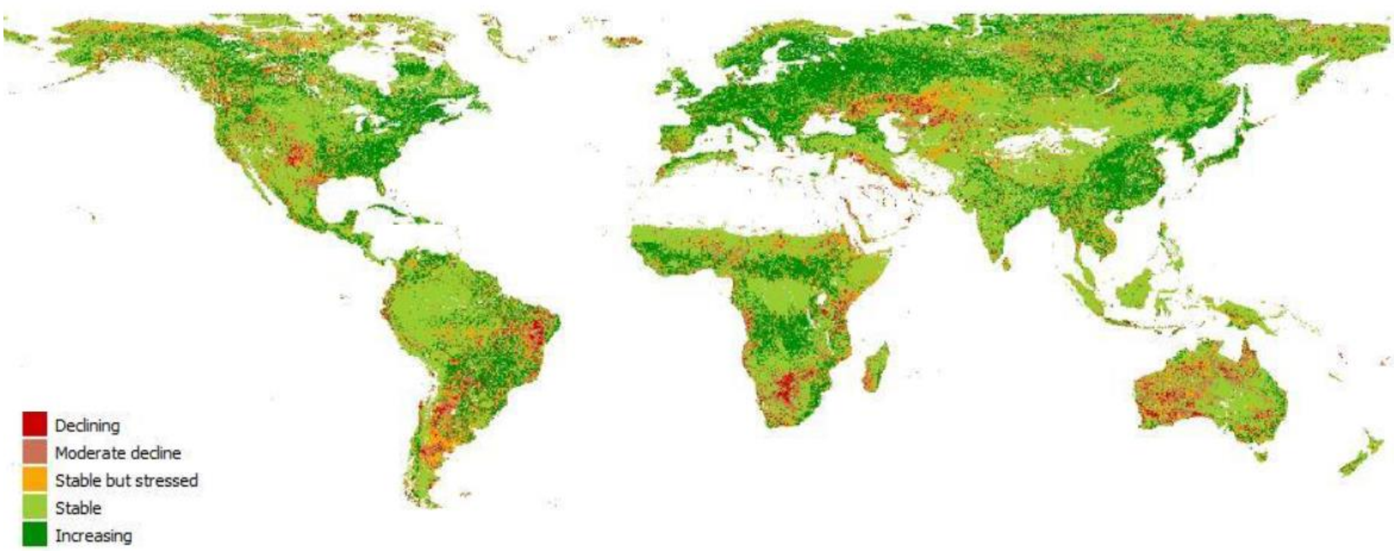
It recommends effort to achieve consensus on **common criteria** and **standards** to harmonize application.

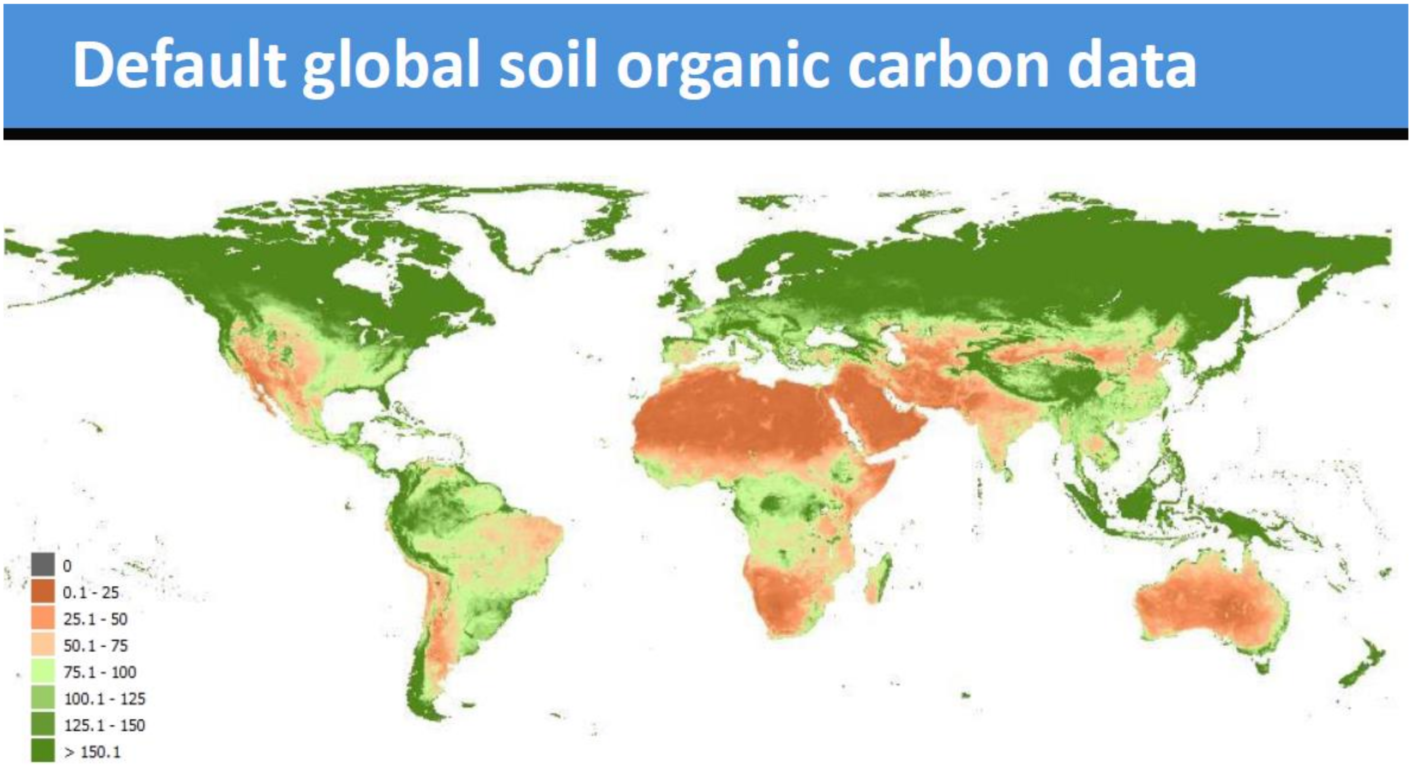
Monitor indicators relative to the baseline

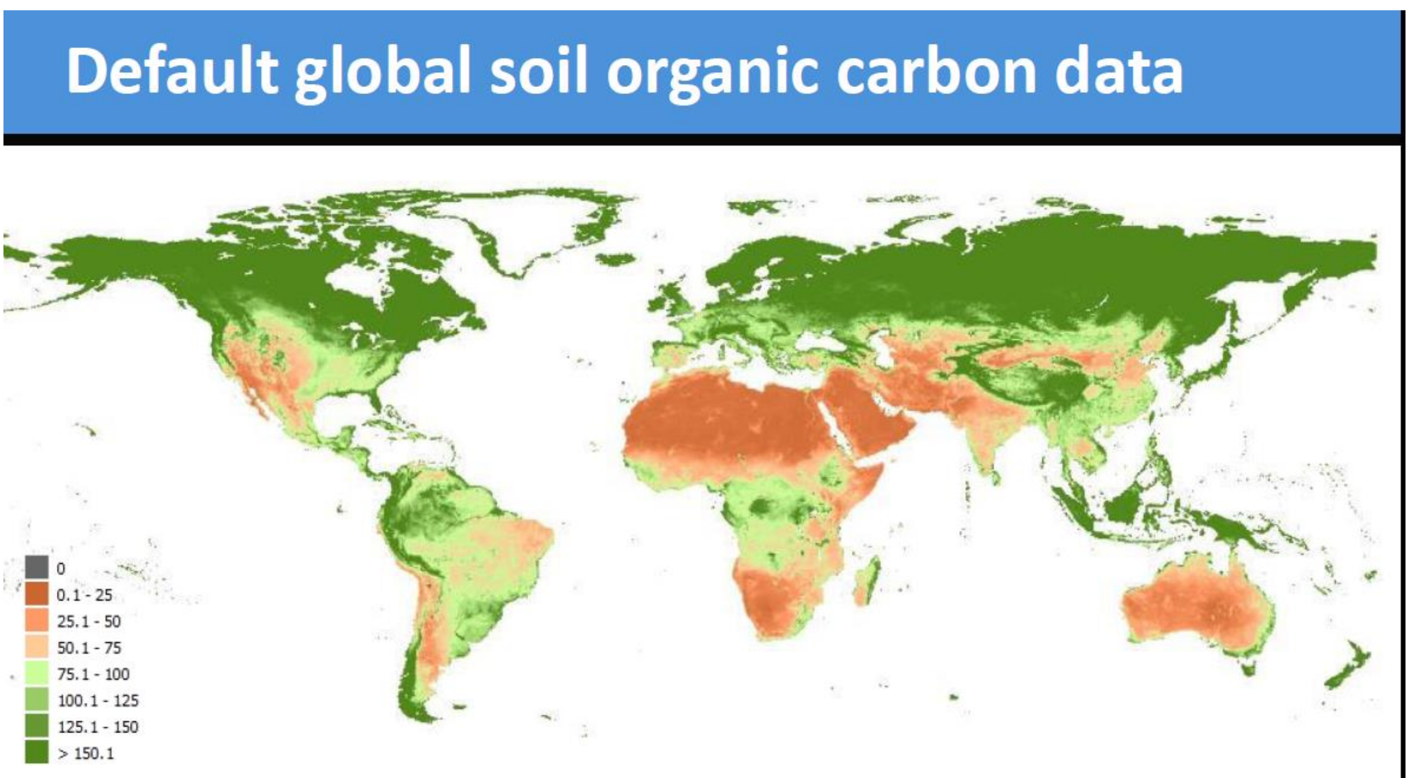
Default Land Cover data



Default land productivity dynamics data




Default global soil organic carbon data
0
0.1 - 25
25.1 - 50
50.1 - 75
75.1 - 100
100.1 - 125
125.1 - 150
> 150.1


Default global soil organic carbon data
0
0.1 - 25
25.1 - 50
50.1 - 75
75.1 - 100
100.1 - 125
125.1 - 150
> 150.1

The combination = SDG indicator 15.3.1

<u>SDG Target 15.3:</u>
"By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land-degradation neutral world"

<u>SDG Indicator 15.3.1:</u>
Proportion of land that is degraded over total land area.

Guiding principles

Principles are provided to govern application of the framework and to help prevent unintended outcomes during implementation and monitoring of LDN.

These principles are central to how LDN can encourage responsible governance and help safeguard land tenure

Guiding Principles (1)

Principles govern application of the framework, and prevent unintended outcomes during implementation of LDN

1. Maintain or enhance land-based natural capital.
2. Protect the rights of land users.
3. Respect national sovereignty.
4. For neutrality, the LDN target equals (is the same as) the baseline.
5. Neutrality is the minimum objective: countries may be more ambitious.
6. Integrate planning and implementation of LDN into existing land use planning processes.
7. Counterbalance anticipated losses in land-based natural capital with interventions to reverse degradation, to achieve neutrality.
8. Manage counterbalancing at the same scale as land use planning.
9. Counterbalance “like for like” (within the same land type). Not between conservation and production areas.
10. Balance economic, social and environmental sustainability.

Guiding Principles (2)

11. Base land use decisions on multi-variable assessments, considering land potential, land condition, resilience, social, cultural and economic factors.
12. Apply the response hierarchy : Avoid > Reduce >Reverse.
13. Apply a participatory process including stakeholders in designing, implementing and monitoring LDN.
14. Reinforce responsible governance: protect human rights, including tenure; ensure accountability and transparency.
15. Monitor using the three UNCCD land-based global indicators: land cover, land productivity and carbon stocks.
16. Use “one-out, all-out” to interpret the three global indicators.
17. Use national and sub-national indicators to aid interpretation and fill gaps.
18. Apply local knowledge to verify and interpret monitoring data.
19. Apply a continuous learning approach: anticipate,
    plan, track, interpret, review, adjust, create the next plan

The *Scientific Conceptual Framework for LDN* was endorsed by all 197 UNCCD Parties in COP 13

ICCD/COP(13)/21/Add.1

Decision 18/COP.13

Follow-up on the work programme of the Science-Policy Interface for the biennium 2016–2017

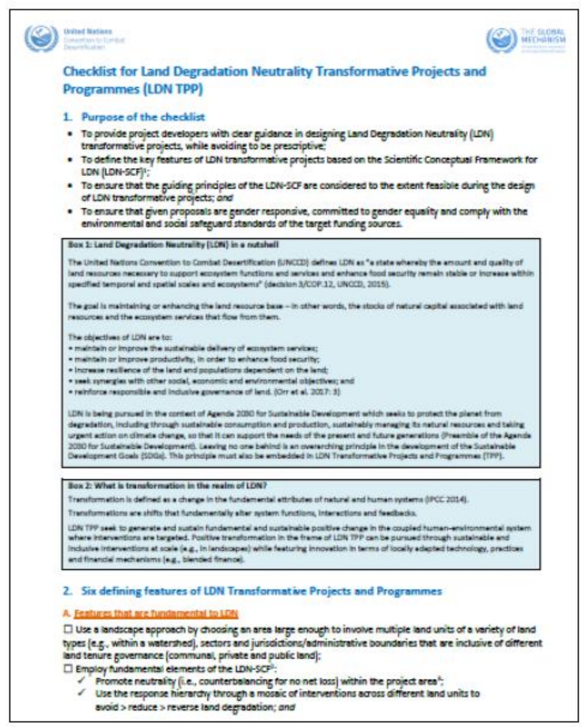
The scientific conceptual framework for land degradation neutrality

1. *Endorses* the scientific conceptual framework for land degradation neutrality summarized in document ICCD/COP(13)/CST/2 and *encourages* further conceptual elaboration and practical verification;

2. *Calls upon* Parties pursuing land degradation neutrality to consider the guidance provided by the scientific conceptual framework for land degradation neutrality and observe the principles summarised in document ICCD/COP(13)/CST/2, taking into account national circumstances;

LDN TPP Checklist

- A tool to help country-level project developers and their technical and financial partners to design effective LDN interventions.
- The checklist is optional, not prescriptive.
- It provides a pragmatic and scientifically grounded guide that encourages innovation.
- It aims to ensure consistency and completeness in the implementation of LDN, and to lead to a positive transformation.



Checklist for Land Degradation Neutrality Transformative Projects and Programmes (LDN TPP)

1. Purpose of the checklist

- To provide project developers with clear guidance in designing Land Degradation Neutrality (LDN) transformative projects, while avoiding to be prescriptive;
- To define the key features of LDN transformative projects based on the Scientific Conceptual Framework for LDN (LDN-SCF)[1];
- To ensure that the guiding principles of the LDN-SCF are considered to the extent feasible during the design of LDN transformative projects; *and*
- To ensure that given proposals are gender responsive, committed to gender equality and comply with the environmental and social safeguard standards of the target funding sources.

Box 1: Land Degradation Neutrality (LDN) in a nutshell

The United Nations Convention to Combat Desertification (UNCCD) defines LDN as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems" (decision 3/COP.12, UNCCD, 2015).

The goal is maintaining or enhancing the land resource base – in other words, the stocks of natural capital associated with land resources and the ecosystem services that flow from them.

The objectives of LDN are to:
• maintain or improve the sustainable delivery of ecosystem services;
• maintain or improve productivity, in order to enhance food security;
• increase resilience of the land and populations dependent on the land;
• seek synergies with other social, economic and environmental objectives; and
• reinforce responsible and inclusive governance of land. (Orr et al. 2017: 3)

LDN is being pursued in the context of Agenda 2030 for Sustainable Development which seeks to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations (Preamble of the Agenda 2030 for Sustainable Development). Leaving no one behind is an overarching principle in the development of the Sustainable Development Goals (SDGs). This principle must also be embedded in LDN Transformative Projects and Programmes (TPP).

Box 2: What is transformation in the realm of LDN?

Transformation is defined as a change in the fundamental attributes of natural and human systems (IPCC 2014).

Transformations are shifts that fundamentally alter system functions, interactions and feedbacks.

LDN TPP seek to generate and sustain fundamental and sustainable positive change in the coupled human-environmental system where interventions are targeted. Positive transformation in the frame of LDN TPP can be pursued through sustainable and inclusive interventions at scale (e.g., in landscapes) while featuring innovation in terms of locally adapted technology, practices and financial mechanisms (e.g., blended finance).

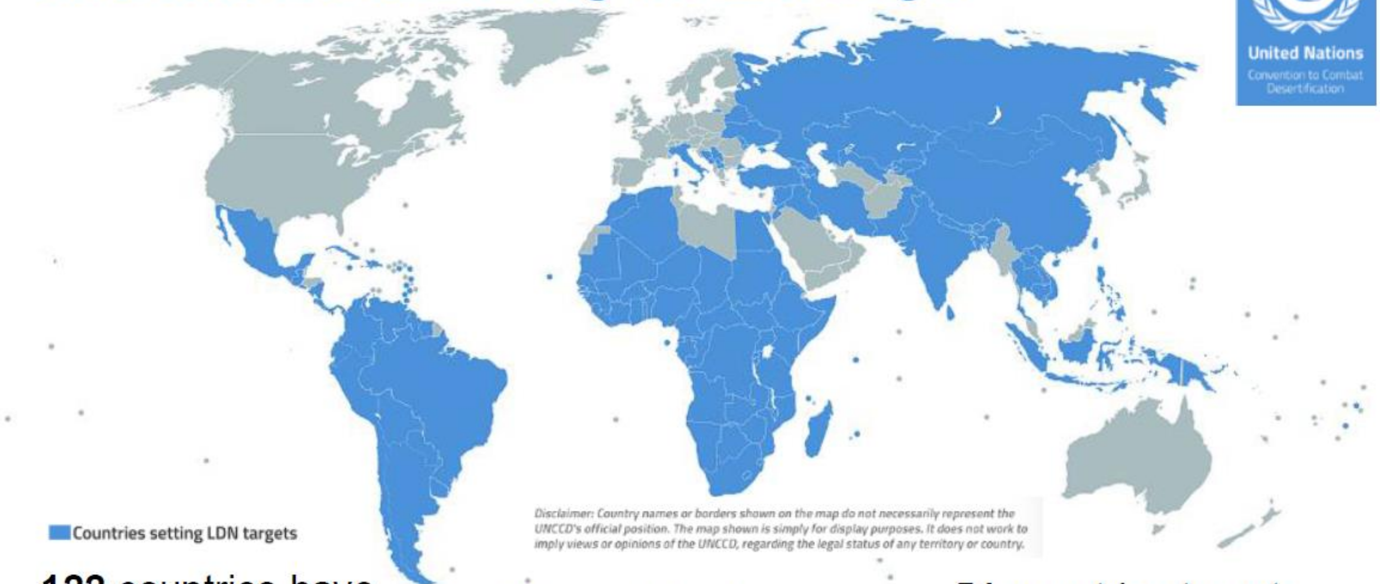
2. Six defining features of LDN Transformative Projects and Programmes

A. Features that are fundamental to LDN

☐ Use a landscape approach by choosing an area large enough to involve multiple land units of a variety of land types (e.g., within a watershed), sectors and jurisdictions/administrative boundaries that are inclusive of different land tenure governance (communal, private and public land);
☐ Employ fundamental elements of the LDN-SCF[3]:
✓ Promote neutrality (i.e., counterbalancing for no net loss) within the project area[4];
✓ Use the response hierarchy through a mosaic of interventions across different land units to avoid > reduce > reverse land degradation; *and*

https://knowledge.unccd.int/publication/draft-checklist-land-degradation-neutrality-transformative-projects-and-programmes

Countries are embracing the LDN target



122 countries have committed to set LDN targets so far

83 countries have officially validated their targets

51 countries targets adopted by their governments

Main achievements of LDN Target Setting

- Facilitated national **stakeholder consultation process**
- **Identified drivers** of land degradation
- Analyzed legal and institutional **environment**
- Identified comprehensive technical and policy **LDN measures**
- Identified opportunities to **mainstream** LDN and develop **LDN Transformative Projects and Programmes**

- **80+** countries developed **leverage plans**
- **90+** countries established **LDN national working groups**

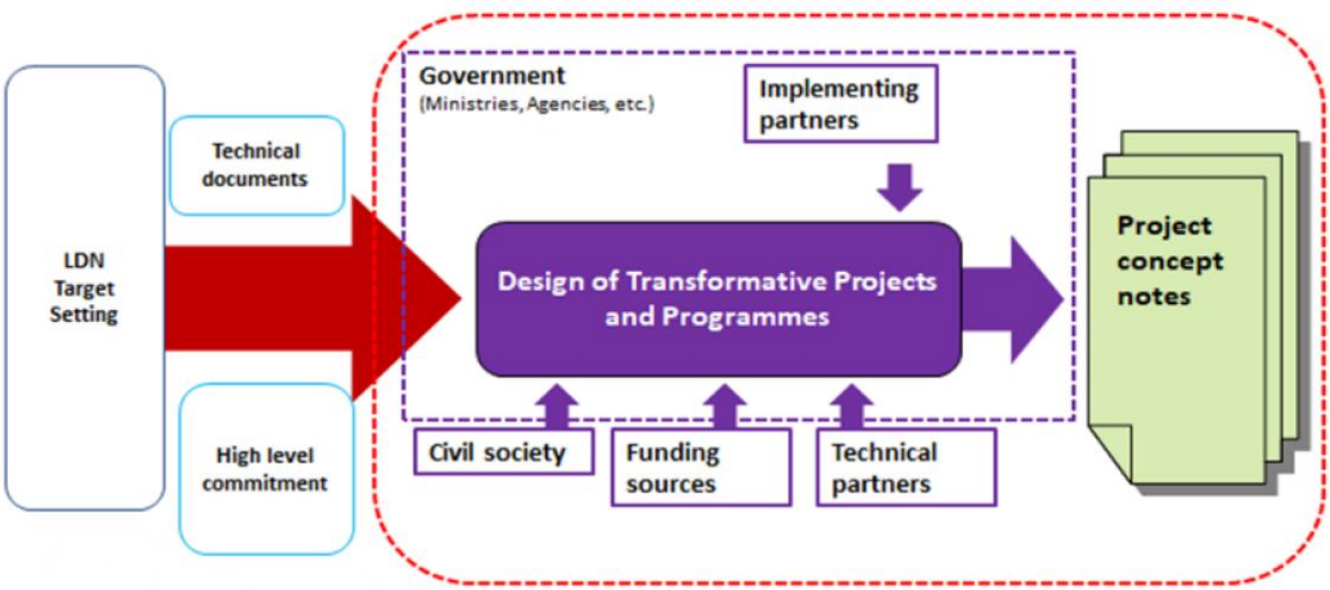
LDN targets are: **national** in scope; **aligned with SDGs**; based on quantitative elements that **can be monitored**, and; founded on the **LDN response hierarchy**

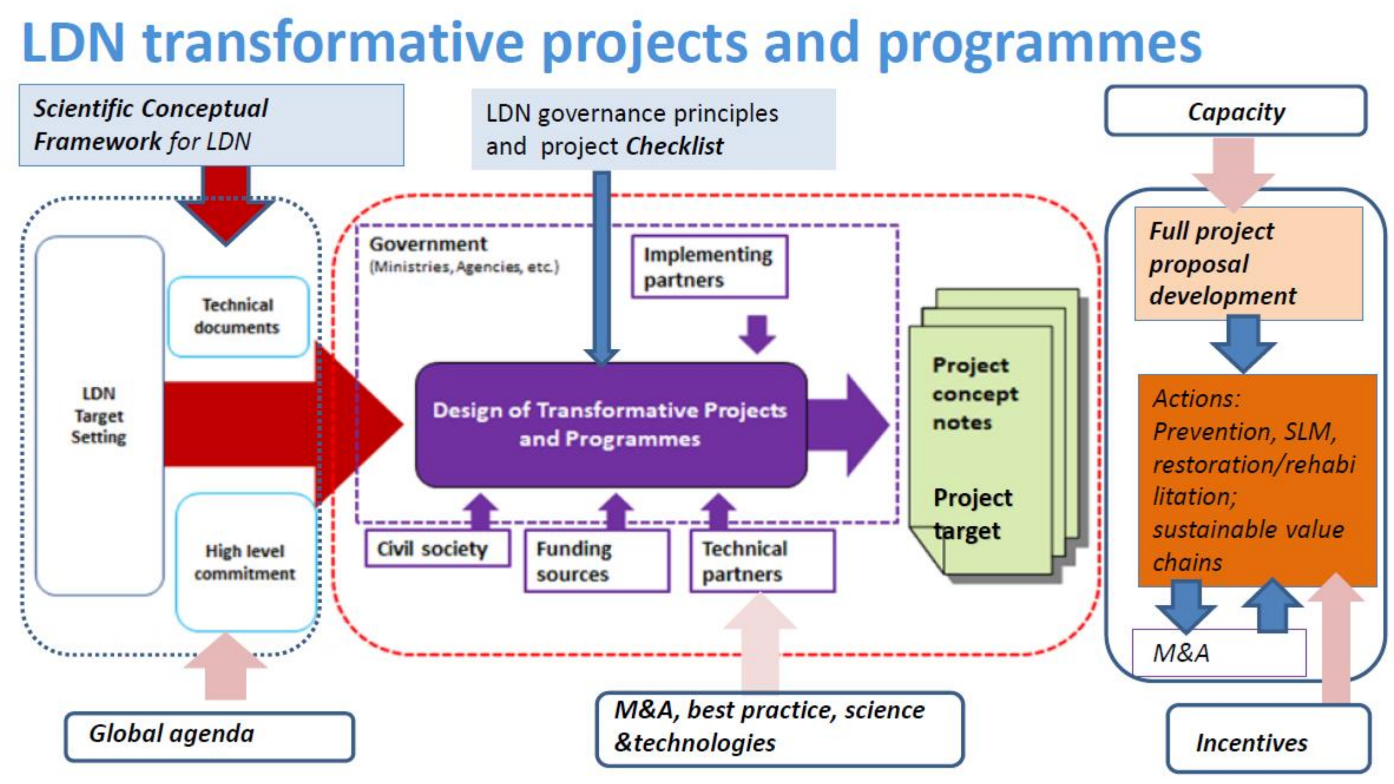
LDN Transformative projects & programmes (LDN TPP)

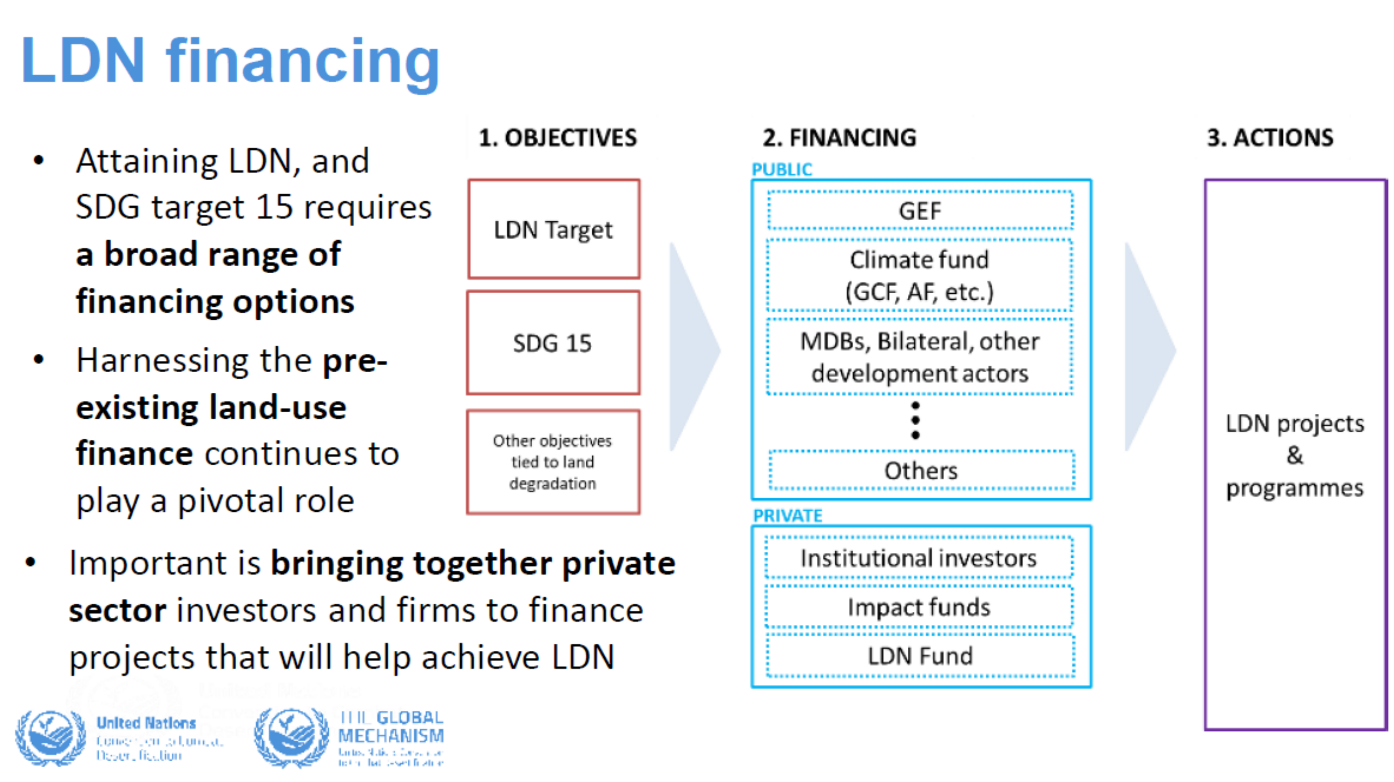
MAIN FEATURES

- Contribute to the achievement of LDN
- Scale up what works
- Leverage finance including private sector
- Deliver multiple benefits, including climate
- Enhance national capacities

From target to implementation




LDN transformative projects and programmes
Scientific Conceptual Framework for LDN
LDN governance principles and project Checklist
Capacity
LDN Target Setting
Technical documents
High level commitment
Government (Ministries, Agencies, etc.)
Implementing partners
Design of Transformative Projects and Programmes
Civil society
Funding sources
Technical partners
Project concept notes
Project target
Full project proposal development
Actions: Prevention, SLM, restoration/rehabilitation; sustainable value chains
M&A
Global agenda
M&A, best practice, science &technologies
Incentives


LDN financing
• Attaining LDN, and SDG target 15 requires a broad range of financing options
• Harnessing the pre-existing land-use finance continues to play a pivotal role
• Important is bringing together private sector investors and firms to finance projects that will help achieve LDN
1. OBJECTIVES
LDN Target
SDG 15
Other objectives tied to land degradation
2. FINANCING
PUBLIC
GEF
Climate fund (GCF, AF, etc.)
MDBs, Bilateral, other development actors
Others
PRIVATE
Institutional investors
Impact funds
LDN Fund
3. ACTIONS
LDN projects & programmes
United Nations
THE GLOBAL MECHANISM

GM support for LDN TPPs

- Supporting the **early-stage project preparation** to address the country's land degradation phenomenon, identified through LDN target setting process
- **Collaborating with various financial and technical partners** worldwide
- Developed a **checklist** on LDN features to support the development of TPPs in collaboration with the UNCCD Secretariat, the SPI and the GEF
- Today, engaged in **20 countries and 5 regions** worldwide

What UNCCD can provide

Early country engagement → Articulation of project → Preparation of project

UNCCD can
- Convene key stakeholders
- Finance the recruitment of a national consultant to develop a project concept note
- Provide technical support for the development of project concept note
- Facilitate dialogue with GEF Secretariat, national focal points of relevant funding sources (GEF, GCF, AF…) and other relevant entities

UNCCD can
- *Upon Government request*, partially fund/cover implementing/funding agency costs of preparation of full project proposal
- Join country missions
- Facilitate dialogue *(continuing from earlier stage)*

Requirements for UNCCD support

Demonstration of country ownership

- ✓LDN targets endorsed at the highest political level
- ✓Official request for support from country Parties
- ✓Identification of potential project ideas, targeted funding sources (including climate finance) and potential implementing partners
- ✓Political buy-in an commitment of national and local authorities with relevant expertise
- ✓Collaboration in facilitation of in-country activities related to the development of the project

Strong linkages to LDN

- ✓Close alignment of project ideas with the national LDN targets, LDN Scientific Conceptual Framework, and UNCCD/SDG reporting process
- ✓Demonstration of multiple benefits: benefits targeting vulnerable groups (e.g., young, women); emphasis on value chain development; strengthened land tenure governance; gender; climate benefits etc.


Thank you!
Web: www.unccd.int
Twitter: @UNCCD
Facebook: www.facebook.com/UNCCD


The Great Green Wall initiative
Initially covering an area 15 km wide and 7,775 km long from Dakar to Djibouti, by 2030, the Wall aims to:
--Restore 50 million hectares of currently degraded land
--Sequester 250 million tonnes of carbon
--Create 10 million green jobs in rural areas.
http://www.greatgreenwall.org/
Led by the African Union and funded primarily by World Bank and the GEF, multiple international and national institutions have mobilized resources and are coordinating development projects in support of the Great Green Wall.
GGW is a $8bn project restoring degraded land

Great Green Wall: Restoration approach

- Landscape scale restoration across land uses and production systems (e.g. forests, agroforestry, croplands, grasslands, and pastoral and fishery systems).
- Involves many sectors and groups, putting communities – and their livelihoods – at the centre.
- Restoration planned along the entire value chain, from land and seed to end products and markets.

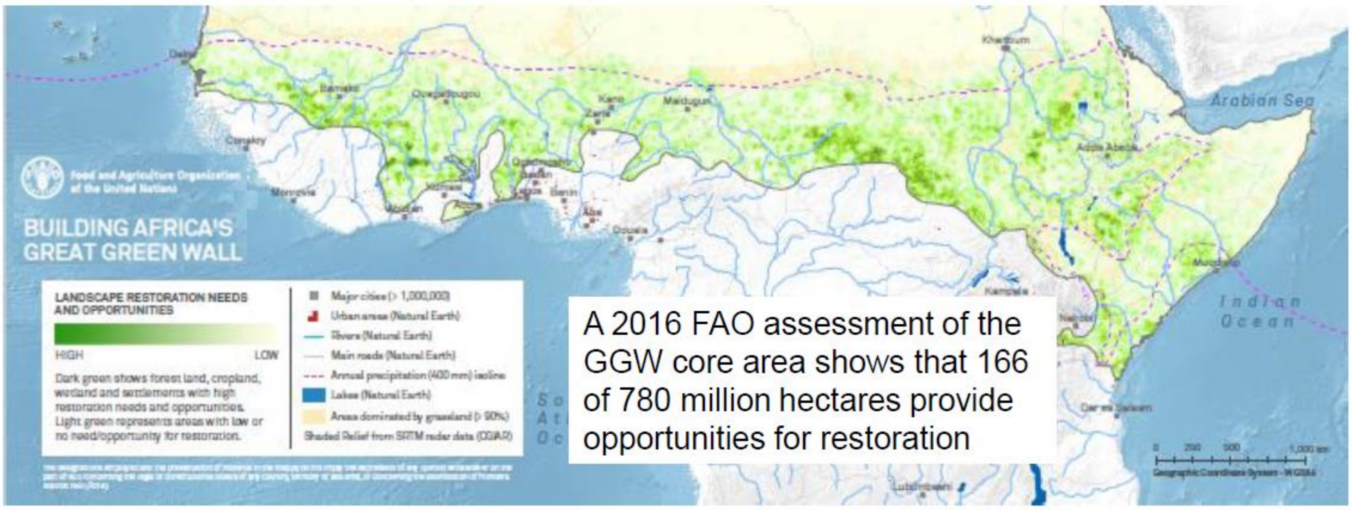
Photograph: Jill Filipovic for the Guardian

Great Green Wall: Strategic relevance

- African ownership and leadership
- Alignment with regional priorities
- Strong poverty reduction focus
- Promotion of climate resilience
- Focus on knowledge networks

Great Green Wall: Restoration potential

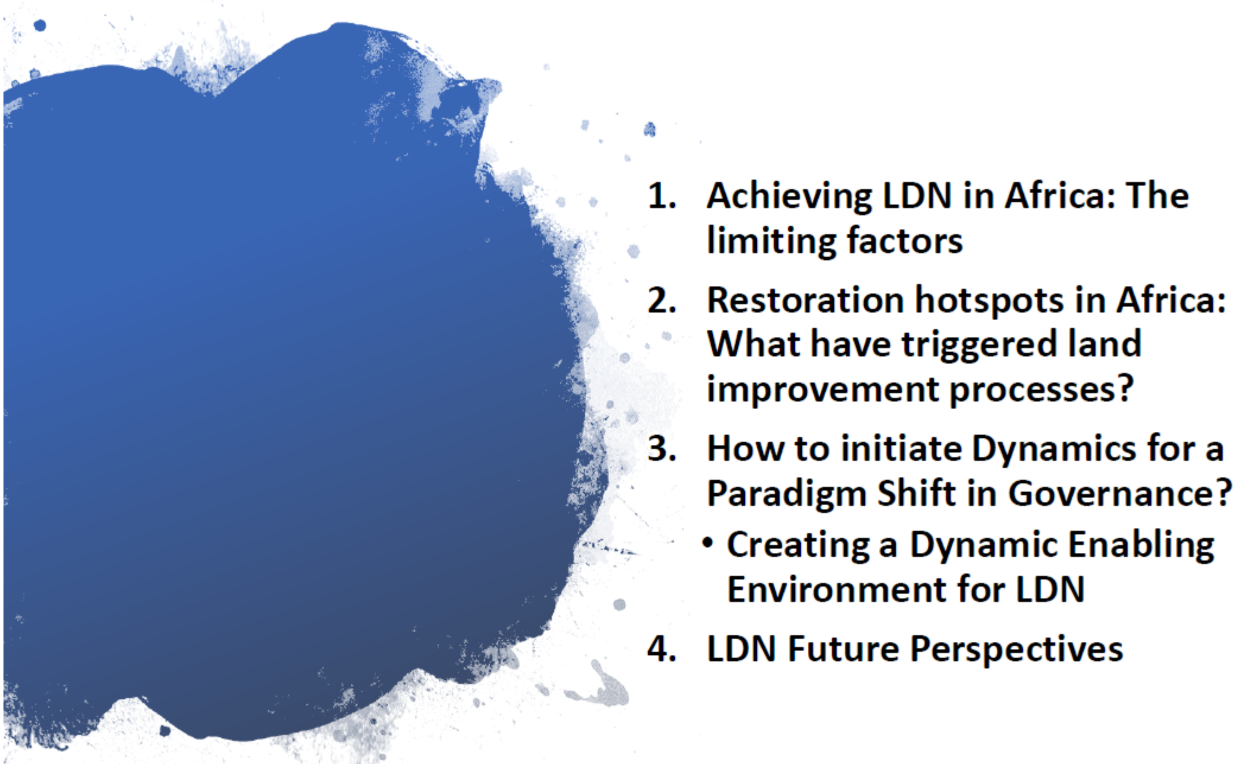
United Nations
Convention to Combat Desertification



United Nations
Convention to Combat Desertification

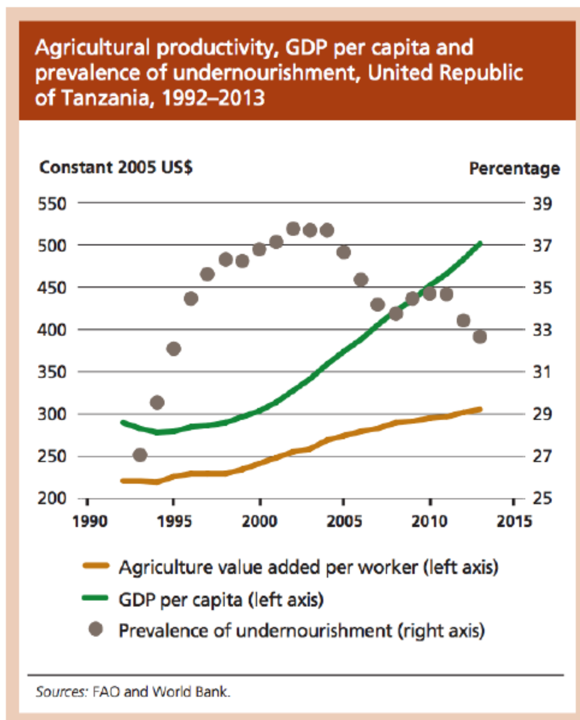
GGW: Impacts

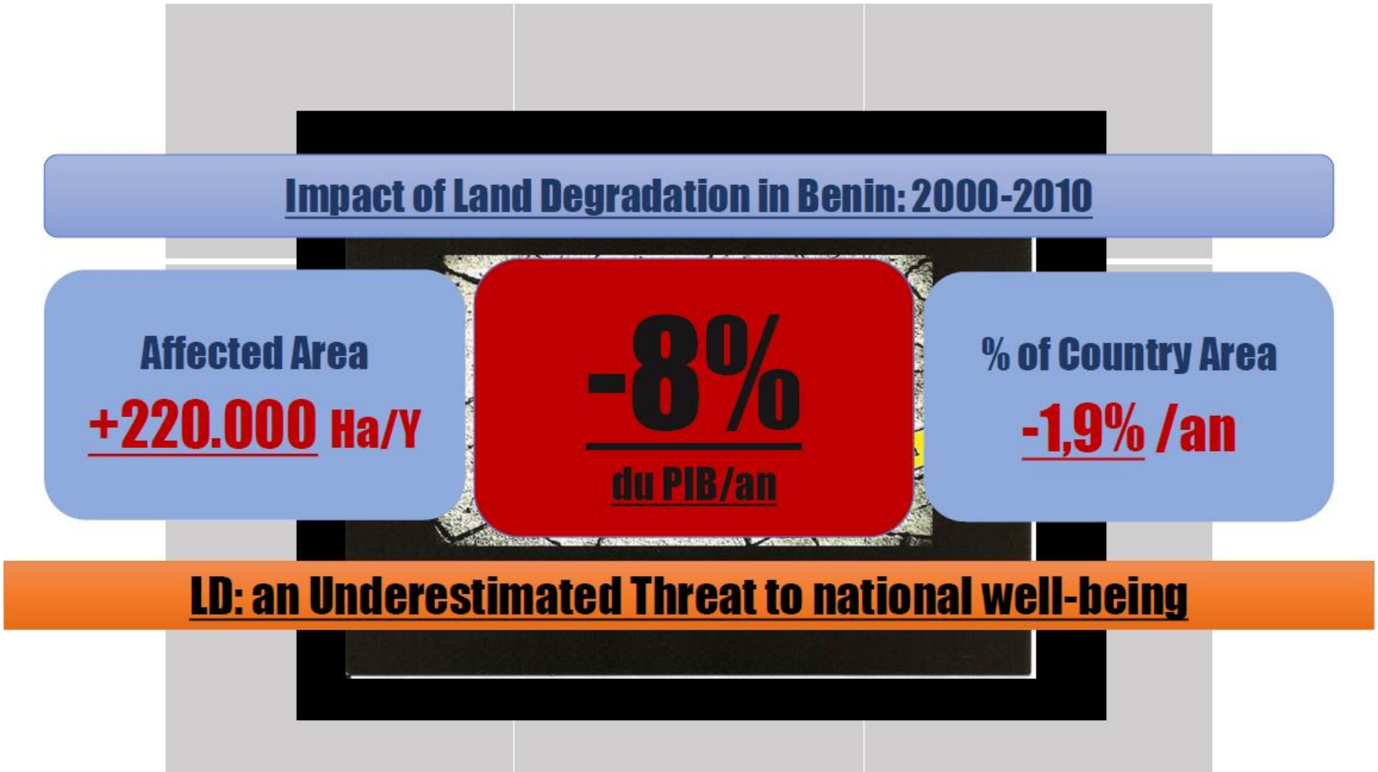

10th International Soil Congress
17-19 June, Ankara Turkey
Successful Transformation
Towards LDN:
Future Perspective
Insights from Africa
Luc GNACADJA
President
GPS-Dev

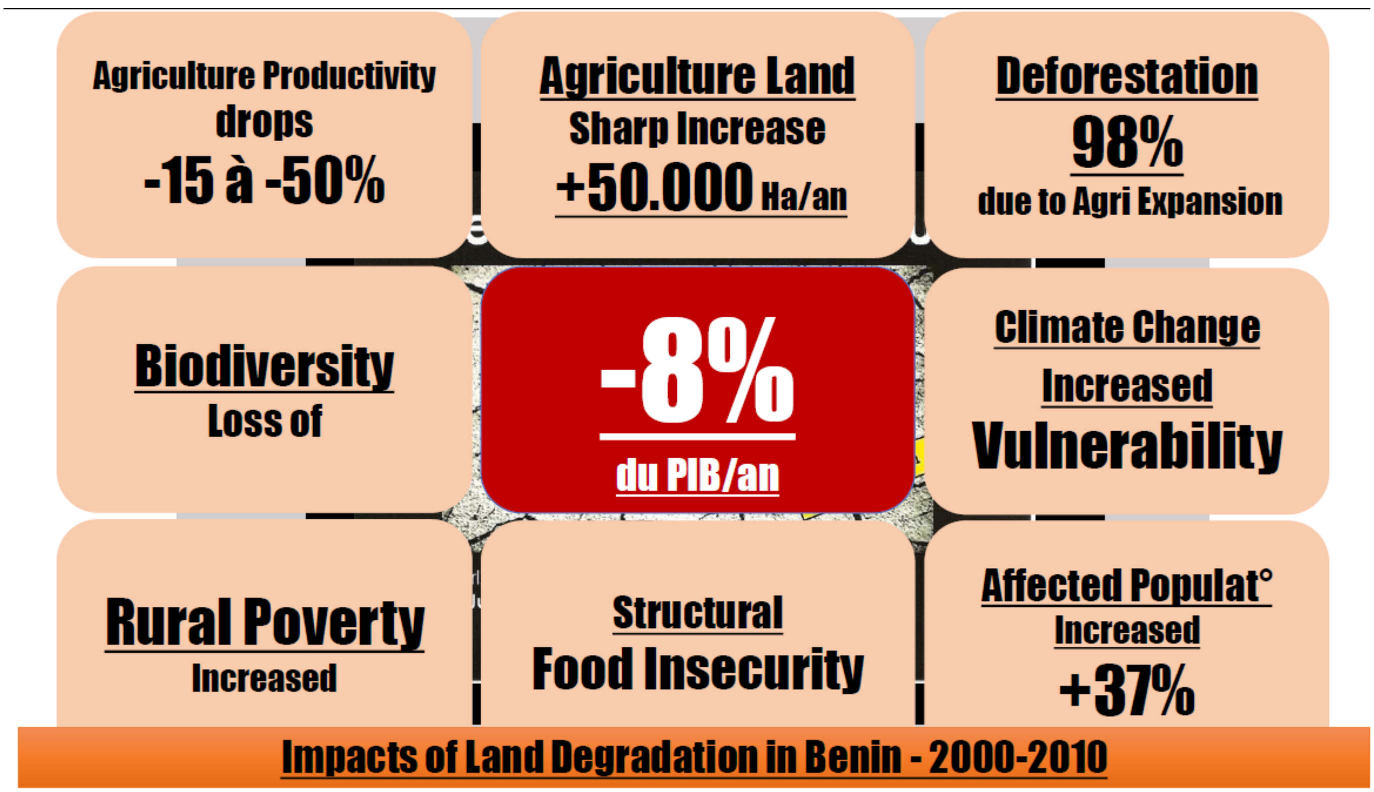

1. Achieving LDN in Africa: The limiting factors
2. Restoration hotspots in Africa: What have triggered land improvement processes?
3. How to initiate Dynamics for a Paradigm Shift in Governance?
• Creating a Dynamic Enabling Environment for LDN
4. LDN Future Perspectives

Economic Growth & Agriculture output have not improved Food Security or reduced Rural Poverty

- **Since 1990 Africa's share in global distribution of hunger has increased by 59% despite the region's overall economic performance**
- **Up to 75% of the poor and & food-insecurity are in rural areas**

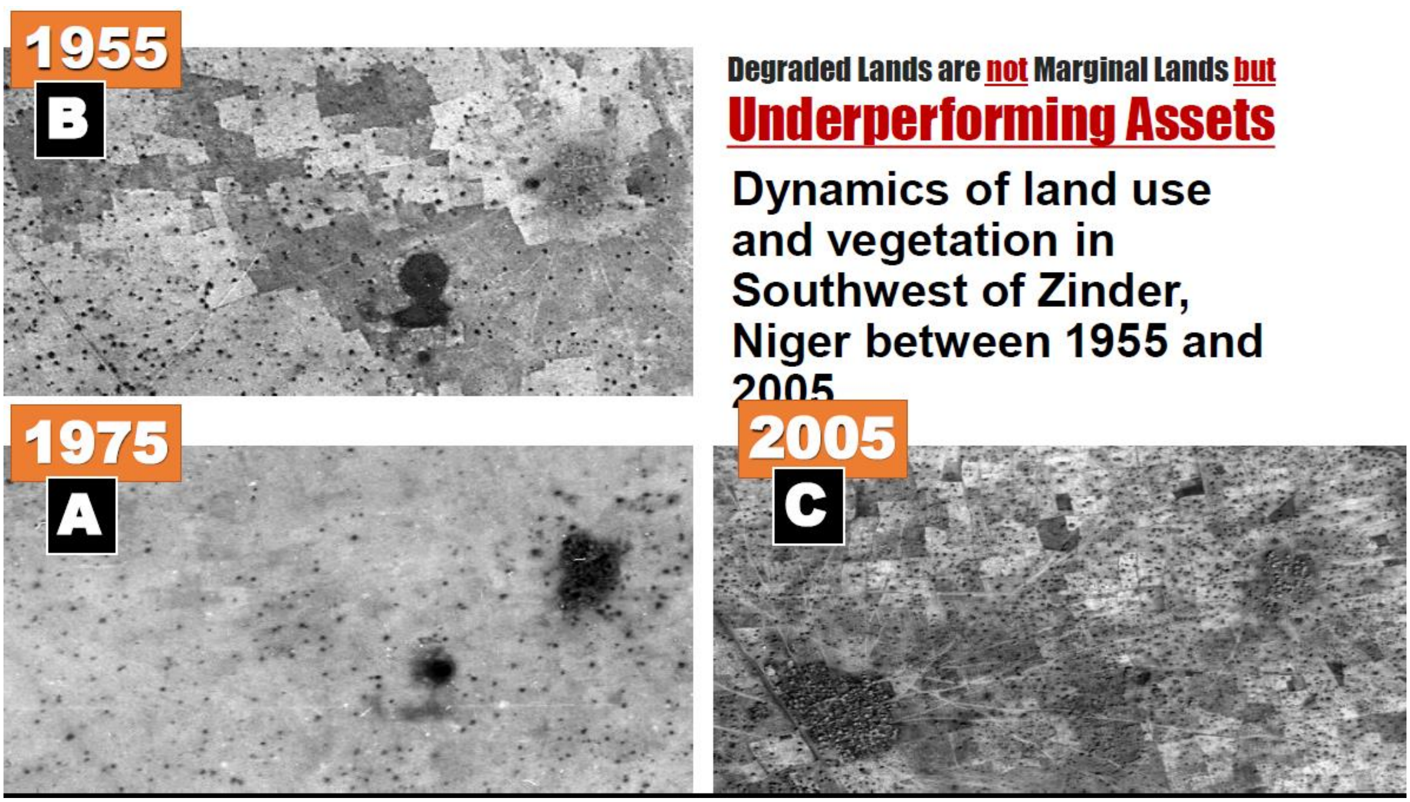


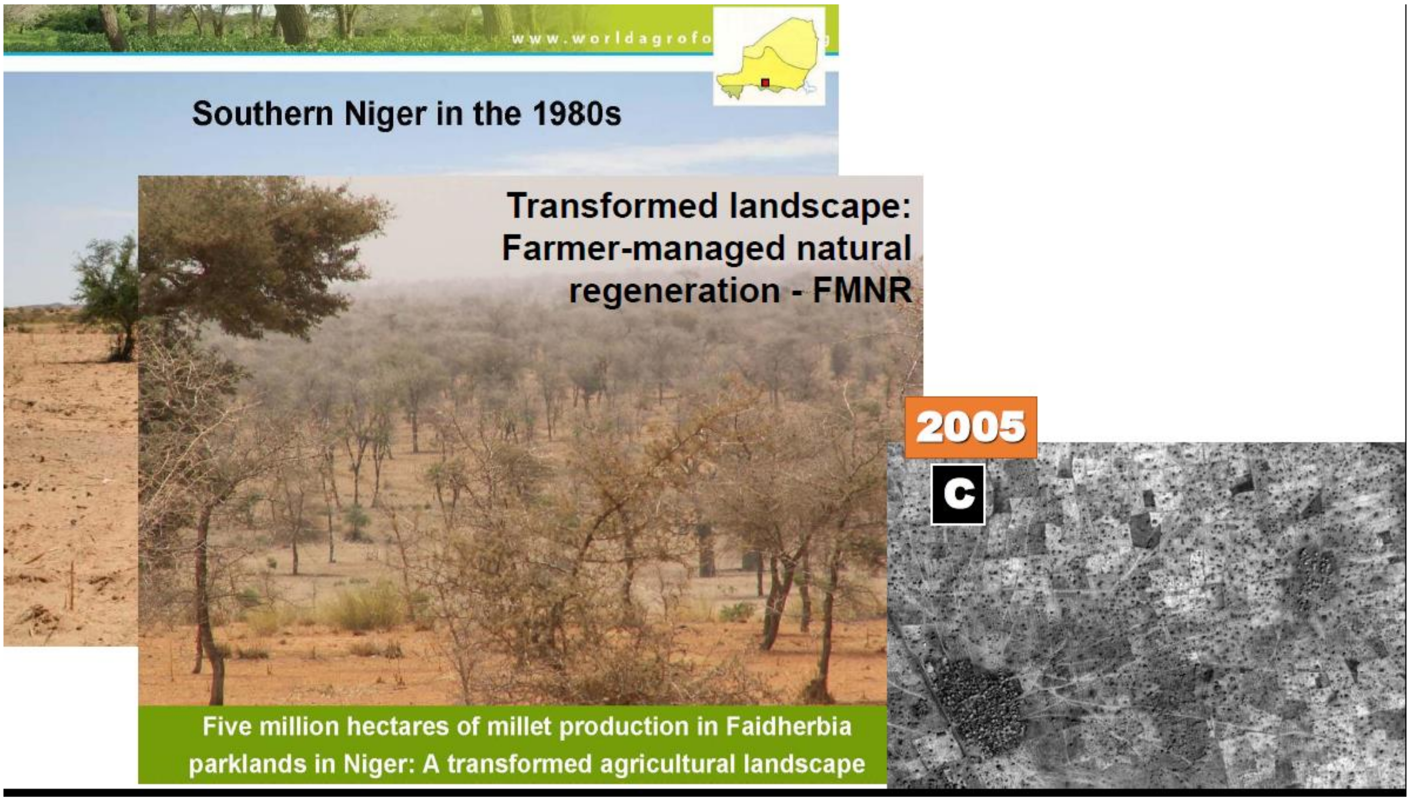

Impact of Land Degradation in Benin: 2000-2010
Affected Area
+220.000 Ha/Y
-8%
du PIB/an
% of Country Area
-1,9% /an
LD: an Underestimated Threat to national well-being


Agriculture Productivity drops
-15 à -50%
Agriculture Land
Sharp Increase
+50.000 Ha/an
Deforestation
98%
due to Agri Expansion
Biodiversity
Loss of
-8%
du PIB/an
Climate Change
Increased
Vulnerability
Rural Poverty
Increased
Structural
Food Insecurity
Affected Populat°
Increased
+37%
Impacts of Land Degradation in Benin - 2000-2010

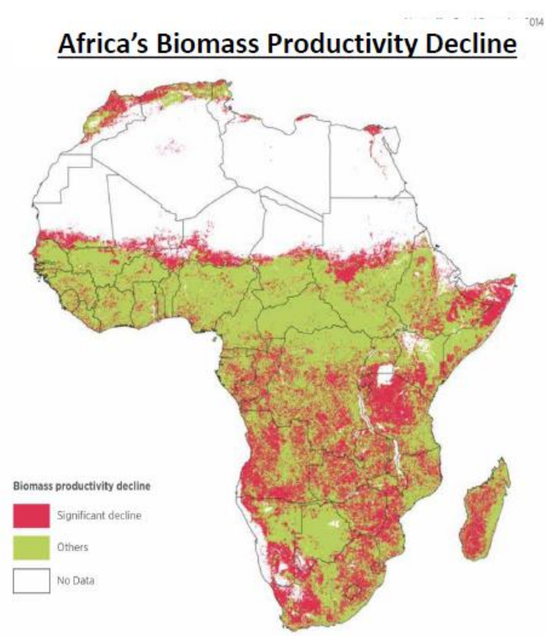
Restoration hotspots in Africa: What have triggered land improvement processes?

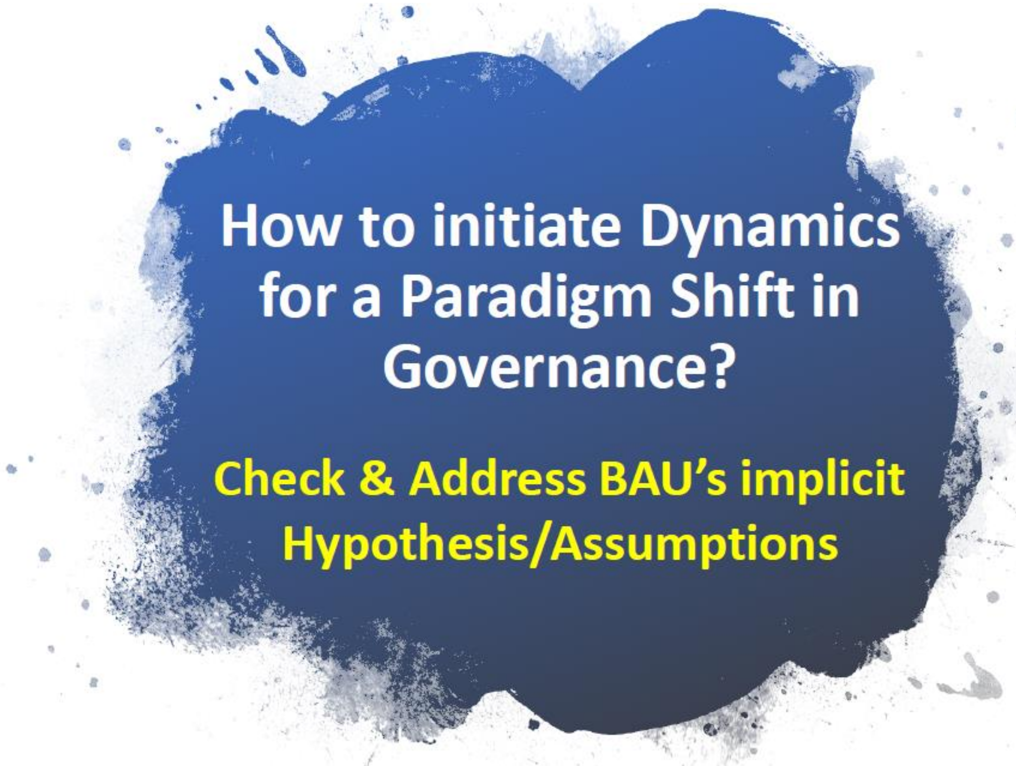
In most cases (Niger, Mali, Ethiopia, and Malawi, etc.) "innovative farmers have taken the lead in regreening efforts" and have built up Africa's restoration hotspots

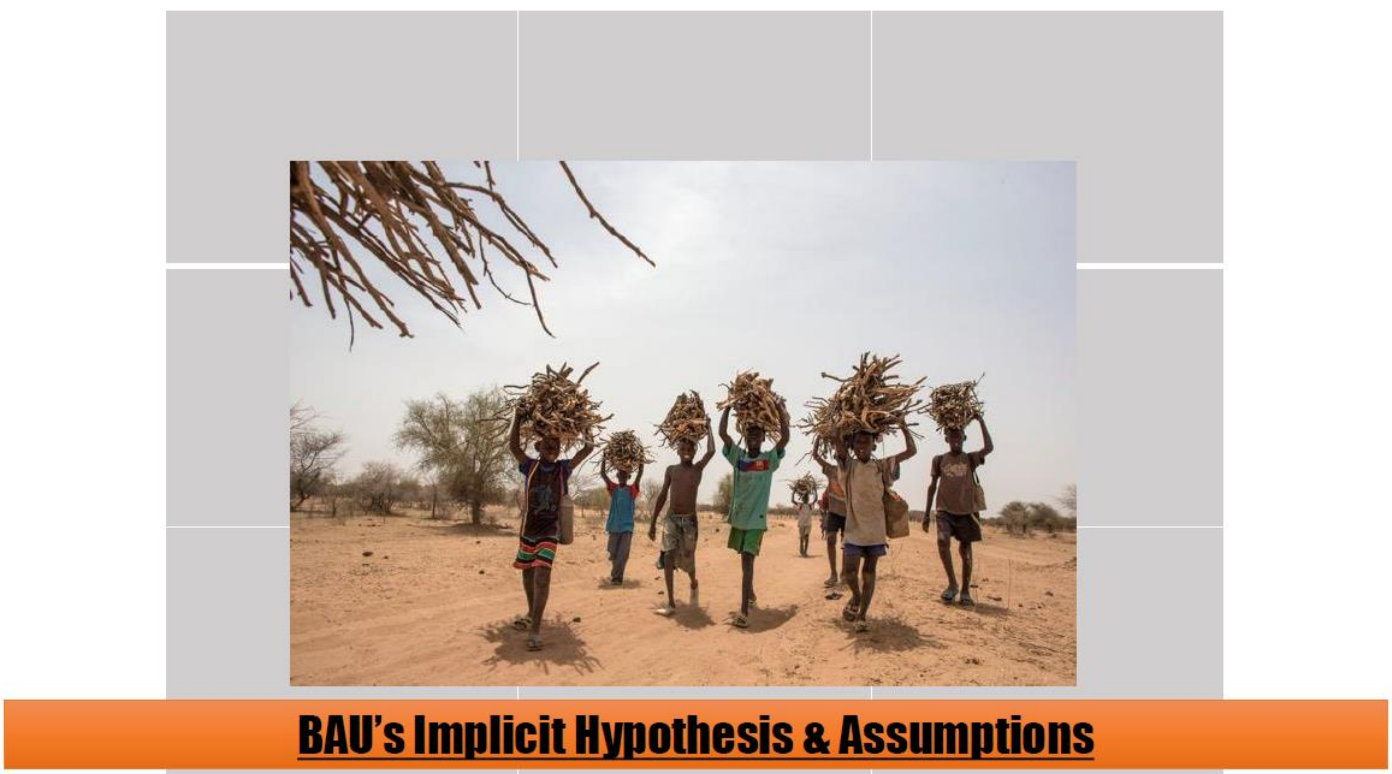


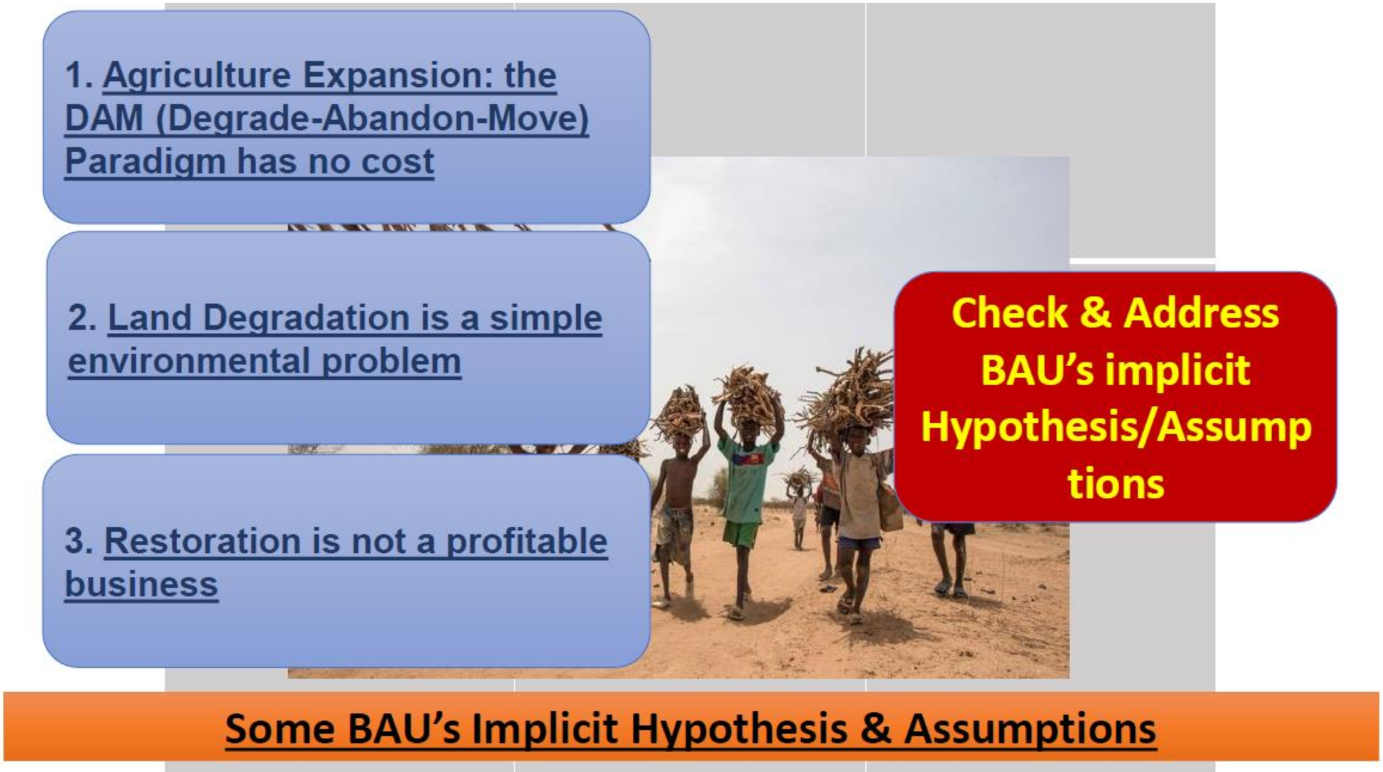

www.worldagrofo
Southern Niger in the 1980s
Transformed landscape: Farmer-managed natural regeneration - FMNR
2005
C
Five million hectares of millet production in Faidherbia parklands in Niger: A transformed agricultural landscape


Degraded Lands are not Marginal Lands but
underperforming Assets
Opportunities for Forest and Landscape Restoration in Africa
715 Millions ha ...
More than in any other continent!

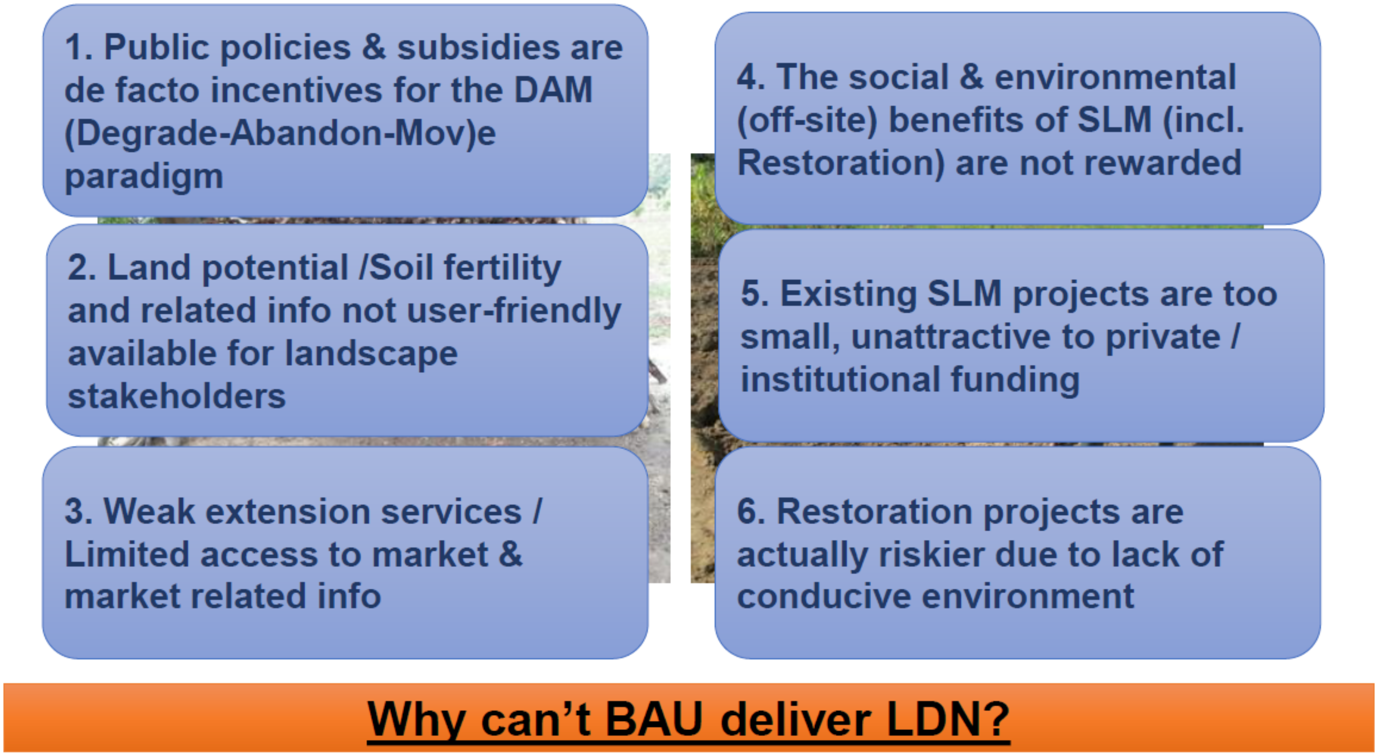

Africa's Biomass Productivity Decline
Biomass productivity decline
Significant decline
Others
No Data

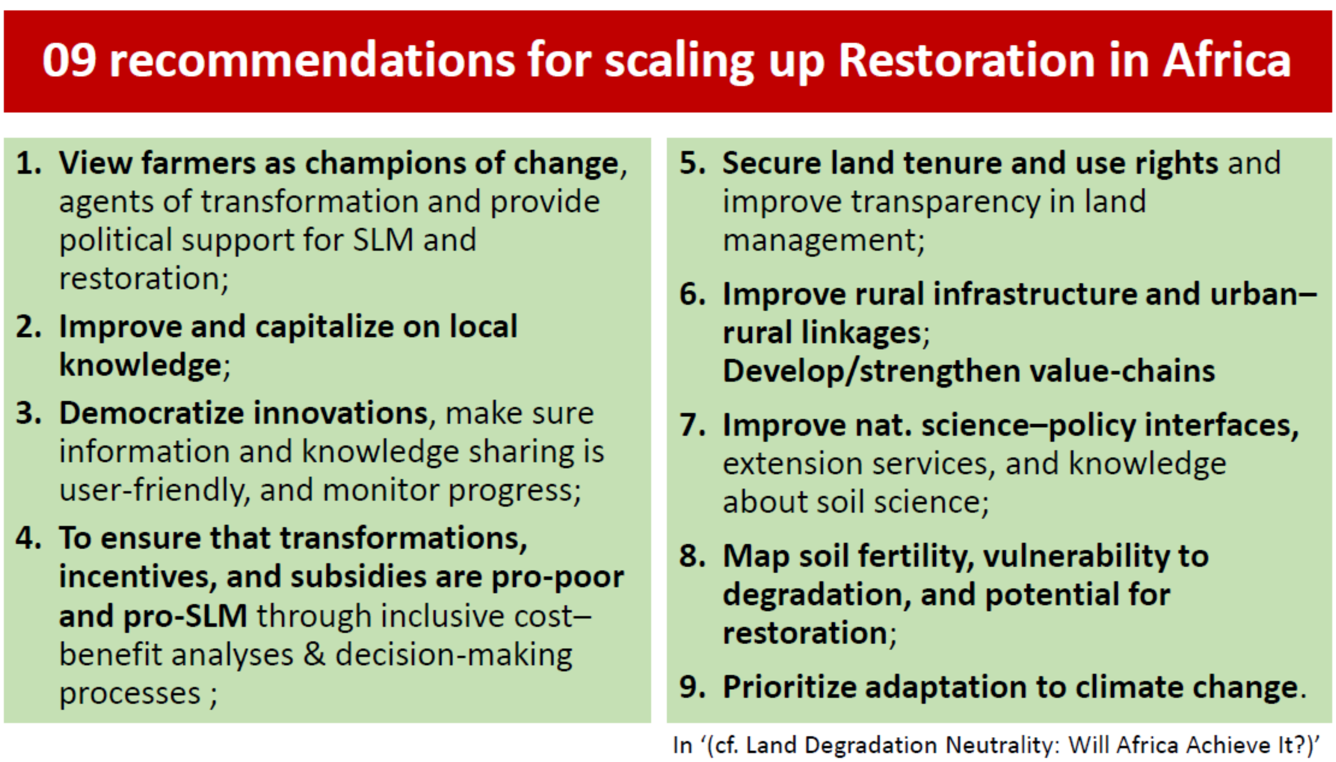

How to initiate Dynamics for a Paradigm Shift in Governance?
Check & Address BAU's implicit Hypothesis/Assumptions


BAU's Implicit Hypothesis & Assumptions

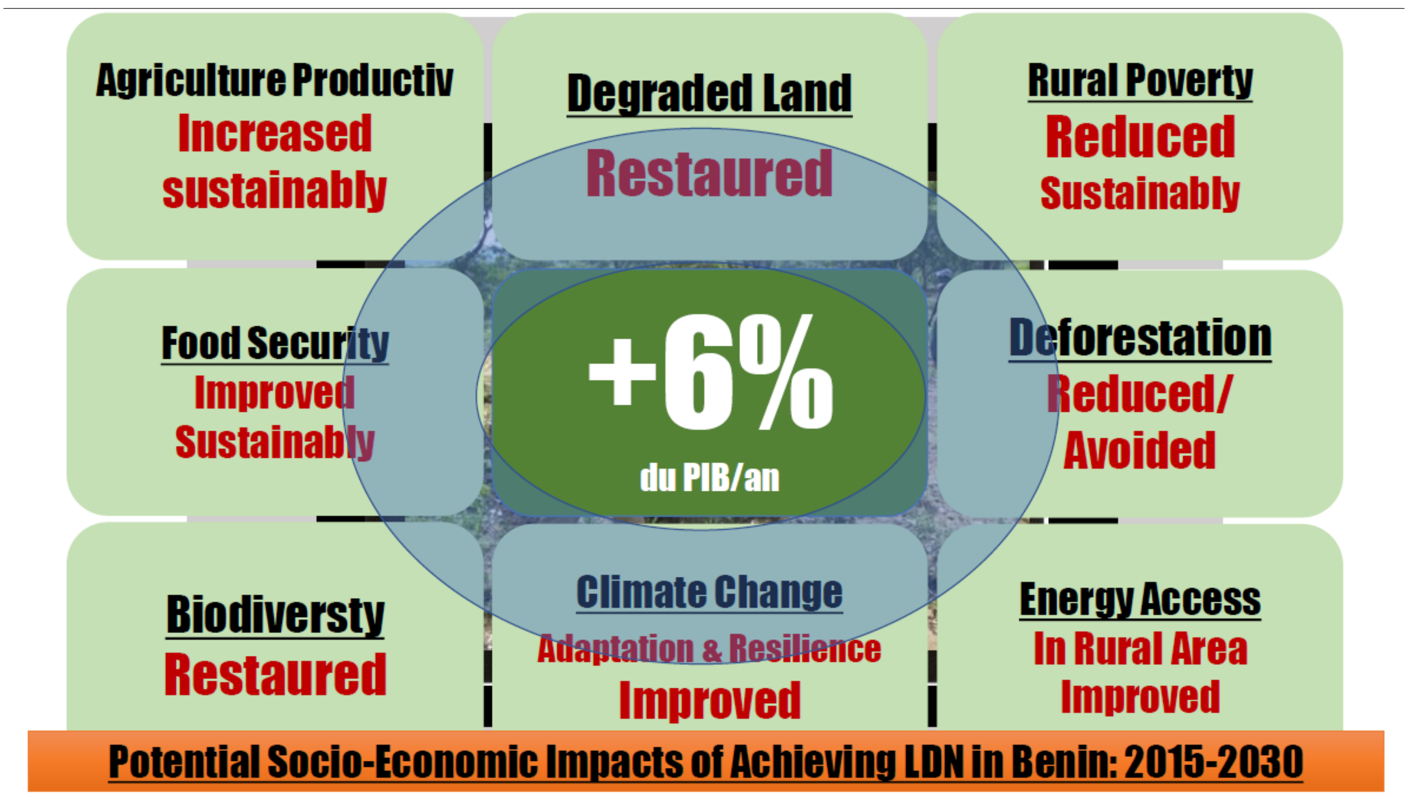

1. Agriculture Expansion: the DAM (Degrade-Abandon-Move) Paradigm has no cost
2. Land Degradation is a simple environmental problem
3. Restoration is not a profitable business
Check & Address BAU's implicit Hypothesis/Assumptions
Some BAU's Implicit Hypothesis & Assumptions


Why can't BAU deliver LDN?


1. Public policies & subsidies are de facto incentives for the DAM (Degrade-Abandon-Mov)e paradigm
2. Land potential /Soil fertility and related info not user-friendly available for landscape stakeholders
3. Weak extension services / Limited access to market & market related info
4. The social & environmental (off-site) benefits of SLM (incl. Restoration) are not rewarded
5. Existing SLM projects are too small, unattractive to private / institutional funding
6. Restoration projects are actually riskier due to lack of conducive environment
Why can't BAU deliver LDN?


09 recommendations for scaling up Restoration in Africa
1. View farmers as champions of change, agents of transformation and provide political support for SLM and restoration;
2. Improve and capitalize on local knowledge;
3. Democratize innovations, make sure information and knowledge sharing is user-friendly, and monitor progress;
4. To ensure that transformations, incentives, and subsidies are pro-poor and pro-SLM through inclusive cost–benefit analyses & decision-making processes ;
5. Secure land tenure and use rights and improve transparency in land management;
6. Improve rural infrastructure and urban–rural linkages; Develop/strengthen value-chains
7. Improve nat. science–policy interfaces, extension services, and knowledge about soil science;
8. Map soil fertility, vulnerability to degradation, and potential for restoration;
9. Prioritize adaptation to climate change.
In '(cf. Land Degradation Neutrality: Will Africa Achieve It?)'


Creating a Dynamic Enabling Environment for LDN
1. Map land status & potential
2. Landscape as the Unit (or Scale) for Integrated or Holistic Management
3. Marginal Land Versus Underperforming Assets
4. Address What Causes Farmers (Smallholder Farmers/Small Family Farms) to Make Poor Land Management Investment Decisions
5. Engage the Private Sector and Business Community
6. Monitor Progress Towards LDN and Improving Institutions Accordingly


Agriculture Productiv
Increased sustainably
Degraded Land
Restaured
Rural Poverty
Reduced Sustainably
Food Security
Improved Sustainably
+6%
du PIB/an
Deforestation
Reduced/ Avoided
Biodiversty
Restaured
Climate Change
Adaptation & Resilience
Improved
Energy Access
In Rural Area
Improved
Potential Socio-Economic Impacts of Achieving LDN in Benin: 2015-2030

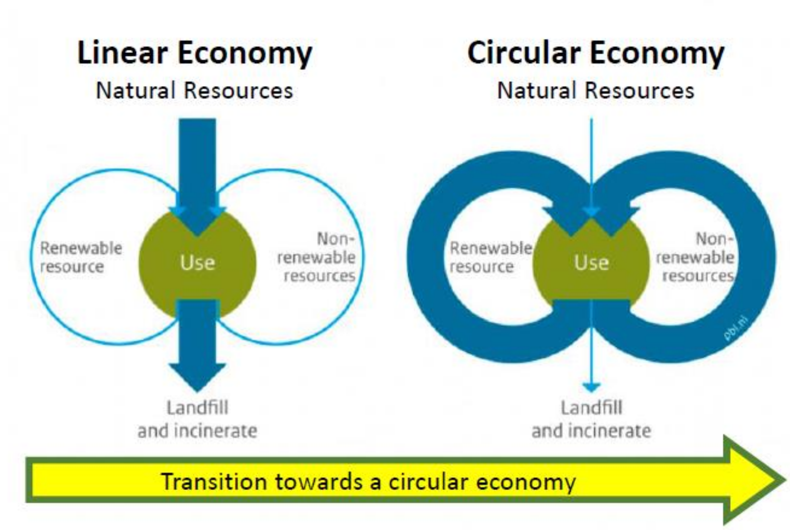
Creating a Dynamic Enabling Environment for LDN

1. **Map land status & economic value potentials**
2. **Landscape as the Unit (or Scale) for Integrated or Holistic Management**
    - the African Landscape Action Plan should be fully mainstreamed at the national and local level throughout Africa.
3. **Marginal Land Versus Underperforming Assets**
    - By taking the lead during land improvement on seemingly "marginal land," farmers have demonstrated that degraded lands are not "marginal" but rather "underper- forming assets"
4. **Address What Causes Farmers (Smallholder Farmers/Small Family Farms) to Make Poor Land Management Investment Decisions**
    - The adoption of SLM practices amongst farmers in Africa remains low despite the considerable potential gains due to a number of factors that influence farmers' land management decisions.
5. **Engage the Private Sector and Business Community**
    - LDN targets can be supported either through businesses' own operations that involve land use or through inclusion in a larger restoration value chain. Companies directly using land for their operations can contribute by adopting SLM practices to minimize current and future degradation, or by actively restoring degraded and abandoned production lands prior to utilization
6. **Monitor Progress Towards LDN and Improving Institutions Accordingly**
    - To be effective, the monitoring system would need to be flexible and cater to the needs of local, national, regional, and global policy makers, which would require a combination of top-down and bottom-up approaches

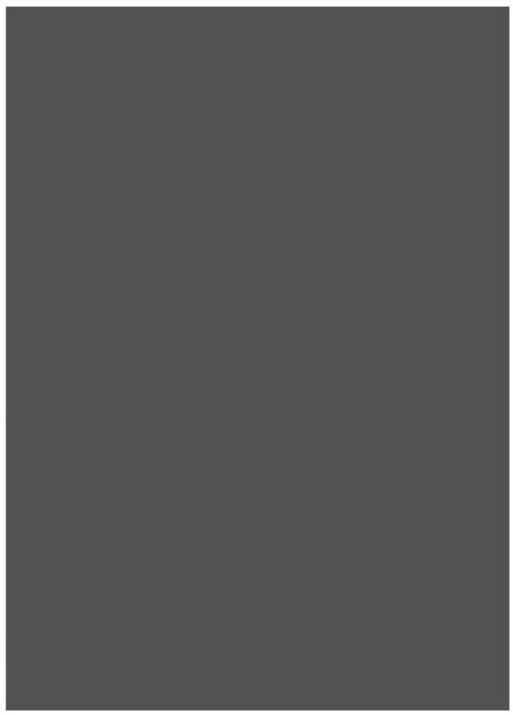
LDN Future Perspectives

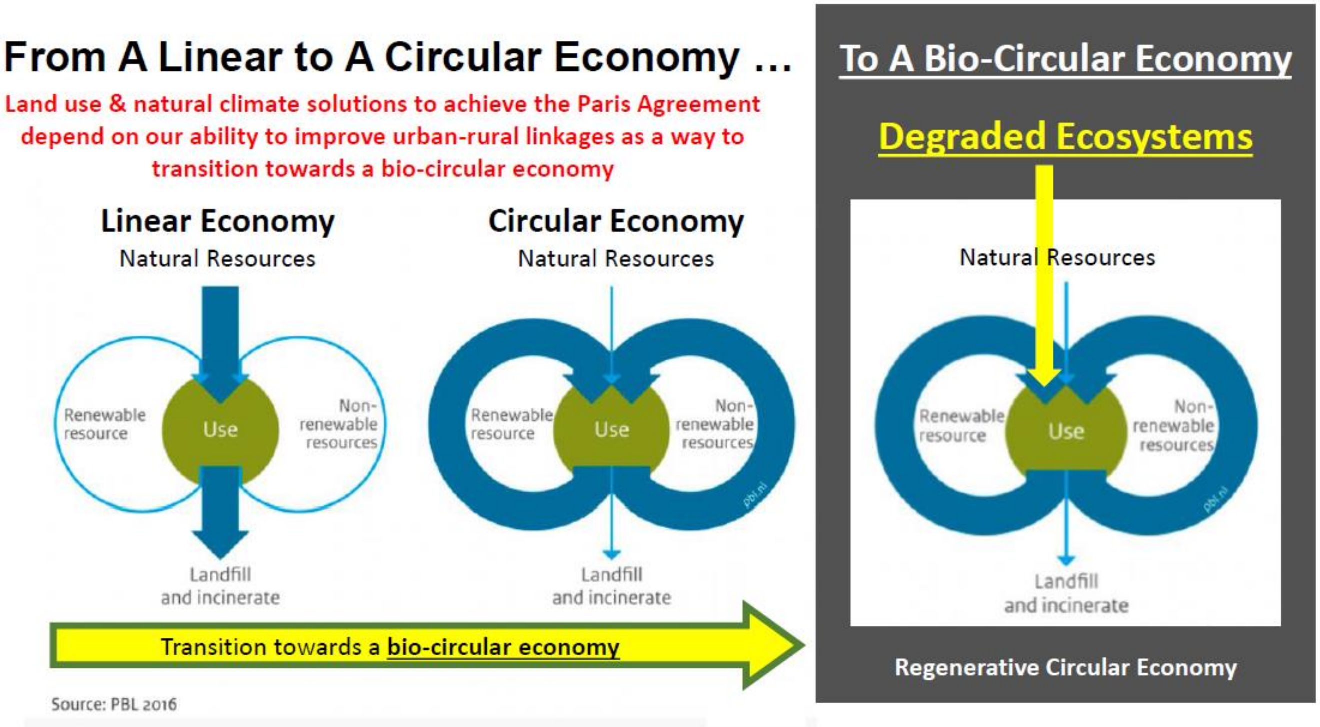
1. Urbanization & Advance Integrated Territorial Development
   - ImproveD urban-rural linkages
2. Transition to bio-circular economy To improve urban-rural linkages
3. Address overall Governance transformation beyond land governance
4. From LDN to LDNW: the issue of virtual land & water use

From A Linear to A Circular Economy …



Source: PBL 2016




From A Linear to A Circular Economy …
Land use & natural climate solutions to achieve the Paris Agreement depend on our ability to improve urban-rural linkages as a way to transition towards a bio-circular economy
Linear Economy
Natural Resources
Renewable resource
Use
Non-renewable resources
Landfill and incinerate
Circular Economy
Natural Resources
Renewable resource
Use
Non-renewable resources
Landfill and incinerate
Transition towards a bio-circular economy
Source: PBL 2016
To A Bio-Circular Economy
Degraded Ecosystems
Natural Resources
Renewable resource
Use
Non-renewable resources
Landfill and incinerate
Regenerative Circular Economy


To achieve LDN, We need a Paradigm Shift in …
Governance
Luc GNACADJA
President
GPS-Dev

Thank You

Luc GNACADJA
Président

GPS-Dev

Governance & Policies for Sustainable Development

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