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Corine Modeli Kullanılarak Niğde Şehrinde Toprak Erozyon Riskinin Değerlendirmesi

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ÖZ

Bu çalışmada çevresel bilginin koordinasyonu modeli kullanılarak toprak erozyon riski hesaplanmıştır. Çalışmanın amacı toprak özellikleri, eğim ve alan kullanımları dikkate alarak, Niğde ilinin toprak erozyon riskinin belirlenmesidir. Potansiyel (PSER) ve gerçek toprak erozyonu riski (ASER), toprak özellikleri, eğim, iklim faktörleri ve arazi örtüsü verileri gibi faktörler kullanılarak belirlenmiştir. Arc-GIS 10.3 yazılımı kullanılarak veriler üretilmiş ve bu haritalar üzerinde sonuçlar elde edilmiştir. Elde edilen verilere göre çalışma alanının doğu ve güneydoğu kesimlerinde yer alan toprakların %34,72'si orta derecede gerçek toprak erozyonu riski olarak sınıflandırılmıştır. Toprakların sırasıyla %51,66'sı düşük ve %13,62'si gerçek toprak erozyonu riski yüksek olarak sınıflandırılmıştır. Gerçek toprak erozyonu riski düşük olan alanlar orta kısımda, yüksek gerçek toprak erozyonu riski olan alanlar ise alanın kuzeybatı kesiminde yer almaktadır. Arazi örtüsü haritası birleştirilerek, potansiyel toprak erozyonu riski düşük olarak sınıflandırılan alanların gerçek toprak erozyonu riski %23,52'den %51,66'ya yükselmiştir. Öte yandan, yüksek ve orta potansiyel toprak erozyonu riski olarak sınıflandırılan toplam alanlar, arazi örtüsü türleri nedeniyle gerçek toprak erozyonu riskinde %76,48'den %48,34'e düşmüştür. Toprak dokusu, arazi örtüsü ve eğimin erozyon riskini etkileyen en önemli faktörler olarak tespit edilmiştir. Bu çalışma, GIS (Coğrafi Bilgi Sistemleri) ve RS (Revize Evrensel Toprak Kaybı Denklemi) ile entegre CORINE modelinin, toprak erozyonu risk değerlendirmesi için çok etkili ve doğru bir potansiyele sahip olduğunu göstermiştir.

Soil Erosion Risk Assessment in The Niğde Using Corine Model

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ABSTRACT

Soil erosion risk was calculated using the coordination of information on the environment (CORINE) model in this study. The aim of the study is to determine the soil erosion risk of Niğde province, taking into account soil properties, slope and land use. Potential (PSER) and actual soil erosion risks (ASER) were determined using factors which were soil properties, slope, climatic factors, and land cover data. Data were produced using Arc-GIS 10.3 software, and results were obtained on these maps. 34.72% of the soils were classified as moderately actual soil erosion risk, which located in the eastern and southeast part of the study area. 51.66% and 13.62% of the soils were classified as low and high actual soil erosion risk, respectively. Areas which have low actual soil erosion risk are located in the middle part, and areas which have high actual soil erosion risk are located in the northwest part of the area. The areas which were categorized as low potential soil erosion risk were increased from 23.52% to 51.66% in the actual soil erosion risk, after combining the land cover map. On the other hand, the total areas classified as high and moderate actual soil erosion risk decreased from 76.48% to 48.34% in the actual soil erosion risk due to land cover types. Soil texture, land cover, and slope are the most important factors that affect erosion risk. This study indicated that the CORINE model integrated with GIS (Geographic Information Systems) and RS (Revised Universal Soil Loss Equation) has a very effective and accurate potential for soil erosion risk assessment.

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Introduction

The demand for natural resources is increasing day by day in order to meet people’s needs. Areas are under intense pressure due to agriculture, urbanization, mining and tourism activities. Natural resources must be used in accordance with their potential for sustainable land use. There are many problems in Turkey's land. The most important of these problems are soil erosion and improper land use. As the lands are not used in accordance with their potential, land fragmentation occurs, and irreversible damage and deterioration occur in natural resources. Soil erosion causes changes in land use. Also, soil erosion is a factor which damages and decreases the productivity of the agricultural soils that are one of the most essential natural resources (Shphinah and Saraswathy, 2005; Edosomwan et al., 2013). Soil erosion is a critical problem throughout the world due to its economic and ecological impacts such as losses in land and reduces in its productivity (Eroğlu et al., 2010; El-Nady and Shoman, 2017). Therefore, estimation of the soil erosion risk is necessary to protect the agricultural lands and to achieve the sustainable management of watersheds.

The changes in the soils caused by erosion are as follows; the loss of the soil, the deterioration of the soil structure, the reduction of organic matter or plant nutrients, and decrease soil depth. Besides these, the most important problem is that the agricultural productivity of the land decreases as a result of erosion and the precautions which are taken to increase production in these lands, are not economically appropriate. When the problems in these areas cannot be resolved, the lands are abandoned or become unusable. Soil loss occurs mostly occur on the Asia continent with 30-40 tons/ha/year (Bashir et al., 2013). It is known that 18.9% of the European continent is exposed to low erosion, 64.7% of them are moderate, and 9.2% of them are exposed to high erosion (Grimm et al., 2011). Soil erosion should not be considered only as soil loss in the area. As a result of soil erosion, the water holding capacity of the soil and the amount of organic materials reduce in the areas (Pimentel and Kounang, 1998).

Agricultural products are being damaged so the fertility of the soil decreases (Stone et al., 1985; Verity and Anderson, 1990). The decrease in the amount of soil causes ecological problems in the region. These problems may be occurred by changes in land use or climate conditions (Lal et al., 1991). The effects of soil erosion are influenced by many climate factors, plant changes, and biological processes. For example, if wind and precipitation increase, soil erosion risk also increases. However, if increase of the vegetation on the soil, erosion risk decreases generally (Valentin, 1998).

When considering research on soil erosion, it is feasible to categorize the studies into three major groups based on their methodologies and scopes. Upper scales and satellite pictures are used in the investigations for the first category. Studies (Mushi et al., 2019; Karydas et al., 2020; Mukharamova et al., 2021; Turan, 2021; Yılmaz et al., 2021) in this context might focus on the entire city or just the neighborhood around it. The second kind of investigation is what is known as observational studies (Revellino et al., 2019; İkiel et al., 2020; Çilek, 2021; Wu et al., 2021; Özvan and Çatır, 2022; Jiang et al., 2022).

These evaluate the data from the existing stations or measuring devices and compare the data from meteorological stations in urban and rural regions. Depending on the number of stations or sensors utilized for the measurements, these studies may focus on a certain axis. The entire city, or a portion of it. Numerical modeling study (Bozyiğit, 2020; Chen et al., 2021; Mutlu et al., 2021; Pal et al., 2021; Buraka et al., 2022) is included in the third group. Most of the investigations in this category are conducted at the sub-, land-, or residential levels. The present study falls into the first and second groups when technique and scope are considered.

In many countries except Turkey, many studies (Cebecauer, 2004; Zhu, 2012; Al Sayah et al., 2019; Yousif et al., 2020) were conducted on this subject. There are a few studies (Özalp et al., 2013; Kanar ve Dengiz, 2015; Özşahin and Uygur, 2019; Kırcı, 2019; Mercan and Arpağ, 2020; Yılmaz and Dengiz, 2021; Turan, 2021; Aykır and Fıçıcı, 2022; Demir et al., 2022; Tuncer and Deniz, 2023) on soil erosion in Turkey. However, these were found insufficient to determine the relationship between CORINE and soil erosion risk. It was determined that the studies about the soil erosion risk were carried out in areas which have high green surfaces and much precipitation. We can say that in the studies given above, slope, land cover and soil properties were examined, and similar factors were examined in this study. Niğde which was determined as the study area, has different characteristics from other areas due to its green areas, lack of rainfall and high snowfall. In addition, Niğde has much different land cover types compared to other provinces where there were studied before.

The aim of the study is to determine the soil erosion risk of Niğde province, taking into account soil properties, slope and land use. In addition, it is aimed to reveal the actual and potential erosion risk of Niğde by using GIS and CORINE. The purpose is to determine the land use/cover and soil erosion risk by remote sensing method. In this context, soil maps were used, soil samples were taken in the study area, and these data were analyzed in detail. Finally, the relationship between CORINE and the soil erosion risk was explained.

The limitation of this study is that the amount of precipitation and the green area is not high. There is very little vegetation on the mountains in the study area. In addition, the status of surface waters and groundwater level are among the parameters that can affect soil erosion. However, these factors were excluded because the study area does not have much groundwater and there is no vegetation in the areas where surface water flows. Therefore, there are limitations in the study in terms of explaining the relationship between vegetation and erosion status.

Material and Method

The entire city of Niğde is included in the study area. Niğde is located between 37°54'00" and 38°06'30" north latitude and 34°30'10" to 34°45'00" east longitude. The study area measures 7,795.22 km^2. Summers in Niğde are hot and dry, and winters are cold and snowy. According to the General Directorate of Meteorology, 2022, the mean annual temperature ranged from -1.0 to 22.4 ^{o}C and the average rainfall ranged from 5.2 to 48.7 mm.

Soil Analysis

In this study, aspect and slope maps were produced using DEM which has 30 m resolution. Soil analyses were made according to USDA. Then, the soils were classified according to Soil Survey Staff (Yousif et al., 2020). These data were processed through the raster calculator in the Arc-GIS. Maps of the potential and actual erosion risk were obtained using some criteria's. Methodology which was used in the study, is seen in Figure 1.

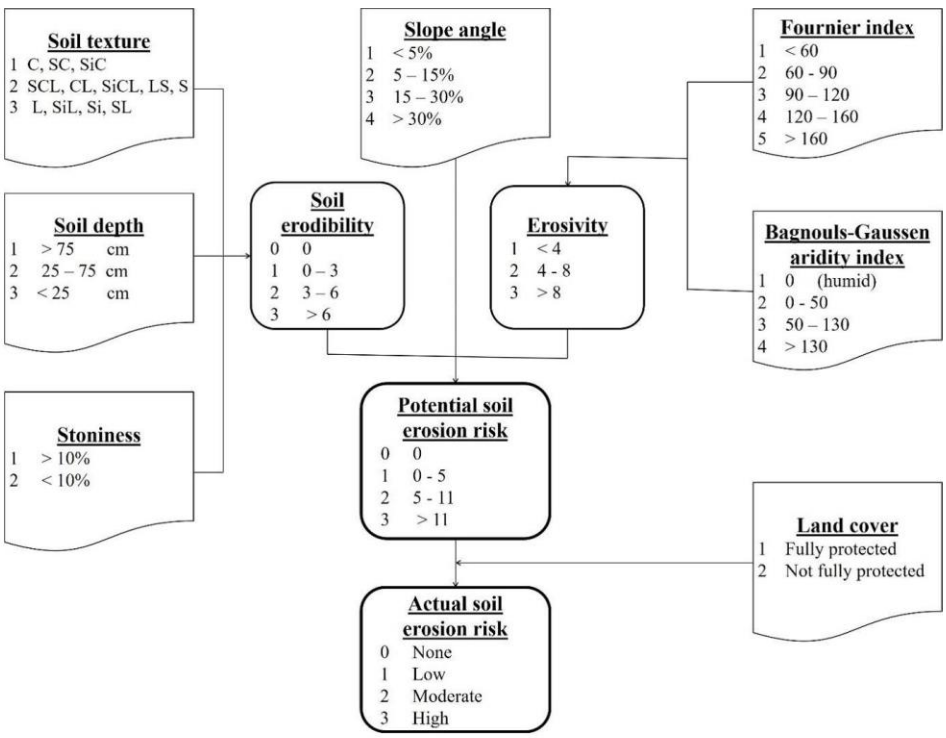

Figure 1. Flow diagram of the CORINE model for erosion risk (Laflen, 1994)

Soil Erodibility

There are several methods to determine the soil erodibility. Soil erodibility was calculated using three factors which were determined within the scope of this study. Soil depth, soil texture and stoniness rate of the soil were obtained from soil maps. Soil maps were obtained from "Food and Agriculture Organization of the United Nations – (FAO/UNESCO)" data. The resolution of the maps obtained is 250 meters, which is an appropriate resolution considering the size of the study area. The formula is given in Equation 1. The values were calculated using the Raster Calculator plugin in Arc-GIS. Values taken as reference for the study are given in Table 1

$$\text{Soil erodibility} = \text{texture of soil} \times \text{depth of soil} \times \text{stoniness rate of soil} \quad (1)$$

Table 1. Classes of the parameters used for the assessment of soil erodibility (Aydın et al., 2010; Yousif et al., 2020)

Soil Factors	Classification	Value	Description
Texture of Soil	Clay-Sandy Clay-Silty Clay	1	Slightly erodible
	Sandy Clay Loam-Clay Loam Silty Clay Loam-Loamy Sand-Sandy	2	Moderately erodible
	Loam-Silty Loam-Silty-Sandy Loam	3	Highly erodible
Stoniness (%)	< 10	1	Not fully protected
	> 10	2	Full protected
Depth of Soil	> 75	1	Slightly erodible
	25-75	2	Moderately erodible
	< 25	3	Highly erodible
Erodibility	0-3	1	Low Erodibility
	3-6	2	Moderate Erodibility
	> 6	3	High Erodibility

Rainfall erosion index (Erosivity Index)

Erosivity index was calculated using various data. Data were obtained from the General Directorate of Meteorology of Turkey. Precipitation and temperature data were used due to calculation the erosivity index. The formula used to calculate the erosivity index is as follows (2-4) (Yüksel et al., 2008; Yousif et al., 2020).

$$\text{Rainfall erosion index} = \text{Fournier (FI) index} * \text{Bagnold-Gawsn (BGI) index} \quad (2)$$

$$\text{The Fournier index (FI)} = \sum_{i=1}^{12} \frac{P_i^2}{P} \quad (3)$$

Where, pi: the monthly precipitation (mm)

P: Total annual rainfall (mm)

$$\text{The Bagnold-Gawsn Index (BGI)} = \sum_{i=1}^{12} (2t_1 - p_1)k_1 \quad (4)$$

Where ti: Average monthly temperature (degrees Celsius)

ki: calculated when 2ti-pi>0.

(ki) is the proportion of the month if 2ti-pi>0

FI and BGI values are classified as shown in Table 2.

Table 2. Ranking of FI and BGI indices (Aydın et al., 2010; Yousif et al., 2020)

<table>
<tr><th rowspan="2">Class</th><th colspan="2">FI</th><th colspan="2">BGI</th><th colspan="2">Erosivity</th></tr>
<tr><th>Range</th><th>Class</th><th>Range</th><th>Class</th><th>Range</th><th>Class</th></tr>
<tr><td>1</td><td><60</td><td>Very low</td><td>0</td><td>Humid</td><td><4</td><td>Low</td></tr>
<tr><td>2</td><td>60-90</td><td>Low</td><td>0-50</td><td>Moist</td><td>4-8</td><td>Moderate</td></tr>
<tr><td>3</td><td>90-120</td><td>Moderate</td><td>50-130</td><td>Dry</td><td rowspan="3">>8</td><td rowspan="3">High</td></tr>
<tr><td>4</td><td>120-160</td><td>High</td><td rowspan="2">>130</td><td rowspan="2">Very dry</td></tr>
<tr><td>5</td><td>>160</td><td>Very high</td></tr>
</table>

Slope Index

The slope was another factor that was used in the study. The slope analysis was produced from the DEM. Slope analysis was made from the "slope" analysis section in the Arc-GIS software. The reference values of the slope groups are given in Table 3.

Table 3. Classification of slope

Classification	Description	Angle of Slope (%)	Classification	Description	Angle of Slope (%)
1	Flat	<5	3	Step	15-30
2	Slight	5-15	4	Very step	>30

Potential soil erosion risk (PSER)

Two maps were used to determine the potential soil erosion risk. In this context, slope and soil erodibility maps were used. The Arc-GIS software's raster calculator plugin was used for this computation. Equation (5) (Yüksel et al., 2008; Yousif et al., 2020) is the formula utilized.

$$\text{Potential Soil Erosion Risk} = \text{Index of Erodibility} * \text{Index of Erosivity} * \text{Index of Slope} \quad (5)$$

Land Cover Index

GIS is one of the most preferred software within the scope of spatial analysis. Land cover classification can be made using GIS software. Landsat satellite images are the most used data for this reason. Today satellite images are available from various locations. The pre-processed data sets downloaded from (https://earthexplorer.usgs.gov/) were used in the study. Land-use/land cover classes were defined from satellite images obtained in 2019 by visual interpretation through ENVI 5.3. LUCC maps were classified into nine different land-use classes using the supervised classification method;

- Urban areas.
- Sparsely vegetated areas.
- Industrial units.
- Pasture lands.
- Agricultural lands.
- Broad-leaved forest.

- Coniferous forest.
- Watercourses.
- Bare land

Forests, water areas and impervious surfaces were described as fully protected areas, and 1 point was given in these areas. Areas which have small vegetation, orchards and agricultural areas, were described as not fully protected, and 2 points were given in these areas.

Actual Soil Erosion Risk

The actual soil erosion risk map was then produced. The land cover map and a potential soil erosion map were merged for this. This was accomplished using the Arc-GIS raster calculator plugin.

Results and Discussion

Niğde is one of the important countries where agricultural activities have been carried out throughout history. When the soil structure of Niğde was examined according to the land use capability classes. 40.38% (3,147.71 ha) of the soils are class VII soils. 2,625.77 ha (33.68%) of the area consists of arable land. (I. II. III. and IV.Classes) (Sever and Kopar, 2014).

Soil Erodibility Index

Sandy loam which is characterized as a highly erodible soil and low resistant to erosion, was the most soil texture class with 73.71% in Niğde (Figure 2). 26.28% of the soil was Loamy sand, Sand and Sandy clay loam. These groups were characterized as moderately erodible soils and moderately resistant to erosion according to CORINE model. Soil depth is a very important factor in the soil erodibility due to the water storage ability of soil profile increased with increasing soil depth (Yüksel et al., 2008). Results in Figure 3 show that 1.66% of the soil with a depth of less than 25 cm and is characterized as severe tendency for erosion which is located in the northeast part. About 0.87% of the soil with a depth of 25-75 cm and recognized as medium susceptibility for erosion, and they are mainly located in the middle part. 97.47% of the soil has a depth of more than 75 cm located in the Niğde, these were classified as low tendency for soil erosion.

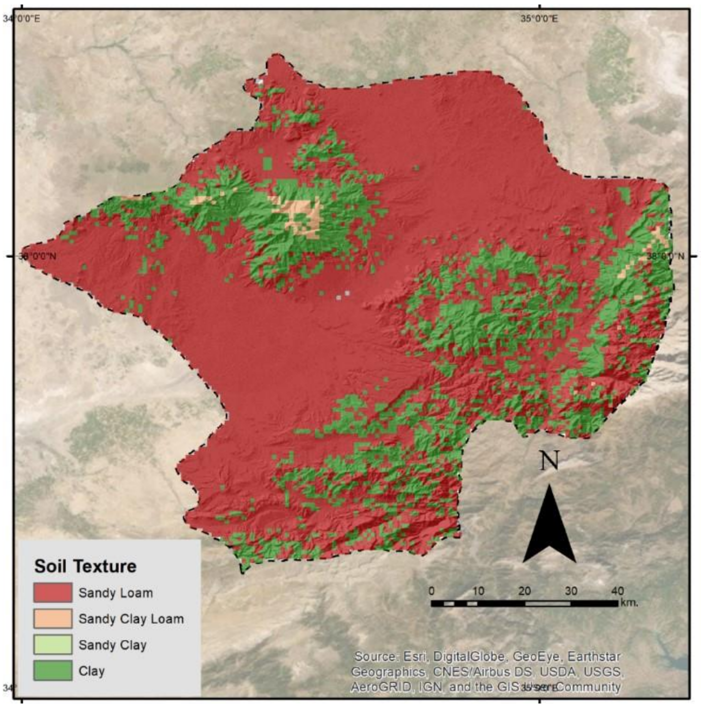

Figure 2. Soil texture of Niğde

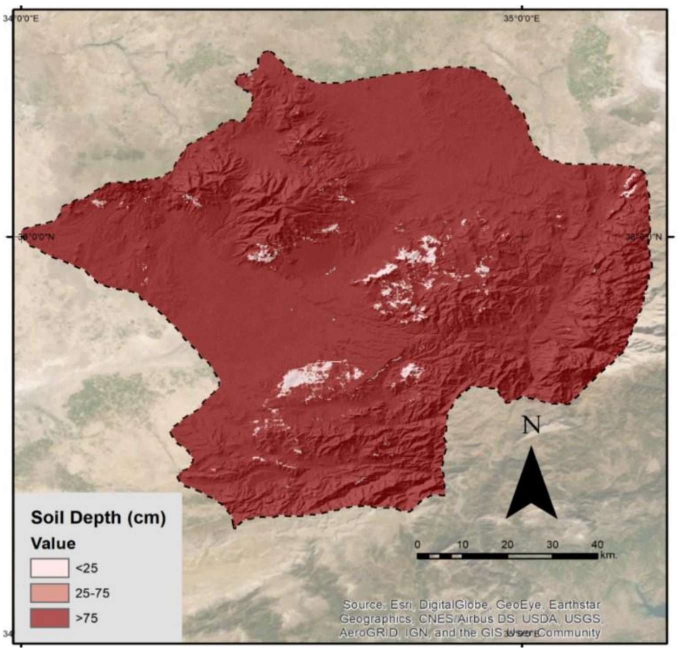

Figure 3. Soil depth of Niğde

26.28% of the soil were characterized as a surface with stone greater than 10%, and these are located in the northeast and northwest part of Niğde. 73.72% of the soil was categorized as a surface with a stone less than 10%, and these are located in the middle part of Niğde (Figure 4).

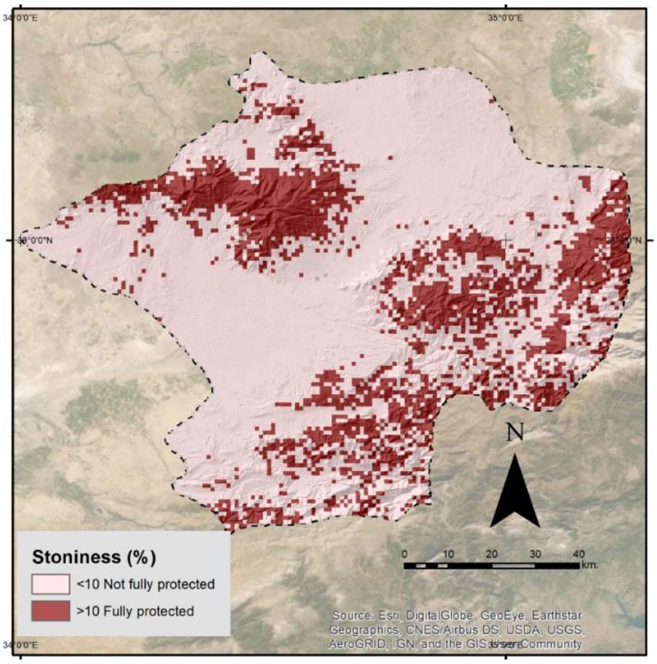

Figure 4. Soil stoniness of Niğde

A soil erodibility map was created by overlaying soil texture, depth, and stoniness maps (Figure 5). The erodibility map show that 96.49% of Niğde is covered by low erodible soil, and these are located in almost all part of Niğde. 2.38% covered by moderately erodible soil, and these are located in the northwest of Niğde. The rest of the area (1.13%) is covered by highly erodible soil due to its shallow soils in the northeast part

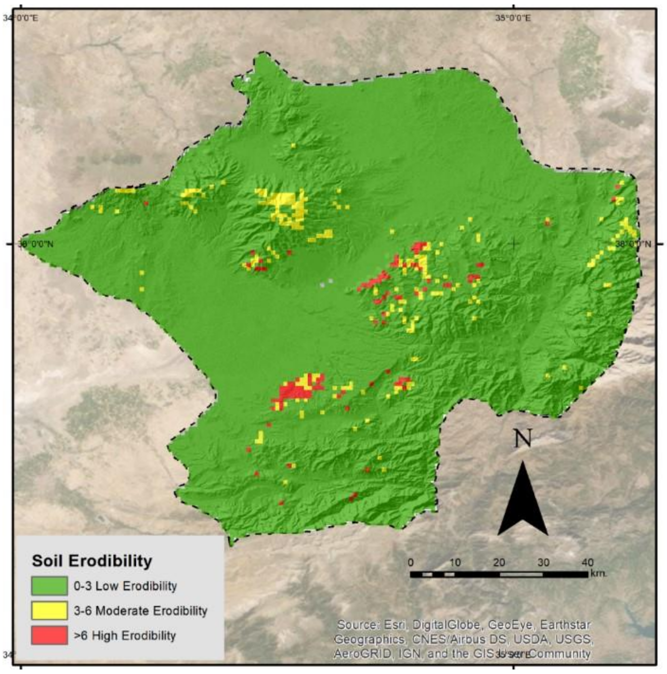

Figure 5. Soil erodibility

Erosivity index (EI)

Erosivity index was calculated using meteorological data obtained from the Niğde metrological station. Results indicated that FI value was 35.18, and classified as very low. While the BGI was 113.14 and classified as dry according to CORINE. Finally, the EI value is equal to 3 and classified as a low rainfall erosion index. It has an effective influence on controlling erosion rates due to its significant impact on surface runoff and water infiltration in the soil. It was created from the DEM and classified based on the CORINE model (Figure 6).

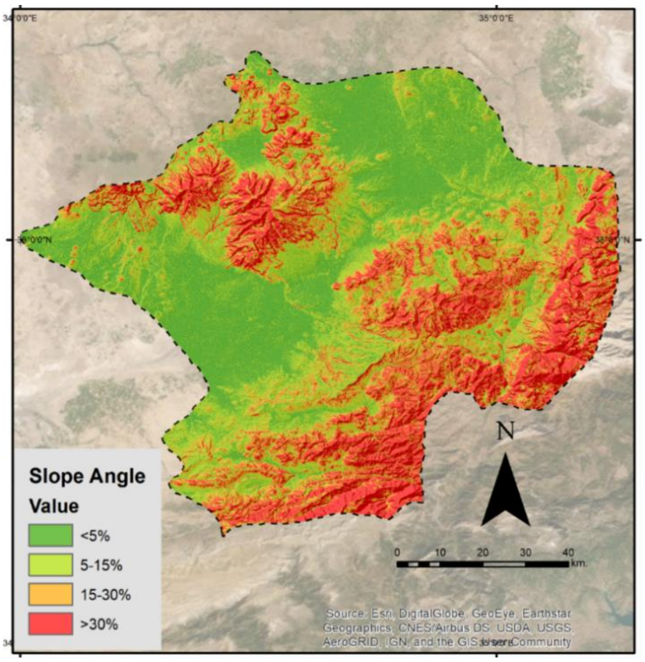

Figure 6. Slope map

The results illustrated that 27.73% of the area has less than 5% slope, 28.01% has a gentle slope (5-15%) and 20.27% has a steep slope (15-30%), 23.97% has a very steep (>30%) in the study area.

Potential Soil Erosion Risk (PSER)

The soil erodibility, erosivity, and slope maps were overlaid to create the PSER map (Figure 7). Results indicated that 23.52% of the area was classified as low PSER, and they are located in the northern and southwest parts of the study area. Moderate PSER covers 42.00% of the area and is located in the middle of the study area. 34.48% of the area was categorized as high PSER which is located in the eastern, southeast and northeast parts of the study area.

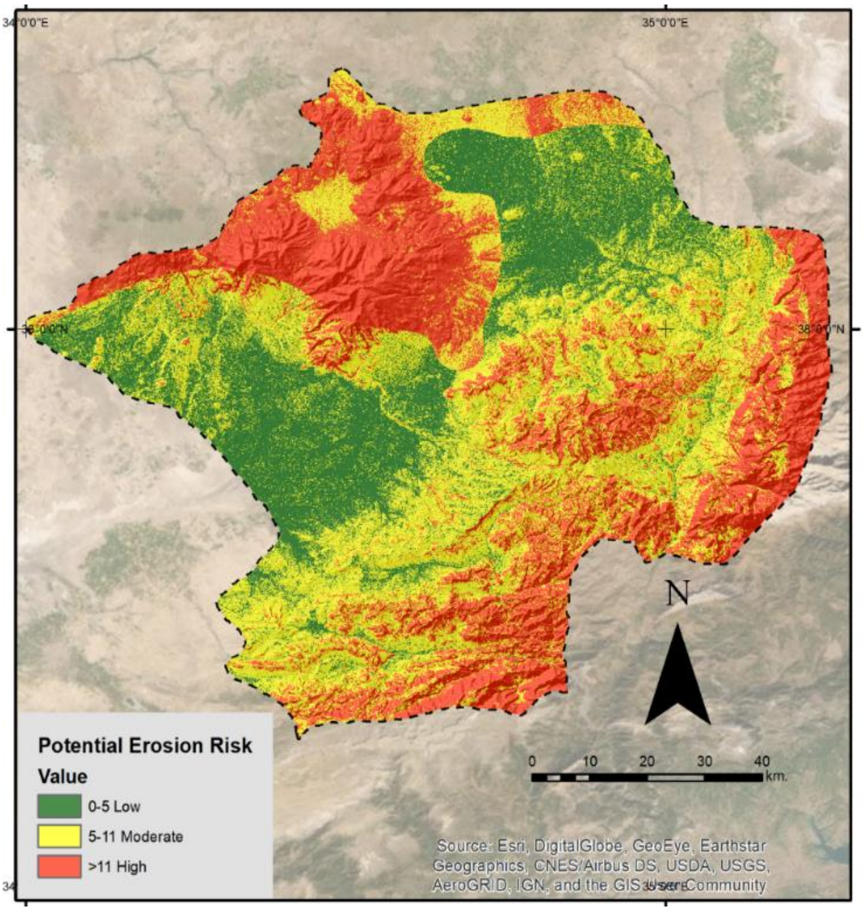

Figure 7. Potential erosion risk of Niğde

Actual Soil Erosion Risk (ASER)

The ASER map illustrated the variance between the areas of PSER and ASER due to the effect of land cover on the hazard of erosion (Figure 8-9). Results indicated that 34.72% of the soil was classified as moderately ASER, which is located in the eastern and southeast parts of the study area. 51.66% and 13.62% were classified as low and high ASER, respectively. Areas that have low ASER, are located in the middle part, while areas that have high ASER, are located in the northwest part of the area. The areas which were categorized as low PSER, were increased from 23.52% to 51.66% in the ASER, after combining the land cover map due to the improper agricultural activities.

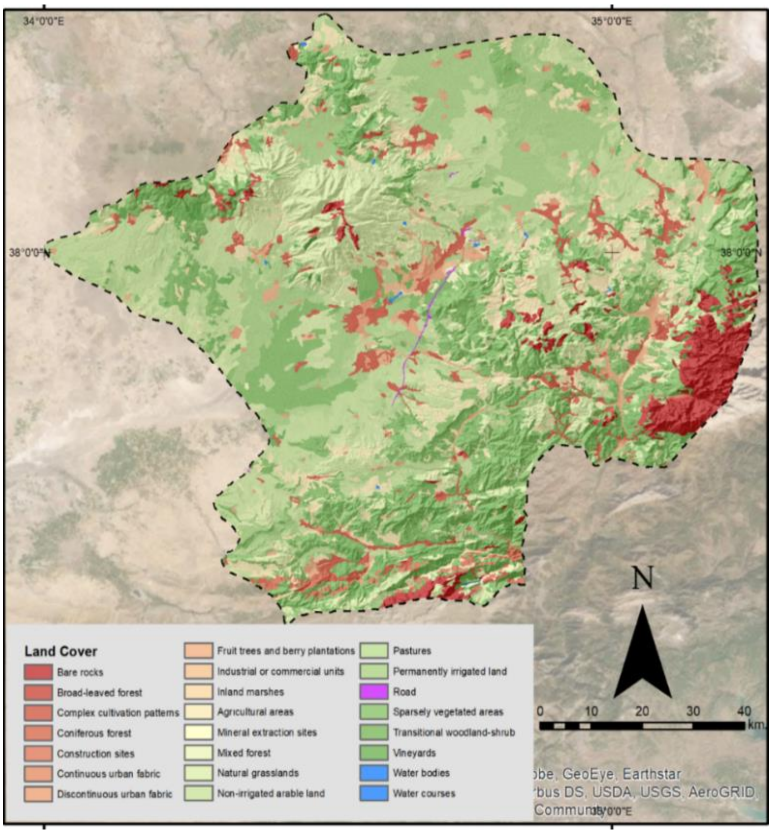

Figure 8. Niğde land cover classification

On the other hand, the total areas which were classified as high and moderate PSER, were decreased from 76.48% to 48.34% in the ASER, due to the effect of land cover on decreasing the risk of soil erosion. The PSER map explained that 34.48% had high risk and 42.00% had moderate risk.

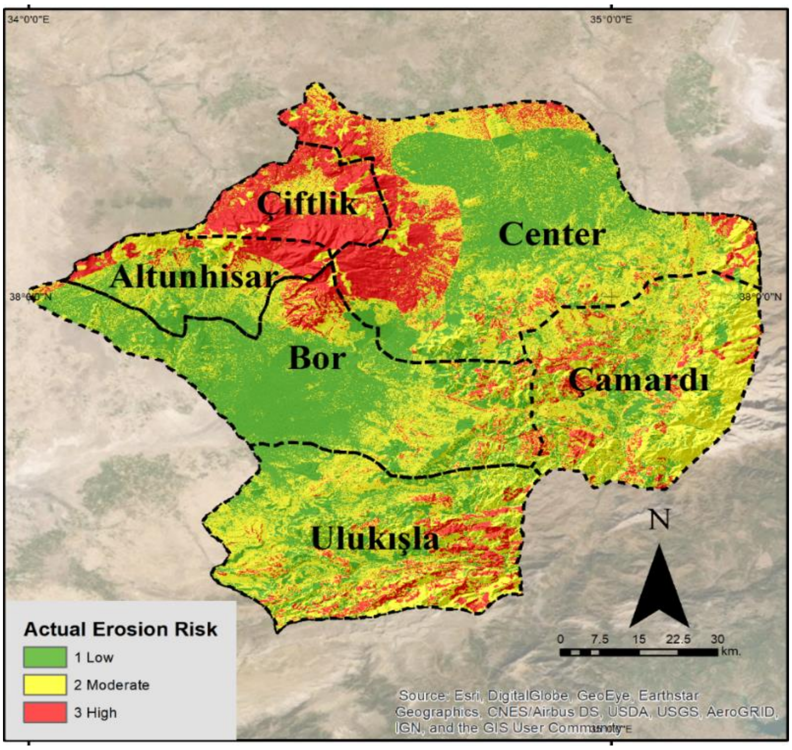

Figure 9. Actual erosion risk

On the other hand, the ASER map indicated that a small area of the study area (13.62%) had high risk, and the large area (51.66%) had moderate ASER. However, the medium and high erosion risk decreased from 76.48% to 48.34% in the ASER map. According to the results of the analysis, the lowest soil erosion risk is in Bor district, and the highest risk is in Çiftlik district (Table 5).

Table 4. Actual erosion risk in Niğde

District Name	Actual Erosion Potential	Percent (%)	Area (km^2)	Total Area (km^2)
Center	Low	38.55	883.51	2,291.43
	Moderate	40.92	937.66	
	High	20.53	470.26	
Bor	Low	59.32	944.33	1,591.93
	Moderate	33.52	533.63	
	High	07.16	113.97	
Ulukışla	Low	30.37	449.78	1,476.26
	Moderate	55.85	824.47	
	High	13.68	202.00	
Altunhisar	Low	30.31	189.30	624.58
	Moderate	47.58	297.19	
	High	22.11	138.09	
Çiftlik	Low	00.85	4.430	523.09
	Moderate	27.42	143.45	
	High	71.73	375.20	
Çamardı	Low	20.51	264.10	1,287.94
	Moderate	67.11	864.37	
	High	12.38	159.47	
Total		100.00	7,795.22	7,795.22

This is a situation related to the land use. According to the CORINE land classification in Niğde. Bor district has the highest green area. The Çiftlik district has the lowest green area and the highest mountainous area. In other districts, it was determined that there is a low or medium level of erosion risk. The most common factors which caused high erosion risk, are soil texture, land cover and soil depth.

Conclusion

In this study, the effect of the changing climatic conditions on soil erosion was investigated in the perspective of the changing rainfall events by considering the historical data and future climatic scenario data of the Regional Climate Model. This study was amid at using the methodology of CORINE model within GIS environment to assess the spatial heterogeneity of soil erosion risk in Niğde, Turkey. Suitable agricultural land use activities should be carried out to minimize soil erosion. This work indicated that the CORINE model integrated with GIS and RS has a very effective and accurate potential for soil erosion risk assessment. In order to determine soil erosion, many factors have been used such as soil texture, soil depth, slope, CORINE etc. All properties belonging to the soil have been identified as the most important factors in determining the soil erosion risk. The slope factor and soil properties caused a change in the potential soil erosion degree in the maps.

In addition to these parameters, other factors such as organic matter and carbonate content of the soil, parent material properties, and the existence of a hard pan should be incorporated in the model to determine the condition of the soil more realistically for the calculation of soil erodibility. However, the Fournier and Bagnouls-Gaussen indices did not cause any major changes in the map. Therefore, it has been determined that the absence of these indices will not bring any deficiencies in the study, especially in dry areas such as Niğde.

Within the scope of the study, it was determined that the most important factor after the soil was CORINE. In the study, potential erosion risk was identified at first. By combining this map with the CORINE map, the actual soil erosion risk has been determined. Differences were detected between the two maps after the CORINE. Especially areas with high erosion potential have turned into areas with low or moderate erosion risk. Land covers are the main reason for this. This reduction occurs especially in areas covered with forest cover. The decrease in the degree of erosion with the dense vegetation is a reason for this change. Another important land cover for erosion potential is agricultural lands. These areas are used for agricultural production for most of the year. These areas remain evergreen. Therefore, the level of erosion risk has decreased in these areas. The use of CORINE land classification in erosion studies to be carried out from now on is absolutely crucial for the accuracy of the study. In the study, it was determined that a large part of Niğde province has low soil erosion risk.

Although the slope is high in the northeast and southeast parts of the study area, low erosion risk has been identified in these areas due to the absence of soil or water. In addition, the middle parts of the Niğde province also have a low slope degree. Therefore, there is a low risk of erosion in these areas. Since there is agricultural production in the northern parts of the study area, the erosion risk is low in these parts. Erosion risk was high only in the northwest of the area. We can say that there is a high risk of erosion in these parts due to the sparse vegetation cover in these areas and low soil depth.

The Fournier index was calculated within the scope of the study. The Fournier index gave suitable results for Niğde. Climate data between 1935-2021 years was used in the study. It has been determined that this is suitable for the study. Because long-term climate data gives accurate results in the calculation of the index. It is known that especially in the last 30 years, precipitation and temperature data have shown a great change. Therefore, at least 50 years of climate data should be used in such calculations. Another important point is that some areas do not have much precipitation due to their topographic features. In such a case, since the Fournier index will be below the “0” value, it may not be used within the scope of the study. For such a situation, it may be more convenient to ignore the Fournier index and the study may do using topographic and climate data.

The main issue in preventing soil erosion is to increase the number of trees in the area. Fibrous root trees should be used. Foot root trees are more effective in preventing erosion than taproot trees. *Eleagnus sp*., *Robinia pseudoacacia*, Olives, etc. species may be preferred. These trees do not have too much paint and have strong root structures. An important factor influencing and connecting many aspects of human existence and our physical environment is land cover. Remote sensing techniques have made it possible to construct a map-like depiction of the Earth's surface that is spatially continuous, mostly trustworthy, and accessible at a variety of geographical and temporal scales. As a result, it has become an effective tool for collecting data on land cover. Land cover is taken into account in scientific investigations. Using satellite imagery, techniques for digital image processing and geostatistical analysis were used to create a map of the land cover and vegetation.

Additionally, the study may be improved in the future by using past and future comparison methodologies. Since constructing fresh information and providing new understandings are crucial for scientific research. As a result, some adjustments in agricultural techniques are required to solve the erosion problem. Good planting time, less soil cultivation and correct planting may reduce soil erosion. It is of great importance to fully control the tree cuttings in the forest areas and to attach importance to the afforestation activities to control erosion. Considering that a significant part of Turkey lands is exposed to erosion, it is clearly seen that the precautions for erosion control are insufficient. Only through educating the public and non-governmental groups about erosion and supporting the state's defense can studies on this topic be completed. The complex impacts of population values, which are a key determinant in the construction of cities, should be taken into account in urban planning. Microclimatic outcomes should be taken into consideration in addition to factors like population, transit, green tissue, and building type. An essential planning and design technique to lessen the adverse environmental conditions of the earth should be to improve the microclimate on a city scale. Coordinated research across design scales and design approaches to improve microclimate at every size should be implemented in the urban planning and architectural design disciplines, which play significant roles in the construction of cities.

Declaration of Competing Interest

There is no conflict of interest about the article.

Author statement

The author declares that he has contributed 100% to the article.

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