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Determination of Land Use Capabilities by GIS Analysis in Nigde Province, Turkey

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Abstract

This study was carried out with the aim of spatial evaluation of land use capabilities and subclasses by using 1/25.000 scaled digital soil maps of Niğde central district borders. For this purpose, spatial distribution maps of land use capabilities were created by using Arc GIS 10.3.1 which is one of the Geographical Information Systems (GIS) software. Within the scope of the research, it has been observed that the 7th class lands are in the majority compared to other land classes within the borders of the central district of Niğde and the ratio of these lands in the total area is 31.68% (864.62 km2). Class I lands in the research area cover 6.76% of the total area (184.47 km2) and II. class lands correspond to 16.61% of the total area with 453.19 km2. It was determined that the areas with slope and erosion damage and soil deficiency in the study area correspond to 39.60% of the total area and cover an area of 1080.63 km2. In the study, it will be inevitable that the spatial distribution maps of the land use capabilities will provide important contributions and basic bases to this and similar studies to be made for agricultural purposes in the center of Niğde in the future.

Keywords: Land Use Capabilities, GIS Mapping, Spatial Analysis, Nigde province, Turkey

Research article
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INTRODUCTION

Soil is a natural entity that directly or indirectly constitutes the life source of many living things due to its functions. In this respect, the soil that covers the earth's surface in the form of a thin cover is the basis of life. Despite having such an important place for the life of living things, the quality of the soil, which is thought to be inexhaustible and can only renew itself in a very long period of time, continues to decrease due to reasons such as erosion, intensive tillage, overgrazing, salinity-alkalinity and desertification (Oldeman, 1994).

One of the main reasons for the deterioration of soil quality is that the lands are not used in a way that is not suitable for their ability classes. Mismanagement of land and water resources leads to a decrease in the productivity of these resources and to their being completely excluded from agricultural production over time (Arshad and Martin, 2002).

Land capability classification has been prepared in many developed countries such as America, England and France. Most of the land capability classification systems and mappings in the world in general are in the USA, which was published in 1961. It is an adaptation of the method of the Ministry of Agriculture. In Turkey, the first land capability classification was published by the "TOPRAKSU" Organization in 1978 as the "Turkey Land Presence" report within the framework of the criteria used in the USA. Accordingly, land capability was determined as eight classes (Atalay and Gökçe Gündüzoğlu, 2015; Atalay and Değeryurt, 2015; Atalay, 2016; Özşahin, Pektezel and Eroğlu, 2016).

Land use capabilities are a classification process made as an indicator of whether the land in an area is suitable for tillage agriculture. In this classification, the aforementioned lands can be classified into 8 different categories by revealing their suitability for agriculture. They are classified as areas that cannot even be used as meadows or forests, but can create an environment for natural life or can be used as resting places and national parks by people (Anonymous, 2005).

In recent years, land and soil classification studies have been carried out with the help of Geographical 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. 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" (Öztekin and Koca 2011).

In this study, land use capabilities and subclasses were spatially evaluated by using 1/25.000 scaled digital soil maps of Niğde central borders. In the research, digital soil maps were classified in the Arc GIS 10.3.1 environment, which is one of the Geographical Information Systems (GIS) software, and spatial distribution maps related to the land use of the borders of the central district of Niğde were produced. It is aimed that the results to be obtained from the study will form the basis for the investments to be made for agricultural purposes and be a guide.

MATERIALS and METHODS

This study was carried out within the boundaries of the central district of Niğde. The location and location of the Niğde Central district borders, which is the subject of the research, is shown in Figure 1.

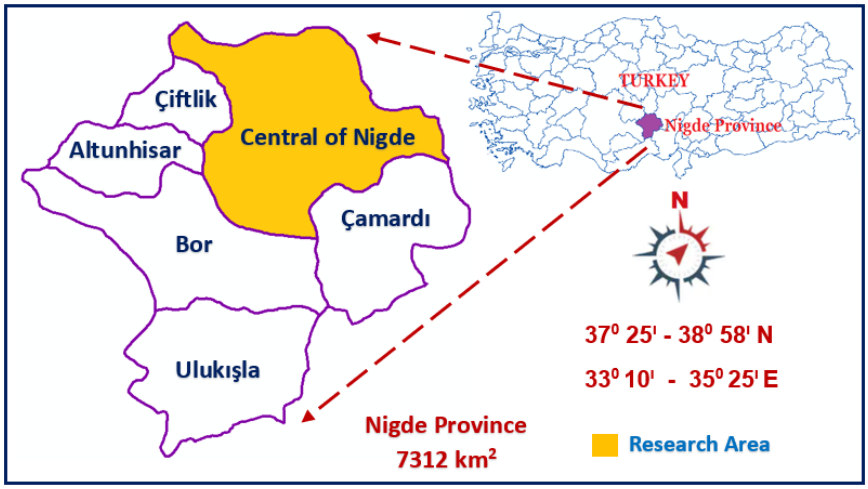

Figure 1. The location of research area

The study area is within the borders of the central district of Niğde province and is located between 37º 25' and 38º 58' north latitudes and 33º 10' and 35º 25' east longitudes. Niğde province has a total area of 7312 km^2 in the Central Anatolian Region, and the borders of the central district are spread over an area of 2699 km^2. Niğde province is adjacent to Nevşehir and Aksaray in the north, Konya in the west, Kayseri in the east and Adana and Mersin in the south. The province has 5 districts, 29 towns and 132 villages, including Altunhisar, Çiftlik, Bor, Çamardı, Ulukışla, excluding the Central district. Within the boundaries of Niğde Central district, which is the subject of the research, a total of 34 villages and 69 neighborhoods are scattered as settlements (Anonymous, 2021). Niğde province has an agricultural area of 2 million 758 thousand decares and approximately 38% of the province's surface area is agricultural lands. Pasture areas cover an area of 2,891,150 decares, and fallow areas cover an area of 676 thousand decares, which corresponds to 9% of the province's surface area. The forest area of Niğde province is 562,380 decares and the economically irrigable area in the province corresponds to 57% (1 million 200 thousand decares) of the province's surface area. The number of farmers who are interested in agricultural production throughout the province of Niğde is around 38 thousand, and 14 thousand of these farmers are active in the farmer registration system (Anonymous, 2020). In terms of climate characteristics, Niğde province has typical continental climate characteristics with hot and dry summers and cold and rainy winters. While the total annual precipitation was measured as 330.50 mm in the city center as of 2019, the average total precipitation value for many years was observed as 286.60 mm (Anonymous, 2019).

In a study evaluating the temperature changes for many years (1970-2019) in the Niğde region, the minimum temperature average was calculated as -1.2 ^{0}C and the maximum temperature average 24.5 ^{0}C. It has been determined that there is an increasing trend in the minimum temperature changes for many years, especially in spring, summer and autumn months. As a result of statistical analyzes, it has been revealed that there is a significant trend in the increasing direction in spring, summer, autumn and winter at maximum and average temperatures (Bağdatlı and Can, 2020).

In a study in which the maximum and total precipitation changes for many years (1970-2019) were evaluated by trend analysis within the borders of the central district of Niğde, it was determined that there was a significantly increasing trend in maximum precipitation in winter, summer and annual general average. It was concluded that there is no trend in total precipitation changes (Bağdatlı and Arslan, 2020). In the research, 1/25.000 scale digital soil maps obtained from the Ministry of Agriculture and Forestry were used (Anonymous, 2000). Arc GIS 10.3.1 software, which is one of the Geographical Information Systems software, was used for digital soil maps (Anonymous, 2010). The numerical data obtained were classified as spatial and the spatial distribution of the land use capabilities of the central district borders of Niğde and their subclasses were revealed. The classified soil maps obtained were evaluated according to the "Soil and Land Classification Standards Technical Instruction" published by the Ministry of Agriculture and Rural Affairs in 2005 (Anonymous, 2005). In the study, classification layers related to land use capabilities and subclasses are summarized in Tables 1 and 2.

Table 1. Land use capability classes (Anonymous, 2005)

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.
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	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 2. Land use capability subclasses (Anonymous, 2005)

Symbols	**Explanations**
e	Slope and Erosion Damage
s	Soil Insufficiency (stoniness, salinity and alkalinity)
w	Age, Drainage disorder and Flood damage

RESEARCH FINDINGS

Spatial Analysis of Land Use Capabilities

Spatial distributions regarding the land use capabilities of the central district borders of Niğde, which is the study area, are given in Figure 2 and the spatial distributions related to this are given in detail in Table 3.

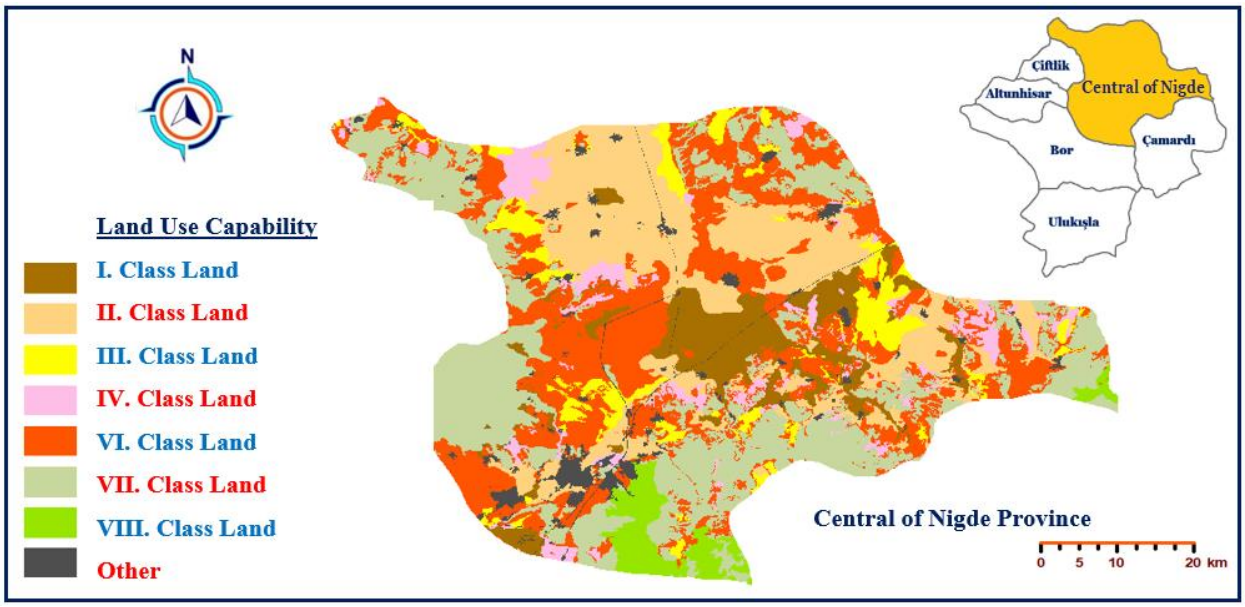

Figure 2. Spatial distribution of land use capabilities

Table 3. Areal distribution of land use capabilities

Land Use Capabilities	Area (km^2)	Total area ratio (%)
I. Class Land	184,47	6,76
II. Class Land	453,19	16,61
III. Class Land	142,43	5,22
IV. Class Land	117,66	4,31
VI. Class Land	671,26	24,60
VII. Class Land	864,62	31,68
VIII. Class Land	216,44	7,93
Other	78,90	2,89

Such lands have good water holding capacity and are known as areas with very good drainage. In contrast, VII. Class lands, on the other hand, are lands formed by areas that are very inclined and exposed to too much erosion and are not suitable for agriculture, and are characterized as lands that can be converted into suitable soil cultivation structures to meadow areas or evaluated as forest areas (Anonymous, 2005).

In the central of Niğde, VII. class lands dominate. IV. Class lands, on the other hand, cover a minimum area of 117.66 km^2 and correspond to 4.31% of the total area. IV. Class lands, on the other hand, are known as lands that restrict agricultural production due to insufficient soil and land conditions and unsuitable climatic conditions, but these areas are also known as areas suitable for allocation to meadow and pasture areas (Anonymous, 2005). The spatial distribution map obtained, spatially evaluated and classified in the subclasses of the land use capabilities classified within the scope of the study, is presented in Figure 3 and the calculated areal distributions for the groups classified accordingly are presented in detail in Table 4.

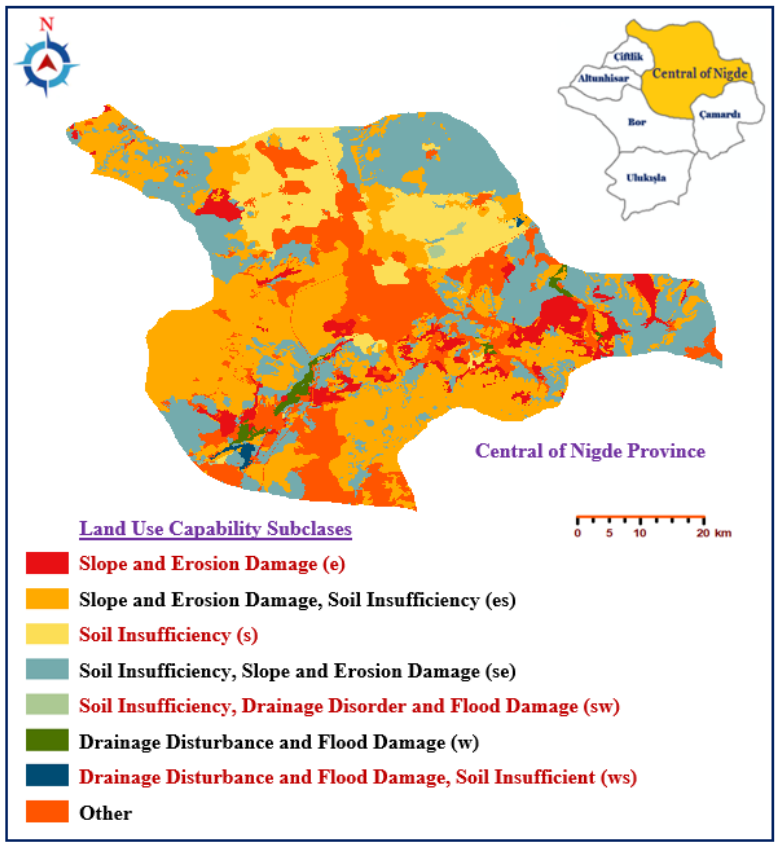

Figure 3. Spatial distribution of land use capability subclasses

Table 4. Areal distribution of land use capability subclasses

Land Use Capability Subclasses	Area (km^2)	Total area ratio (%)
Slope and Erosion Damage (e)	136,84	5,01
Slope and Erosion Damage, Soil Insufficiency (es)	1080,63	39,60
Soil Insufficiency (s)	253,82	9,30
Soil Insufficiency, Slope and Erosion Damage (se)	677,78	24,84
Soil Insufficiency, Drainage Disorder and Flood Damage (sw)	5,23	0,19
Drainage Disturbance and Flood Damage (w)	19,46	0,71
Drainage Disturbance and Flood Damage, Soil Insufficient (ws)	5,90	0,22
Other	549,30	20,13

It has been determined that the areas where slope and erosion damage and soil insufficiency are high in the research area are especially seen in 39.60% of the total area. It has been determined that drainage disorder and flood damage are seen in 0.71% of the total area in an area of 19.46 km^2. Soil insufficiency is also observed in the study area and it is seen that 9.30% of the total area is exposed to this situation.

CONCLUSION and RECOMMENDATIONS

In this study, spatial analyzes of land use capabilities and subclasses were carried out in the central district of Niğde. Accordingly, when we look at the distribution of land use capabilities based on 7 classes in the central of Niğde, it has been determined that Class I lands cover an area of 184.47 km^2 and correspond to approximately 6.76% of the total surface area of the study area. First class lands; It is a land containing flat or nearly flat, deep, fertile and easily cultivated soils where conventional agricultural methods can be applied. There may be little water and wind erosion on this grade of land. Soils have good drainage and are not subject to flood damage. They are suitable for hoe plants and other intensively grown crops. First class lands irrigated in places with low rainfall are lands with less than 1% inclination, deep, loamy structure, good water holding capacity, moderately permeable soils (Anonymous, 2005). In this context, it is seen that class I land assets in the study area are low compared to other land classes. In the research area II. Class land asset is 453.19 km^2, which corresponds to 16.61% of the total area. These lands, on the other hand, are good lands that can be easily cultivated only by taking some special precautions. Its differences from prime land may be one or more of the limiting factors such as light inclination, moderate erosion, moderately thick soil, occasional moderate flooding, and moderate wetness that can be easily isolated (Anonymous, 2005).

Areas with soil deficiency in the study area correspond to 9.30% of the total area (253.82 km^2). On the other hand, the areas where all components such as soil insufficiency, slope and erosion damage are seen constitute 24.84% of the total area. The areas where soil sufficiency is seen are not suitable for cultivated agriculture and can be characterized as mostly abandoned steppe and barren areas. In addition, the presence of water and wind erosion in the existing area causes the erosion of the existing soil surface and the transport of the fertile soil part. As can be seen in the classification of land use capabilities, I. and II. The scarcity of class land and the fact that it has a very low rate of 23.37% in the total area is an indicator that the slope, erosion, drainage and soil insufficiency problems that occur in the field are dominant.

Similar to this study conducted in Niğde province, other studies have been found in the literature using digital soil maps with Geography Information Systems (GIS) in Turkey. For example, in determining some land characteristics in Niğde province, in determining some soil resources potential in Thrace Region, in determining land slope, soil depths, erosion classes and large soil groups in Kayseri province, in determining land use and some soil properties in Kırşehir province, in determining some land and soil characteristics in Nevşehir province. Studies have been carried out to determine the large soil groups, current land uses, soil depths, land slope and erosion classes in Kırşehir province. In these studies, 1/25.000 scaled digital soil maps were used and some land and soil properties were analyzed spatially by using GIS (Bağdatlı and Arslan, 2020; Bağdatlı and Can, 2021a; Bağdatlı and Arslan, 2021; Bağdatlı and Ballı, 2021; Bağdatlı and Can; 2021b; Bağdatlı and Arıkan, 2021).

In this study, land use capabilities within the boundaries of the central district of Niğde province and accordingly its subclasses were spatially evaluated in the GIS method. As a result, the dimensions of the damages (soil deficiency, erosion, braking problem, slope) occurring in the lands of the region have been clearly revealed. The results obtained will make significant contributions to the agricultural investments to be made in the region. It will be inevitable that the spatial distribution maps of the land use capabilities will form the basis for different studies and will provide important bases for planning.

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