Evaluation and Spatial Analysis of Agricultural Soils by GIS based Mapping in Nevsehir Province (Türkiye)

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Abstract

In this study, soil depths, degrees of erosion and other soil properties in Nevşehir province of Türkiye were evaluated spatially. For this purpose, 1/25.000 scale digital soil maps were used. Digital soil maps were analyzed spatially using Arc GIS 10.3.1 program from Geography Information Systems (GIS) software. As a result of the research, 7.50% of Nevşehir province is Deep soils (>150 cm), 8.88% is medium deep (90-150 cm) soils, 53.65% is shallow (50-90 cm) soils, 26.28% of it is very shallow (20-50 cm) soils. 57.01% of the surveyed lands consist of soils that may be exposed to moderate erosion. Soils exposed to severe erosion cover 26.32% of the total area. 23.25% of the research area consists of stony soils. Areas with insufficient drainage correspond to 1.49% of the total area. It is thought that the results obtained in the research will make significant contributions to the farmers and local governments operating in the region.

Keywords: Soil Depth, Land Properties, Erosion, Spatial Analysis, GIS, Nevsehir, Türkiye

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INTRODUCTION

The characteristics of the soils vary according to their location. In order to identify and solve the problems, the determination of all the characteristics of the existing soils, the management techniques applied from the beginning to the end of production should serve the sustainable and efficient use of the land. For the sustainable use of production areas, at this stage, it is necessary to determine all the characteristics of the existing soils and to review the management and techniques applied from the beginning to the end of production in order to identify and solve the problems (Tunçay and Bayramin, 2010).

Soil is an important factor in obtaining most of the nutrients necessary for life. Land owners and managers concerned with the conservation of land uses stated that rational and sustainable land use is important for the benefit of current and future populations (Dengiz et al., 2009).

Today, the rapid development of technology provides many conveniences. This comprehensiveness of GIS plays an active role in accessing many data as well as analyzing and storing numerical data. Revealing the geographical distribution of important soil features is a necessary prerequisite for the sustainable use and management of soils and guides which applications can be made in which areas (Doğan and Aslan, 2013).

In this study, soil depth classes, erosion degrees and other soil properties of the lands were spatially evaluated with the help of geographic information systems using 1/25.000 scaled digital soil maps of Nevşehir province. It is thought that the results obtained will make significant contributions to public institutions and organizations operating in the region and to the private sector investments.

MATERIALS and METHODS

This study was carried out within the borders of Nevşehir province. The location of Nevşehir province, which is the subject of the research, is shown in Figure 1.

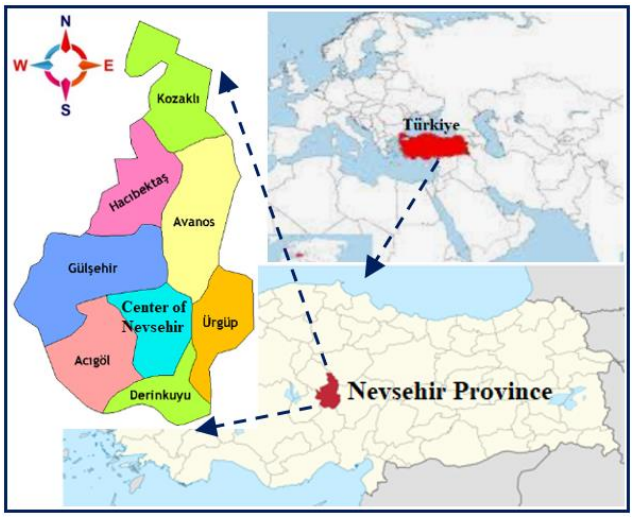

Figure 1. The location of research area

Nevşehir is located in the Central Anatolia Region and is surrounded by Kayseri in the east, Aksaray in the west, Niğde in the south, and Yozgat and Kırşehir in the north. The surface area of Nevşehir province is 5,386 km^2. The altitude of Nevşehir city center, which was established on the southern slope of the Kızılırmak valley, is 1150 m (Anonymous, 2016).

The longest river of Nevşehir province, Kızılırmak, passes through this region. The center of Nevşehir province was established on the western slopes of the wide and high plains known as the Kızılırmak plateau. Nevşehir province has a surface area of 5.485 km² and consists of a total of 23 municipalities and 153 villages, 8 of which are districts (including the central district), 15 of which are town municipalities (Anonymous, 2021).

Agricultural land in Nevşehir has % 65.4 of the total land. 538,630 hectares (% 2.5) of Nevşehir Province is forest, 65.4% is arable land, 18.8% is unsuitable for agriculture and % 13.3 is meadow-pasture. In Nevşehir, % 56.1 of the agricultural production area use is made up of grain cultivation areas (Anonymous, 2022).

Nevşehir has a warm and temperate climate. In winter, there is much more rainfall than in other months. Nevşehir's annual average temperature is 10.73 °C and average precipitation is 362.9 mm. Considering the climatic characteristics of the study area, the continental climate is dominant in Nevşehir. Summers are hot and dry, winters are cold. In a study conducted with temperature data for many years between 1970 and 2017, the average minimum temperature for many years in Nevşehir center was calculated as -1.99 ^{0}C, the maximum temperature was 26.85 ^{0}C and the average of all temperature values was 10.73 ^{0}C. The long annual averages of maximum temperature values are 27.1 ^{0}C in spring, 15.17 ^{0}C in winter, 28.36 ^{0}C in autumn, 36.76 ^{0}C in summer, and the general temperature average is 26.85 ^{0}C (Bağdatlı and Arıkan, 2020).

In order to spatially evaluate some soil features related to the study area, 1/25.000 scale digital soil maps were used (Anonymous, 2000). With the help of Arc GIS 10.3.1 program, which is a GIS software, soil depth classes, erosion degrees and other soil properties of the research area were analyzed spatially (Anonymous, 2010).

Spatial analyzes were interpreted in accordance with the criteria specified in the soil and land classification tandards Ttechnical instruction of the Ministry of Agriculture and Forestry (Türkiye) and spatial distribution maps of soil properties were created (Anonymous, 2005). In the spatial evaluation of digital soil maps, soil depth classes, erosion degrees and layers related to other soil properties of the investigated areas are presented in Tables 1, 2 and 3.

Table 1. Soil deep classes (Anonymous, 2005).

Symbol	Class	Soil Depth Classes (cm)
A	Deep	150+
B	Medium Deep	90-150
C	Shallow	50-90
D	Too Shallow	20-50
E	Lithosolic	0-20

Table 2. Erosion classes (Anonymous, 2005).

Erosion Classes	Explanation
1	None or Very little (1) Light (less than 25% of topsoil eroded)
2	Medium (2) Hydrangea (25-75% of topsoil eroded)
3	Severe (3) (more than 75% of the topsoil and less than 25% of the subsoil is eroded)
4	Very Severe (4) (all topsoil, 35-75% of subsoil eroded)

Table 3. Other soil properties (Anonymous, 2005).

Other Soil Properties	Symbol
Poorly Drainage	(f)
Lightly salted	(h)
Slightly saline with poor drainage	(hf)
Slightly salty Insufficient Drainage	(hy)
Slightly salty-Alkaline poorly Drained	(kf)
Slightly salty-Alkaline Insufficient Drainage	(ky)
Kayali	(r)
Salty Insufficient Drainage	(sy)
Stony	(t)
Salty Alkali Poor Drained	(vf)
Salty Alkali Insufficient Drainage	(vy)
Insufficient Drainage	(y)

RESEARCH FINDINGS

Spatial Analysis of Soil Depth Classes

Soil depth classes of Nevşehir province lands were spatially evaluated using 1/25.000 scaled digital soil maps. As a result of the analyses, the spatial distributions of soil depth classes are presented in Figure 2.

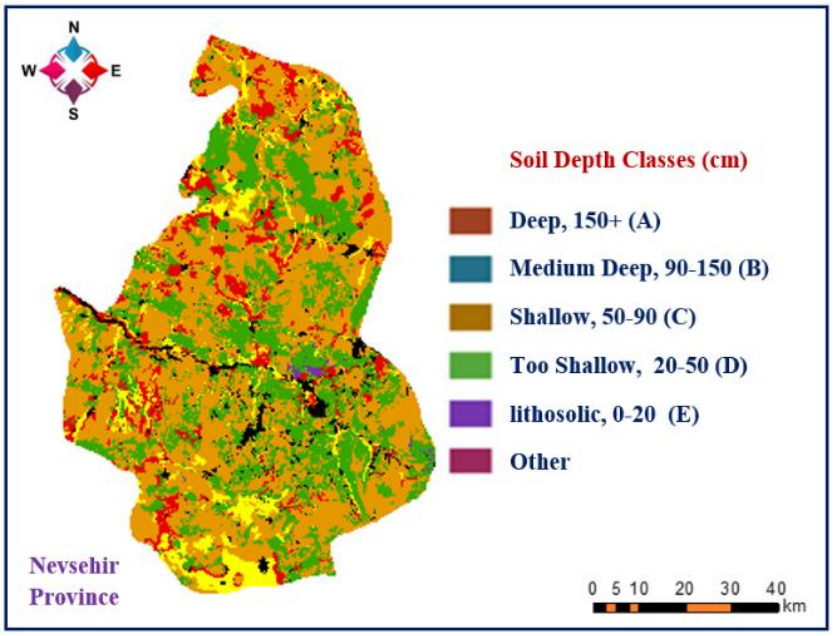

Figure 2. Spatial distributions of soil depth classes

Considering the soil depth distribution in Nevşehir province, it is seen that the soils in the depth class of 50-90 cm are generally dominant. It has been observed that the soils with a depth of 20-50 cm are predominant in the southeast, middle and north parts of Nevşehir province.

The soil group between 90-150 cm, defined as medium deep, is located in the northwest and center of the region. The soil group, known as deep, with a depth of 150 cm, is mostly seen in the southern part of the field. The areal amounts of the depth classes of Nevşehir province are calculated and given in Table 4.

Table 4. Areal quantities of soil depth classes

Soil Depth Classes (cm)	Area (ha)	Ratio to General Area (%)
Deep , 150+ (A)	**45052,04**	**7,50**
Medium Deep ,90-150 (B)	**53317,77**	**8,88**
Shallow , 50-90 (C)	**322101,01**	**53,65**
Too Shallow , 20-50 (D)	**157769,49**	**26,28**
lithosolic , 0-20 (E)	**1802,89**	**0,30**
Other	**20286,20**	**3,38**

It is seen that 53.65% of Nevşehir province has soils with a depth of 50-90 cm. Very shallow soils (20-50 cm) cover an area of 157.769,49 hectares. Areas that fall under the medium deep soil class (90-150 cm) correspond to % 8.88 of the total area. Deep soils (>150 cm) spread in 45052.04 hectares of the studied area.

Soil depth, in general, refers to the depth at which the roots of cultivated plants can process and benefit from water and nutrients. Soil depth and nutrient and water holding capacity often determine crop yield, especially in summer crops. In summary, it has been observed that shallow soils with a soil depth of 50-90 cm are dominant throughout the province of Nevşehir.

Spatial analysis of erosion degrees

Erosion degrees of Nevşehir province lands were evaluated spatially. The results obtained and the distribution of erosion degrees are presented in Figure 3 and the calculated areal amounts are summarized in Table 5.

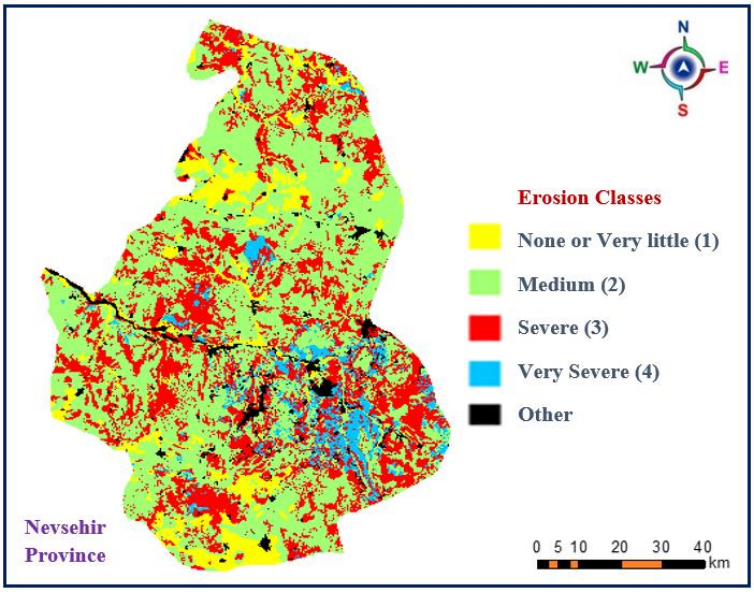

Figure 3. Spatial distribution of erosion classes

Table 5. Areal quantities of erosion degrees

Erosion Classes	Area (ha)	Ratio to General Area (%)
None or Very little (1)	50794,70	8,46
Medium (2)	342227,47	57,01
Severe (3)	158023,88	26,32
Very Severe (4)	28997,15	4,83
Other	20286,20	3,38

Erosion is a concept that expresses the transportation and removal of soil by being exposed to all kinds of effects. As a result of the spatial analysis, it has been seen that the areas that can be exposed to moderate erosion in Nevşehir province are dominant. In the southeastern part of the study area, it was determined that areas that could be exposed to very severe erosion dominate. It has been observed that there are no or very few areas that can be exposed to erosion in the lands towards the north and the areas in the southern part of Nevşehir province.

When the area is examined generally, it is determined that the soils with the 2nd degree medium erosion class are formed and this area covers an area of 342.227,47 hectares. Areas with 3rd degree erosion group correspond to 26.32 % of the total area. It has been calculated that soils with 1st degree erosion cover an area of 50.794,77 hectares. Areas that may be exposed to severe erosion correspond to 4.83 % of the total area.

Spatial Analysis of Other Soil Properties

It is seen that there are mostly stony areas in the southeast of Nevşehir province. Salty and poorly drained soils are observed in the center and north of the province. There are poorly drained soils in the northwest of the study area. It has been observed that there are slightly salty, alkaline and poorly drained and salty alkali poorly drained soils in the research area. The stony areas cover 23.25% of the study area. It has been determined that there are insufficiently drained soils in an area of 8916.61 hectares in Nevşehir province. The rocky areas cover an area of 5292.76 hectares. Spatial distribution analyzes and areal amounts of other soil properties of Nevşehir province are given in Figure 4 and Table 6

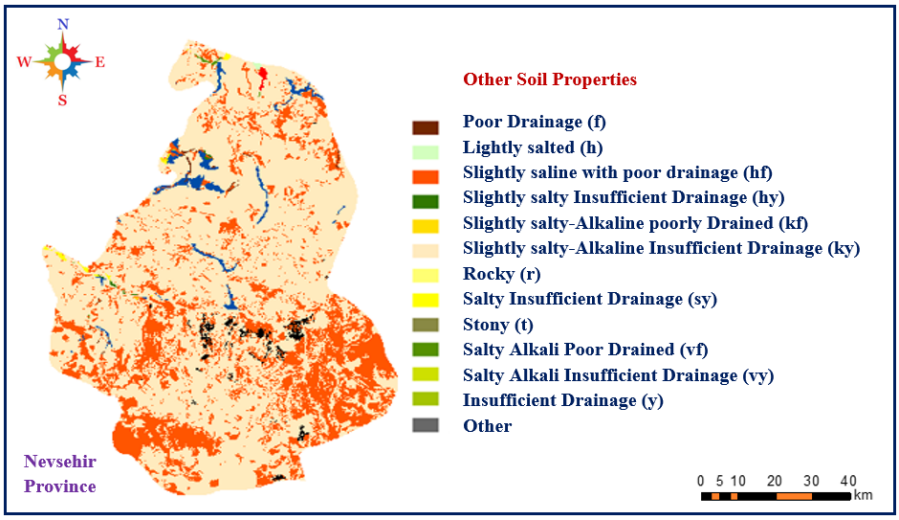

Figure 4. Spatial distributions of other soil properties

Table 6. Areal quantities of other soil properties

Other Soil Properties	Area (ha)	Ratio to General Area (%)
Poorly Drainage (f)	967,00	0,16
Lightly salted (h)	226,29	0,04
Slightly saline with poor drainage (hf)	157,71	0,03
Slightly salty Insufficient Drainage (hy)	370,21	0,06
Slightly salty-Alkaline poorly Drained (kf)	178,73	0,03
Slightly salty-Alkaline Insufficient Drainage (ky)	1133,32	0,19
Kayali (r)	5292,76	0,88
Salty Insufficient Drainage (sy)	563,61	0,09
Stony (t)	139553,11	23,25
Salty Alkali Poor Drained (vf)	368,12	0,06
Salty Alkali Insufficient Drainage (vy)	28,96	0,00
Insufficient Drainage (y)	8916,61	1,49
Other	442572,96	73,72

CONCLUSION and RECOMMENDATIONS

Spatial distribution maps of soil classes are important for appropriate land use and management decisions. Numerical soil mapping can predict the spatial distribution of soil classes as GIS analysis. Many studies have been found in the literature on the determination of some soil and land properties in the GIS environment using digital soil maps.

In a study carried out within the scope of spatial evaluation of some land features of the Çiftlik district of Niğde province in the Geography Information Systems (GIS) environment, the majority of the lands were located in the VI. and VII. It has been seen that it is in the class of agricultural land (Bağdatlı and Arslan, 2021a)

In a research conducted in the Çankırı Ilgaz Gökdere basin, different land types were determined in the GIS environment and the effect of land aspect on soil properties was analyzed. As a result of the study, 55 soil samples were taken and some soil properties were evaluated and distribution maps for these properties were created (Yılmaz, 2010).

In a study carried out in an area where industrial establishments are concentrated in Kocaeli province; Soil moisture, organic matter and elemental contents were determined by taking soil samples from seven villages determined in the area (Uytun, 2012).

In a study around Çorlu and Çerkezköy in Tekirdağ, 20 soil and wheat plant samples were taken from agricultural areas at a depth of 0-20 cm. The results of heavy metal analysis in the soil were spatially evaluated with the help of Arc GIS 10.3.1 software and distribution maps showing the heavy metal pollution levels were produced in this context (Kocaman, 2016).

In a research to determine the soil potential of Kırşehir province using GIS, current land use, large soil groups, other soil properties, soil depth, slope and erosion were classified using Arc GIS 10.3.1 software, which is a GIS program, and the results were revealed in detail as map outputs. they have put. In the light of the data obtained, they concluded that this study will provide infrastructure support to the investor organizations in the region, and that the study will be transferred to users in the digital environment, creating a database and thus setting a precedent, and will guide similar studies (Bağdatlı and Arslan, 2020). Considering other similar studies in the literature; For example, in Nevşehir, Kayseri, Niğde and Ankara provinces, land and soil properties were spatially analyzed and distribution maps were produced using 1/25.000 scaled digital soil maps (Bağdatlı and Can, 2021a; Bağdatlı and Can; 2021b; Bağdatlı and Ballı, 2021; Bağdatlı and Arıkan, 2021; Bağdatlı and Öztekin, 2021; Pekacar and Bağdatlı, 2020; Bağdatlı and Can 2020; Bağdatlı and Arslan, 2021a; Bağdatlı and Arslan 2021b; Bağdatlı and Arslan, 2021c

In this study, spatial evaluation of soil depths, degrees of erosion and other soil properties was carried out by using 1/25.000 scaled digital soil maps of Nevşehir province. For this purpose, Arc GIS 10.3.1 software, which is one of the GIS software, was used and it was seen that shallow soils constitute % 53.65 of the total area, according to the depth class analysis in Nevşehir province. Very shallow soils cover an area of 157.769,49 hectares. Areas classified as medium deep correspond to %8.88 of the total area.

When the study area is examined in general, it has been determined that the soils with the 2nd degree erosion class are mainly formed and this area covers an area of 342227.47 hectares. The rate of areas with 3 degrees of erosion is % 26.32. Class 1 erosion areas, which are classified as no or very little erosion, cover an area of 50794.70 ha. In the study area, it is seen that the 2nd and 3rd degree eroded land areas dominate. In the research area, stony areas cover % 23.25 of the study area. 8916.61 hectares of the area consists of poorly drained soils. It has been determined that 5292.76 hectares of the field are rocky soils. The data obtained at the end of the research will provide significant background information to public institutions and organizations operating in the region, local governments and investor organizations.

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REFERENCES

Anonymous 2000. Sayısal Toprak Haritaları, Mülga Köy Hizmetleri Genel Müdürlüğü, Ankara (in Turkish)

Anonymous 2005. Toprak ve Arazi Sınıflaması Standartları Teknik Talimatı", Tarım ve Orman Bakanlığı, Ankara (in Turkish)

Anonymous 2010. Arc GIS 10.3.1 software, ESRI, Environmental System Research Institute, Redland, CA, USA

Anonymous 2016. Nevşehir İli Çevre Durum Raporu, Çevre ve Şehircilik İl Müdürlüğü, Nevşehir. (in Turkish)

Anonymous 2019. Nevşehir İli 2017 Yılı Çevre Durum Raporu, Nevşehir Çevre ve Şehircilik İl Müdürlüğü, Nevşehir, Türkiye (in Turkish)

Anonymous, 2022., Toprak Kaynakları Potansiyeli, Nevşehir İl Tarımsal Kuralık Kriz Merkezi Raporu, Nevşehir Tarım ve Orman İl Müdürlüğü, Nevşehir, Türkiye (in Tukish)

Bağdatlı M.C. &Arıkan E. N. 2020. Evaluation of Monthly Maximum, Minimum and Average Temperature Changes Observed for Many Years in Nevsehir Province of Turkey, *World Research Journal of Agricultural Science*, 7(2), p.209-220

Bağdatlı, M. C. &Arslan O. 2020. GIS mapping of large soil groups, current land use, soil depths and slopes, erosian in Kırsehir province of Turkey, *World Research Journal of Agricultural Sciences*, 8(1): 265-277 .

Bağdatlı M. C. & Can E. 2020. Nevşehir Organize Sanayi Bölgesinde Bazı Toprak Özelliklerinin Coğrafi Bilgi Sistemleri (CBS) Ortamında Değerlendirilmesi, *5. Uluslararası Marmara Fen Bilimleri Kongresi Bildiriler Kitabı*, s.75-76, 4-5 Aralık, Kocaeli, Turkey (in Turkish)

Bağdatlı M.C. & Can E. 2021a. Spatial Evaluation of Land and Soil Properties in the Example of Nevşehir Province, Turkey, International Journal of Engineering Technologies and Management Research (IJETMR), 8(7):90-103, doi:10.29121/ijetmr.v8.i7.2021.1007

Bağdatlı M.C. & Can E. 2021b. Spatial Analysis of Soil Resources Potential by Using Geography Information Systems (GIS): A Case Study from Thrace Region, Turkey, International Journal of Innovative Research and Reviews (INJIRR), 5(2): 45-50

Bağdatlı M. C. & Arslan O. 2021a. Bazı Arazi Özelliklerinin Niğde-Çiftlik İlçesi Örneğinde Mekansal Olarak İncelenmesi, *8. Uluslararası KOP Bölgesel Kalkınma Sempozyumu, Bildiriler Kitabı*, s.13-21, 26-28 Ekim, Nevşehir, ISBN: 978-605-4163-49-6 (in Turkish)

Bağdatlı M. C. & Arslan O. 2021b. Nevşehir- Hacıbektaş İlçesi Toprak Özelliklerinin Coğrafi Bilgi Sistemleri (CBS) Yardımıyla Değerlendirilmesi, *8. Uluslararası KOP Bölgesel Kalkınma Sempozyumu, Bildiriler Kitabı*, s.5-12, 26-28 Ekim, Nevşehir, ISBN: 978-605-4163-49-6 (in Turkish)

Bağdatlı M.C. & Arslan O. 2021c. Classification and Mapping of Land Use and Some Soil Properties in Kırşehir Province, Turkey, International Journal of Engineering Technologies and Management Research (IJETMR), 8(8):81-93, doi: 10.29121/ijetmr.v8.i8.2021.1022

Bağdatlı M.C. & Ballı Y. 2021. GIS Mapping of Land Slopes, Soil Depths, Erosian Classes, Large Soil Groups and Some Soil Properties: A Case Study of Kayseri Province in Turkey, Universal Journal of Agricultural Research, 9(5):166-175, doi:10.13189/ujar.2021.090503

Bağdatlı M.C. & Arıkan E.N. 2021. Assessment of Some Land Properties by Using GIS in Niğde Province of Turkey, International Journal of Recent Development in Engineering and Technology (IJRDET), 10(11):1-9

Bağdatlı M.C. & Öztekin, M. E. 2021. Determination of Land Use Capabilities by GIS Analysis in Nigde Province, Turkey, Eurasian Journal of Agricultural Research (EJAR), 5(2):121-129, ISSN: 2636-8226

Dengiz O., Gülser C., İç S. & Kara Z. 2009. Aşağı Aksu Havzası Topraklarının Fiziksel ve Kimyasal Özellikleri ve Haritalanması. *Anadolu Tarım Bilimleri Dergisi*, 24 (1); 34-43. (in Turkish)

Doğan H.M. & Aslan S. 2013. Aşağı Kelkit Havzası`nın Bazı Toprak Özelliklerinin Coğrafi Bilgi Sistemleri ve Uzaktan Algılama ile Haritalanması. *Gaziosmanpaşa Bilimsel Araştırma Dergisi*, 3:25-33. (in Turkish)

Kocaman P. 2016. Çorlu-Çerkezköy civarındaki bazı fabrikalara yakın tarım arazilerindeki çeşitli ağır metal kirlilik düzeylerinin toprak ve bitki analizleri ile belirlenmesi, *Namık Kemal Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi*, Tekirdağ, (in Turkish)

Pekacar A. Y. & Bağdatlı M. C. 2020. Bazı Toprak Özelliklerinin Coğrafi Bilgi Sistemleri (CBS) Yardımıyla Değerlendirilmesi: İstanbul Anadolu Otoyoluna Yakın Tarım Alanları Uygulaması, *Uluslararası Akademik Araştırmalar Kongresi,Bildiriler Kitabı,* s.87-88, 7-9 Aralık, Turkey

Tunçay T. & Bayramin İ. 2010. Çiçekdağı-Kırşehir Tarım İşletmesi Topraklarının Detaylı Toprak Etüt ve Haritalanması. *Anadolu Tarım Bilim Dergisi*, 25(1):53-60 (in Turkish)

Uytun A. 2012. Kocaeli, kentinde seçilen kırsal bölgelerde toprak nemi ve toprak kirliliğinin belirlenmesi, *Kocaeli Üniversitesi Fen Bilimleri Enstitüsü*, *Yüksek Lisans Tezi*, Kocaeli. (in Turkish)

Yılmaz H. 2010. Çankırı Gökdere Havzasının Havza Karakteristiklerinin Ve Bazı Hidrofiziksel Toprak Özelliklerinin Araştırılması, *Ankara Üniversitesi Fen Bilimleri Enstitüsü*, *Yüksek Lisans Tezi*, Çankırı (in Turkish)