DETERMINATION OF SOIL QUALITY INDEX OF BALA STATEFARM SOILS ACCORDING TO THE MEDALUS METHODOLOGY

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ABSTRACT

As a result of global and regional climate changes, MEditerranean Desertification And Land USe (MEDALUS) project is one of the largest project of the European Commission established in the environment program. In this study, MEDALUS soil quality index parameters were applied to the Bala Statefarm soils using geographic information systems and soil quality index of study areas soils were determined. Distribution of the soil quality index values of the study area soils was determined as 91.8 % high, 8.18 % medium and 0.01 % low respectively. It was observed that 99.7% of Ustocreptic Calciorthid that has the largest soil (27.4 %) in study area has high soil quality index value. In addition that, all of the Calci Gypsiorthid that has the smallest soil (1.9 %) in study area, has moderate soil quality index values.

INTRODUCTION

The productivity of agricultural lands is the result of complex interactions between soil, climate, crops and management. Today most land on the world are being degraded by over cultivation, overgrazing, deforestation and poor irrigation practices. Due to population growth, changing economic and political circumstances, ignorance and social pressure, such overexploitation of natural resources is caused. Rapid growth in population causes agricultural expansion into marginal land, leading to subdivision of land, deforestation and desertification. Excessive use of pesticides and other chemical substances can lead to desertification (Özden, 2000). In this sense, desertification is a phenomenon affecting very large areas where the land has lost productive capacity due to both to human activities and regional and global climate changes. In other to understand this case, we must identify the physical and manmade processes and their interactions (Sciortion et al, 2000). As a result of these pressures the European Commission (EC) has established through its effects of desertification. MEDALUS is the largest project in this programme involving 31 groups and 10 countries. The MEDALUS methodology (Basso, 2000) aims at assessing sensitivity to desertification by applying the so called EAS Index (Environmentally Sensitive Areas). Environmentally sensitivity can be defined as the degree of reactivity of the ecosystem, in particular of the soil to strains natural origin (Sequi and Viarello, 1998). This ESA Index are identified by the combination of four quality indexes that are soil, climate, vegetation and land management. Particularly, soil quality index formed by parent material, texture, depth and slope is highly important factor in relation to the capacity to sustain the growth and maintenance of vegetation.

The objective of this study was to evaluate and determine soil quality index of Bala Statefarm to reduce risk of desertification effect using GIS techniques.

MATERIAL AND METHOD

Material

The survey was conducted in the Bala Statefarm located in the Central Anatolia and between 39° 19' 39'' - 39° 30' 55'' South latitude, 33° 15' 02''-33° 20' 48'' East longitude (Figure 1). Total study area is 8442 ha. Some part of this area is approximately 640.2 ha in size and consists of various land types (barren land, road, mountainous etc.). According to MEDALUS methodology, to determine soil quality index of Bala Statefarm soils, digital soil map (Arcak, 1992), digital geological map and DEM (Digital Elevation Model) scale 1:25 000 were used. Mapping projection of these maps are European 1950 Datum and Universal Transverse Mercator (UTM). To analysis these data, Arc Info and Arc View GIS (Geographical Information Systems) programs were used.

Method

Soil quality indicators for mapping ESAs can be related to water availability and erosion resistance. These qualities can be evaluated by using some soil properties given in regular soil survey reports such as texture, parent material, soil depth, slope angle (Figure 2). The use of these properties for defining and mapping ESAs requires the defination of distinct classes with respect to degree of land protection from desertification (Giardano, 2000)

According to MEDALUS (**ME**diterranean **D**esertification **A**nd **L**and **U**se, European Comission, 1999), Soil Quality Index (SQI) was estimated with the formula. Information on parent material was derived from the lithological map of study area in digital format. MEDALUS parent material index was prepared using Arc Info Grid Tool from geological map. Soil depth and soil texture maps were derived as different layers from digital soil map based on series level and Soil Taxonomy. Mapping units of soil texture and soil depth were re-classified according to MEDALUS texture and depth indexes using Arc Info Grid Tool. The slope indicator was derived form a DEM (Digital Elevation Model), scale 1: 25.000. By means of GIS technique, SQI formula was applied by using all these parameters. Finally, the last layer was adopted for MEDALUS SQI.

Texture Classes	
Class	Description
Medium-Fine-Coarse Medium-Coarse Medium Medium-Fine	Good (A)
Fine-Coarse Fine-Medium	Medium (B)
Fine	Poor (C)
Coarse	Very Poor (D)

Slope Classes	
Class (%)	Description
S < 6	Very Gently (A)
S=7-18	Gently (B)
S= 19-35	Poor (C)
S>35	Very Poor (D)

Depth Classes	
Class	Description
Very Thick From medium to thick	Good (A)
From thin to very thick Medium From Medium to very thin	Medium (B)
From medium to very thin	Poor (C)
Very thin	Very Poor (D)

Parent Material Classes	
Class	Description
Unconsolidated Clastic, Slayt-metamorphic, Volcanic Conglomeratic-sandstone	Good (A)
Carbonate, Sandy-calcarnetic	Medium (B)
Evaporite, Clayey sandstone	Poor (C)
Clayey	Very Poor (D)

Score			
A	B	C	D
1	1.33	1.66	2

SQI = (Parent material * Texture * Depth * Slope)1/4

SOIL QUALYT CLASSES	
CLASS	RANGE
HIGH	1 - 1.33
MEDIUM	1.34 - 1.66
LOW	1.67 - 2

Figure 1. Follow cahar of the methodology

RESULTS and DISCUSION

In this study, MEDALUS Soil Quality Index parameters were applied to the Bala Statefarm soils using GIS and soil quality index of study area soils were determined. Distribution of soil quality index values of study area soils were determined as 91.8 % high, 8.18 % medium and 0.01 % low respectively (Figure 3 and Table 1). In addition that, Distribution of SQI parameters, parent material, texture, depth, slope, were detail investigated on study area and given Figure 3,4,5 and 6

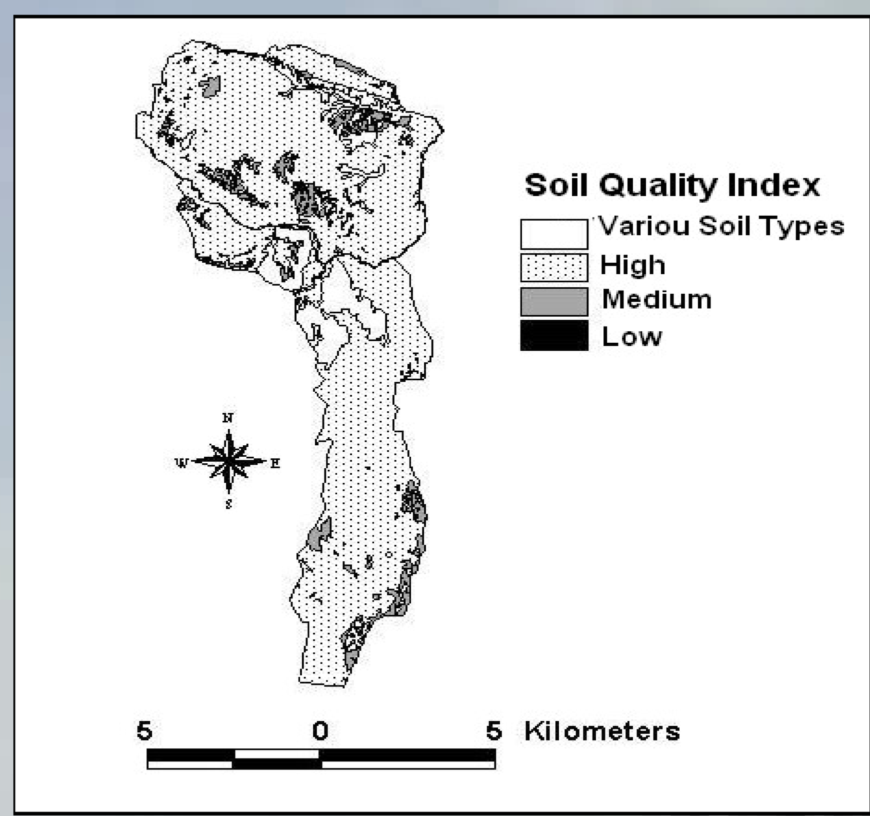


Figure 2 Ditribution of SQI

Soil texture is related to erodibility, water retention capacity, crusting and aggregate stability. The amount of available water is related to both texture and structure. Texture group must be recalled that the categories Fine, Medium, and Coarse referred to the FAO system, corresponds respectively clayey, loamy, and sand texture of the USDA classification. The medium texture having high quality index guarantees the best condition for water retention capacity and drainage. The coarse texture does not enable the soil to retain water sufficiently. On the other hand, the fine texture makes drainage difficult and insufficient. According to Figure 3, while more than half of the study area (54.35 %) is high, 21.54 % of the study area has a poor and very poor quality.

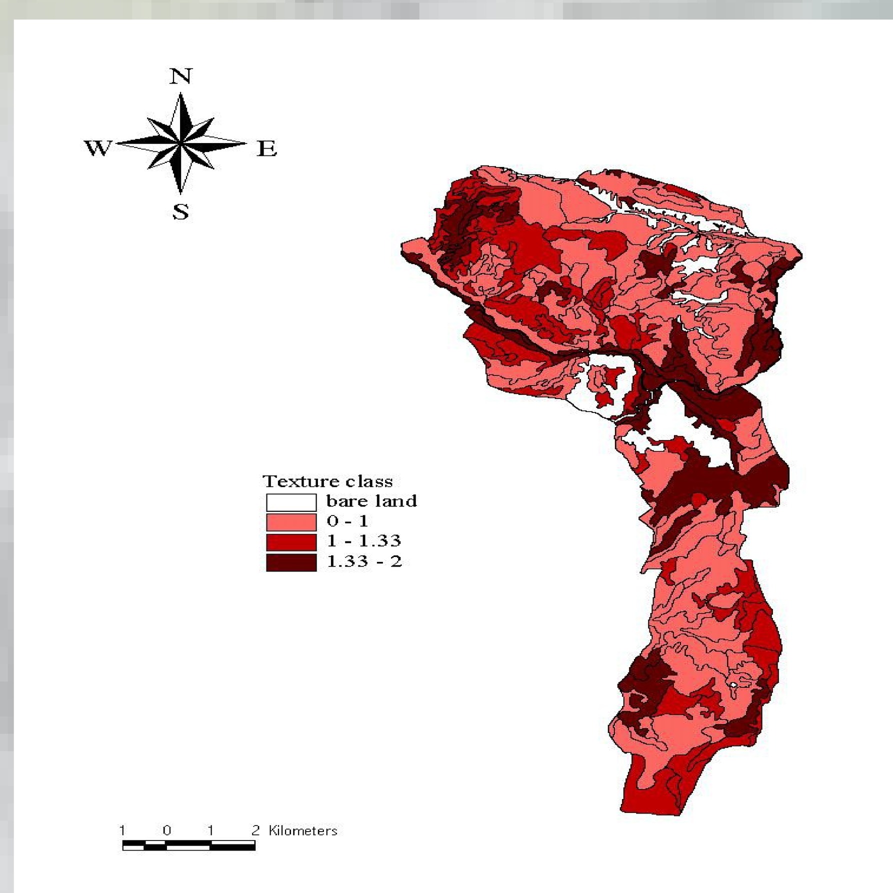


Figure 3. Distribution of soil texture classes

Soil depth is closely related to the possibility of establishing or maintaining various types of vegetation which play a fundamental role in preventing erosion. Soil depth parameters derived from the digital soil map of the study area presented in Figure 4.. It can be seen that 77.8 % of total area is good and very good soil quality and distribution in SQI is 99.6 % and 96.9 % respectively.

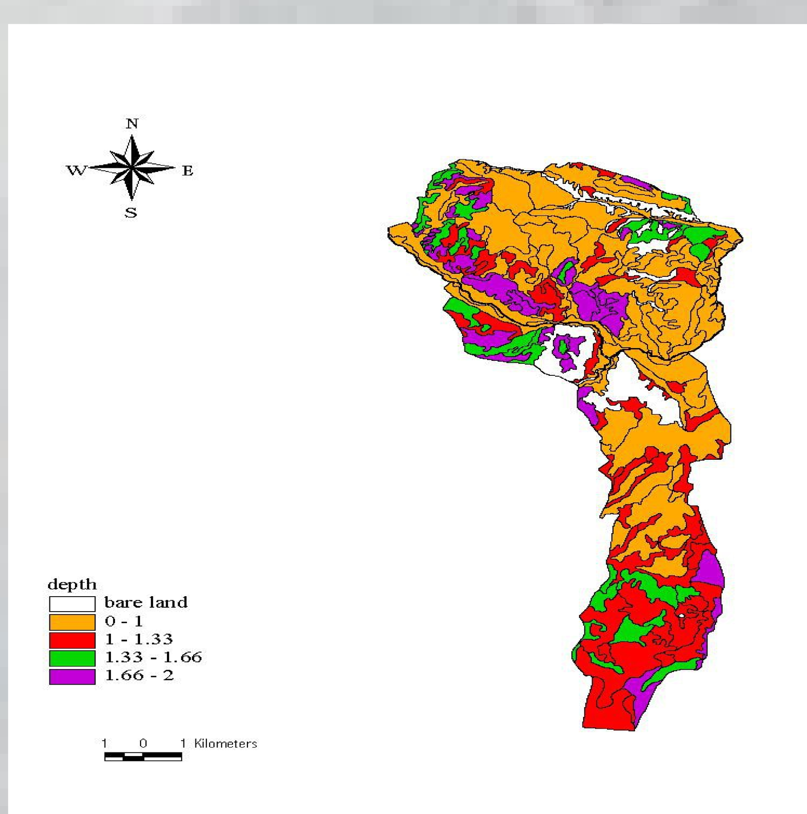


Figure 4. Distribution of soil depth classes

It can be seen form Figure 5, distribution of parent material index values is 17.6 % (good), 79.9 % (medium) and 2.5 % (low). In addition that, It was found that high and medium SQI values are 97.1 % and 92.3 % in this parameter.

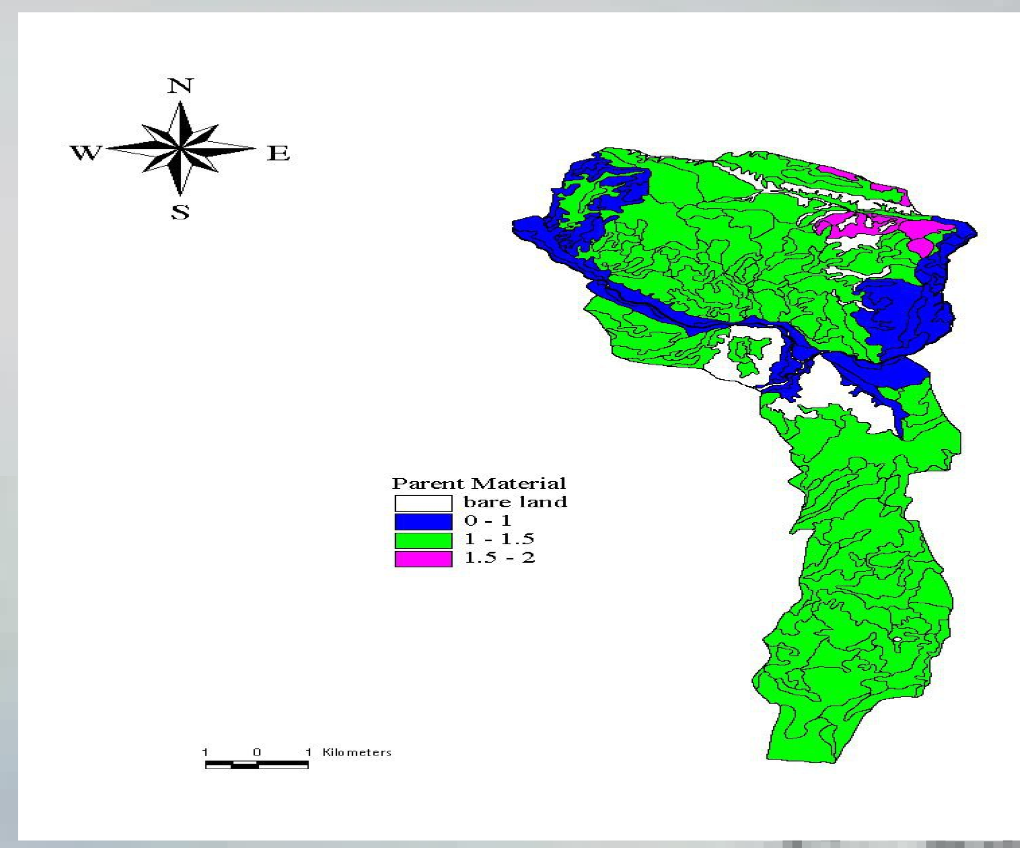
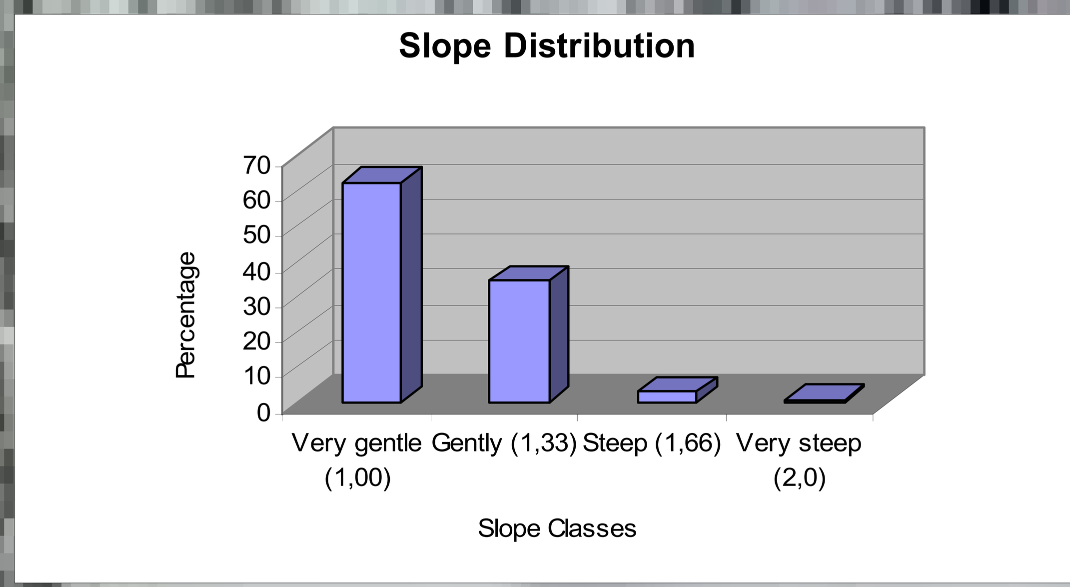


Figure 5. Distribution of parent materyal classes

The slope parameter was derived from a DEM. This parameter is a crucial factor in the processes of soil erosion. In order to start erosion process a certain critical angle is required. According to SQI, distribution of slope was given Table 5. While very steep and steep slopes are 3.3 %, very gentle and gently slopes are 96.7 % in study area. Moreover, it can be seen that while slope degree is increasing, SQI values is decreased.



There are 21 soil series in research area. Distribution of these series based on Soil Taxonomy is given Table 1. A smaller part of the study area (1.9 %) is Calcic Gypsiorthid (Agıl series). The most common soil taxonomic class is Ustochreptic Calciortid (27.4 %- Kumseki, Omohun, Büvelek series).

Table 6 shows that all soil taxonomic classes don't have low SQI. It was determined that all Calci Gypsiortid soils are medium quality, 64.6 % of Ustic Torriorthent is high quality. Only 14.4 % of Petrogypsic Gypsiorthid is medium. 99.7 % of Ustocreptic Calciorthid, the most common soils in study area, is high quality

Table 1. Distribution of SQI groups according to soil taxonomy

Series Name	Taxonomic Subgroups	Ha	General Ratio (%)	SQI	In group (%)
Ağıl	Calcic Gypsiorthid	14,4	1,9	Medium	100
Purlu	Ustic Torriortent	168,0	2,2	Good	64.6
				Medium	35.4
Höyük	Petrogypsic Gypisorthid	1282,2	16,4	Good	85.6
				Medium	14.4
Sarı sırtı Tavukçulu Çit Yaslı	Typic Gypsiortid	1159,6	14,9	Good	77.4
				Medium	22.6
İşletme Avcıoğlu	Ustalfic Haplargid	326,9	4,2	Good	94.9
				Medium	5.1
Bahçearkas Mezarlık 3. Pompa 4.Pompa	Ustic Torriorthent	742.8	9.5	Good	94.8
				Medium	5.2
Kumseki Omohun Büvelek	Ustocreptic Calsortid	2141,0	27,4	Good	99.7
				Medium	0.3
Şeritler Uyku Tepe Sığırcılık Çiftekum 2. Pompa	Ustocreptic Cambortid	1832,9	23,5	Good	98.8
				Medium	1.1
	Toplam	7801,8	100,0		

CONCLUSION

In this study, properties of parent material, slope, depth and texture parameters are more important to determine SQI and it was found that there is a relation between the SQI, soil taxonomy and land uses. In addition that the present study shows that GIS techniques have an important role to play in model studies. Because GIS technologies were very effective at providing and processing large amounts of spatial and provide more accurate and accessible information (Bayramin et al, 2000).

REFERENCES

Arcak, Ç. 1992. Bala Tarım İşletmesi Topraklarının Detaylı Toprak Etüd ve Haritalaması. TİGEM Sayı:18.

Bayramin, I., Dengiz, O., Başkan, O., Parlak., M. 2003. Soil Erosion Risk Assessment with ICONA Model; Case Study: Beypazarı Area. Turk J Agri For. 27 (2003) 105-116. TÜBİTAK.

Basso, F., Bellotti, A., Faretta, S., Ferrara, A., Mancino, G., Pisante, M., Quaranta, G and Taberner, M.1999. The ESA Estimate in the Agri Basin. MEDALUS Project

Basso, F., Bove, E., Dumontet, S., Ferrara, A., Pisate, M., Quaranta, G Taberner, M. 2000. Evaluating evironmental sensitivity at the basin scale through the use of geographic information system and remotely sensed data: an example covering the Agri basin (Southern Italy). Catena 40, p. 19-35.

European Comission, 1999. Mediterranean desertification and land use Project MEDALUS, Project report. Kosmas, C., Kirkby, M., Geeson, N. (Edt.) EUR 1882 V.

Giordano, L., Giardino, F., Grauso, S., Iannetta, M., Sciortina, M., Rossi, L., and Bonati, G. 2002. Identification of areas sensitive to desertification in Siciliy Region. ENEA, Centro Ricerche Casaccia, Via Anguillarese 301, 00060 Rome, Italy.

Kosmas, C., Gerontidis, St., Detsis, V., Zafiriou, Th., and Marathianou, M.1999. Application of the Proposed Methodology for Defining ESA in Lesvos Island-Geece. MEDALUS Project. EUR: 18882.

Özden, D.M. 2000.The Facts of Desertification and United Nations Convention to combat Desertification, Proceedings of International Symposium on Desertification, p. 1-13, Konya, 2000.