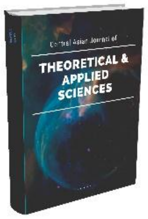

CENTRAL ASIAN JOURNAL OF THEORETICAL AND APPLIED SCIENCES

Volume: 04 Issue: 05 | May 2023 ISSN: 2660-5317
https://cajotas.centralasianstudies.org

Use of Sentinel 2 Satellite Images in Land Cover Mapping for Selected Areas in the Diwaniyah Government

Hussain Muhi Ali, Janan Adnan Aboud
University of Al-Kufa/ Faculty of Education for Girls

Received 7th Mar 2023, Accepted 5th Apr 2023, Online 8th May 2023

Abstract: *The use of remote sensing images in the preparation and monitoring of land covers proved to be a very effective and successful technique for various types of land covers such as urban, water or urban cover… etc. The aim of this study is to prepare the land covers classification maps for the years 2016 and 2022 by using European Satellite Sentinel 2 images, for the two seasons (Spring and Autumn). The Anderson land cover classification system was adopted at the first level, using the supervised classification technique, the maximum probability method, and taking advantage of the integration between geographic information systems and remote sensing data. The error matrix was used to evaluate the accuracy of the land cover classification results. The results showed that the manner of the spatial distribution of the land cover classes during the years 2016 and 2022 is almost identical in terms of an increase in the area of vegetation and water cover during the spring season, and a decrease during the autumn season. In contrast to both the barren lands and the salty lands, which decrease during the spring and increase during the autumn season.*

Keywords: *Sentinel 2, Land cover, Supervised classification, Diwaniyah, and Iraq.*

1- Introduction:

Population growth and economic development have brought rapid changes to the Earth's land cover over the past two centuries, and there are indications that the pace of these changes will accelerate in the future [1]. Land cover can be defined as the surface cover of the earth's infrastructure such as vegetation, water, bare soil...etc. Land cover identification and mapping are important for global observation studies, resource management, and planning activities. Land cover identification establishes the baseline from which monitoring activities (change detection) can be carried out [2]. Land cover is a recognizable image of the many processes that occur on Earth's surface. It reflects the occupation of land by various natural, adjusted, or artificial systems, and to some extent the way land is used in such systems. Land cover cartographic and statistical information plays a central role in describing and quantifying the interaction between economy and nature [3]. However, the land covers and the way people utilize land have become identified over the past 15 years as significant global environmental changes in their own right [4].

The use of remote sensing images in the preparation and monitoring of land covers proved to be a very effective and successful technique for various types of land covers such as urban, water or urban cover … etc., [5, 6]. Remote sensing systems are in continuous progress day by day, especially with the availability of many remote sensing imaging solutions. Among the most important systems or platforms that provide open-source satellite images, including American Landsat satellite images, the most important of which are Landsat7, Landsat8, Landsat9, and the European Sentinel2 satellite images [7]. Remote sensing techniques can be used to classify the land cover types in an economical, practical, and iterative manner over extensive areas [8]. The integration between remote sensing data and geographic information systems has helped in the emergence of advanced scientific techniques that can be used easily in change detection in land cover [9].

The aim of this study is to prepare the classification maps of land covers for selected areas in the Diwaniyah government, and for the period from 2016 to 2022 and for the two seasons (Spring and Autumn) by using European Sentinel2 Satellite images.

2- Study Area

The study area is located in the northern part of Al-Diwaniyah Governorate between longitudes (44° 30' 25") and (45° 34' 13") and latitudes (31° 46' 14") and (32° 24' 33"). The study area represents one of the cities in southern Iraq and the middle Euphrates region, which includes the, Al-Shafeia district, Sumer district, Al-Mihanawiya district, center of Al-Diwaniyah district Afak district, Al-Daghara district, and Al-Saniya district, Al-Fawwar district, with a total area of 3695 km^2 of the total area of Al-Diwaniyah governorate, which amounts to 8471.6 km^2, Figure (1). The study area is located at altitudes between 7-55 meters above sea level.

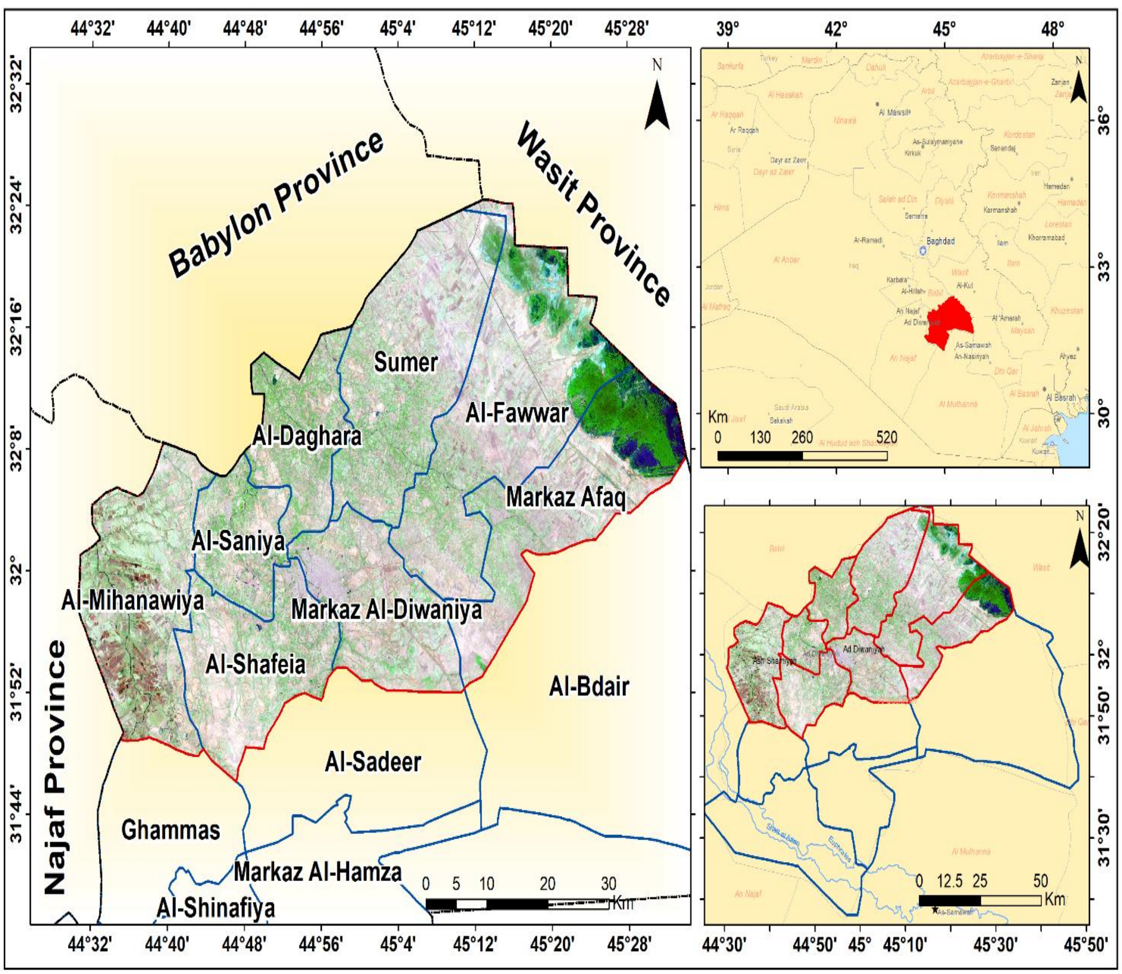

Figure (1) Location of the study area

3- Data used:

Sentinel2 satellite is the first optical observance satellite in the program of European Copernicus, which was developed and constructed under the supervision of the European Space Agency (ESA). Sentinel 2 have two satellite, Sentinel 2A was launched on 23 June 2015, and Sentinel 2B on 7 March 2017 [8]. Sentinel 2A and Sentinel 2B European satellite images were used in this study, which amounted to eight scenes. Four scenes from the Sentinel 2A satellite for 2016, and four scenes from Sentinel 2B satellite for 2022. All images of the European Sentinel 2A and Sentinel 2B satellite images were obtained from one of the European Space Agency's websites(https://scihub.copernicus.eu/dhus/#/home) . Table (1) shows the details of the images used in this study.

Table 1: Characteristics of satellite images of Sentinel-2 used in this study

Year	Acquisition date	Season	Satellite	Level	Scene Number
2016	March 25, 2016	Spring	Sentinel2-A	1C	T38SNA
			Sentinel2-A	1C	T38SMA
	September 21, 2016	Autumn	Sentinel2-A	1C	T38SNA
			Sentinel2-A	1C	T38SMA
2022	March 19, 2022	Spring	Sentinel2-B	2A	T38SNA
			Sentinel2-B	2A	T38SMA
	September 15, 2022	Autumn	Sentinel2-B	2A	T38SNA
			Sentinel2-B	2A	T38SMA

4- Methodology

The methodology for this study was based on the use of supervised classification techniques, using the maximum likelihood method, and according to Anderson's 1976 first-level classification [10]. This classification is the most popular and used [11]. Then, the area of each class for the different seasons was calculated and then compared to monitor the most important changes that occurred in the study area. To evaluate the accuracy of the land cover classification maps, an error matrix of 500 reference points was used. A number of measures were used, including product accuracy, user accuracy, overall accuracy, and Kappa coefficient, to validate the classification maps of land cover. Table (2) summarizes the equations used in the accuracy assessment process.

Table2: Error matrix used to assess the land cover classification accuracy, TP represents True Positive (the correct number of extracted pixels); FN represents False Negative (the undetected number of pixels); FP represents False Positive (the incorrect number of extracted pixels; and TN represents True Negative (the correct number of rejected pixels; UA represents the User’s accuracy; PA represents the Producer’s accuracy; OA represents the Overall accuracy; AC represents the chance agreement [12].

Classified data		Reference Data			
		Class1	Class2	Total	User’s accuracy UA
	Class1	**(TP)**	(FP)	TP+FP	(TP/TP+FP)*100
	Class2	(FN)	**(TN)**	FN+TN	(TN/ FN+TN)*100
	Total	TP+FN	FP+TN	**Total**	Overall Accuracy (OA)= (TP+TN/T) *100
	Producer’s accuracy PA	(TP/TP+FN)*100	(TN/ FP+TN)* 100		

$$\textbf{Kappa coefficient} = OA - AC/1 - AC \qquad (2)$$
$$\mathbf{AC} = ((TP + FP)(TP + FN) + ((FN + TN)(FP + TN)) \qquad (3)$$

5- Results and discussion:

5.1 Classification maps of the Land cover 2016

The land cover classification maps of the year 2016 for the Spring and Autumn seasons are shown in Figure (2), with six classes of land cover within the study area. The percentage and area of each land cover class are shown in Table (3). A comparison between the area of land cover classes for the spring and autumn seasons of the year 2016 is shown in Figure (3). The barren land class occupies the largest area within the study area, which amounted to 1882 km^2 (51% of the area of the study area) during the spring season, to 2401 km^2, (65% of the area of the study area) during the autumn season. The agricultural land comes in second class in terms of area, with an estimated area of 989 km^2 (27% of the study area) during the spring season, and 551 km^2 (15% of the study area) during the autumn season. There is a significant decrease in the area of agricultural land during the Autumn season compared to its area during the spring season, from 998.7 km^2 in the spring season to 551.2 km^2 in the autumn season. The main reason for the decrease in the area of agricultural lands may be the decrease in the area of surface water, which decreased from 183.6 km^2 (5% of the study area) in the spring season to 89 km^2 in (2.4% of the study area) the autumn season, Figure (3). While the percentages for each classes of mixed lands, salty lands, and urban lands were estimated at 11.7%, 2.6%, and 2.8% of the study area, respectively.

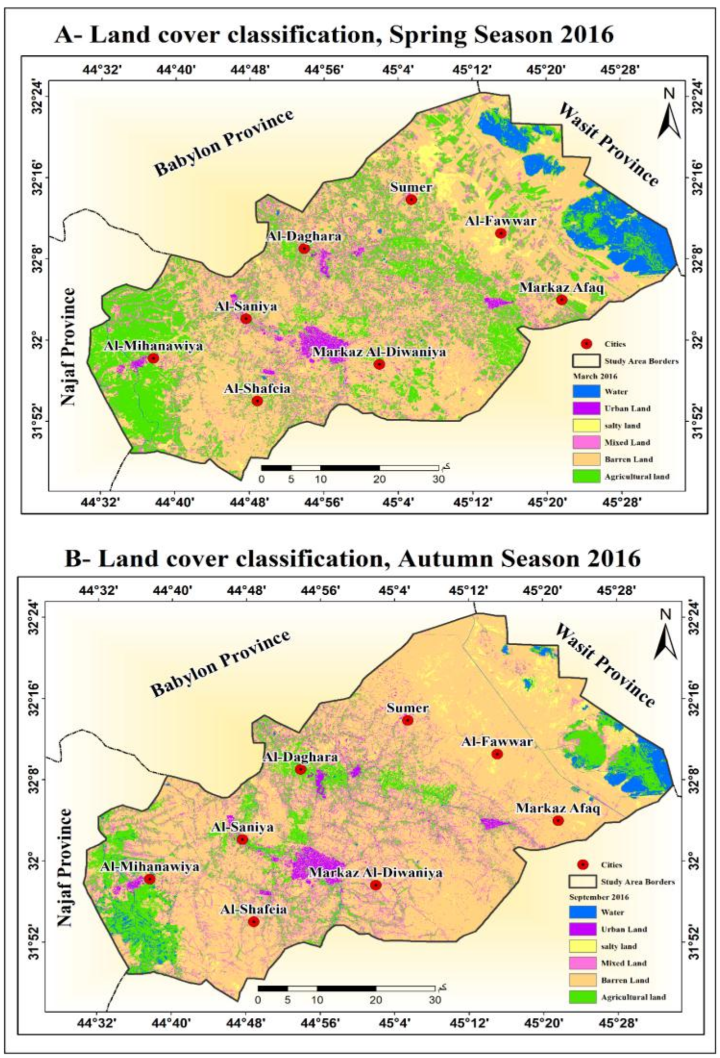

Figure (2) Land cover Classification maps for the spring and autumn seasons 2016

Table (3) The area and percentage of the land cover of the year 2016

Class	Spring Season 2016		Autumn season 2016	
	Area (Km^2)	Area (%)	Area (Km^2)	Area (%)
Water	183.6	5.0	89.0	2.4
Agricultural land	998.7	27.0	551.2	14.9
Mixed Land	431.4	11.7	450.3	12.2
Urban Land	103.0	2.8	107.8	2.9
Barren Land	1882	50.9	2401	65.0
salty land	96.4	2.6	95.6	2.6
	3695 Km^2	**100%**	**3695 Km^2**	**100%**

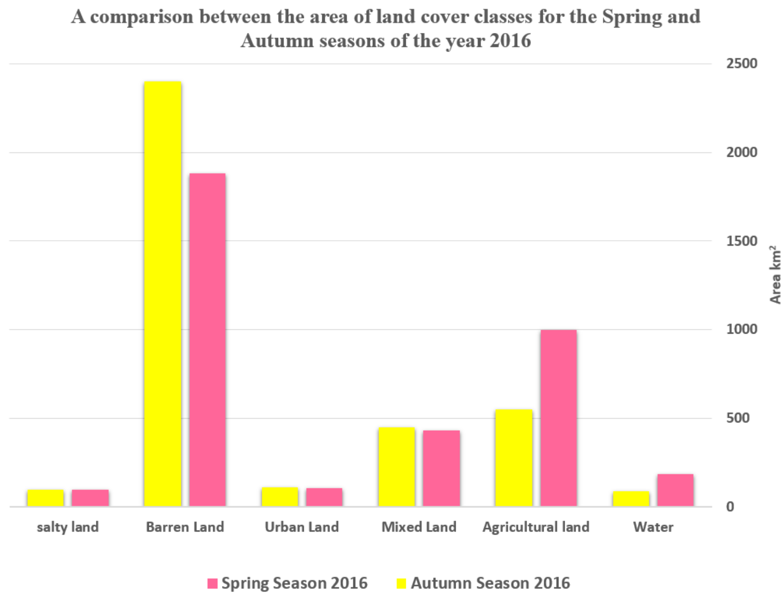

Figure (3) A comparison between the area of land cover classes for the Spring and Autumn seasons of the year 2016

5.2 Classification maps of the Land cover 2022

The land cover classification maps of the year 2022 for the Spring and Autumn seasons are shown in Figure (4), with six classes of land cover within the study area. The percentage and area of each land cover class are shown in Table (4). A comparison between the area of land cover classes for the spring and autumn seasons of the year 2016 is shown in Figure (5). In general, the spatial distribution of land cover classes during the year 2022 is almost identical to that distribution during the year 2016, with the exception that the class of surface water during the spring and autumn seasons did not change its surface area, which amounted to 123 km^2 (3.3% of the study area) during Spring season and 111 km^2 (3% of the study area) during the autumn season, i.e. a change of 12 km^2 (0.3% of the study area). In contrast to the year 2016, when the rate of change in the surface water area was 2.6% of the study area.

Although the area of the water surface area did not change much in 2022, the agricultural land decreased significantly during the autumn season compared to the spring season, from 990 km^2 (27% of the study area) during the spring season to 440 km^2 (12% of the area of the study area). study) during the autumn season, that is, the amount of change in the agricultural land was about 550 km^2, or 15% of the study area. This significant decrease in the area of agricultural land was accompanied by an increase in the area of both the barren lands and the salinized lands, whose areas increased from 1995 km^2 and 98.6 km^2 during the spring season to 2453 km^2 and 188.6 km^2 during the autumn season, respectively. That is, the percentage change during the period from the spring season to the autumn season for each of the barren lands and the salinized lands was estimated at 12.4% and 2.4% of the area of the study area, respectively.

Table (4) The area and percentage of the land cover of the year 2022

	Spring Season 2022		Autumn season 2022	
Class	Area (Km^2)	Area (%)	Area (Km^2)	Area (%)
Water	122.7	3.3	111.0	3.0
Agricultural land	989.6	26.8	440.0	11.9
Mixed Land	355.7	9.6	360.4	9.8
Urban Land	133.6	3.6	142.5	3.9
Barren Land	1995	54.0	2453	66.4
salty land	98.6	2.7	188.6	5.1
	3695 Km^2	**100%**	**3695 Km^2**	**100%**

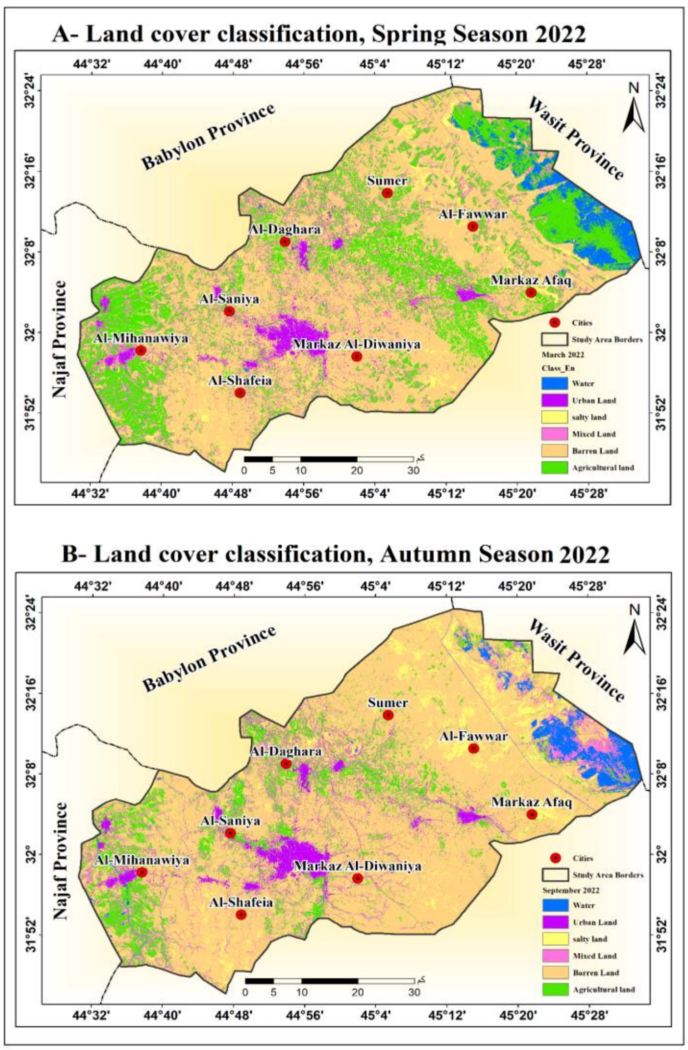

Figure (4) Land cover Classification maps for the spring and autumn seasons 2022

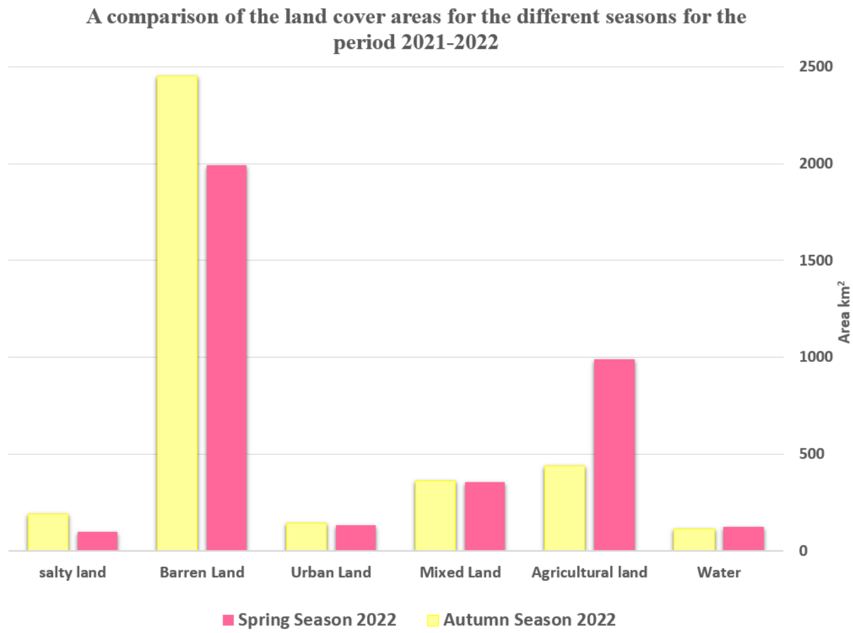

Figure (5) A comparison between the area of land cover classes for the Spring and Autumn seasons of the year 2022

5.3 Accuracy Assessment

To assess the accuracy of land cover classification maps, 500 reference points was used. Tables (5) and (6) show the Error matrix table for the land cover classification map of the spring and autumn seasons, 2016 respectively. While Tables (7) and (8) show the Error matrix table for the land cover classification map of the spring and autumn seasons, 2022 respectively. The final results to assess the overall accuracy and kappa coefficient of the land cover classification maps are shown in Table (9). The overall accuracy and kappa coefficient values for land cover classification maps ranged between 85% to 90%, and 0.8 to 0.86, respectively. In general, these values of the overall accuracy and the Kappa coefficient are considered good and acceptable values within the conditions for accepting land cover maps, which must not be less than 85% [13]. One of the most important reasons for the convergence of the overall accuracy values and the Kappa coefficient for all land cover classification maps is the similarity in the spatial, spectral, or radiometric characteristics of the Sentinel 2 satellite images that used in this study.

Table (5) Error matrix for Spring season, 2016

	Reference Data								
Classified Data	**Class**	**Water**	**Agricultural land**	**Mixed Land**	**Barren land**	**Urban Land**	**salinized land**	**Total**	**User Accuracy %**
	Water	**66**	0	1	0	1	1	**69**	**95.65**
	Agricultural land	1	**71**	2	1	4	3	**82**	**86.59**
	Mixed Land	2	3	**81**	3	3	3	**95**	**85.26**
	Urban Land	1	3	3	**97**	6	2	**112**	**86.61**
	Barren land	1	3	3	5	**62**	4	**78**	**79.49**

	salinized land	0	3	3	6	3	**49**	**64**	**76.56**
	Total	**71**	**83**	**93**	**112**	**79**	**62**	**426**	**Overall accuracy %85.2**
	Product Accuracy	**93**	**85.54**	**87.1**	**86.61**	**78.5**	**79.0**		

Table (6) Error matrix for Autumn season, 2016

	Reference Data								
Classified Data	**Class**	**Water**	**Agricultural land**	**Mixed Land**	**Barren land**	**Urban Land**	**salinized land**	**Total**	**User Accuracy%**
	Water	**56**	0	0	0	1	1	**58**	**96.55**
	Agricultural land	1	**71**	1	1	1	3	**78**	**91.03**
	Mixed Land	1	3	**77**	2	2	3	**88**	**87.50**
	Urban Land	1	3	3	**119**	3	2	**131**	**90.84**
	Barren land	0	1	4	2	**68**	1	**76**	**89.47**
	salinized land	0	2	2	4	3	**58**	**69**	**84.06**
	Total	**59**	**80**	**87**	**128**	**78**	**68**	**449**	**Overall accuracy %89.8**
	Product Accuracy	**94.9**	**88.75**	**88.5**	**92.97**	**87.2**	**85.3**		

Table (7) Error matrix for Spring season, 2022

	Reference Data								
Classified Data	**Class**	**Water**	**Agricultural land**	**Mixed Land**	**Barren land**	**Urban Land**	**salinized land**	**Total**	**User Accuracy%**
	Water	**66**	1	0	0	0	1	**68**	**97.06**
	Agricultural land	1	**79**	4	3	3	4	**94**	**84.04**
	Mixed Land	0	2	**84**	2	1	4	**93**	**90.32**
	Urban Land	1	5	3	**97**	1	2	**109**	**88.99**
	Barren land	0	3	3	3	**56**	1	**66**	**84.85**
	salinized land	1	3	1	3	3	**59**	**70**	**84.29**
	Total	**69**	**93**	**95**	**108**	**64**	**71**	**441**	**Overall accuracy 88.2%**
	Product Accuracy	**95.7**	**84.95**	**88.4**	**89.81**	**87.5**	**83.1**		

Table (8) Error matrix for Autumn season, 2022

	Reference Data								
	Class	**Water**	**Agricultural land**	**Mixed Land**	**Barren land**	**Urban Land**	**salinized land**	**Total**	**User Accuracy%**
Classified Data	**Water**	**46**	0	1	0	0	0	**47**	**97.87**
	Agricultural land	1	**65**	2	2	3	3	**76**	**85.53**
	Mixed Land	1	4	**86**	2	2	2	**97**	**88.66**
	Urban Land	0	2	2	**121**	3	3	**131**	**92.37**
	Barren land	0	5	4	4	**47**	2	**62**	**75.81**
	salinized land	0	1	3	3	5	**75**	**87**	**86.21**
	Total	**48**	**77**	**98**	**132**	**60**	**85**	**440**	**Overall accuracy 88%**
	Product Accuracy	**95.8**	**84.42**	**87.8**	**91.67**	**78.3**	**88.2**		

Table (9) Overall accuracy and Kappa coefficient of the land cover classification maps

Year	Classified Image	Overall accuracy%	kappa coefficient
2016	**Spring Season, 2016**	**85.2**	0.8
	Autumn Season, 2016	**89.8**	0.86
2022	**Spring Season, 2022**	**88.2**	0.84
	Autumn Season, 2022	**88**	0.84

6- Conclusions and Recommendations:

1. Sentinel 2 satellite images with a spatial resolution of 10 meters can be considered an important source and integrated record that can be used in preparing land cover maps and monitoring the most important changes that can occur.
2. The integration between remote sensing data and geographic information systems can be considered one of the most important techniques that can save effort and time in building or preparing land cover maps. Hence its use in urban planning and sustainable development.
3. The manner of the spatial distribution of the land cover classes during the years 2016 and 2022 is almost identical in terms of an increase in the area of vegetation and water cover during the spring season, and a decrease during the autumn season. In contrast to both the barren lands and the salty lands, which decrease during the spring and increase during the autumn season.
4. The overall accuracy and the Kappa coefficient of land cover classification map are considered good and acceptable values. One of the most important reasons for the convergence of the overall accuracy values and the Kappa coefficient for all land cover classification maps is the similarity in the spatial, spectral, or radiometric characteristics of the Sentinel 2 satellite images that used in this study.

References

1. Navalgund, R. R., Jayaraman, V., & Roy, P. S. (2007). Remote sensing applications: An overview. current science, 1747-1766.
2. Manakos, Ioannis; Braun, Matthias. Land use and land cover mapping in Europe. Springer London, 2014.
3. Di Gregorio, A.; Jaffrain, Gabriel; Weber, J. L. Land cover classification for ecosystem accounting. London, UK, 2011.
4. Turner, B. L. Toward integrated land-change science: Advances in 1.5 decades of sustained international research on land-use and land-cover change. In: Challenges of a Changing Earth: Proceedings of the Global Change Open Science Conference, Amsterdam, The Netherlands, 10–13 July 2001. Springer Berlin Heidelberg, 2002. p. 21-26.
5. Petrescu, R., Șmuleac, A. (2019). Topographic lifting of a sewerage network in Santamaria Orlea commune, Hunedoara county. Research Journal of Agricultural Science, 51(4).
6. AlMusawi, H. M. A., & Mohsen, H. N. (2022). Study of the relationship between NDVI and LST for four months in 2021. NeuroQuantology, 20(6), 2190-2195.
7. Herbei, M.V., Sala, F. (2015). Use Landsat image to evaluate vegetation stage in sunflower crops. AgroLife Scientific Journal 4(1), pp. 79-86.
8. Aboud, J. A. & Ali, H. M. (2023). Monitoring and Detecting Land Cover Changes for Selected Areas of Al-Diwaniyah Governorate Using Remote Sensing Techniques and Geographic Information Systems. Journal of Biomechanical Science and Engineering, March 2023 – Special Issue II.
9. Saleh, N. (2000). Informatics in Agricultural Applications, General Organization of Remote Sensing, Damascus, Syria.
10. Shoko, C., Mutanga, O. (2017). Examining the strength of the newly launched Sentinel 2 MSI sensor in detecting and discriminating subtle differences between C3 and C4 grass species. ISPRS Journal of Photogrammetry and Remote Sensing 129(2017), pp. 32-40.
11. Anderson, J. R. (1976). A land use and land cover classification system for use with remote sensor data (Vol. 964). US Government Printing Office.
12. Sahar, A. A., Alhadithi, A. A., Hassan, M. A., & Jasim, A. A. (2021). Integrated remote sensing and GIS for developed new spectral index for estimating Sandy land and its potential hazards. Case study: north-east Al-Muthanna Province area, south of Iraq. Arabian Journal of Geosciences, 14(3), 1-11.
13. Anderson, G. L., Hanson, J. D., & Haas, R. H. (1993). Evaluating Landsat Thematic Mapper derived vegetation indices for estimating above-ground biomass on semiarid rangelands. Remote sensing of environment, 45(2), 165-175.

