

Determining and GIS Mapping Some Soil and Land Properties in Niğde Province of Turkey

M. Cüneyt Bağdatlı and Eda Nur Arıkan

Abstract— This study was carried out within the scope of spatial evaluation of major soil groups, land slope, erosion degrees, soil depth classes, and other soil properties by using 1/25.000 scaled digital soil maps in Niğde province. Arc GIS 10.3.1 software, which is one of the Geography Information Systems (GIS) software, was used for spatial analysis. Classification results were evaluated according to the "Soil and Land Classification Standards Technical Instruction" published by the Ministry of Agriculture and Rural Affairs in 2005. As a result of the research, it was seen that the class covering the largest area in terms of major soil groups was brown soils with 224466.1 ha. Red-brown soils cover the least area with 45.4 ha. Areas with a steep slope with a 5% slope on the land slope cover the largest area of 140325.7 ha. Areas with a very steep slope of 6%, on the other hand, cover the least area with 69064 ha. Areas with C class (50-90 cm) soil depth in the study area cover the largest area with 294054.7 ha. The areas with E class (0-20 cm) soil depth were seen in the least area with 22203.5 ha. In terms of soil erosion classes, the most common erosion class is III. These are areas with a degree of erosion risk and their total area is 269374.8 ha. It has been determined that areas with slightly salty, alkaline, weak, and adequate drainage are seen in an area of 234.1 ha in the research area. Areas with insufficient drainage have an area of 7350.9 ha. In this study, spatial analysis of some land and soil properties in Niğde province was carried out and distribution maps were produced. It is thought that the results of the research will make significant contributions to the agricultural investments operating in the region.

Index Terms— Soil and Land Sources, GIS Mapping, Spatial Analysis, Niğde Province, Turkey

1. INTRODUCTION

Bedrock, climate, landform, living things, and time factors are effective in the formation of soils [1]. Soil, with the help of its physical, chemical, and biological properties;

It is one of the important components of terrestrial ecosystems because it both stores the plant nutrients required for plant production and filters or retains pollutants that have negative effects on the environment [2]. People mostly use the land to meet their nutritional and shelter needs. These benefits that the soil provides to people are called the functions of the soil [3]

Especially in agricultural ecosystems, soil properties show significant temporal and spatial variability depending on soil formation factors, management practices, and land uses. In addition, information about the physical and chemical properties of soils is important for understanding and evaluating the physical and chemical processes that occur in the soil, such as weathering, erosion, runoff, and groundwater storage [4].

While some static soil properties such as texture or soil mineral content are determined by the formation processes, some dynamic soil properties such as water content, electrical conductivity, compaction, and organic matter content may vary depending on land management practices [5].

Geography Information Systems (GIS), is designed to solve complex planning and management problems; It is a system of hardware, software, personnel, and methods that include the collection, management, processing, analysis, modeling, and display of data located in the space [6, 7].

The effectiveness of GIS is largely due to its analytical power. Analyzes that can take a long time with traditional methods can be done much simpler and faster. For this reason, GIS has become one of the indispensable tools of the people involved in the "decision-making" mechanism today. Because the results obtained from GIS with the help of computer technology offer important clues to researchers and managers and help people to make more accurate decisions [8].

It stated that Geography Information Systems (GIS) can be used by all branches of science and professional groups, which includes one or all of the natural environment, time variable, and human subjects that somehow represent a part of the earth in terms of the subject and scope of GIS [9].

GIS can perform multi-dimensional analysis processes integrating graphic and descriptive data. They have the ability to retrieve and combine data from the GIS geodatabase and create new information [11].

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Map algebra and cartographic modeling have greatly influenced the development of these capabilities of GIS [10]. Map Algebra is an integrated set of functions and commands and is used to analyze and change geographic information, while more complex analyzes are performed with cartographic modeling [11].

In this research, spatial determination of some soil and land characteristics of Niğde province, which is located in the Central Anatolia Region of Turkey, was carried out using digital soil maps. It will be inevitable that the spatial distribution maps obtained as a result of the research will make significant contributions to the investor organizations operating in the region.

2. MATERIAL and METHOD

The study area is the province of Niğde, located in the south of Central Anatolia in Turkey. It is surrounded on three sides by the young fold mountains of the Taurus Mountains. On the western end, there is the Emen Plain, which is combined with the Konya Plain. Niğde province, which has an area of 7312 km², is 1300 meters above sea level. The western parts are undulating plains, while the other parts have a mountainous structure. It is bordered by Aksaray in the northwest, Nevşehir in the north, Kayseri in the northeast, Konya in the west and southwest, Mersin in the south, and Adana in the southeast and east. The geological structure is dominated by volcanic tuffs and basalt flows. The dominant structure in the plains is alluvium [12]

Niğde, which has a population of 362861 people, has 29 municipalities, 139 neighborhoods, and 130 villages, together with the Center, Altunhisar, Bor, Çamardı, Çiftlik, Ulukışla districts [13]. The continental climate prevails in Niğde province, with hot and dry summers and cold and snowy winters.

In a study examining the temperature values between 1970 and 2019, it was seen that the minimum temperature average for long years in Niğde province was -1.2 °C. The maximum temperature average is 24.5 °C. [14].

There is a significant trend toward increasing maximum precipitation in the winter and summer months in Niğde province for many years. For many years, no trend was observed in the annual total precipitation changes [15].

Precipitation occurs in the form of snow in the winter, and in the form of rain in the spring. The natural vegetation is pine and fir in mountainous areas and willow and poplar trees on the edges of streams and ponds. The plains are covered with herbaceous plants [12].

It is seen that the economic structure of Niğde province is under the influence of the agricultural economy. It is stated that the natural structure of the province plays an important role in shaping the economic structure in this way.

In the pastures, which are found in large quantities in the western and southern regions of the province, a small amount of grain farming is carried out together with animal husbandry;

In the northern and eastern regions, there are vegetable, fruit, and viticulture fields with intensive grain agriculture. Niğde province has a wide agricultural area; The cultivation land is flat and sloping and mostly barren. The annual average precipitation is around 350 mm. Therefore, tillage gains great importance in the province where large grain agriculture is made; a fallow farming system should be implemented [16].

In Niğde province, agricultural land is 275.783 ha, Pasture-Meadow Land is 264.035 ha, Forest Land is 62.161 ha and Non-Agricultural Land is 177.543 ha [17].

Fruit production is plentiful and diverse. The number of apple trees takes first place in the country. ¼ of Turkey's potato grows here. The main livelihood of the people is agriculture. Therefore, the population is concentrated in rural areas. Niğde province is among the 10 provinces that are considered to be the wheat warehouses of Anatolia. Most apples are grown in this province in Turkey. In addition to these, legumes, sunflowers, potatoes, wheat, barley, rye, beans, chickpeas, garlic, and sugar beet are also grown. Vegetables are not important. However, it is advanced in fruit growing [12].

There are large apple orchards in Bor, Center, Çamardı, and Kemerhisar districts. The limes are famous. Viticulture also plays an important role. It is one of the leading provinces in grape growing in Central Anatolia of Turkey. Fertilization, irrigation, and use of modern agricultural tools and pesticides are increasing rapidly. The yield of all kinds of products increases from year to year. In these areas, livestock and handicrafts continue with all their vitality [12].

It is one of the tourism centers of Turkey with its proximity to major centers, being in the Cappadocia region, close to Kayseri and Nevşehir airports, historical monuments, natural assets, and rich museums [12]. It has important tourism attractions with its natural beauties, cultural assets, and thermal resources [13]. The location and location of the research area are given in Figure 1.



Fig 1. The research area

The data used in the study were 1/25.000 scaled soil maps [18]. The layers used in the classification of land and soil properties were evaluated according to the "Soil and Land Classification Standards Technical Instruction" published by the Turkey Ministry of Agriculture and Rural Affairs in 2005. In the study, major soil groups, erosion degrees, soil depths, land slopes, and other soil properties were spatially investigated. The classification layers used in the research are given in Tables 1, 2, 3, 4, and 5.

TABLE 1: MAJOR SOIL GROUPS [20]

Major Soil Groups	
Alluvial Soils	Hydromorphic Soils
Brown Soils	Colluvial Soils
Limeless Brown Soils	Regosols on
Chestnut Color Soils	Brown Forest Soils
Reddish Chestnut Color Soils	Nursery Brown Forest Soils
Reddish Brown Mediterranean Lands	Red Yellow Podzolic Soils
Reddish Brown Soils	Rendzinal Soils

TABLE 2: EROSIAN DEGREE [20]

Erosion Degrees	
I.	Light Surface Erosion
II.	Medium Surface Erosion
III.	Severe Surface Erosion
IV.	Very Severe Surface Erosion

TABLE 3: SOIL DEPTHS CLASSES [20]

Soil Depths (cm)		
A	>150	Deep
B	90 - 150	Medium Deep
C	50 - 90	Shallow
D	20 - 50	Very Shallow
E	0 - 20	Litolic

TABLE 4: LAND SLOPE CLASSES [20]

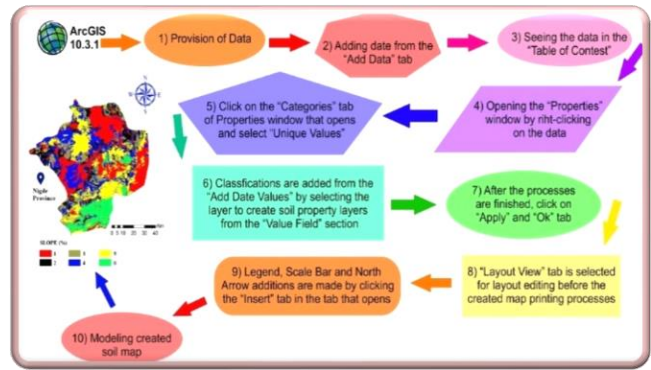
Land Slope (%)	
1 (% 0-2, Straight)	5 (%20-30, Very Steep Slope)
2 (% 3-6, Slight Slope)	6 (% 30-45, Craggy Slope)
3 (% 7-12, Medium Slope)	Cliff
4 (13-20, Steep Slope)	

TABLE 5: OTHER SOIL PROPERTIES [20]

Other Soil Properties	
Slightly Salty	Stony
Salty	Rocky
Alkali	Poorly Drained
Slightly Salty- Alkali	Bad Drained
Salty-Alkali	

The 1/25,000 scaled digital soil and land data used in the study were spatially analyzed in the Arc GIS 10.3.1 program, one of the Geography Information Systems software [19]. The spatial analysis stages are shown in Figure 2 schematically.

Fig 2. Spatial analysis stages of digital soil layers in Arc GIS software



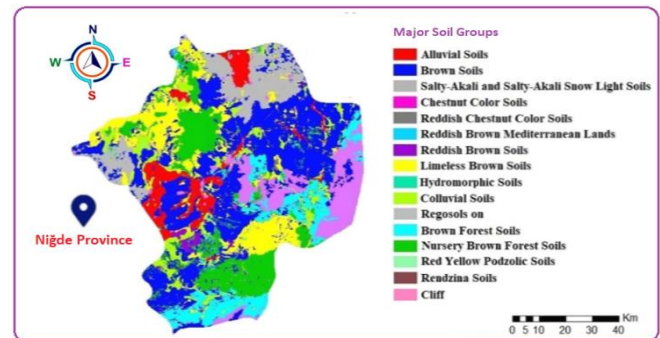
3. RESEARCH FINDINGS

In this study, using 1/25.000 scaled soil maps of Niğde province, major soil groups, erosion degrees, land slopes, soil depths, and other soil properties were spatially evaluated and the results are presented in detail under the headings below.

3.1. Spatial Analysis of Major Soil Groups

The distribution map obtained regarding the spatial analysis results of the major soil groups of Niğde province is given in Figure 3.

Fig 3. Spatial analysis of major soil groups



Brown soils cover the largest area with 224466.1 ha. The Red Brown Mediterranean Soils, which are seen more in the south and middle of Niğde Province, have an area of 45.4 ha. The areal amounts of major soil groups are given in Table 6.

TABLE 6: AREAL QUANTITIES OF LARGE SOIL GROUPS

Major Soil Groups	Area (ha)
Salty-Alkali and Salty-Alkaline Snow Light Soils	457.2
Red Brown Mediterranean Lands	45.4
Reddish Chestnut Color Soils	480.6
Limeless Brown Forest Soils	91336.7
Red Yellow Podzolic Soils	240.6
Limeless Brown Soils	91089.9
Reddish Brown Soils	5206.1
Chestnut Color Soils	206.2
Hydromorphic Soils	650.8
Brown Forest Soils	60890.0
Colluvial Soils	41933.4
Alluvial Soils	44385.7
Brown Soils	224466.1
Rendzinas	442.3
Regosols	67248.5
Cliff	72174.1

3.2. Spatial analysis of erosion degree

Erosion degrees of the study area lands were analyzed spatially and spatial distributions of erosion degrees are given in Figure 4 and areal amounts in Table 7.

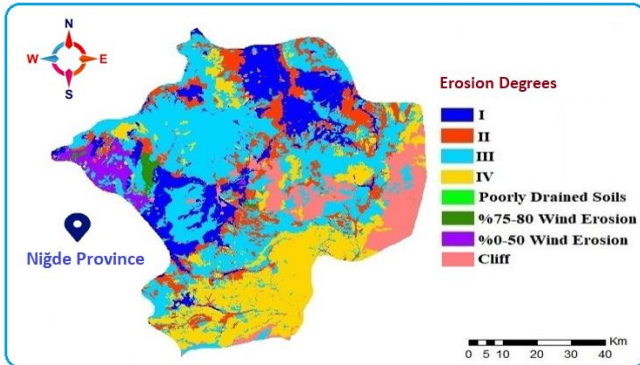


Fig 4. Spatial analysis of erosion degree

TABLE 7. AREAL QUANTITIES OF EROSIAN DEGREE

Erosion Degree	Area (ha)
I	100219.0
II	94513.3
III	269374.8
IV	140861.2
Poorly Drained Soils	5496.2
%75-80 Wind Erosion	18612.9
Cliff	72174.1

It is seen that the areas with III. degree of erosion risk is distributed throughout the province of Niğde. III. Erosion degree which has a large area. The lands exposed to the degree of erosion cover an area of 269374.8 ha. Areas with an I. degree erosion risk are seen in an area of 100219 ha.

3.3. Spatial analysis of erosion degree

The spatial distribution of the land slope classes obtained as a result of the spatial analysis is given in Figure 5 and the areal amounts of the land slope classes are given in Table 8.

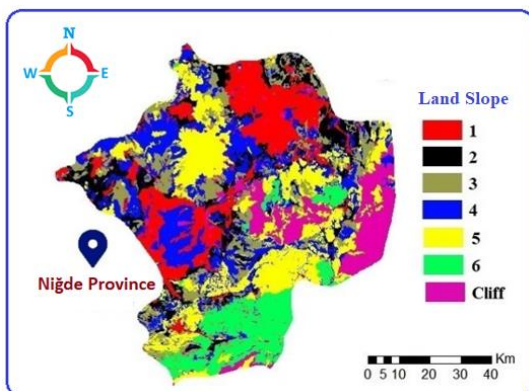


Fig 5. Spatial analysis of land slope

TABLE 8: AREAL QUANTITIES OF LAND SLOPE

Land Slope (%)	Area (ha)
1 (% 0-2, Straight)	109743.1
2 (% 3-6, Slight Slope)	77455.5
3 (% 7-12, Medium Slope)	98356.1
4 (%13-20, Steep Slope)	134135.2
5 (%20-30, Very Steep Slope)	140325.7
6 (% 30-45, Craggy Slope)	69064.2
Cliff	72174.1

The rocky areas, which are densely seen in the east of Niğde province, cover an area of 72174.1 ha. The areas with the 6th group slope, which are mostly seen in the southern parts, are classified as very steep sloping land and the total area is calculated as 69064.2 ha. Class 3 sloping areas, which are classified as steeply sloping, cover a very small area and have an area of 98356.1 ha.

3.4. Spatial analysis of soil depths

As a result of the spatial analysis made in the Arc GIS software; the spatial distribution of the soil depth classes is given in Figure 6 and the areal amounts of the depth classes are given in Table 9.

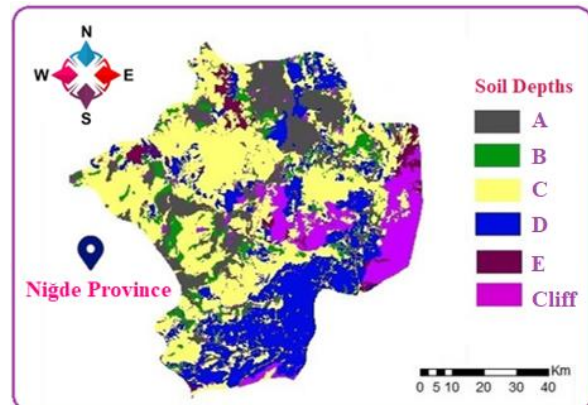


Fig 6. Spatial analysis of soil depths

TABLE 9: AREAL QUANTITIES OF SOIL DEPTHS

Soil Depths (cm)	Area (ha)
A (>150)	106037.2
B (90 – 150)	41678.4
C (50 – 90)	294054.7
D (20 – 50)	164285.7
E (0 – 20)	22203.5
Cliff	72174.1

In the study area, most C class (50-90 cm) soil depth class areas are seen. Areas with class C soil depth cover an area of 294054.7 ha. Areas in group A in the deep soil class (>150 cm) cover an area of 106037.2 ha. Rocky areas are seen in the middle and east of the region and dominate an area of 72174.1 ha.

3.5. Spatial analysis of other soil properties

Spatial analysis of other soil properties obtained as a result of spatial analysis is given in Figure 7. The areal values of other soil properties are given in Table 10.

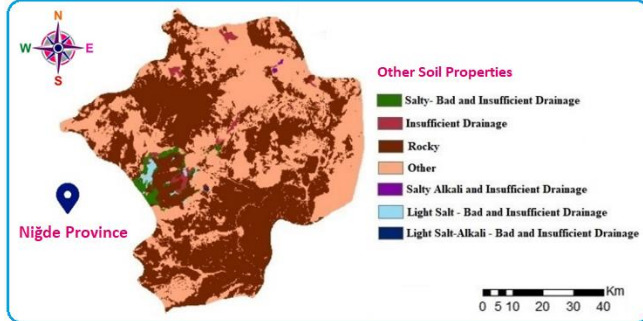


Fig 7. Spatial analysis of other soil properties

TABLE 10: AREAL QUANTITIES OF OTHER SOIL PROPERTIES

Other Soil Properties	Area (ha)
Light Salty - Alkali - Poor and Insufficient Drainage	234.1
Salty - Alkali and Insufficient Drainage	469.1
Salty - Bad and Insufficient Drainage	9133.5
Light Salty and Poorly Drained	3511.3
Insufficient Drainage	7350.9
Rocky	371906.9
Other	308648.2

Rocky areas were seen in an area of 371906.9 ha. Areas with insufficient drainage cover an area of 7350.9 ha.

4. CONCLUSION AND DISCUSSION

Soil classification and mapping studies in our country first started in 1951 with the "Soil Conservation and Agricultural Irrigation Organization" within the body of the Ministry of Agriculture and the first 1:800.000 scaled Soil Map of Turkey were made in 1958. Later, in 1965, "Turkey Enhanced Soil Maps" studies were started by making use of 1:25.000 scale topographic maps of the General Directorate of Soil and Water [21].

The earth's soil layer is critical for sustaining plant life, offering mechanical support, and providing water and nutrients. The earth acts as a major heat storage mechanism, collecting energy during the day and releasing heat during the night. Over the course of a year, the soil conserves energy in the warmer seasons and releases heat into the air during the colder seasons [22].

In this study, soil properties were revealed by examining the soil fertility, soil structure, and function of the soil in agricultural areas by using the data of the Niğde Province Center. Looking at the spatial distribution of the maps, the largest soil groups are brown soils and 224466.1 ha, while the least area is red-brown Mediterranean soils and 45.4 ha. the 3rd degree erosion has the largest area with 269374.8 ha.

On the other hand, the slope covers an area of 140325.7 ha with a steep slope of 5%, while it covers the least area with 69064 ha with a very steep slope of 6%. In the depth areas, while the C class area is 294054.7 ha, the E class area is 22203.5 ha. In other soil properties, the stony area is 371906.9 ha and has the largest area. The minimum area in terms of Slightly Salty - Alkali - Poor and Insufficient Drainage class is 234.1 ha.

As a result of the spatial analysis studies, data on large soil groups, soil depth classes, land erosion degrees, land slopes, and other soil characteristics of Niğde province were presented as a database. Spatial distribution results are given in Figure 8 stratified.

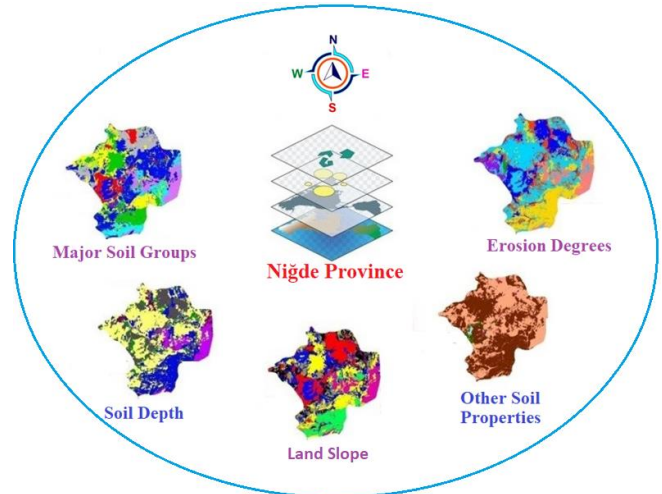


Fig 8. Spatial analysis of layers of some land and soil properties in Niğde province

Similar to this study carried out in Niğde province, other studies conducted in the GIS environment using digital soil maps were found in the literature. In the studies carried out to determine some land features in Niğde, Kırşehir, Kayseri, and Nevşehir provinces and Thrace Region in Tukey, 1/25.000 scale digital soil maps were used. The land and soil characteristics of the research areas were classified and analyzed by using GIS, [23, 24, 25, 26, 27, 28, 29].

The spatial distribution maps of some land and soil characteristics obtained as a result of this study will form the basis for agricultural investments planned to be made in Niğde province.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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