International Journal of Research in Advent Technology, Vol.10, No.1, March 2022
E-ISSN: 2321-9637
Available online at www.ijrat.org

GIS Based Mapping and Assessment of Major Soil Groups and Land Capabilities in Nevsehir Province of Turkey

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Abstract— This study was carried out in Nevşehir province of Turkey with the aim of spatial evaluation of major soil groups, land use capabilities and subclasses by using 1/25.000 scaled digital soil maps. For this purpose, the Geography Information Systems (GIS) software, Arc GIS 10.3.1 was used. As a result of the research; The area covered by brown soils corresponds to 50.68% (304248.49 ha) of the total area. Hydromorphic soils were observed in an area of 7.23 ha. VI. class lands are in the majority in Nevşehir province and the ratio of these lands in the total area is 39.06% (234491.21 ha). II. class lands are 9.48% (56934.79 ha) of the total area and VIII. class lands cover the least area. These lands correspond to 5564.41 ha and 0.93% of the total area. It was determined that the areas with slope and erosion damage and soil insufficiency in the study area correspond to 62.80% of the total area and cover an area of 376990.54 ha. In the study, the spatial distribution maps of the land use capabilities will form the basis for the studies to be carried out for agricultural purposes in Nevşehir province.

Index Terms— Major Soil Groups, Land Use Capabilities, Spatial Classification, Nevsehir province, Turkey

I. INTRODUCTION

Nevşehir province is located in the Central Anatolia Region of Turkey and the border of the province is formed by Kayseri in the east, Aksaray in the west, Niğde in the south, and Yozgat and Kırşehir provinces in the north. The surface area of Nevşehir province is 5,386 km^2. The altitude of Nevşehir province, which was established on the southern slope of the Kızılırmak valley is 1,150 m altitute. [1]. 2.5% of Nevşehir province consists is forest, 65.4% arable, 18.8% non-arable and 13.3% meadow-pasture areas. A large part of the arable land (2,209,395 decares) consists of areas where grain and other plant products are cultivated. The area of fruit, beverage and spice plants covers a very small area (230,989 da) compared to other areas. Nevşehir province is very poor in terms of vegetation.

It has a large share in potato production as an agricultural product, and the food and beverage industry related to grapes has an important place in the economy. In addition to these, pumpkin, sugar beet, wheat, barley, rye, broad beans, chickpeas, beans, lentils, garlic can also be grown in Nevşehir. The production of zucchini for snacks around the study area is grown on 21.1654 da area and its annual production exceeds 16.000 tons [2].

Geography Information Systems (GIS) ensures that the data processed in the program is more clear and interpretable. Designed to solve complex problems; It is a system of software and methods that covers the processes of containing, processing, managing, analyzing, displaying and modeling located data. GIS is an information system that integrates functions such as collecting, storing, analyzing and presenting data to the user. GIS provides visualization on maps by organizing layers of information along with the analysis of spatial locations that fall into all areas of our lives. With this capability, GIS offers a deeper perspective to the user by modeling and relating data to help users make more informed decisions.

In recent years, land and soil classification studies have been carried out with the help of Geography Information Systems and Remote Sensing techniques, with the development of more technological possibilities. “For example, in a study conducted on the advantages of using Quickbird satellite images in detailed soil survey studies in Adana, soil boundaries were tried to be determined by using combinations of aerial photographs, Quickbird satellite images and Landsat satellite imagery [3].

It has been revealed that it is not appropriate to use Landsat images in detailed soil survey studies, but it has been concluded that due to the high resolution of Quickbird satellite images, survey studies can be carried out in half the time spent in survey studies conducted with classical methods [3]. In the study conducted in Malatya province, GIS and Remote Sensing techniques were used together and the risk map and soil map of sloping lands were determined [4].

In this study, large soil groups, land use capabilities and subclasses were evaluated spatially by using digital soil maps of Nevşehir province. In the research, digital soil maps were spatially classified using Arc GIS 10.3.1 program, which is one of the GIS software.

It is thought that the data obtained as a result of the study will make significant contributions to agricultural production activities in Nevşehir province.

Manuscript revised 12 February, 2022 and published on 20 February, 2022
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doi: 10.32622/ijrat.101202204

II. 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.

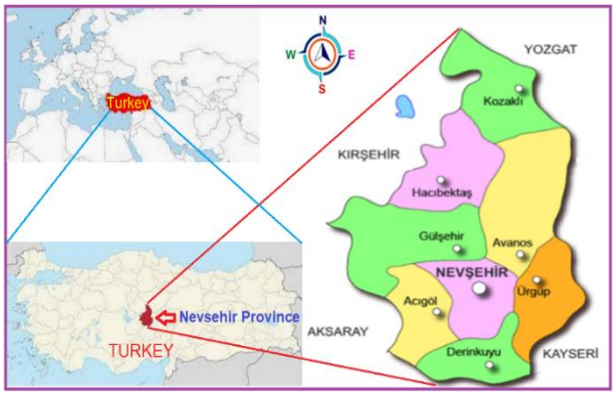

Fig 1. The location of research area

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. 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. 56.1% of the agricultural production area use in Nevşehir consists of grain cultivation areas. 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 [2].

Nevşehir has a warm and temperate climate. In winter, there is much more rainfall than in other months. Nevşehir has an average annual temperature of 10.73 °C and an average precipitation of 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 50 years of data covering the years 1986-2019 in Nevşehir, it was seen that the annual average precipitation amount was 362.9 mm. Total precipitation is 130.3 mm in spring, 123.5 mm in winter, 71.6 mm in autumn and 37.5 mm in summer [5].

In a study conducted with temperature data 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 0C. 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 [6].

In the study carried out to determine the total number of rainy days in Nevşehir center for many years;

It has been determined that the minimum number of rainy days is 77 days, the maximum number of rainy days is 142 days, and the average number of rainy days is 109 days [7].

In another study conducted on the climate data observed in Nevşehir for many years (2001-2019), the average maximum open surface evaporation for many years in Nevşehir Center was calculated as 59.7 mm and the total open surface evaporation as 1017.6 mm. It has been observed that there is a significant increase in open surface evaporation values in the spring, winter and autumn months, varying from year to year [8].

1/25.000 scaled digital soil maps were used to spatially evaluate some soil features related to the study area [9]. With the help of Arc GIS 10.3.1 program, one of the GIS software, large soil groups, land use capabilities and subclasses of the research area were spatially analyzed. The spatial distribution maps of soil properties were created by interpreting the evaluations in accordance with the criteria specified in the Soil and Land Classification Standards Technical Instruction of the Ministry of Agriculture and Forestry [10]. The layers related to large soil groups, land use capabilities and land use capabilities subclasses used in the spatial evaluation of digital soil maps are presented in Tables 1, 2 and 3.

TABLE 1: MAJOR SOIL GROUPS [10

Major Soil Groups	Explanation
Alluvial Soils	Usually formed on fresh sedimentary deposits, these are young soils and are either absent or very poorly developed. There are different mineral layers. These lands are mostly under the influence of ground water.
Brown Soils	These soils are mostly found in arid and semi-arid climates. The natural vegetation on them consists of short grass and bushes. These are soils rich in calcium. Natural drainage is good. Organic matter content is moderate.
Reddish Brown Soils	It is very similar to brown soils except for the color. Like them, they are found in arid and semi-arid climates. The natural vegetation is grass and bushes. Natural drainage is good. Biological activity in these soils is low.
Colluvial Soils	They are young soils formed on material called collivium deposited by gravity, landslides, surface flows or side currents at the foot of steep slopes and transferred over short distances.
Regosols	These are shallow soils of very sandy, low water holding capacity and high permeability, formed on loose and unconnected sediments. They have an undeveloped profile.
Limeless Brown Soils	These soils have a dark coating on the top and a slightly different coating on the bottom. Soils do not contain lime and the reaction is acid, neutral or calcium.
Hydromorphic Soils	It is a type of soil that is constantly under water in places with poor drainage such as swamps and reeds.
Brown Forest Soils	Brown forest soils are young soils that develop on slopes.
Lime-free brown forest soils	It is seen in the Black Sea mountains, in the Yıldız Mountains in Marmara, in the Innerwest Anatolian part, and in the Southeast Taurus Mountains.

doi: 10.32622/ijrat.101202204

TABLE 2: LAND USE CAPABILITY CLASSES]10]

Land Use Capability Classes	Explanations
I. Class Land	It is a land containing flat or nearly flat, deep, fertile and easily cultivable soils where conventional agricultural methods can be applied. First lands irrigated in places where there is little rainfall are those that have less than 1% slope, deep, loamy structure, good water holding capacity, moderately permeable soils.
II. Class Land	The differences of this from first-class terrain may be one or more of the limiting factors, such as mild inclination, moderate erosion exposure, moderately thick soil, occasional moderate flooding and moderate wetness that can be easily isolated.
III. Class Land	Moderate tendency, sensitivity to erosion, excessive wetness, shallow soil, presence of base stone, excess sandiness or graveliness, low water holding capacity and low productivity are the properties of this class.
V. Class Land	These lands, which are generally stony and wet, are flat or nearly flat. These are soils that are not exposed to excessive water and wind erosion.
IV. Class Land	Especially land suitable for permanent allocation to the meadow class is. Excessive slope, erosion, bad soil characteristics and climate are factors limiting agriculture to be made on this class of soils.
VI. Class Land	It is a land that requires moderate measures even when used as a forest or a meadow. It is very inclined and exposed to severe erosion.
VII. Class Land	It is very inclined, eroded, stony and defective, and includes shallow, dry, marshy or some other unfavorable soils. It can be used as a meadow or a forest provided that much attention is paid. If the vegetation on it decreases, erosion becomes very severe.
VIII. Class Land	It contains features that prevent cultivation and use as meadow or forest. These include marshland, desert, terrains containing very deep cavities, and high mountainous, overly defective, stony lands.

TABLE 3: LAND USE CAPABILITY SUBCLASSES [10].

Symbol	Explanations
e	Slope and Erosion Damage
es	Slope and Erosion Damage, Soil Insufficiency
s	Soil Insufficiency
se	Soil Insufficiency, Slope and erosion damage
sw	Soil shortage and Flood damage
w	Flood Damage
ws	Flood damage and Soil scarcity

III. RESEARCH FINDINGS

Spatial Analysis of Major Soil Groups

Classification of large soil groups in Nevşehir province was made using 1/25.000 scaled digital soil maps. The spatial distribution map of the large soil groups obtained as a result of the classification is presented in Figure 2.

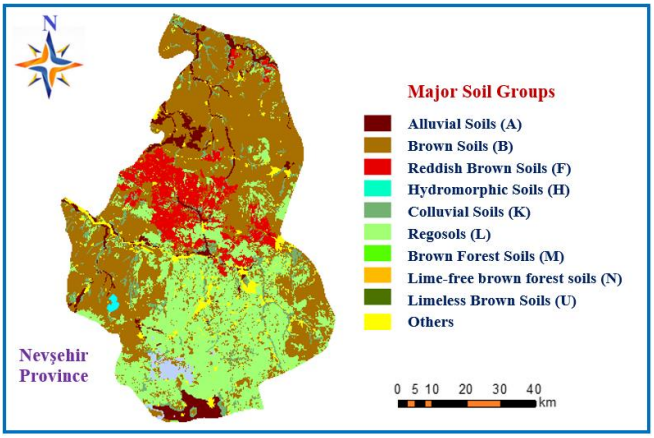

Fig 2. Spatial distributions of major soil groups

It is seen that brown soils and regosol soils are dominant in Nevşehir province. While regosol soils are dominant in the southern parts of Nevşehir province, brown soils are encountered especially in the northern and western parts of the province. It has been observed that reddish brown soils are dominant in the middle parts of the province and alluvial soils are located in the southernmost part. The areal distribution amounts of large soil groups of Nevşehir province are calculated and presented in Table 4.

TABLE 4: AREAL QUANTITIES OF LARGE SOIL GROUPS

Major soil groups	Area (ha)	Total area ratio (%)
Alluvial Soils (A)	26671,83	4,44
Brown Soils (B)	304248,49	50,68
Reddish Brown Soils (F)	50899,94	8,48
Hydromorphic Soils (H)	7,23	0,001
Colluvial Soils (N)	30229,49	5,04
Regosols (L)	161285,65	26,87
Brown Forest Soils (M)	17,31	0,001
Lime-free brown forest soils (N)	401,74	0,07
Limeless brown Soils (U)	6281,52	1,05
Other	20286,20	3,38
Total	600329,40	100,00

Brown forest soils in Nevşehir province correspond to 50.68% of the total area. Soil groups in the Regosol class are the second dominant soil class and cover 26.87% of the total area. Alluvial soils correspond to 4.44% of the total area with approximately 26671.83 ha.

Spatial analysis of land use capability classes

The spatial analysis results regarding the land use capabilities of the study area are given in Figure 3.

doi: 10.32622/ijrat.101202204

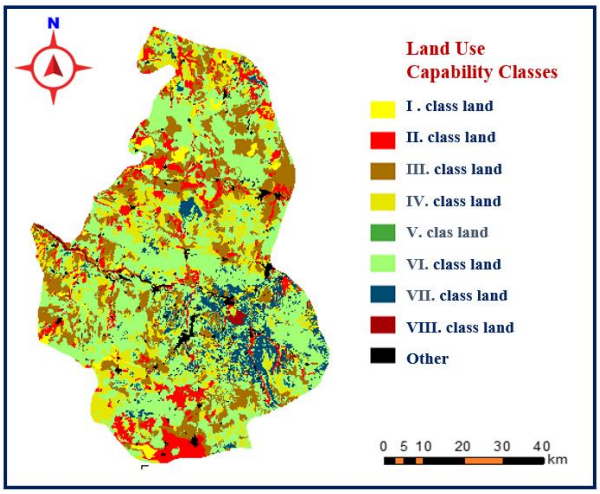

Fig 3. Spatial distribution of land use capability classes

When the spatial distribution of land use capability classes of Nevşehir province is examined, it is observed that VI. class land appears to be dominant. III. class land is in the second place in terms of the area it covers. VIII. class land is seen in the least area. The spatial distribution amounts of the land use capability classes of Nevşehir province are presented in Table 5.

TABLE 5. AREAL QUANTITIES OF LAND USE CAPABILITY CLASSES

Land Use Capabilities	Area (ha)	Total area ratio (%)
I . Class Land	12015,15	2,00
II . Class Land	56934,79	9,48
III . Class Land	148122,88	24,67
IV . Class Land	89883,33	14,97
V . Class Land	7,23	0,00
VI . Class Land	234491,21	39,06
VII . Class Land	38588,57	6,43
VIII. Class Land	5564,41	0,93
Other	14721,78	2,45
Total	600329,40	100,00

VI. class land dominates an area of 234491.21 ha (39.06%). Lands in this soil class are heavily sloped and subject to severe erosion. Soils in this class of land are exposed, wet or very dry or not suitable for cultivation for other reasons. III. class land covers an area of 148122.88 ha. IV. Class land corresponds to 14.97% of the total area.

Spatial Analysis of Land Use Capability Subclasses

Spatial distribution of the land use capability subclasses of the study area is given in Figure 4

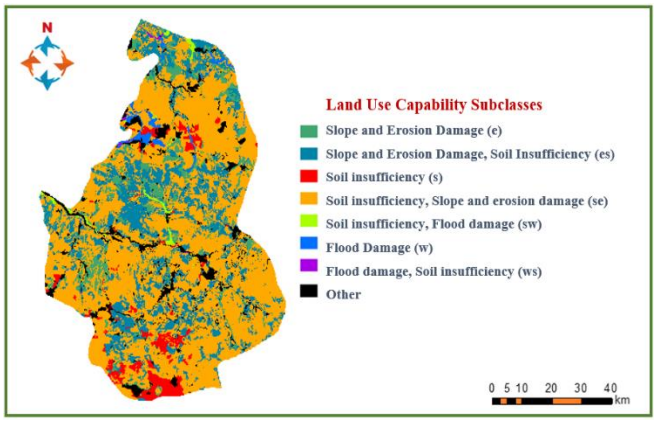

Fig 4. Spatial distributions of land use capability subclasses

It has been observed that soil insufficiency, slope and erosion damage group dominate throughout Nevşehir province. In general, it is seen that the areas with slope and erosion damage and soil insufficiency are high. It is seen that the damage of slope and erosion is in the whole of Nevşehir province. In the south, there is a lack of soil. It has been determined that in the north and northwest parts, flood damage and soil insufficiency are dominant. The spatial distribution amounts of the land use capability subclasses of Nevşehir province are given in Table 6.

TABLE 6: AREAL QUANTITIES OF LAND USE CAPABILITY SUBCLASSES

Land Use Capability Subclasses	Area (ha)	Total area ratio (%)
Slope and Erosion Damage (e)	45847,51	7,64
Slope and Erosion Damage, Soil Insufficiency (es)	109307,14	18,21
Soil Insufficiency (s)	23077,16	3,84
Soil Insufficiency, Slope and Erosion Damage (se)	376990,54	62,80
Soil Insufficiency, Drainage Disorder and Flood Damage (sw)	3913,79	0,65
Drainage Disturbance and Flood Damage (w)	8006,29	1,33
Drainage Disturbance and Flood Damage, Soil Insufficient (ws)	852,85	0,14
Other	32334,12	5,39
Total	600329,40	100

The slope and erosion damage of the total area in Nevşehir corresponds to 62.80% (376990.54) of the total area. The areas where only slope and erosion damage are seen are determined as 45847.51 ha.

IV. CONCLUSION and RECOMMENDATIONS

Spatial distribution map of soil classes is 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.

doi: 10.32622/ijrat.101202204

For example, in Niğde province, land use capabilities and some land features were analyzed spatially and distribution maps were created [11,12]. Soil resources potential in the Thrace Region was analyzed spatially with the help of GIS [13]. In the province of Kayseri, land slopes, soil depths, erosion classes and large soil groups were spatially examined and distribution maps were created using numerical soil maps [14].

In a study conducted for the classification of soils in Bursa province, large soil groups were classified by using Arc GIS program, which is one of the software of geographic information systems. As a result of the study, a large part of the land within the borders of Bursa Uludağ National Park, approximately 81.8% (10648.53 ha) is covered by Limeless Brown Forest soils [15]. Updating the soil map and monitoring the soil quality of Aksaray Koçaş Tigem (General Directorate of Agricultural Enterprises, Turkey) lands using GIS techniques [16].

In a study conducted in Adana region (Turkey), physiographic units and land use capability classes of the soils in mountainous areas were defined by satellite imaging and their maps were made with the help of Arc GIS [17].

As can be seen in the numerical map of the large soil groups as a result of the related GIS study of the soil classification of Tokat province, the largest area in the Tokat province covers 60.63% (6037.11 km^2) brown forest soils. And these lands are common in the eastern, western, northern and southern parts of the province, respectively. The second largest area (13.62%) is non-calcareous brown forest soils [18].

Land use capability maps were produced in a study conducted in GIS environment in Mardin province. As a result of the study, 16.48% of Mardin province is class I land, 9.73% is II. Class land, 2.68% of which is III. class land [19].

In a study conducted on the determination of land use capabilities in the Umurbey Stream Basin (Çanakkale-Lapseki), the VII. class lands have a rate of 71.8% (243,661 decares) in the total area [20].

In this study, spatial evaluation of large soil groups, land use capabilities and subclasses was carried out by using 1/25.000 scaled digital soil maps of Nevşehir province. For this purpose, large group lands using Arc GIS 10.3.1 software, which is one of the Geographical Information Systems (GIS) software. Spatial distribution maps of land use capabilities and subclasses were created. Within the scope of the research, brown soils correspond to 50.68% of the total area and cover an area of 304248.49 hectares. Regosols soils were seen in an area of 161285.65 ha. Reddish brown soils cover 8.48% (50899.94 ha) of the total area.

In terms of land use capability, VI. class lands are in the majority and the ratio of these lands in the total area is 39.06% (234491.21 ha). IV. class lands are 89883.33 hectares. In the research area II. Class lands cover 9.48% of the total area.

It was determined that the areas with slope and erosion damage and soil insufficiency in the study area correspond to 62.80% of the total area (376990.54 ha). Slope and Erosion Damage, Soil Insufficiency covers 18,21% (109307,14 ha) of the total area. Only Slope and Erosion Damage corresponds to 7.64% of the total area.

In the study, it is thought that the spatial distribution maps of land use capabilities will make important contributions to the studies to be made for agricultural purposes in Nevşehir province.

ACKNOWLEDGMENT

This study is based on some of the Master's Thesis titled " Assessment Along with Environmental Dimensions Soil and Water Resources Potential of Nevsehir Province with Geography Information Systems (GIS) by Mohammad Aalim NAZARI, a MSc student at Nevşehir Hacı Bektaş Veli University, Institute of Science, Department of Environmental Engineering prepared using the results.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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doi: 10.32622/ijrat.101202204