Migration Letters

Volume: 20, No: S6(2023), pp. 951-968

ISSN: 1741-8984 (Print) ISSN: 1741-8992 (Online)
www.migrationletters.com

Detection of Soil Degradation using Spectral Indicators in Canaan District (Case Study)

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Abstract

The study (detection of soil degradation using spectral indicators) was carried out by identifying the changes in soil degradation in the Canaan district located between latitudes (-25, 32o_-33,46o) north and longitudes (-44,42o_-44, 58o) east, with an area of (613 km2), as the study of soil degradation is one of the important studies due to the environmental changes it obtains, as well as the role of natural and human factors in changing the characteristics and characteristics of the soil, especially after the passage of a period of time, Satellite data (Landsat 5-9) was used for each of the sensors (ETM+, OLI) in the process of monitoring soil degradation for the years (1995 and 2022). To reach accurate results, spectral indicators were applied. The vegetative difference index was classified into four categories. As for the degradation index The soil was classified into three categories, the soil salinity index into three categories, and the bare soil index into two categories, and then the change value for the two years was extracted to show the extent of soil deterioration and make a comparison between the two years. It was shown in the (NDVI) index that the category (devoid of vegetation) increased in 2022 from what it was. It was in 1995 and the class (dense plant) decreased significantly in 2022 from what it was in 1995.And it was found in the Soil Degradation Index (LDI) that the (severe deterioration) category increased significantly in 2022, and that the (mild recession, moderate deterioration) category decreased in 2022 as it was in 1995, and it was shown in the soil salinity index that the (high salinity) category It increased significantly in 2022, and it was found in the Barren Soil Index that the category (Bare Lands) increased in 2022 from what it was in 1995.

Keywords: *deterioration, spectral indicators, Canaan district.*

Introduction

The study of soil degradation assessment is a direct field that reflects the spatial relationship between the natural, human and life components and their interaction and integration at the same time, since the problem of soil degradation is one of the environmental problems that threatens the future of lands in arid and semi-arid environments, and even semi-humid environments that are characterized by fragile ecosystems with a degree of sensitivity. There is severe pressure from human activity on the elements of the vital environment, and because of the dangerous climatic and environmental variations facing humanity, as well as the continuous increase in population growth and unsustainable land exploitation, this has led to the deterioration of large areas of land in the world in general and Iraq in particular.

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Geoinfortilation techniques were used, including: remote sensing data, geographic information systems, and global positioning systems, which have proven their importance in soil survey studies because they reduce time and field effort and increase their accuracy. And the speed of its completion, in addition to the data provided by this technology that helps in giving continuous information and values for soil degradation, with spatial, temporal, comprehensive and pluralistic discriminating capabilities.

1-The problem of the study

- What are the spectral indicators used to identify and monitor soil degradation in the region?

2- The hypothesis of the study

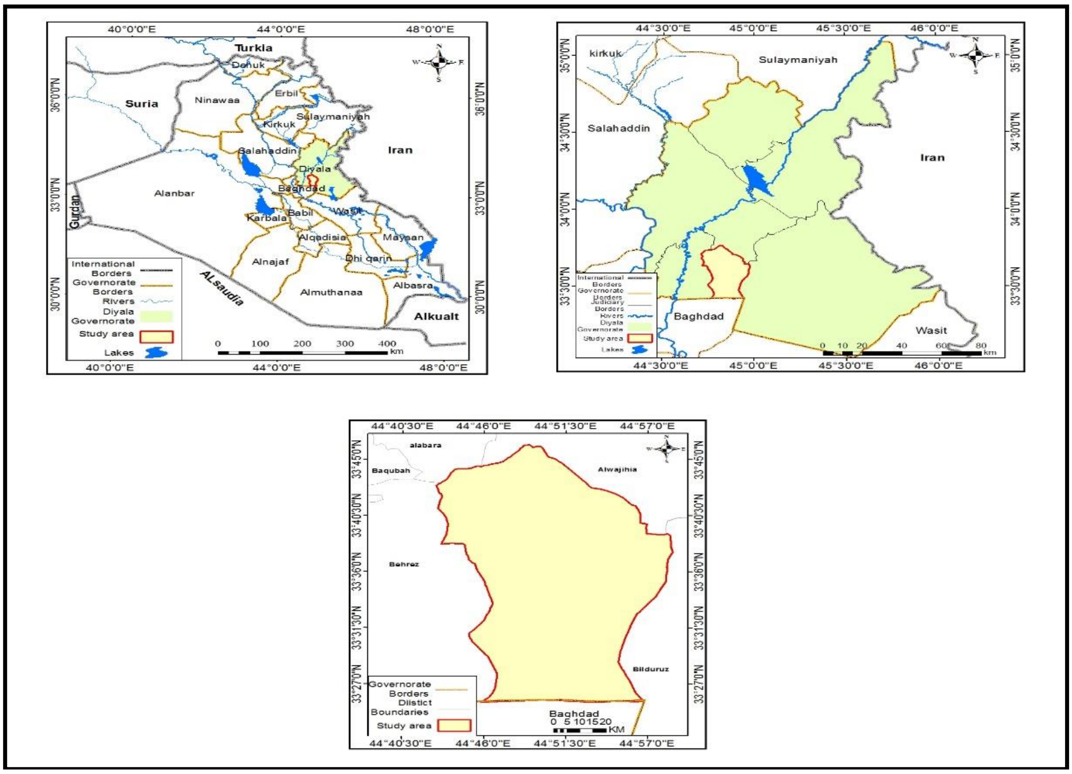
- There are several types of spectral indicators that have the ability to identify and monitor soil degradation in the region.

3- The aim of the study:

The study aims to reveal the state of soil degradation in Canaan district, its causes and stages, and monitor it using spectral indicators.

4- The location of the area

The region is located astronomically between two latitudes (-25, 32o_-33,46o) north and longitudes (-44,42o_-44,58o) east. Geographically, it is located in the southwestern part of Diyala Governorate, and it is one of the five sub-districts. Baquba district, as it is bordered by the center of Baladruz district from the east, from the west by Buhriz district, from the north by Al-Wajihiyah sub-district of Al-Muqdadiya district, and from the south by Baghdad governorate, which is part of the sedimentary plain, as it is located in the northeastern part of it.



Map (1) The study area within Diyala Governorate and Iraq

Source: The General Commission for Survey, the administrative map of Iraq at a scale of 1:1,000,000 and the map of the administrative province of Diyala and the study area at a scale of 1:500,000.

The satellites provided the opportunity to monitor the land cover and predict accurate and real information about soil degradation and changes in it, especially after improving the ability of spatial discrimination of the sensors carried by these satellites. One of the most important techniques applied to satellite visuals that results from dividing the values of the digital numbers of one of the spectral bands These visuals show the difference in the spectral reflectivity curve of the beam in question, regardless of the reflectivity values absorbed by the spectral bands. These indicators depend on deriving some mathematical relationships from the reflectivity data recorded by the sensors to reach the target and collect these indicators based on the principle of interaction of the rays falling on the body. Subject to study: These methods are among the most famous and most widely used automated methods. We may find many researchers calling them algebraic detection methods because they use statistical algorithms and mathematical methods such as addition, subtraction, division, and multiplication to extract variables from different dates.

First: The Normalized Difference Vegetation Index (NDVI(

Many recent studies and researches in the world have indicated the possibility of using remote sensing techniques in assessing deterioration cases based on the Natural Vegetative Variation Index (NDVI). The Natural Vegetative Variation Index was proposed for the first time by (Rouse, et al., 1973) at the University of Texas To diagnose and detect the type and density of vegetation cover, in addition to being a good indicator of the state and degree of desertification and separating the vegetation cover from the barren soil, as it is a measure of the spectral reflective variations of the life components, as well as its ability to reduce external noise factors such as topographical effects and changes in the angle of incidence of the sun, and is the most reliable indicator Common to measure.

As for the spectral bands used for this indicator, they are the fourth red channel (Red) and the fifth channel near infrared (Nearinfrared) in the (Landsat8) satellite.

The NDVI value was classified into four categories according to the study area. The value of the normal vegetative diversity index (NDVI) is calculated according to the following equation

NDVI= (NIR_ RED) / (NIR + RED)

Landsat TM5, NDVI = (Band 4_Band 3) / (Band 4+ Band 3)

Landsat OLI9, NDVI= (Band 5_Band 4) / (Band 5+Band 4)

So that

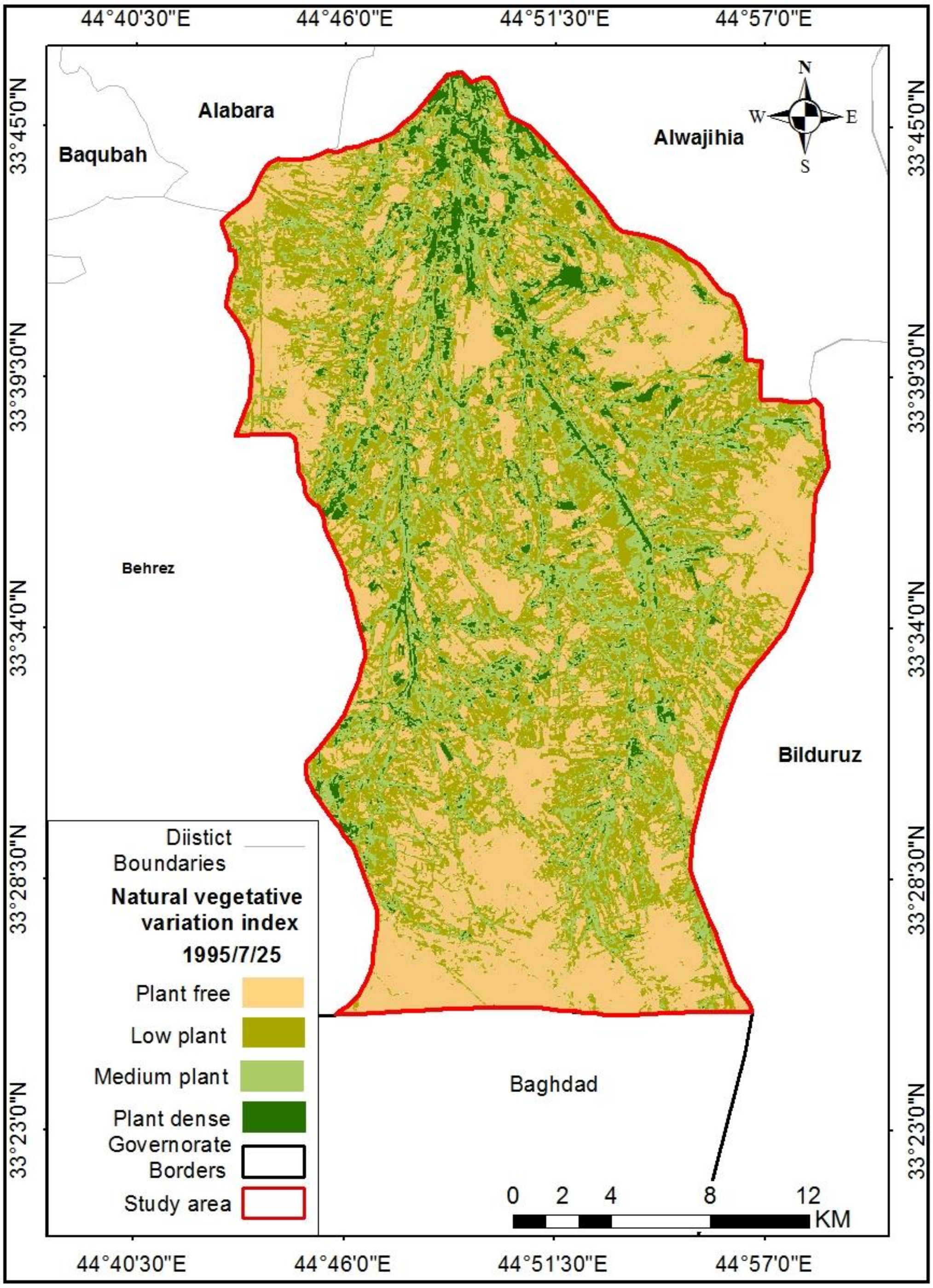
NDVI = vegetative divergence index value

NIR = Infrared

RED = red rays

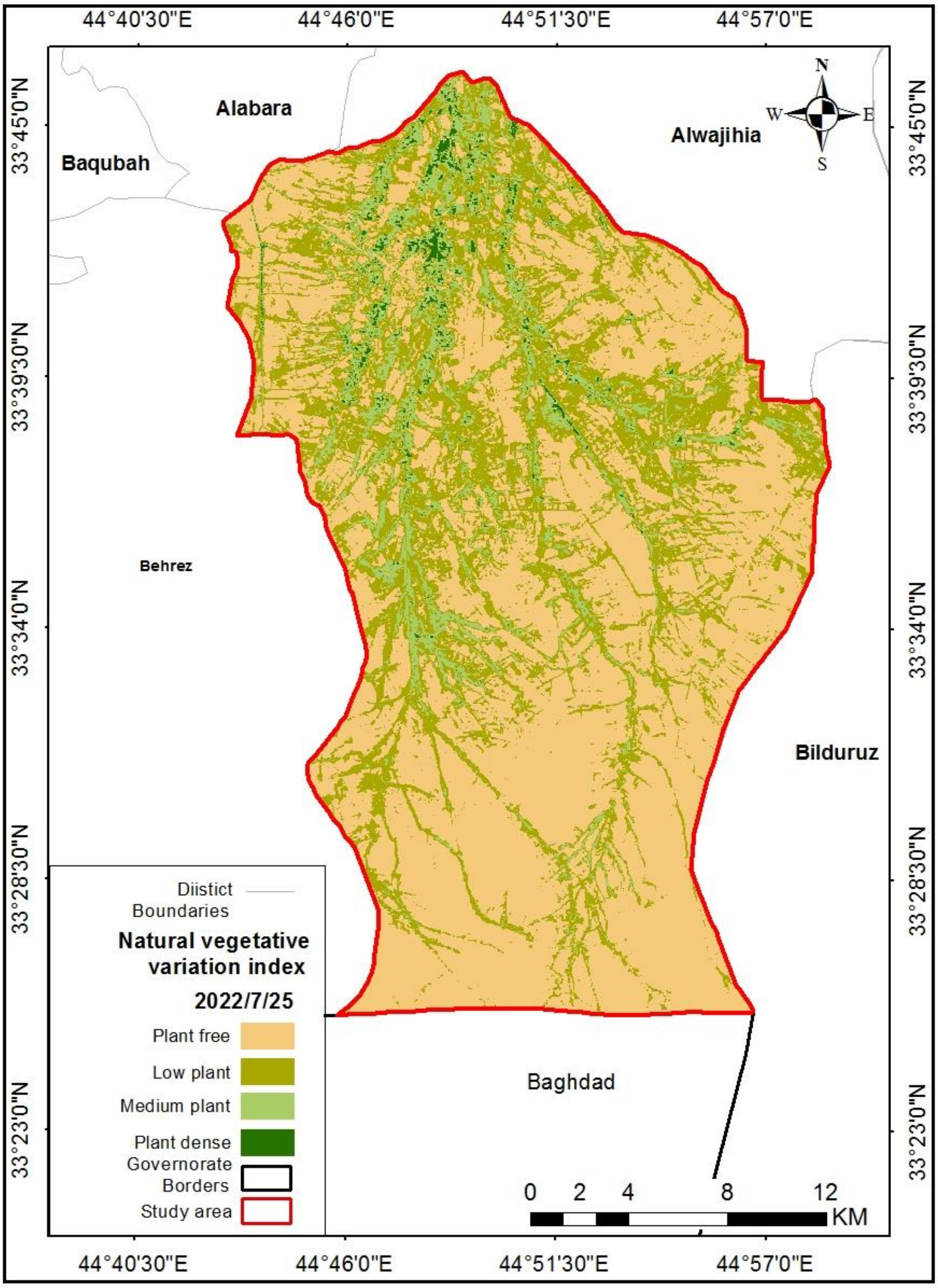
According to this indicator, the area was divided into four types. The first was devoid of vegetation, which was the most dominant type in 1995, as it occupied an area of (233 km2) with a percentage of (38%). However, in 2022, when it showed an increase in the area of land devoid of vegetation, it occupied an area of (376 km2). (61.4%) of the total area of the region, i.e. a change amount of (143 km2) and a change value of (61.373). As for the second low-plant type, it occupied an area in 1995 (211 km2) and a percentage of (34.4%). In 2022, it occupied (178 km2) at a rate of (29%), and the amount of change was (-33) and the value of change was (-15.63). As for the third type, which is medium vegetation, in 1995 it occupied an area of (128 km2) at a rate of (21%).In 2022, the area of this type was occupied by (52 km2) at a rate of (8.6%), and the amount of change was (-76 km2) and the value of change was (-59.37). As for the fourth category, which is densely planted lands, it occupied an area of (41 km2) and at a rate of (6.6%) in 1995, but in 2022 it occupied an area of (7 km2) at a rate of (1%), and the amount of change was (-

34) and the value of change was (-82.92%) of the total area of the region, Map (2) and (3)) and Table (1) and Figure (1)



Map (2) the natural vegetative diversity index for the year 1995

Source: From the researcher's work based on visuals from the Landsat 5.9 satellite for the year 1995 and using the outputs of the ArcGIS 10.8 program.



Map (3) The natural vegetative diversity index for the year 2022
Source: From the researcher's work based on visuals from the Landsat 5.9 satellite for the year 2022 and using the outputs of the ArcGIS 10.8 program.

Table (1) Area, percentages and amount of change of vegetation cover (NDVI) for the region between 1995-2022

change value	The amount of change / km2	2022		1995		Item name	
		Percentage%	Area km2	Percentage%	Area km2		
61.37339	**143**	**61،4**	**376**	**38**	**233**	**vegetation**	**1**

-15.6398	**-33**	**29**	**178**	**34,4**	**211**	**Low vegetation**	**2**
-59.375	**-76**	**8،6**	**52**	**21**	**128**	**Medium vegetation**	**3**
-82.9268	**-34**	**1**	**7**	**6,6**	**41**	**Bushy plants**	**4**
		100	**613**	**100**	**613**	**The total**	

Source: Worked by the researcher based on maps (2) and (3)

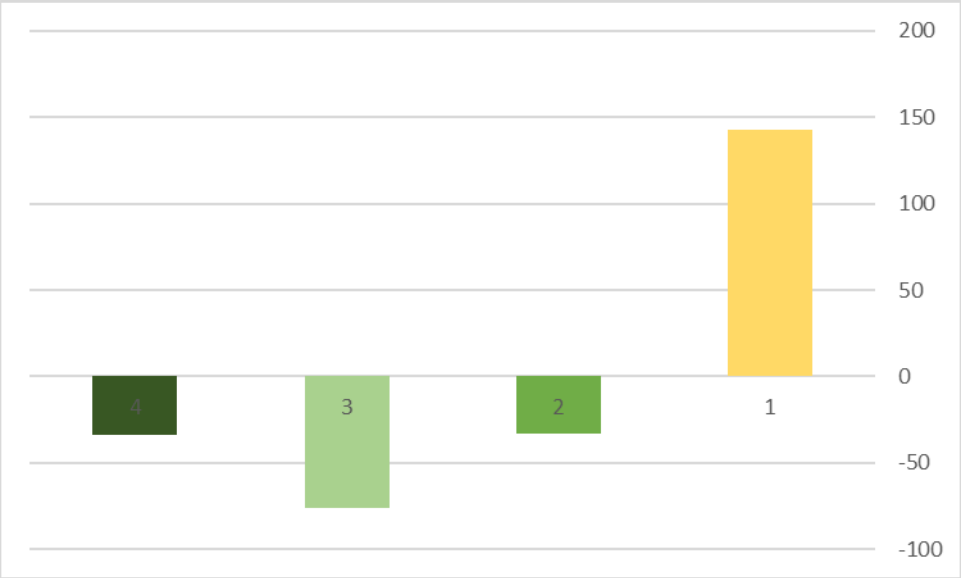


Figure (1) The amount of change in the natural vegetative difference in the Canaan region for the years 1995-2022

Source: From the researcher's work based on Table (1).

Second: Land Degradation Index (LDI(

Soil degradation is defined as a quantitative or qualitative change in the properties and characteristics of the soil that leads to a decrease in the current or potential capacity of this land to produce. It is not necessarily continuous, but may be temporary, as it is a relative condition estimated over a time frame.

Deterioration comes as a result of a combination of natural and human factors. The most important of these factors is wind erosion, to which 85% of soil degradation is attributed. It comes at the forefront of soil erosion processes, especially in dry and semi-arid areas. This occurs as a result of the availability of appropriate conditions of fragile, dry soil with fine joints. Lack of vegetation cover and strong winds, the soil was classified into three categories according to the evidence of soil degradation using the following equations.

LDI 5= ((255-(Green+ Red) \ ((255+ (Green +Red))

LDI 9 = ((65535-(Green+ Red) \ ((65535+ (Green +Red))

So that

LDI = soil degradation index

Green = represents the green band

Red= represents the red band

65535= constant value

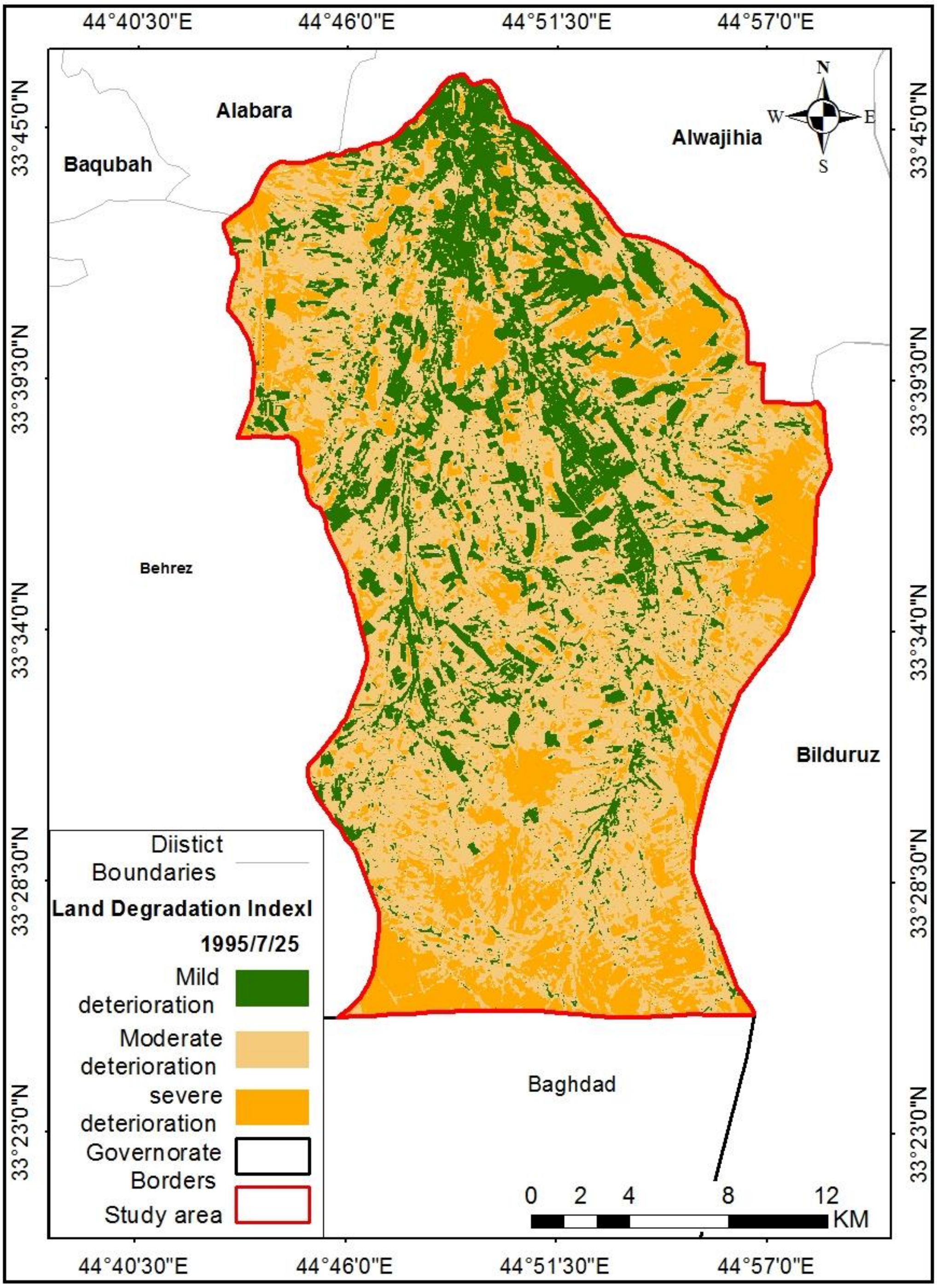
255= constant value

According to this indicator, the region was divided into three categories. The first had mild deterioration. In 1995, it reached an area of (139 km2), with a rate of (22.6%). However, in 2022, it reached an area of (136 km2), with a rate of (22.2%), with a change amount of (-3 km2) and a change value. (-2.15). As for the second category, moderate deterioration, it occupied an area in 1995 (322 km2) at a rate of (52.6%), while in 2022 it occupied (291 km2) at a rate of (47.4%), with a change amount of (-31 km2) and a change value of (-9, 62), as for the last severely deteriorating type, the area in 1995 occupied (152 km2) at a rate of (24.8%), while in 2022 it occupied (186 km2) at a rate of (30.4%), with a change amount of (34 km2) and a change value of (22.36), map (4), (5), Table (2) and Figure (2).

Table (2) Area, percentages and amount of change between 1995-2022 according to the soil degradation index (LDI) for the region

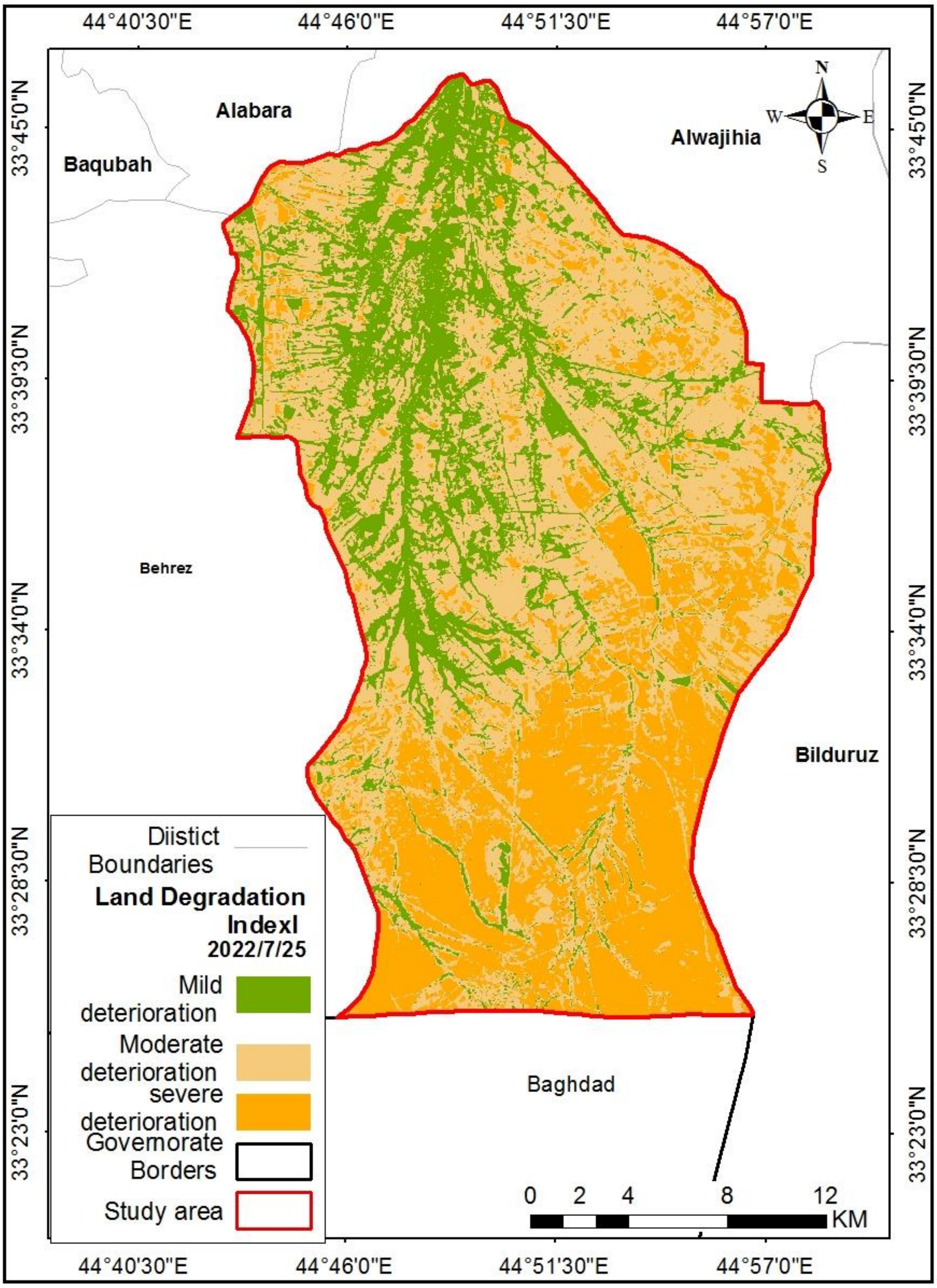
change value	The amount of change / km2	2022		1995		Item name	
		Percentage%	Area km2	Percentage%	Area km2		
-2.15827	-3	22.2	136	22,6	139	Mild deterioration	1
-9.62733	-31	47.4	291	52,6	322	Moderate deterioration	2
22.36842	34	30.4	186	24,8	152	Severe deterioration	3
		100	613	100	613	Total	

Source: The researcher's work based on map (4) and (5) and the ARC GIS 10.8 program.



Map (4) Soil degradation index for the dry season 1995

Source: From the researcher's work based on Landsat 5.9 for the year 1995 using the ARC GIS 10.8 program



Map (5) Soil degradation index for the dry season 2022

Source: From the researcher's work based on Landsat 5,9 for the year 2022 using ARC GIS 10.8 software.

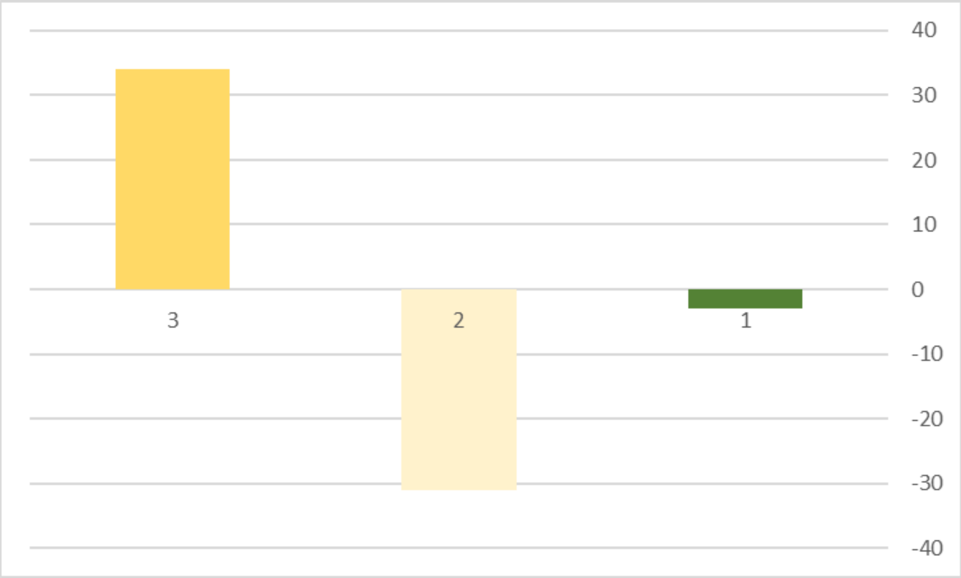


Figure (2) The amount of change in soil degradation between 1995-2022, according to the soil degradation index (LDI) for the region

Source: From the researcher’s work based on Table 2))

Third: Normalize Difference Salinity Indexs (NDSI)

Soil salinity is one of the widespread environmental problems responsible for soil degradation, especially in arid and semi-arid regions.

As a result of progress and technological development and the use of modern technologies, remote sensing techniques succeeded in monitoring the phenomenon of salinization, and researchers (Reeve1975 and ALMahwily 1983) found that infrared waves are the best in predicting soil salinity, and at the level of distinguishing between saline and non-saline soils, as saline soils have reflective values Low spectral waves compared to non-salt soils in the visible and near-infrared parts were better than the visible waves for predicting the level of soil salinity, and soil salinity differs from the rest of the other soil characteristics through its effect on the spectral reflectivity values, as it is useful in inferring the content and type of salts in soils,Salinization is the process of enriching the soil with soluble salts that are harmful, close and clear to the surface of the earth. When the salts dissolve, it affects the agricultural and environmental production, and thus its effect on the metabolism of soil organisms and reduces the productivity of the land and then destroys all plants and other organisms that live in the soil. The soil was classified according to the salinity index into three categories According to the use of the following equation:

NDSI= (Red-NIR) / (Red+NIR

Landsat TM5, SI= (Band 3 – Band 4) / (Band 3 + Band 4)

Landsat OLI9, SI= (Band 4 – Band 5) / (Band 4+ Band 5)

Since:

SI = salinity index

Green = green range

Red= represents the red band

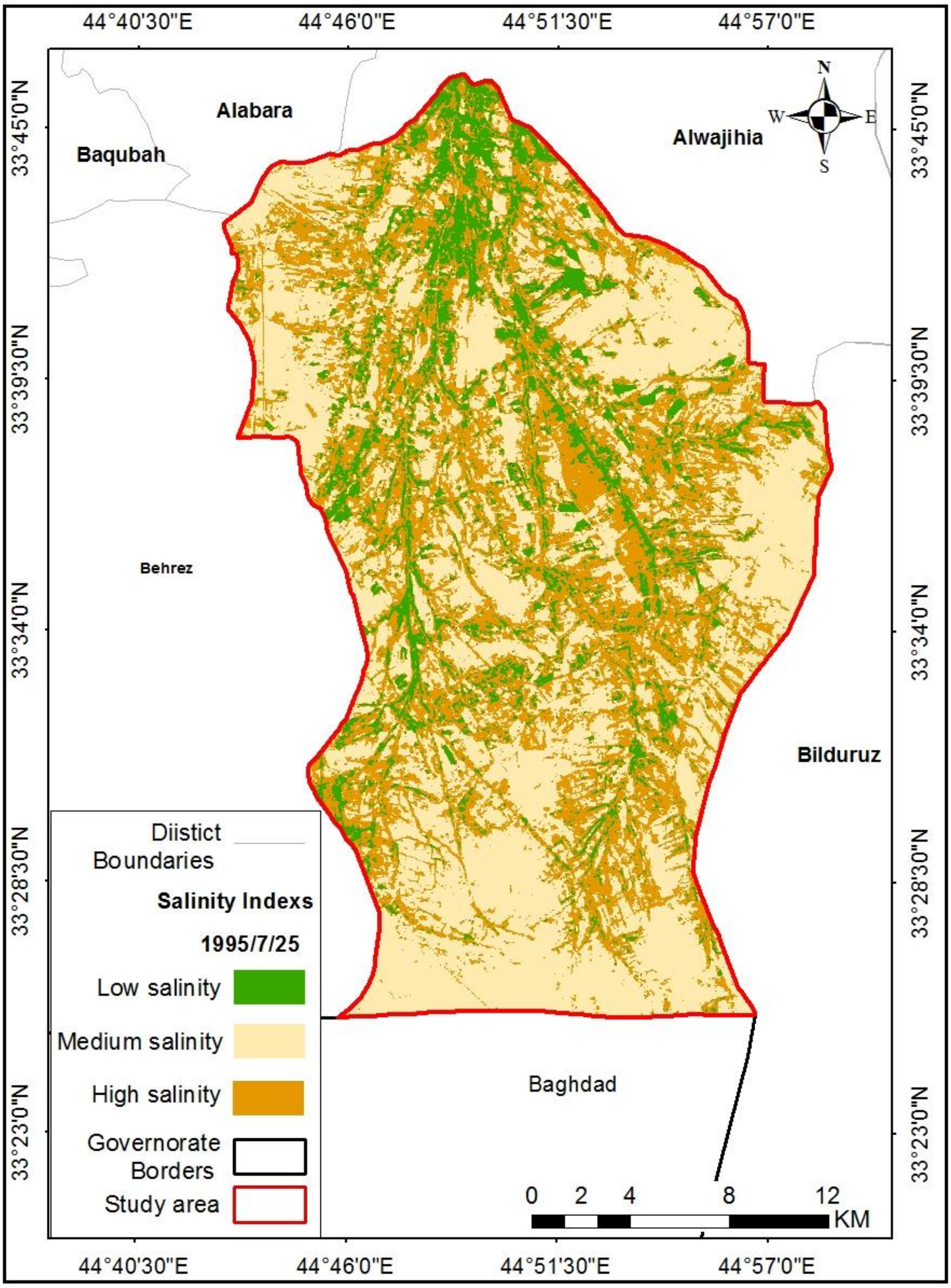
Blue = blue ray range

According to this indicator, the area was divided into three categories. The first is brackish. In 1995, it occupied an area of (79 km2) at a rate of (12.9%). In 2022, it occupied an area of (12 km2) at a rate of (1.9%), with an amount of change of (-67 km2) and a value of change of (-84.81).), As for the second medium-salinity class for the year 1995, it occupied an area of (305 km2) with a rate of (49.7%), and in 2022 it occupied an area of (93 km2) with a rate of (15.2%), with an amount of change (-212) and a value of change (-69.50). As for the third high-salinity category, for the year 1995 it occupied an area of (229 km2) with a rate of (37.4%), while for the year 2022 it occupied an area of (508 km2) with a rate of (82.9%) and an amount of change (279 km2) and a value of change (121.83), Map (6).) and (7) and Table (3) and Figure (3).

Table (3) Area, percentages and amount of change in soil salinity between 1995-2022 according to the salinity index index for the region for the dry month of July

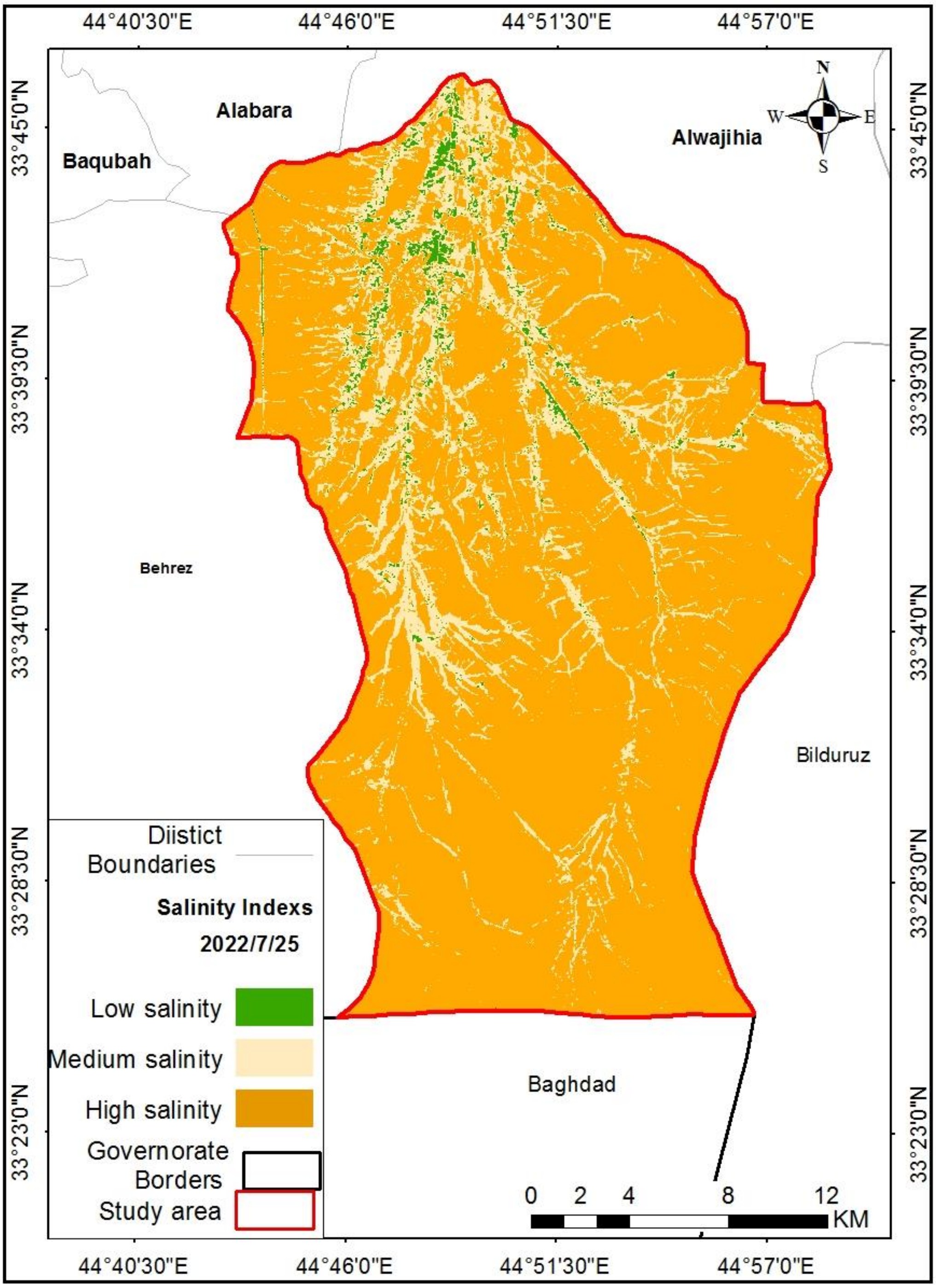
change value	The amount of change / km2	2022		1995		Item name	
		Percentage %	Area km2	Percentage %	Area km2		
-84.8101	-67	1.9	12	12.9	79	Low salinity	1
-69.5082	-212	15.2	93	49.7	305	medium salinity	2
121.8341	279	82.9	508	37.4	229	high salinity	3
		100	613	100	613	the total	

Source: The researcher's work based on map (6) and (7) and the ARC GIS 10.8 program.



Map (6) salinity index for the dry season 1995

Source: From the researcher's work based on Landsat 5,9 for the year 1995 using ARC GIS 10.8 software.



Map (7) salinity index for the dry season 2022

Source: From the researcher's work based on Landsat 5,9 for the year 2022 using ARC GIS 10.8 software.

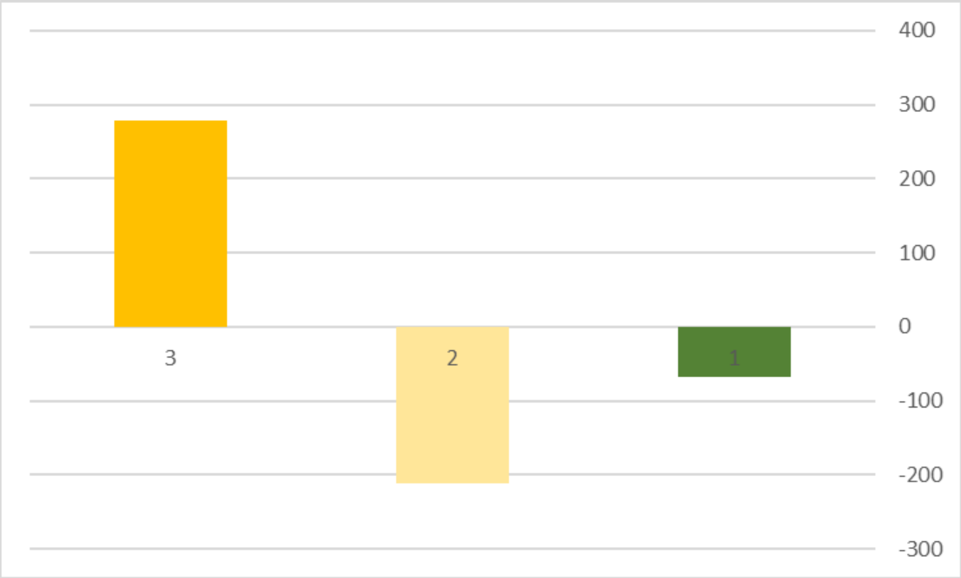


Figure (23) The amount of change in soil salinity between 1995-2022 according to the salinity index index (NDSI) for the region

Source: From the researcher's work based on Table (3)

Fourthly: Bare Soil Index (BSI)

It is soil devoid of plants due to the loss of its fertility and the loss of most of its organic and mineral materials.

The bare soil indicator may be used to distinguish soil devoid of vegetation. The BSI is a digital indicator that combines blue, red, near-infrared, and short-wave infrared to capture soil differences. These spectral bands are used in a natural way and short-wave infrared is used. The red and red spectral bands are used to determine the mineral composition of the soil, while the blue and infrared spectral bands are used to enhance the presence of plants. The soil is classified according to the above indicator into two categories by using the following equation:

BSI=((RED+SWIR) _(NIR+BLUE))/((RED+SWIR) + (NIR_ BLUE))

Landsat TM5, BSI= ((Band 3+Band 5) - (Band 4+ Band 1)) / ((Band 3+ Band 5) +(Band 4_Band 1))

Landsat OLI9, BSI= ((Band 4+ Band 6) - (Band 5+ Band 2)) /

((Band 4+ Band 6) +(Band 5_ Band 2))

So that

RED = red rays

NIR = near infrared

SWIR=short infrared

BLUE = blue band

According to this indicator, the region was divided into two categories. The first is green land. In 1995, it occupied an area of (113 km2) with a rate of (18.4%), while in 2022 it occupied (63 km2) with a rate of (10.2%), with a change amount of (-50) and a change value of (-44, 24%), while the second category, the barren land category, occupied an area of (500 km2) in 1995, at a rate of (81.6%), while for the year 2022, it occupied (550 km2), at a rate of (89.8%), with a change amount of (50 km2) and a change value of (10%), map (8), (9), Table (4), and Figure ((4

Table (4) Area, percentages and amount of change between 1995_2022 according to the Barren Soil Index (BSI) of the region for the dry month of July

		2022		1995			
change value	**The amount of change / km2**	**Percentage %**	**Area km2**	**Percentage %**	**Area km2**	**Item name**	
-44.2478	-50	10,2	63	18,4	113	Green lands	1
10	50	89,8	550	81,6	500	Barren lands	2
		100	613	100	613	the total	

Source: Worked by the researcher based on maps (8) and (9) and the ARC GIS 10.8 program

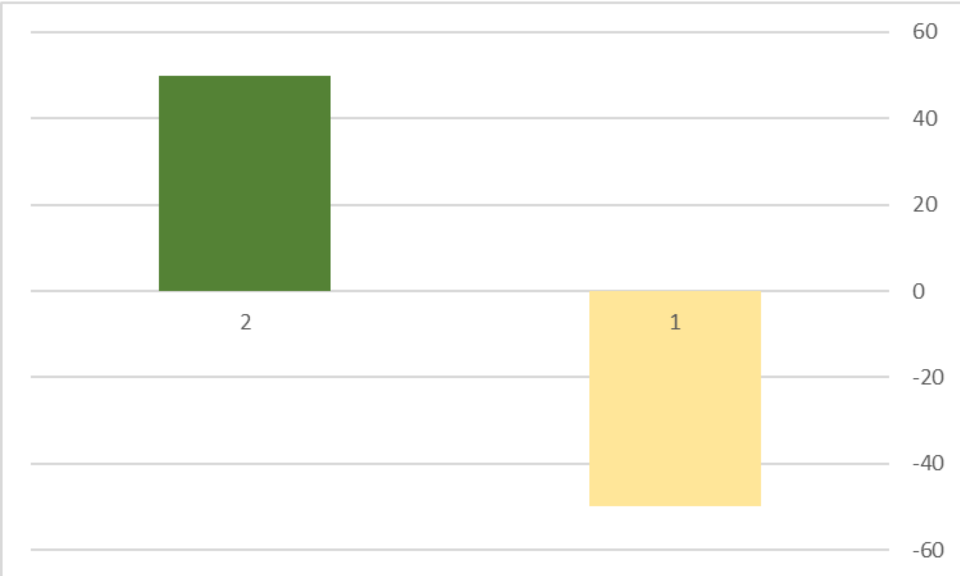
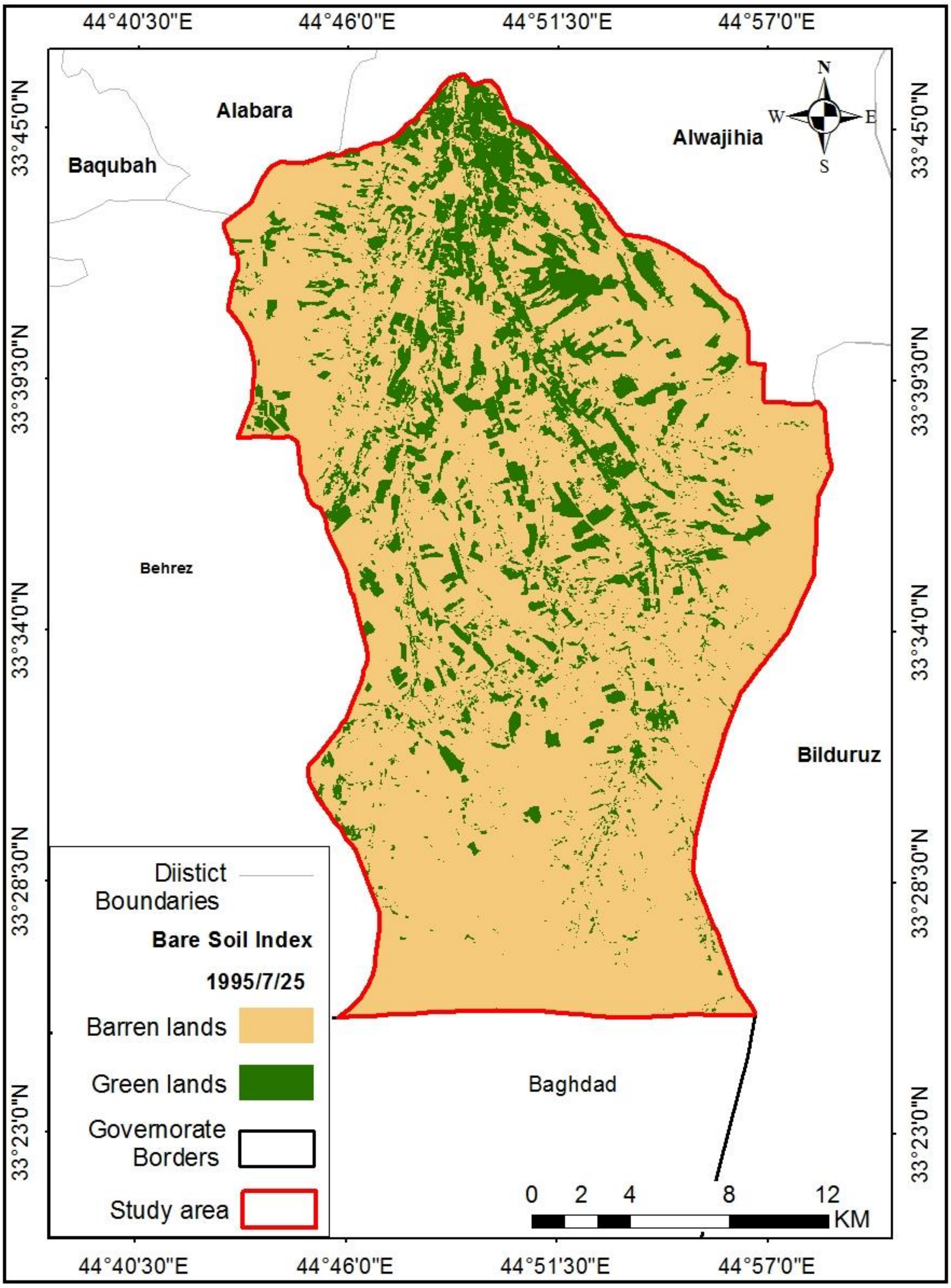
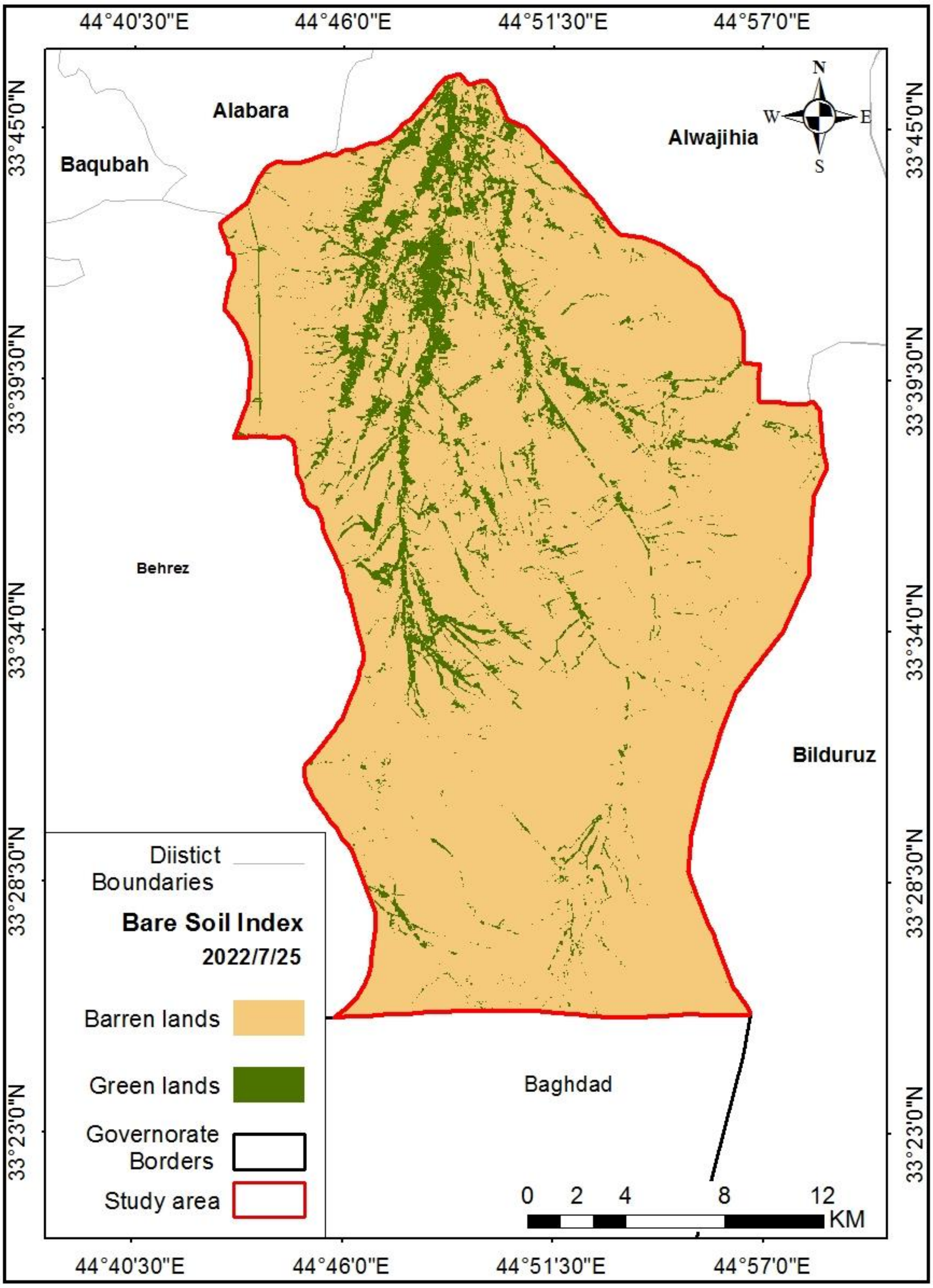


Figure (4) The amount of change between 1995-2022 according to the Bare Soil Index (BSI)

Source: From the researcher's work based on Table 4))



Map (8) of the dry soil index for the 1995 dry season



Map (9) Bare Soil Index for Dry Season 2022

Source: From the researcher's work based on Landsat 5,9 for the year 2022 using ARC GIS 10.8 software.

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