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A Study of the Land Cover of Razzaza Lake during the Past 25 Years Using Remote Sensing Methods

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Abstract

In this study, the Earth's surface was studied in Razzaza Lake for 25 years, using remote sensing methods. Images of the satellites Landsat 5 (TM) and 8 (OLI) were used to study and determine the components of the land cover. The study covered the years 1995-2021 with an interval of 5 years, as this region is uninhabited, so the change in the land cover is slow. The land cover was divided into three main classes and seven subclasses and classified using the maximum likelihood classifier with the help of training sets collected to represent the classes that made up the land cover. The changes detected in the land cover were studied by considering 1995 as a reference year. It was found that there was a significant reduction in the water mass that made up the lake and its transformation into arid land. The vegetation cover was characterized by the relative stability of the crop class. Its constant percent ranged 60% to 80%, unlike the natural plant class, which fluctuates due to its dependence on environmental factors, which is characterized by change. The Kaju presence of continuous change between soil subclasses was due to the different environments affecting the study area. The most affected class was the shallow water class, which disappeared as a result of the drought experienced by the lake.

keywords: Constancy percent, Omission, Commission, Landsat 8 & Landsat 5.

1. Introduction

Particular attention must be paid to natural resources, especially water, to maintain the balance of the ecosystem, especially in countries with arid and semi-arid climates, such as Iraq, where water resources have suffered from many problems affecting the quality and quantity of water. These water resources have changed from one season to another because of the weather and the amount of falling rain [1]. Therefore, GIS and remote sensing were the two technologies that have grown in importance due to their ability to provide critical environmental data derived from the analysis of satellite imagery. They have been used in various applications that help us learn more about the world around us [1]. It is an acronym for Geographic Information Systems; It can be

defined as a set of data organized in a certain way. Computer hardware and software are used to store, manage, and retrieve data to obtain maps and spatial data and to analyze and interpret data and information [2].
The land cover classes must be classified according to the criteria established by the US Geological Survey (USGS) in defining the land cover classes (Anderson classification), with each significant class containing several subclasses [3].

The land cover components reflect specific percentages of the total land cover area. Therefore, its change is a collection of changes that emerge on its primary types. The natural factor encompasses all variables arising due to the environment's effects and changes. For example, when the amount of fallen rain decreases, naturally vegetated regions become barren, and in a hot climate, wet soil becomes dry[3-5].

By utilizing physical phenomena such as reflection and emission, we can measure, identify, and analyze the land cover attributes without directly contacting the target or object in question [7]. Remote sensors often record wavelengths in various ranges, including visible and infrared rays (near, medium, and far), ultraviolet rays, and other types. These energies are processed and recorded as data, then saved for future use [8].

Iraq is going through a historical water crisis for internal and external reasons. The internal factors are: the increased demand for sweet water, its use for agriculture and human requirements, and the exploitation of water resources after 2003. External factors include water projects in neighboring countries, climate change, and high temperatures. Remote sensing is essential because it has the potential to provide us with huge amounts of data and regulatory information that can be reproduced efficiently and at a low cost over large areas [6-7].

The track of land cover feature changes that have occurred in specific locations is essential in many research fields, which can be achieved by recognizing and distinguishing differences and similarities and comparing scenes from different years or periods taken in the same location [6-7].

In Iraq, most water resources come from the Tigris and Euphrates rivers, which feed many lakes, especially Razzaza Lake, the second largest lake in Iraq after Tharthar Lake. It is located in southwest Iraq and derives water from the Euphrates River, one of the country's most important rivers [8]. A decrease in the water level of Razzaza Lake was recorded due to the neglect of the lake, which may lead to the drying up of the lake in the future. The importance of water bodies and the necessity to address their deterioration led to much research on the subject. The following are some of the studies that have been conducted:

Remote sensing has been used to evaluate water quality parameters, and GIS-GPS techniques were used to give a valuable tool for water monitoring and evaluation. To improve water quality, changes in water standards and quality were tracked. They conclude that increased remote sensing techniques should be used when satellites with higher spectral and spatial resolutions are launched [9].

Four types of water depths were detected in this study for different seasons from Habbaniyah and Razzaza lakes: (extremely shallow, shallow, moderate, and deep). This needed satellite images according to depth and water reflection by taking three pictures of Baghdad and its surroundings for the year (1991-1999). - 2014) [10]

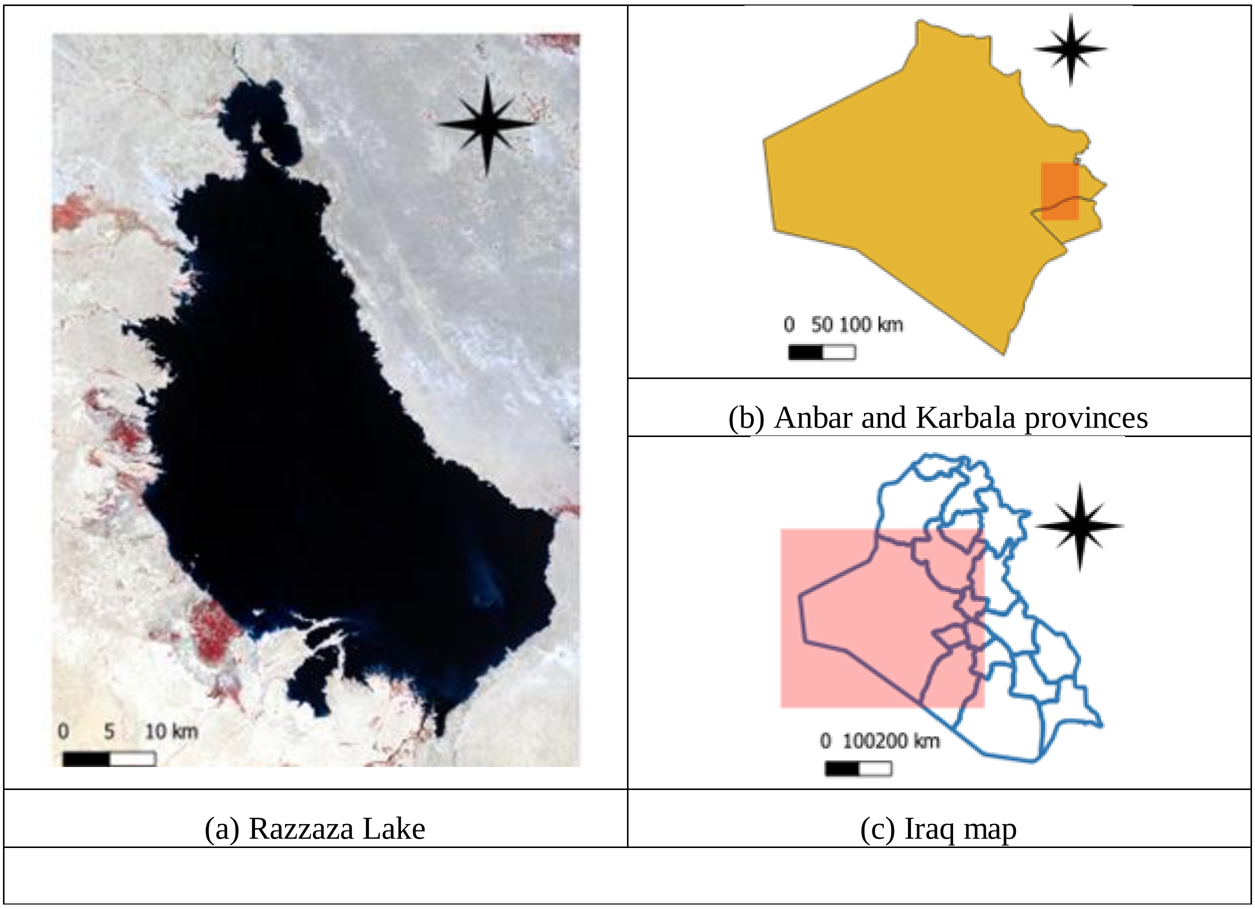
Determination the land covers the Razzaza Lake area between 2000 and 2015 using remote sensing techniques. The area of the lake decreased by about 320 km2, with a significant increase in the saline areas in 2015. This was due to an increase in the aridity of the lake and a significant decrease in the water cover in terms of depth and volume [11].

The winter season was chosen as the time for the study to investigate the changes in Al-Saadya marsh from 1987 to 2012, and because it is the season of the recovery of the marshes in Iraq. The period spanned seven years (1987, 1990, 1995, 2000, 2007, 2014, 2017). The marshes receded after rehabilitation from 1990 to 2014, during which natural and human forces altered the swamp, according to the study that used the classifier (Maximum likelihood) [12].

2. Study Site Description

Razzaza lake is a water body surrounded by desert from all sides. That has increased the importance of the lake. The area of the lake is (1575km2)and was about 29m above sea level in 1995. This lake is located between the governorates of Karbala and Anbar, 15 kilometers north of Karbala, and the western side of the lake is more profound and covered with dense vegetation.

Razzaza lake is mainly fed by the Majara regulator, located in the northern part of the lake, and connects it to Lake Habbaniyah, the lake's only tributary [11]. It is situated between the longitude 33º 9'55.33] to [43º18'4.42] and latitude [32º27'10.13] to [43º55'37.85], as shown in Figure 1. The eastern and southern parts of the lake are surrounded by desert and semi-arid areas.



(a) Razzaza Lake

(b) Anbar and Karbala provinces

(c) Iraq map

Figure 1. The location of Razazza lake in Iraq (1995)

3. Methodology

The main steps used in this research are illustrated in the below:

1. Using Equation 1: the operational Land Image (OLI) bands were converted from a digital pixel-based (DN) system to top-of-atmosphere (TOA) reflectance. The scenes were converted from pixel-based digital (DN) to TOA reflection in Landsat 5 scenes using ENVI5.3 software [13].

$$\rho_{\lambda} = \frac{M_p * Q_{cal} + A_p}{\sin\theta} \qquad (1)$$

Where:

ρ_{λ} =TOA Planetary Spectral Reflectance, with correction for the solar angle.

M_p =reflectance multiplicative band scaling factor (Reflectance Multiband from the metadata).

A_p= Reflectance additive scaling factor for the band (Reflectance Addband from the metadata).

Q_{cal}= pixel value in DN.

2. Seven bands representing the OLI sensor (blue, green, red, coastal, IR, SWIR-1, SWIR-2) in Landsat 8 scenes were selected to represent the spectral signature of the land cover.

3- Six bands (blue, green, red, IR, SWIR-1, SWIR-2) were selected in Landsat 5 scenes .to represent the spectral signature of the land cover.

4- The research area was clipped from the Landsat 8 and 5 sceneries.

5- Gathering training sets for the various land cover classes offered.

6- Using the supervised maximum likelihood classifier to classify the satellite scenes.

7- Statistics were calculated for each scene.

4. Results and Discussion

Using the US Geological Survey website, images of Landsat 5 (TM) and Landsat 8 (OLI) were obtained [14].The scenes were captured in Jun and July of each year, as shown in **Table 1**.

Table 1. The satellite scenes information

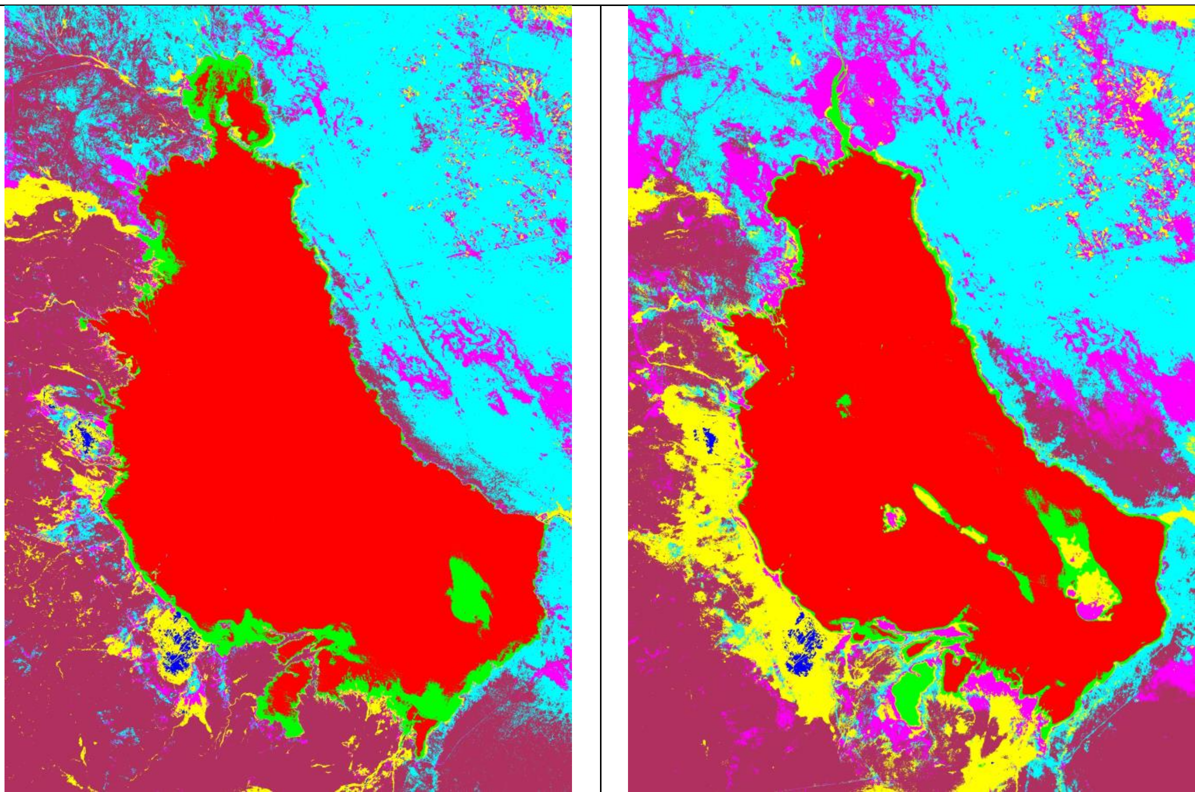
Date	Time (GMT)	Satellite	Sensor	Row	Bath
7/23/2021	07:39-47.19	Landsat 8	OLI	167	39
7/23/2015	7:39:24 AM	Landsat 8	OLI	167	39
7/9/2010	7:30:20 AM	Landsat 5	TM	167	39
7/11/2005	7:27:31 AM	Landsat 5	TM	167	39
7/16/2001	7:20:11 AM	Landsat 5	TM	167	39
7/29/2000	7:16:58 AM	Landsat 5	TM	167	39
6/25/1999	7:17:40 AM	Landsat 5	TM	167	39
7/16/1995	6:44:35 AM	Landsat 5	TM	167	39

Examining the images of Razzaza Lake, one can note that the deterioration began in 2000. It is considered a turning point for the lake, so two scenes were used with a one-year difference from this year to follow the lake's deterioration meticulously. In contrast, five years difference was to be considered between each successive scene for the rest images.

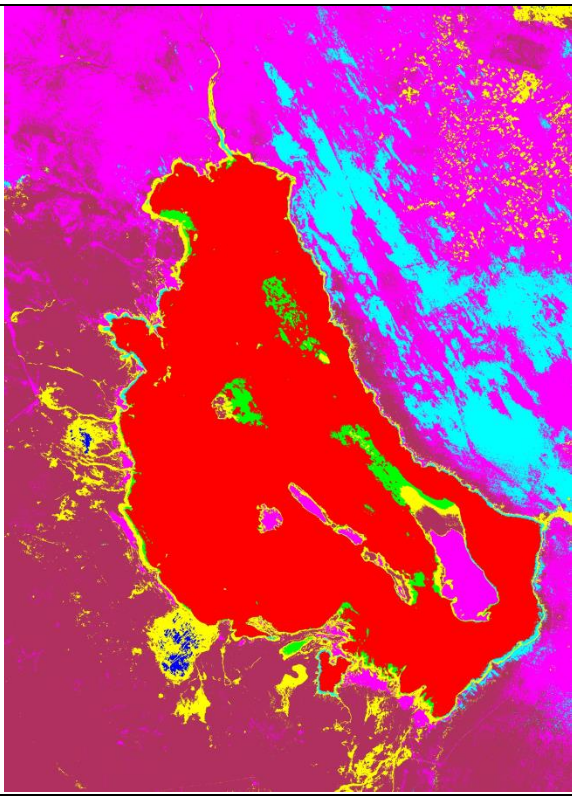
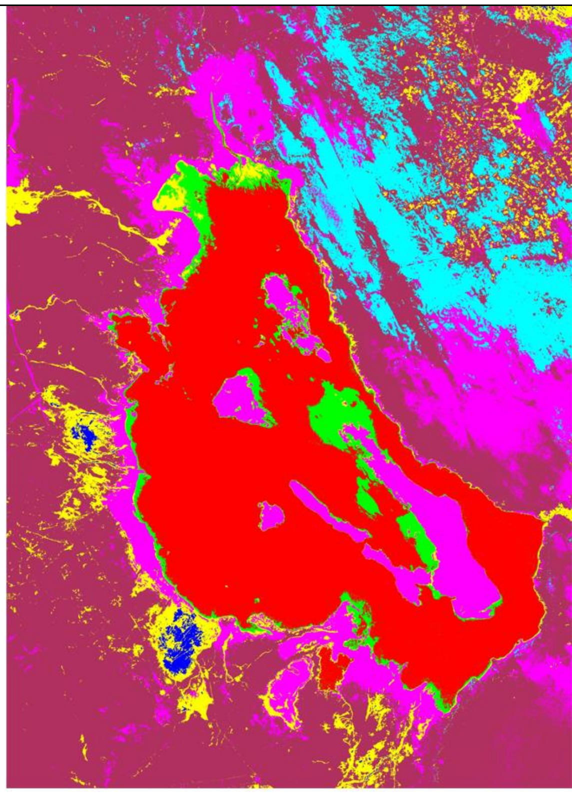
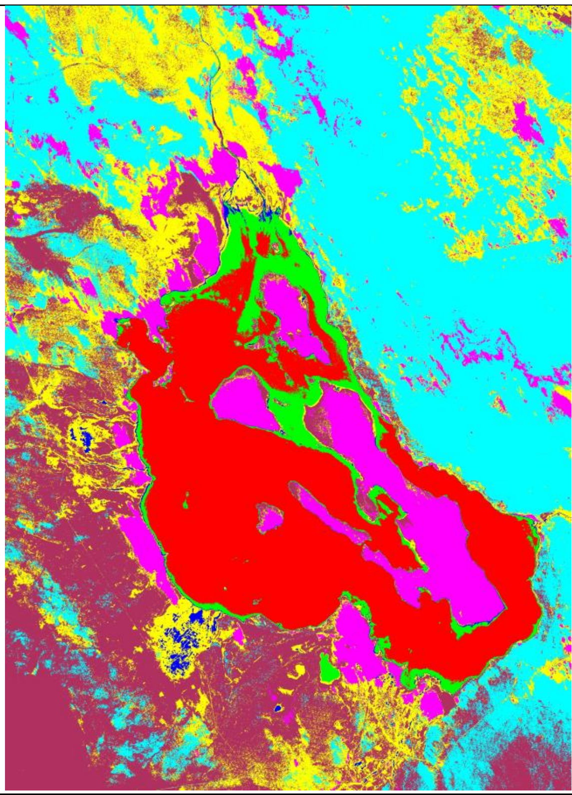
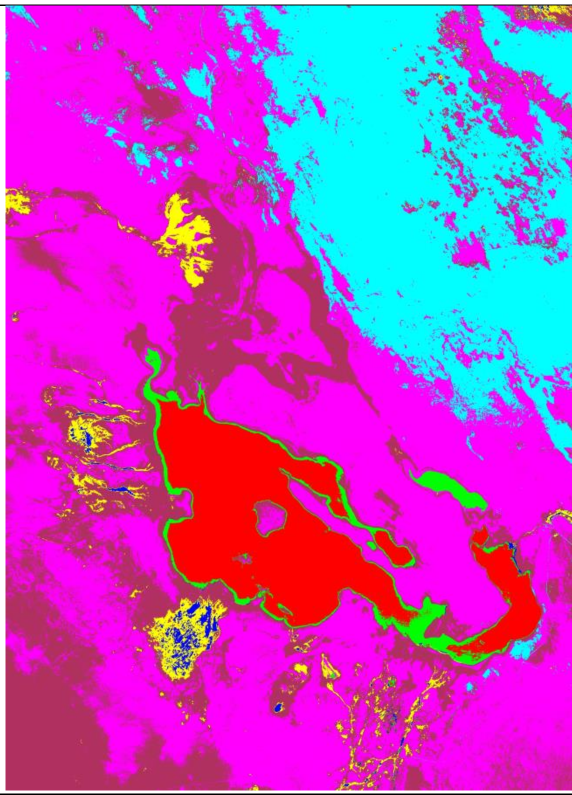
The land cover components were classified for the study area using the maximum likelihood classifier, as shown in figure 2. The land cover components were represented in pseudo colors, making it easy to distinguish between them. The study area was divided into three main classes and seven sub-classes, as shown in **Table 2.**

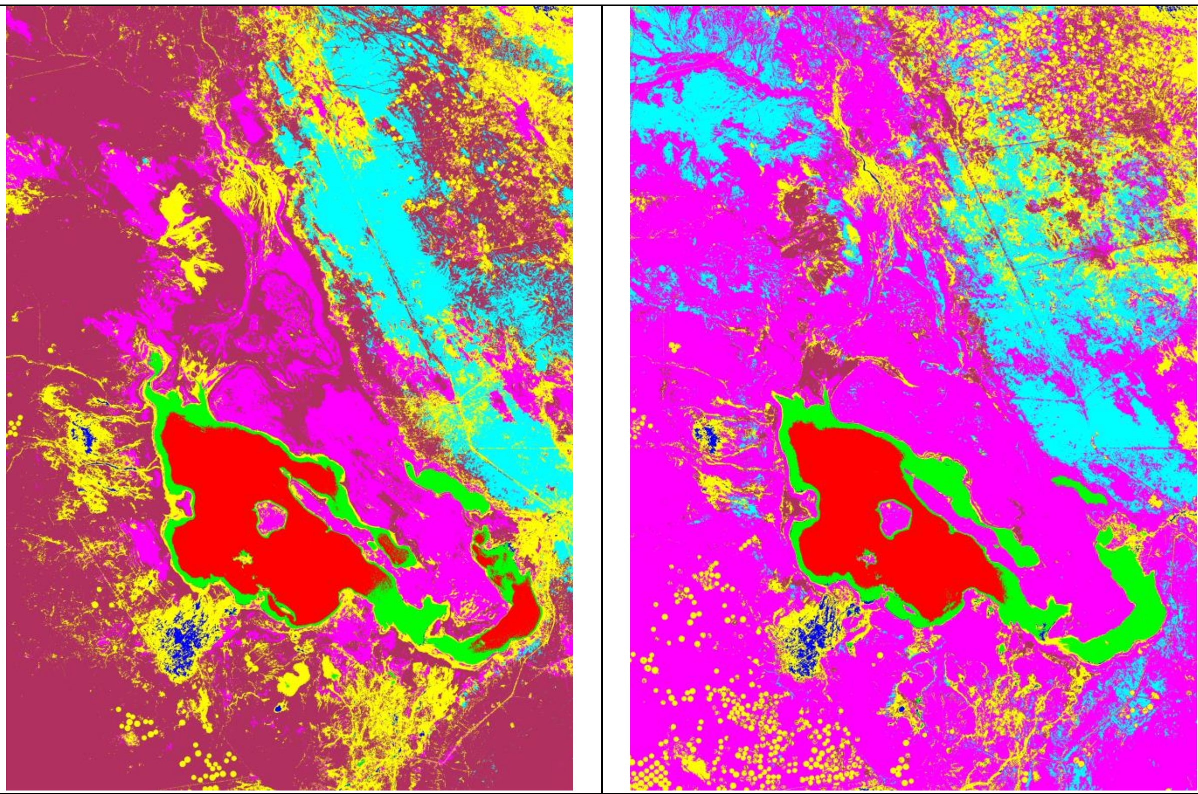
Table 2. the Main and subclasses of the study site land cover

Water	Deep Water	
	Shallow Water	
Plant	Natural Plant	
	Crops	
Soil	White Soil	
	Gray Soil	
	Yellow Soil	



1995	1999

	
2000	2001
	
2005	2010



2015	2021

Figure 2. Changing the surface area of Razzaza water from 1999 to 2021.

The accuracy percentage of the classification step was calculated compared to the training sets to verify the credibility of the results and the extent of dependence on them in the land cover analysis. It was found that the results have a high accuracy rate, as shown in **Table 3**.

Table 3. The classification accuracy

No	Year	Overall Accuracy	Kappa Coefficient
1	1995	100	1
2	1999	100	1
3	2000	99.91	0.99
4	2001	99.72	0.99
5	2005	99.96	0.99
6	2010	100	1
7	2015	100	1
8	2021	99.94	0.99

Despite the high accuracy percentage of classification, when calculating the accuracy percentage for the user and the classifier, it becomes clear that the year 1995 suffered from a decrease in the accuracy percentage, as shown in **Figure 3 and 4**:

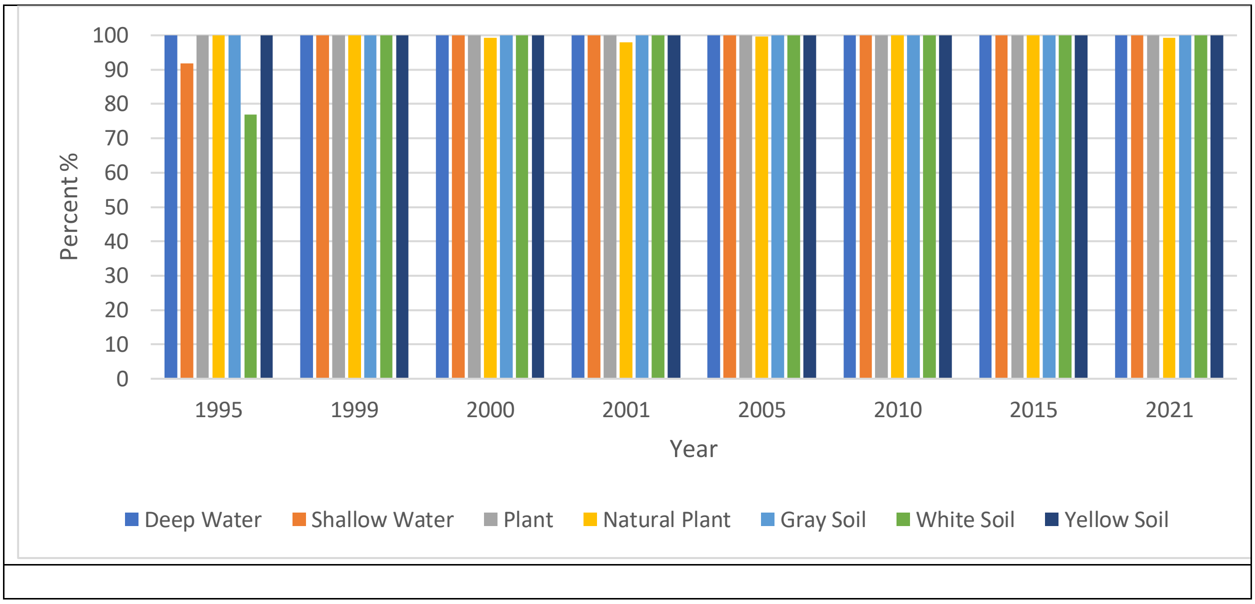


Figure 3. User accuracy percent

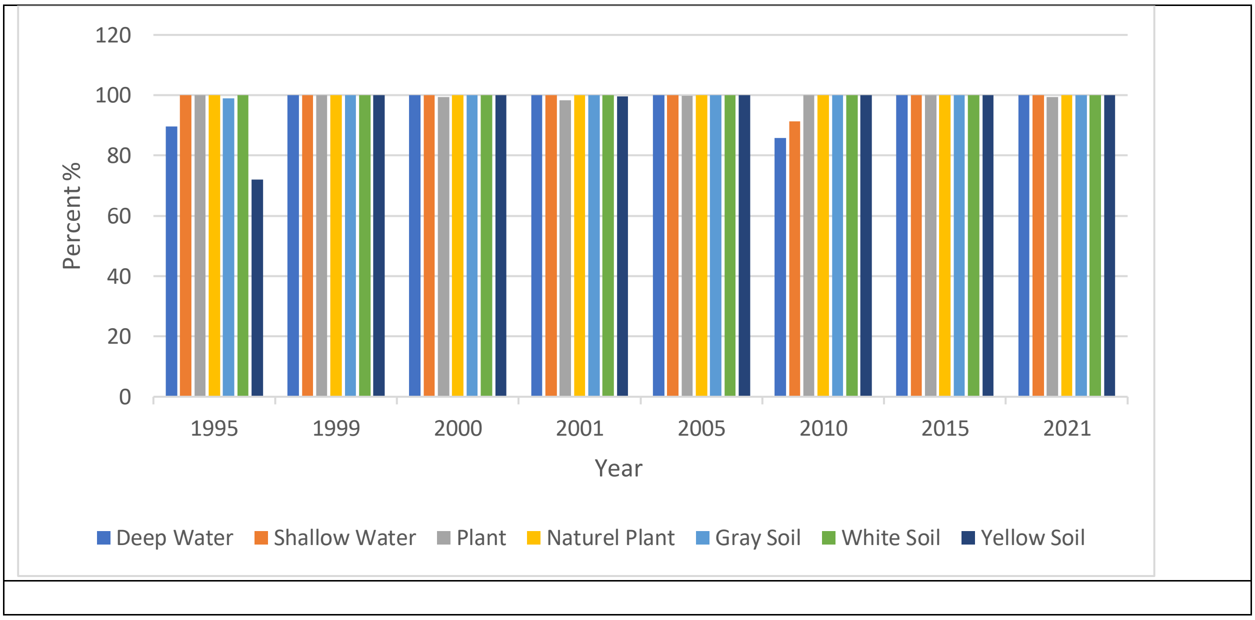


Figure 4. Producer accuracy percent

The decrease in classification accuracy for both the user and the classifier for the year 1995 led to an apparent omission in classifying some classes to their correct class and commissioning them to classes that do not represent them, as shown in **Figures 5 and 6**.

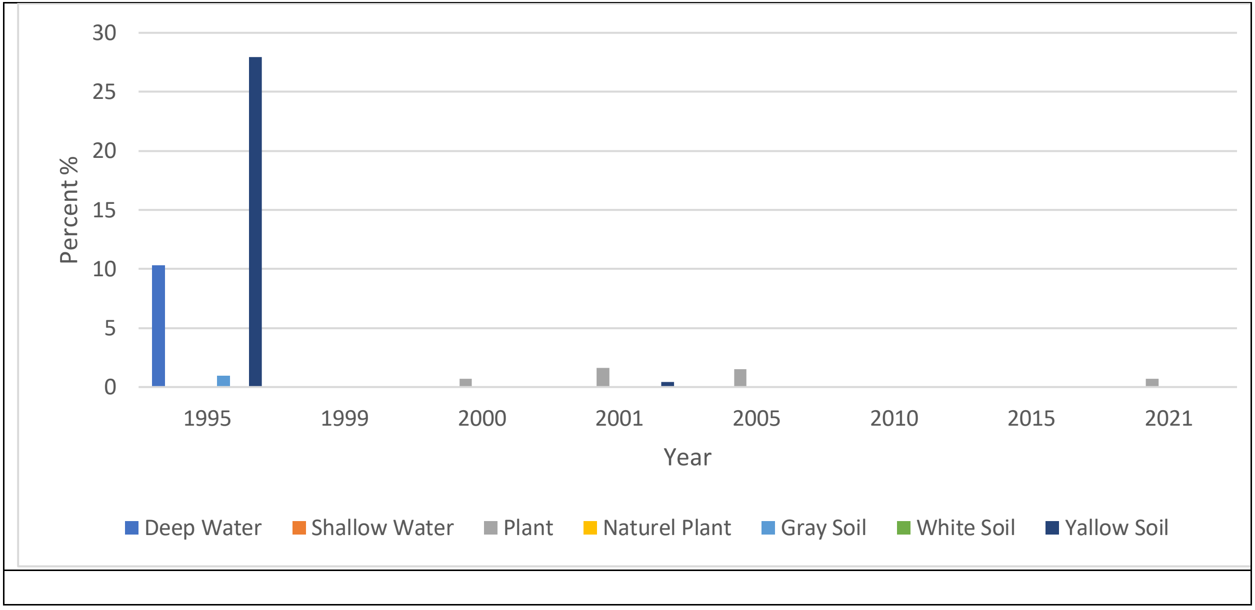


Figure 5. the omission percent

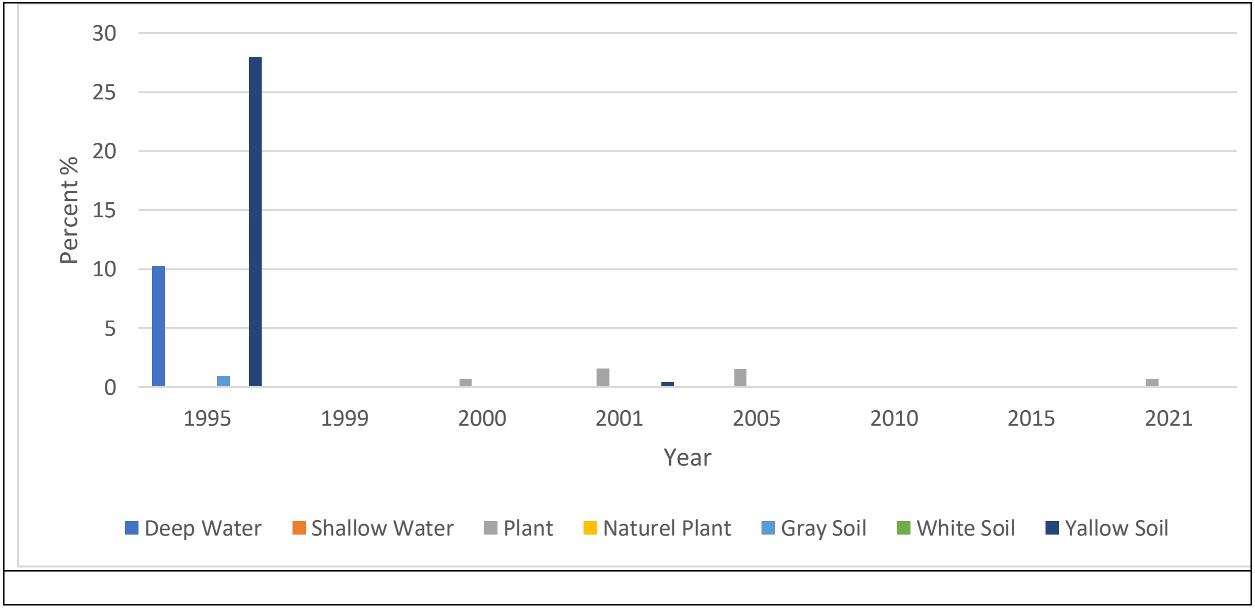


Figure 6. the omission percent

by choosing a 10% threshold for each of the omission and commission percent, two classes suffered from omission, which are gray soil and yellow soil, where they were omitted in the classification as it classified as white soil, and this is due to close spectral response since they belong to the same main class, as illustrated in **Table 4**.

Table 4. The omission and the commission between the classes

Year	Omission		Commission	Notes
1995	Gray Soil	→	White Soil	Belong to the same main class (have a close spectral response)
	Yellow Soil	→		

To study the change in the land cover in the study area, 1995 was adopted as a reference year to measure the percentage of class constancy in the study area over time, as shown in **Figure 7**.

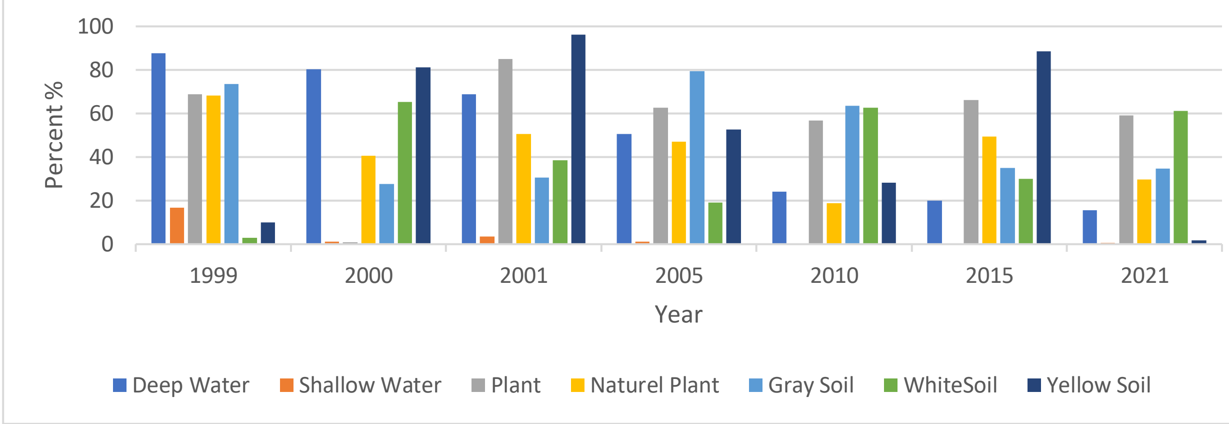


Figure 7. The constancy percentage of the class for the adopted years

The constancy percentage of the plant class (the plant that the beneficiaries of the land, such as crops, have cultivated)

is fixed at about 60%, and sometimes it reaches 80%. This is because these areas are cultivated permanently and do not change significantly. With time, it is stable because it is always planted. Only the percentage of cultivation varies from year to year according to the amount of rain, unlike the natural plant class. It can be noted that it fluctuates in some years such as 1999 where its percentage is high, and in some years such as 2010 where the percentage is low.

Since Iraq was suffering from drought, we noticed a decrease in the percentage of categories of water bodies for many reasons, including climatic conditions and the amount of rain that affects the percentage of natural vegetation, and therefore it changes from year to year, as shown in **Table 5**

Table 5. Water releases of Al-Razzaza Lake

Year	June	July	Average
1995	57	53	55
1999	54	53	54
2000	47	43	45
2005	45	41	43
2010	41	45	43
2015	37	32	35
2016	34	37	36
2017	32	34	33
2018	29	31	30
2019	27	30	29
2020	29	31	30
2021	27	24	26

One of the classes that face a reduction in its percentage is the deep water class due to the drying up of the Razzaza lake. In contrast, after several years, the shallow water class suffered from extinction because it dried up and turned into a land where it existed only in 1999 by only 20%

compared to 1995. It disappeared in the rest of the years that followed 1999 since the deep water class replaced it due to the decrease in the deep water.

For the soil, classes are in a state of fluctuation. This fluctuation is due to the quality of the soil, as it changes according to climatic conditions in terms of the moisture content inside the soil, which changes it from one type to another.

5. Conclusions

According to the results, the following conclusions can be driven:

- The water mass of Razzaza Lake has declined to about 20% or 30% compared to the year 1995.
- Some classes have been transformed into others, such as (water turned into soil or became a plant, plants turned into soil, and part of it is a natural plant and not stable).
- The land cover components for the study area are few and distinct, as most are desert and water areas, with few cultivated areas compared to other varieties. This makes it easy for us to classify the area with high accuracy.

References

1.Abduljabbar, H. M.; Hatem A. J.; Al-Jasim, A. A.; Desertification Monitoring in the South-West of Iraqi Using Fuzzy Inference System, *NeuroQuantology*, **2020,** *18, 1*.

2.Abed, D. J.; A study of Alshoayga Marsh's Digital elevation model using G1S and remote sensing methods, Baghdad/Iraq: *University of Baghdad College of Education for Pure Sciences / Ibn Al-Haitham*, **2021.**

3.Anderson, J. R.; A land use and land cover classification system for use with remote sensor data, Fourth printing 1983 ed., *Washington: US Government Printing Office*, **1976**.

4.Bukheet, Y. C.; Al-Abudi, B. Q.; Mahdi, M. S.; Land Cover Change Detection of Baghdad City Using Multi-Spectral Remote Sensing Imagery, *Iraqi Journal of Science, no. Special Issue, Part A*, **2016,**195-214.

5.Abbas , H. N.; Ali, I. M.; A study of the climate change impacts on Al Shuwaija Marsh-Wasit province using satellite remote sensing, *AIP Conference Proceedings*, **2020,** *2307*, 020048.

6.Naji, T. A.; Hatem, A. J.; New Adaptive Satellite Image Classification Technique for Al Habbinya Region West of Iraq, *Ibn AL-Haitham Journal For Pure and Applied Science*, **2017,** *26, 2*, 143-149.

7.Abbas, A. H.; Sadiq, A.; Hussain, L.; Vegetation Detection Using Remote Sensing Images and NDVI Index: in Marshlands of Iraq, *Science International*, **2018**, *30, 4*, 541-544

8.Mohammed, M. A.; Hatem, A. J.; Change detection of the land cover for three decades using remote sensing data and geographic information system, *AIP Conference Proceedings*, **2020,** *2307*, 020029.

9.Muhsin, I. J.; Monitoring of south Iraq marshes using classification and change detection techniques, *Iraqi Journal of Physics*, **2017,** 15, 78-86.

10.Huang, C.; Chen, Y.; Zhang, S.; Detecting, Extracting, and Monitoring Surface Water From Space Using Optical Sensors, *Journal of Geophysical*, **2018,** *56, 2*, 333-360.

11.Mashpee, F. K.; Ali, A. R. B.; Jasim, M. S.; Spatial Monitoring for Degradation Al-Razzaza Lake by Analysis Temporal of Remote Sensing Data Using Geographic Information System Techniques, *EurAsian Journal of BioSciences*, **2020,** *14, 50*, 14677-14684.

12.Ritchie, J. C.; Zimba, P. V.; Everitt, J. H.; Remote Sensing Techniques to Assess Water Quality, *American Society of Photogrammetry*, **2003,** *69, 6*, 695-704.

13.Kadhum, S. N.; Alsudani, E. S.; Monitoring the Land Covers around Al- Razaza Lake - Iraq Based Upon Multi-Temporal Analysis Technique, *Al-Mustansiriyah Journal of Science*, **2021,***32, 2*, 2521-3520 .

14.Abdel Meguid, M. I.; Predicting Water Depth of Lake Using Remote Sensing image, *Iraqi Journal of Science*, **2015,** *56, 2*, 1208-1215.

15.Al-Jasim, A. A.; Hatem, A. J.; Abduljabbar, H. M.; Utilizing remote sensing for studying Al-Saadya Marsh in the period 1987-2017, *EurAsian Journal of BioSciences*, **2020,** *14, 2*, 6415-6420.

16.Zanter, K.; Landsat 8 (L8) - Data Users Handbook, Sioux Falls, South Dakota: Department of the Interior, U.S. Geological Survey, **2016.**

17.EarthExplorer, U.S. Geological Survey (USGS), [Online]. Available: https://earthexplorer.usgs.gov/. [Accessed 1 12 2021].

18.Richards, J. A.; Richards, J.; Remote sensing digital image analysis., *Springer*, **1999.**

19.Abduljabbar, H. M.; Satellite Images Fusion Using Modified PCA Substitution Method, *Ibn AL-Haitham Journal For Pure and Applied Science*, **2017,***30, 1*, 29-37.

20.Mashpee, F. K.; Ali, A. R. B.; Jasim, M. S.; Spatial Monitoring for Degradation Al-Razzaza Lake by Analysis Temporal of Remote Sensing data using Geographic Information System Techniques, *EurAsian Journal of BioSciences*, **2020,** *14, 50*, 14677-14684.

21.Qassim, Z. H.; Abduljabbar, H. M.; Land cover change for Baghdad City in the period 1986 to 2019, *AIP Conference Proceedings*, **2020,** *2307*, 020031.