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Investigation of spatial change on badlands topography around Kuyulu Village (Adıyaman) with remote sensing and geographic information systems

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Abstract

The badlands topography located around Kuyulu Village (Adıyaman) to the west of Atatürk Dam, which is one of the most important erosion area in Southeastern Anatolia in Turkey. In this study, it is aimed to determine the time-dependent change in the badlands topography area around Kuyulu Village (Adıyaman) by using Remote Sensing and geographic information system techniques. As a result of the research, it was determined that there was a continuous expansion in the badlands area in the period between 1984-2020.

1. Introduction

Erosion can be defined as corrosion and acquaintance of the soil with external factors and processes. Erosion examines under two headings as natural erosion (geological erosion) and ekstralated erosion. Natural erosion is the removal of soil due to natural processes throughout all geological times. Also ekstralated erosion is caused by human misuse of land. (Yılmaz, 2006).

Badlands topography is one of the important topography shapes in arid and semi-arid regions. It mostly occurs on the slopes where clayey, sandy, spindle and marly layers come in succession.

Drop erosion, which starts on slopes devoid of vegetation from time to time during heavy rains, turns into surface erosion by the flow of rain water covering the surface (Semenderoğlu et al., 2006). Later, with the progress of surface erosion, small streamlines formed on the surface and small rills occur on the slopes. Small channels that expand and deepen over time turn into grooves, slits and gullies. (Semenderoğlu ve diğ., 2006). The topography of badlands, which consists of steeply sloping slopes, is very weak in terms of vegetation, quite dense in terms of small brooks and has a high erosion rate (Erinç, 2015).

In this study, it is aimed to determine the time-dependent change in the area of badlands topography located around Kuyulu Village (Adıyaman) to the west of Atatürk Dam, using remote sensing and geographic information systems techniques.

2. Study Area

The study area includes Kuyulu village and its surroundings, located within the borders of Adıyaman province in the Southeastern Anatolia Region.

The badlands topography to the west of the Atatürk Dam; It is located between the villages of Uğurca, Bebek, Akyazı and Kuyulu (Fig. 1). The study area covers an area of roughly 150 km^2.

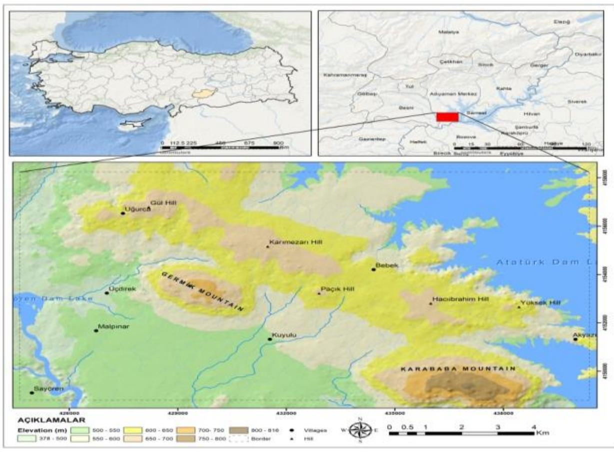

Figure 1. Location of the Study Area.

2.1. Geology and Geomorphology of the Area

In the study area, the oldest units are Cretaceous limestones, clayey limestones, shales, and the youngest units are Quaternary alluviums. Badlands topography has developed on stationary clayey limestones and

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ware. (Fig. 2). The highest parts of the area, which has a plateau appearance in terms of geomorphology, are Karababa Mountain Hill (816 m) and Germik Mountain Hill (732 m). The Badlands topography also developed on the slopes of the corresponding anticlines.

Atatürk Dam is located in the northeast of the study area and Sayören Dam Lake is located in the southwest.

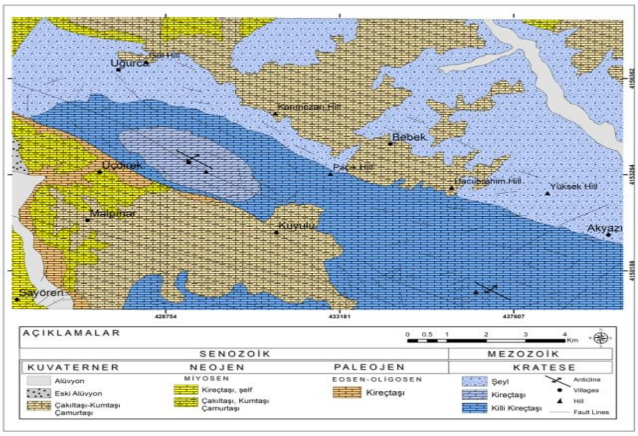

Figure 2. Geological of the Study Area

2.2. Climate features of the study area

The continental Mediterranean climate features are observed in the field, with hot and dry summers and colder winters, and the annual average temperature in the field is approximately 17 °C. Average annual precipitation in the area is around 400 mm. In the area, which has semi-arid conditions in terms of annual precipitation, the vast majority of precipitation occurs in the period between November and October. The period from June to October is quite dry. Due to its semi-arid climate characteristics, the field has very acceptable conditions for the development of badlands topography.

3. Material and Method

In the research, 1/100,000 scaled geology and topography maps and Landsat satellite images of the field were used. During the research, the general geological and lithological features of the area were determined. and subsequently satellite images were used to detect the spatial development of the badland's topography.

In the research, satellite images of the field from 1984 to 1990, 2000, 2010, 2020 were specified by using the Minimum Likelihood Classification method in the Controlled Classification method of the ENVI 5.3 Program, the change of the Badlands area over time has been determined (Fig. 3, Tab. 1).

Minimum Likelihood Classification method: basically, it creates a certain amount of classes by recognizing the data sets according to the number of data sets created for classification, and then compares with the average of the classes that make up the brightness value of each pixel, and selects the closest class to the pixel. (Karayol, 2012). By using this method, four classes were created to best represent the field. These classes are: Badlands, Cultivated, Uncultivated Area and the Water Area.

Table 1. Features of Satellite Images Used in Analysis.

	Landsat 4-5 TM C1 Level-1	Landsat 4-5 TM C1 Level-1	Landsat 4-5 TM C1 Level-1	Landsat 4-5 TM C1 Level-1	Landsat 8 OLI-TIRS C1 Level-1
Image Properties	1984	1990	2000	2010	2020
View Date	30.08.1984	28.08.1990	23.08.2000	06.08.2010	01.08.2020
Rows/ Bands	319/6	319/7	319/6	319/6	319/7
Image Cloudiness Rate	0	0	0	0	0
Image Resolution	8 bit.	8 b.	8 b.	8 b.	8 b.

The development of Badlands over the years has been revealed by digitizing on the layers and data index obtained as a result of the analysis in the ENVI 5.3 interface. Digitized Badlands layer was mapped by editing in Arcmap interface.

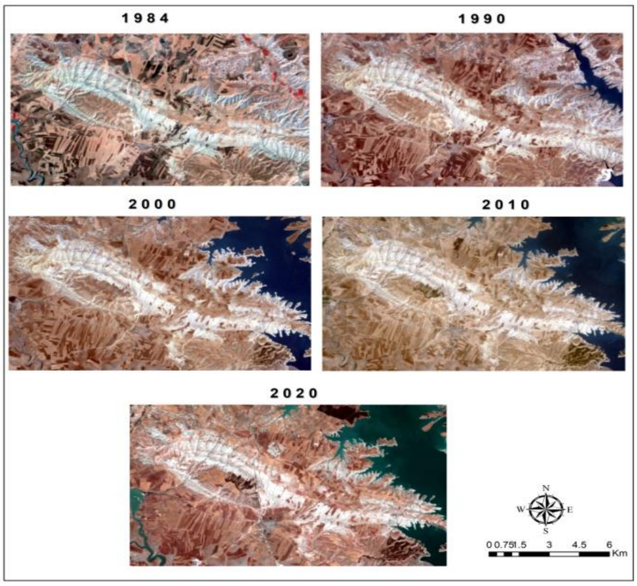

Figure 3. Satellite images of the study area.

4. Results

By using satellite images of the research area, maps of the badlands area were obtained and the spatial change of the Badlands in 10-year periods were tried to be revealed (Fig. 4-5).

As of 1984, the total area of badlands in the field is 41.35 km^2. The total area of badlands in 1990 was 43.2 km2. There is an increase of about 2 km^2 in the area of badlands during this time period. Due to the Atatürk Dam Lake, which started to collect water in this period, some of the badland's area located under the lake.

In 2000, the total area of badlands decreased to 39.55 km^2; In 2010, the total area of badlands decreased to 34.2 km^2. The main reason for this situation is that some of the badland's area is flooded due to the Atatürk Dam Lake reaching its maximum level, and some areas that were not cultivated before are opened to agriculture.

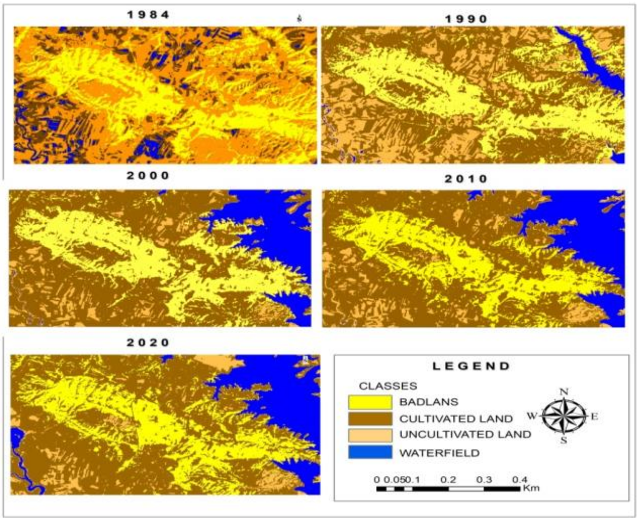

Figure 4. Badlands images by Maximum Likelihood Classification method.

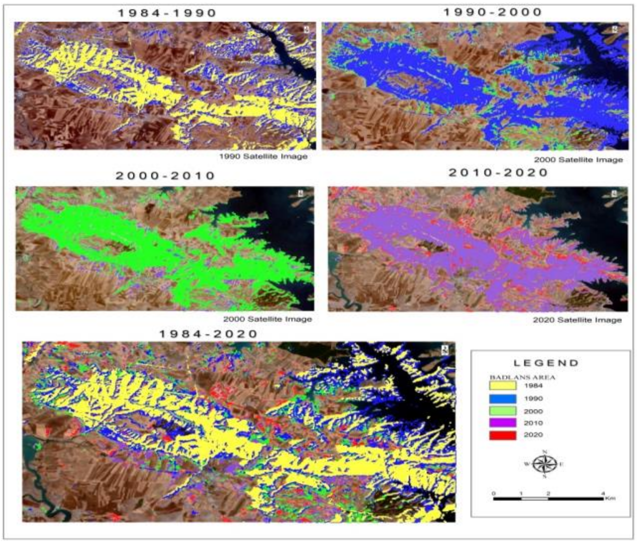

Figure 5. The areal changes of the Badlands land in 10-year periods

In 2020, the total area of badlands increased to 36.87 km² (Tab. 2). According to the areal changes of the badlands in 10-year periods in the between 1984-2020 increased over time; however, it is seen that it cannot be followed statistically due to the rise of the dam lake level and the opening of agricultural areas in the periods between 1990-2000 and 2000-2010.

As a matter of fact, in the areal changes of the Badlands in 10-year periods, it is clearly observed that the badlands increase regularly in the areas outside the reservoir. The amount of this increase is approximately 2 km² between 1984-1990, 0.96 km² between 1990-2000, 0.98 km² between 2000-2010, 2.9 km² between 2010-2020 (Fig. 6).

5. Result

According to the areal change of the Badlands in 10-year periods between 1984-2020, the badlands area has increased over time; however, it was determined that this increase could not be observed due to reasons such as the rise of the dam lake level and the farming in the periods between 1990-2000 and 2000-2010. The combination of RS and GIS is flexible and effective tool for detecting and monitoring environmental changes.

Table 2. Minimum Likelihood Classification data index

	1984		
Class Summary	Pixel Count	Percent	Area km²
Badlands	45944	27.329.237	41.35
Cultivated Area	30171	17.946.857	27.15
Uncultivated Area	5714	3.398.904	77.66
Waterfield	86284	51.325.002	5.14
	1990		
Badlands	48002	28.553.413	43.2
Cultivated Area	81627	48.554.841	73.46
Uncultivated Area	4964	2.952.776	30.17
Waterfield	33520	19.938.970	4.47
	2000		
Badlands	43942	26.138.371	39.55
Cultivated Area	89016	52.950.099	80.11
Uncultivated Area	23694	14.094.091	10.31
Waterfield	11461	6.817.438	21.32
	2010		
Badlands	37801	22.485.471	34.02
Cultivated Area	90328	53.730.526	81.93
Uncultivated Area	26671	15.864.924	11.98
Waterfield	13313	7.919.078	24
	2020		
Badlands	40970	24.370.513	36.87
Cultivated Area	89374	53.163.051	80.44
Uncultivated Area	26716	15.891.692	9.95
Waterfield	11053	6.574.744	24.05

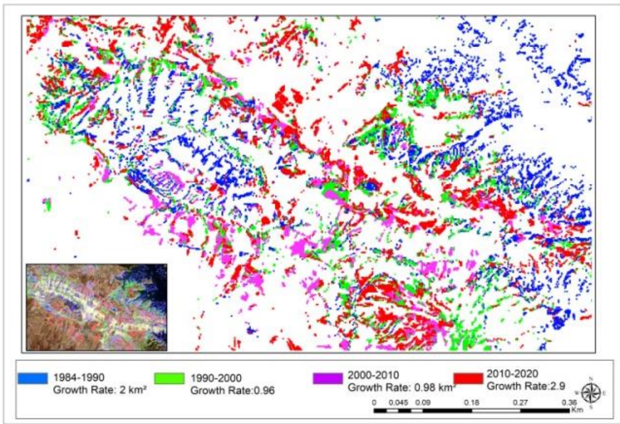

Figure 6. Spatial distribution of Badlands changes by years

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