DETECTION LAND COVER CHANGES OF THE BAQUBA CITY FOR THE PERIOD 2014-2019 USING SPECTRAL INDICES

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ABSTRACT

This study was conducted on the Land coverings of the city of Baquba and its outskirts in Diyala province, central Iraq, between latitudes 44º 42′ 31.78″ – 44º33′ 14.99″ and 33º41′ 46.66″ – 33º 48′ 23.18″ an area of 180,835 km^2. In order to classify the earth covers, it was relied on the field survey to determine the grounding points. Also used two satellite data from Landsat 8, the first one on 23/3/2014, the second on 21/3/2019, and the production of Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI) and Normalized Differences Built- up the Index (NDBI) maps. The results of the survey was showed five varieties are vegetation cover, agricultural land, water, buildings and barren land. They were identified and compared with the 75 land control points, The accuracy of the classification was calculated using Kappa It was 89% , and purely concluded that the use of manuals NDVI, NDWI and NDBI was useful for classifying Land coverings and detecting changes as they are considered an easy and fast method.

Key words: vegetation index, NDVI, NDWI, NDBI. remote sensing

كشف التغيرات في الغطاء الأرضي لمدينة بعقوبة للفترة 2014–2019 باستعمال المؤشرات الطيفية

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المستخلص

أجريت هذه الدراسة على الأغطية الأرضية لمدينة بعقوبة واطرافها في محافظة ديالى وسط العراق والواقعة بين خطي طول ″14.99 ′33 º44 - ″31.78 ′ 42 º44 ، ودائرتي عرض ″46.66 ′41º33 - ″23.18 ′48 º33 ، وبمساحة مقداره 180,835 كم2. ولغرض تصنيف الأغطية الارضية ، تم الاعتماد على المسح الحقلي لتحديد نقاط ضبط ارضية ، وكذلك باستعمال بيانين فضائيين للقمر الصناعي Landsat 8 الاولى ملتقطة بتاريخ 2014/3/23 والثانية ملتقطة بتاريخ 2019/3/21 ومن خلال انتاج خرائط دليل الاختلاف الخضري الطبيعي(NDVI)، دليل اختلاف الماء الطبيعي (NDWI) و دليل اختلاف المباني الطبيعي (NDBI) وتصنيفه من البيان الفضائي ومقارنته مع خارطة التصنيف الموجه للبيان الفضائي ولفترتي الدراسة ،اظهرت نتيجة التصنيف الحصول على خمسة أصناف هي غطاء نباتي،أراضي زراعية ، مياه، أبنية وأراضي جرداء.وتم التعرف عليها ومقارنتها مع نقاط الضبط الارضي والبالغ عددها 75 نقطة، حسبت دقة التصنيف باستعمال المقياس الإحصائي Kappa فكانت 89%, وتوصل البحث الى ان استعمال الادلة NDVI ، NDWI و NDBI كان مفيدا لتصنيف الأغطية الارضية وكشف التغير فيها إذ تعتبر طريقة سهلة وسريعة .

كلمات المفتاحية :دليل الغطاء النباتي، NDVI، NDWI، NDBI، التحسس النائي .

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INTRODUCTION

The use of remote sensing techniques in the classification and detection of change in Earth-based, coatings on electromagnetic radiation through satellite images is very effective for obtaining a better understanding of the Earth's environment (18, 26). Remote sensing data is one of the most important sources of available ground information, allow systematic and cost-effective monitoring, and monitoring of the Earth and its resources, comparisons among different time periods and the production of maps. (1, 12). Changes in natural resources as shown in land cover and land-use change (LCLUC) are one of the most important components of global environmental change (20, 27). Rapid growth in population and industrialization has led to increased exploitation of natural resources to meet the basic human societal needs (17), which requires continued monitoring and development of their management and investment programs through remote sensing sensors and geographic information systems. (21). Spectral indics were obtained from satellite images is a very simple and effective algorithm for quantitative and qualitative assessment of earth cover (6). In a study of the researcher Daniela et al. (4) using spectral indics, especially the NDVI (Normalized Difference Vegetation Index) and the NDWI(Normalized Difference Water Index) in detecting change in the earth cover in Donana, Spain for the years 2009-2010. The study found that the use of spectral indics was good Detection of change of ground cover for the study area. Kusay and Muntaha (8) found that the best indics for land degradation was the indics of modified soil cover (MSAVI) as well as (NDVI), which showed the largest percentage change at area (Husseini) irrigation project at Karbala governorate between 1989 and 2011. The researcher Manikandan (11) Use the Water Ratio Index (WRI), (NDWI) and Modified Normalized Difference Water Index (MNDWI), along supervised classification. The study was showed that the lakes of Chelekleka in India had a decrease of 1.309 km2 by 79% between 2000-2017 and NDWI was the best guide for quantitative expression Change. Either Taghreed (24) has used indics Difference Vegetation-Index (DVI), Perpendicular Vegetation Index (PVI) and Weighted Difference Vegetation Index (WDI) for detection and control of vegetation cover between 2001-2002 at Al Fit'ha north of Salah al-Din Governorate. The researcher found that the indics is better than the other indics used in the study. The objective of this study was to adopt the modern scientific methods based on the required software in the preparation of the required information to classify the Land coverings and detect the change in these covers at the city of Baquba in a sophisticated scientific method by creating land classification maps and showing the various practical applications of remote sensing and geographic information systems.

MATERIALS AND METHODS

Study area

The study area was determined by field visits using the Global Positioning System (GPS).. In addition to using Google Earth, The administrative boundaries of Diyala Governorate are limited to 44º 42′ 31.78″ – 44º33′ 14.99″ and 33º41′ 46.66″ – 33º 48′ 23.18″ an area of 180,835 km^2.

Satellite image

In this study, two satellite images were used for the satellite Landsat 8, the OLI_TIRS sensor (Path 168 and Row 37), the first was taken on 23/3/2014 and the second was taken on 21/3/2019 as in Figure 1.

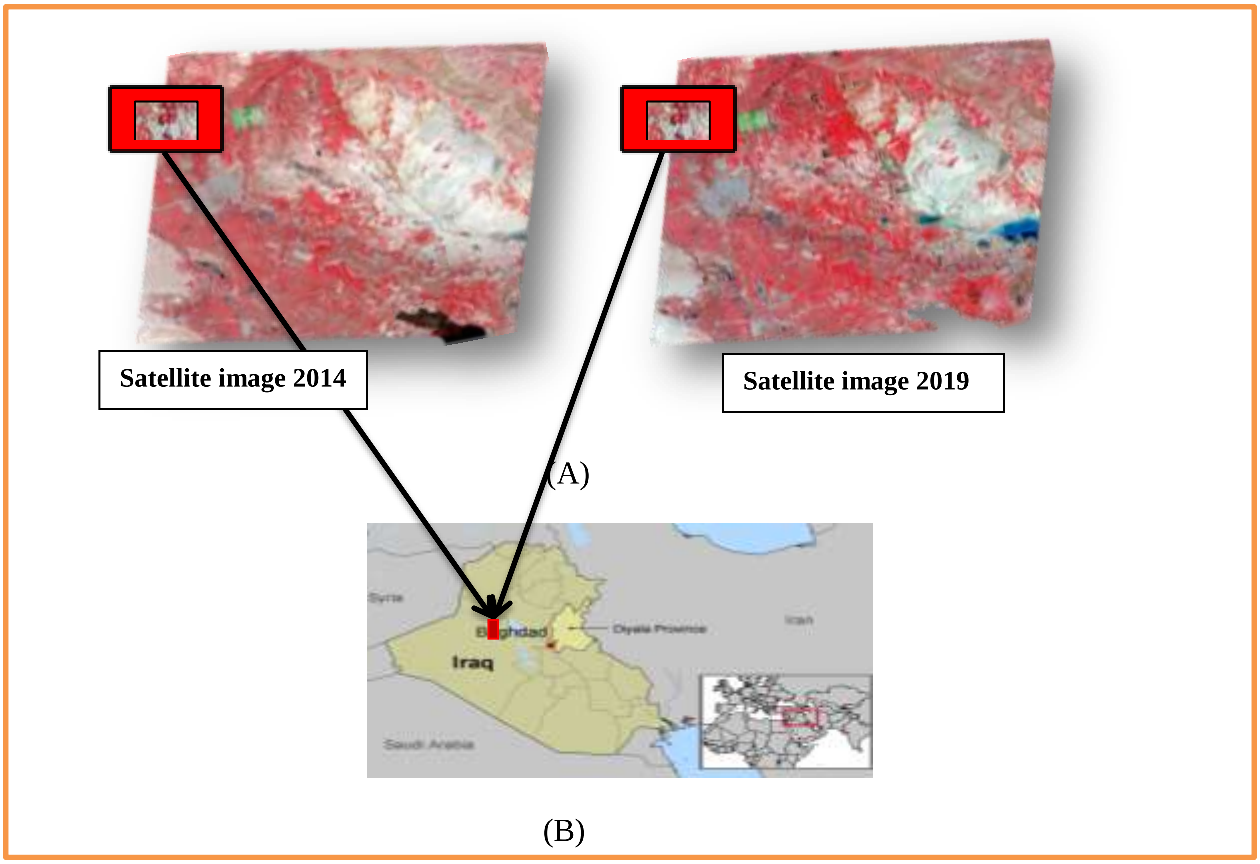


Figure 1. The area of study in Baquba is part of the satellite's Landsa(2014), Landsat 8 (2019)(A) and Diyala province (B).

Processing of satellite images

In order to obtain a spatial resolution of 15m, Landsat 8 was integrated or collected by using the Erdas Imagine V. 14 program. After that, the study area was cut. Using ArcMap 10.3.1, as in Figure 2.

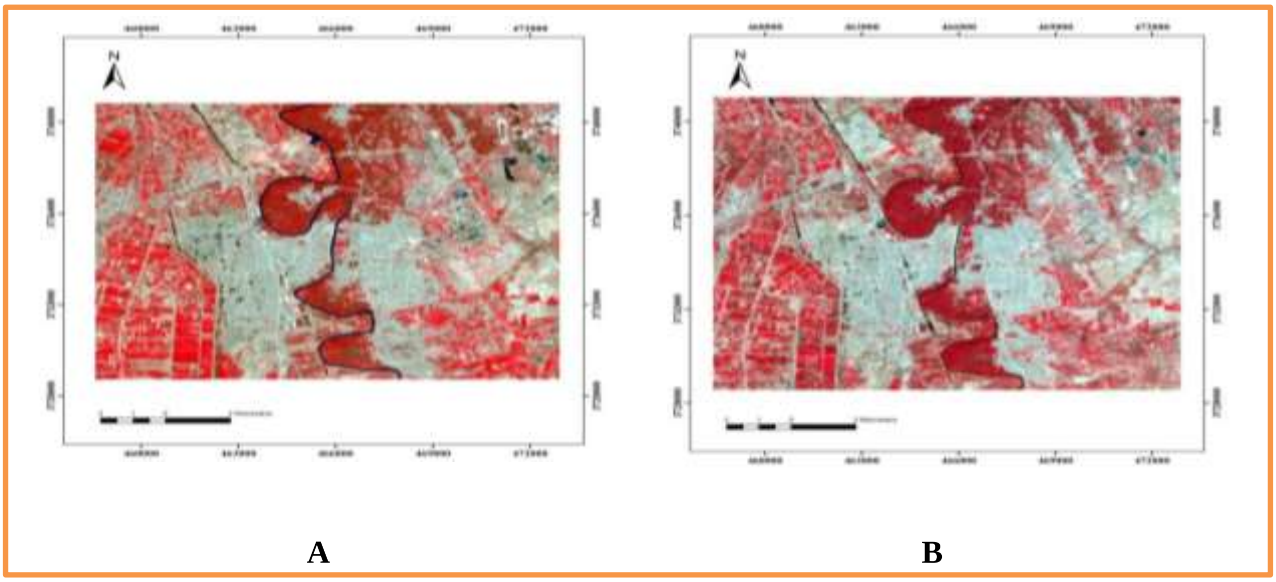


Figure 2. The studied area in Baquba is part of the satellite A (Landsat 8 2014) and B (Landsat 8 2019).

Spectral indics used in the study

Normalized Difference Vegetation Index (NDVI): It is one of the most well-known spectral and plant indics used in the study of vegetation. It has been used extensively in the study of temporal and spatial dynamics of vegetation cover (14). The NDVI index is based on the spectral characteristics of vegetation, compared to vegetation-free areas. The red colo absorbs heavily and reflects the nearby infrared radiation. This occurs by the chlorophyll found in the green leaves. Therefore, areas with dense vegetation cover their spectral properties in the infrared and infrared ranges, Areas with less dense or plant-free vegetation (7). The NDVI index is calculated based on the difference in the amount of reflected radiation in the nearby red and infrared channels divided by the sum of the reflection in the two channels. The value of the NDVI index is between (-1 and + 1), the value of which is close to 1 (0.8-0.3) when there is dense vegetation, about 0.1 in the case of bare soil, and (0.2 – 0.3) with shrubs and grasses. The negative values of the guide are recorded in the case of clouds and snow-capped areas (5, 16). Its equivalent (22):

$$NDVI = (\mathbf{NIR}) - \boldsymbol{Band}(\boldsymbol{Red}) \; / \; \mathbf{Band}(\mathbf{NIR}) + \boldsymbol{Band}(\boldsymbol{Red}) \ldots\ldots. 1$$

As:

NIR = Near Infrared rays .

RED = red rays

Using Erdas Imagine V.14 and ArcMap 10.3.1, the NDVI map of the study area and for the 2014 and 2019 periods, as shown in Figure 3**.**

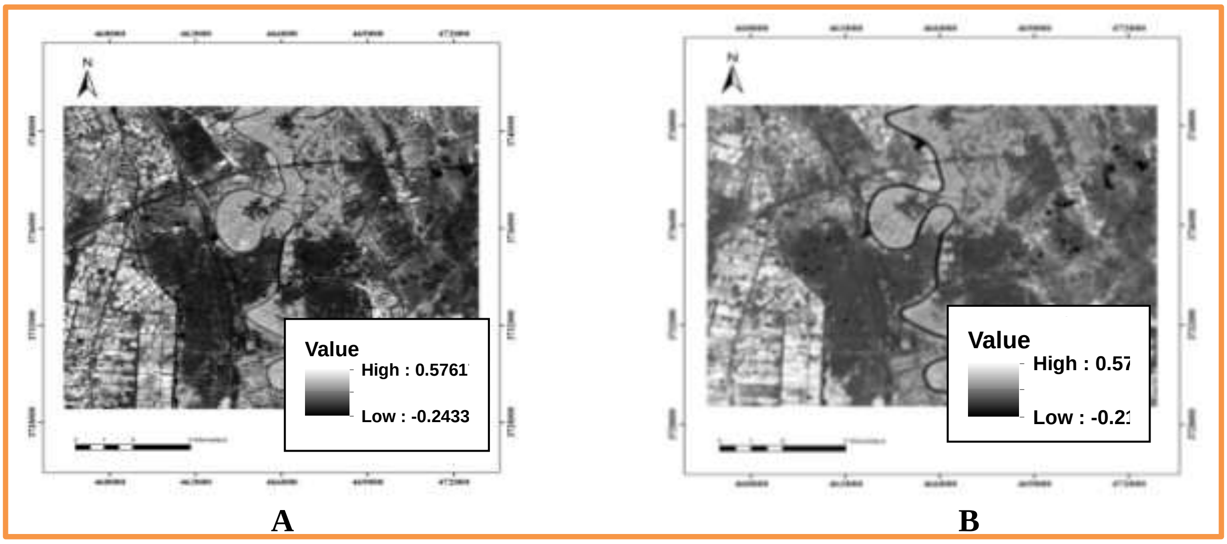


Figure 3. NDVI map of the study area and for the two periods 2014 (A) and 2019 (B)

Using Erdas Imagine 2014 and ArcMap 10.3.1. Based on the NDVI map, we conducted the classification process and obtained 5 main categories: buildings (buildings, residential buildings and roads), water, barren land, vegetation cover, and agricultural land, as shown in Figure 4.

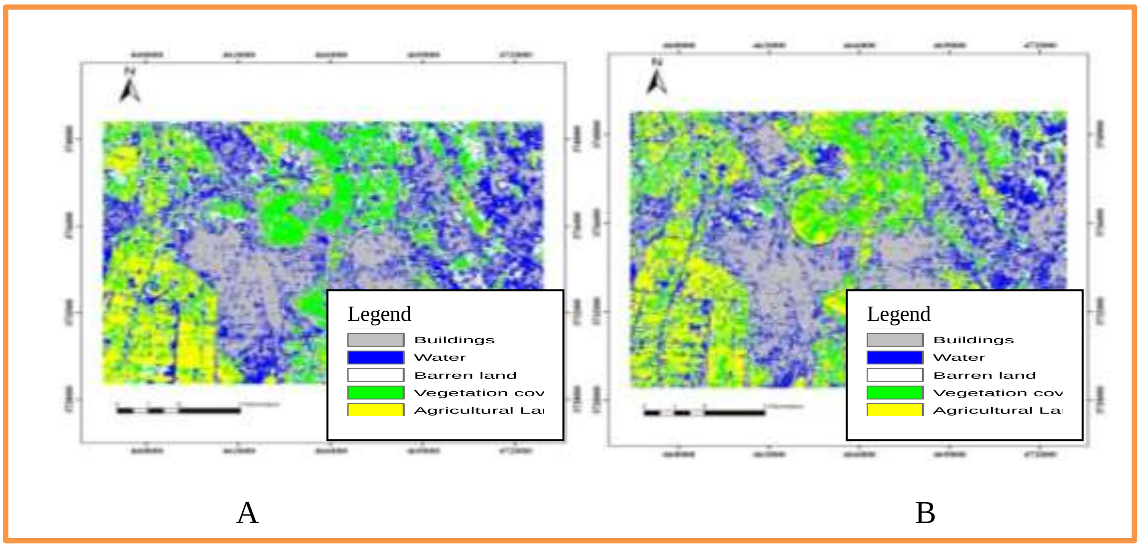


Figure 4. NDVI map of the study area and for the two periods 2014 (A) and 2019 (B)

Normalized Differences Water Index

The NDWI was determined using the same NDVI principle as the spectral reflectivity of the water is high in the range of the green wave length (0.52-0.60) µm and very little in the near infrared wavelength (0.76-0.90) µm. The high reflectivity of the plant and the soil. The range of red wavelengths makes the NDWI values positive for the aquatic regions, so the regions appear to be bright and have positive values in NDWI when the green and built areas are dark and dark and have negative or zero values (2, 3). Equivalent (25):

$$NDWI = (GREEN) - \boldsymbol{Band}(NIR) \; / \; \mathbf{Band}(GREEN) + \boldsymbol{Band}(NIR) \ldots..2$$

Using the Erdas Imagine V.14 program and the ArcMap 10.3.1 program, the NDWI map of the study area and for the 2014 and 2019 periods was prepared as in Figure 5

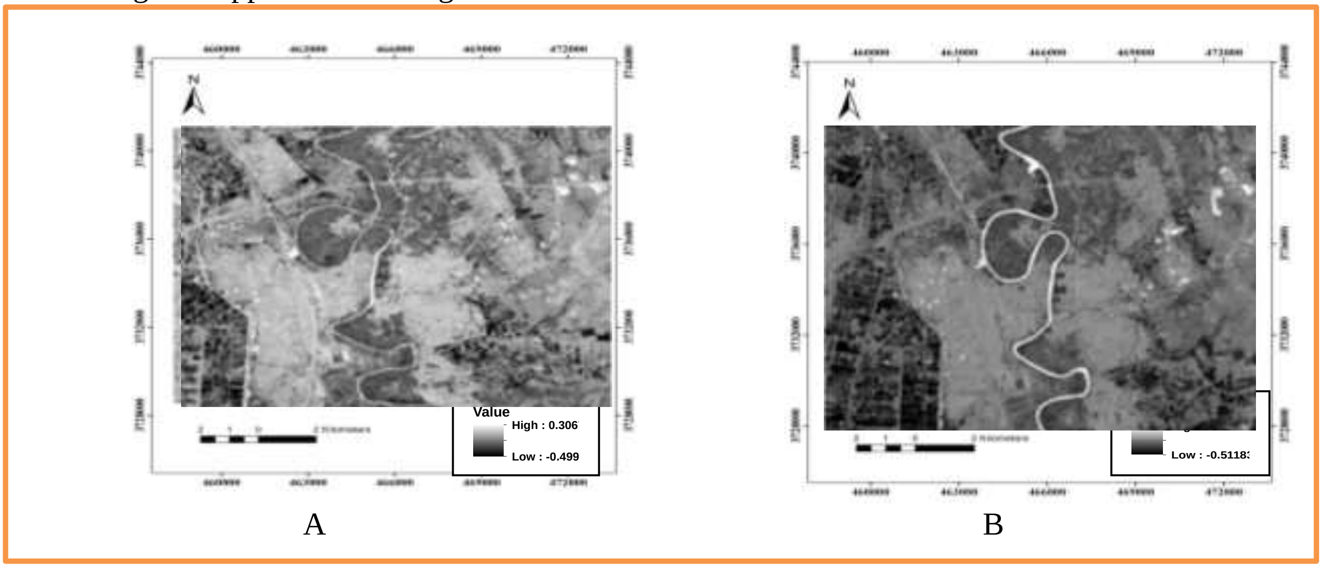


Figure 5. NDWI map of the study area and for the two periods 2014 (A) and 2019 (B).

Using Erdas Imagine 2014 and ArcMap 10.3.1. Based on the NDWI map, we conducted the classification process and obtained 5 main categories: buildings (buildings, residential buildings and roads), water, barren land, vegetation cover, and agricultural land, as reveal in Figure 6.

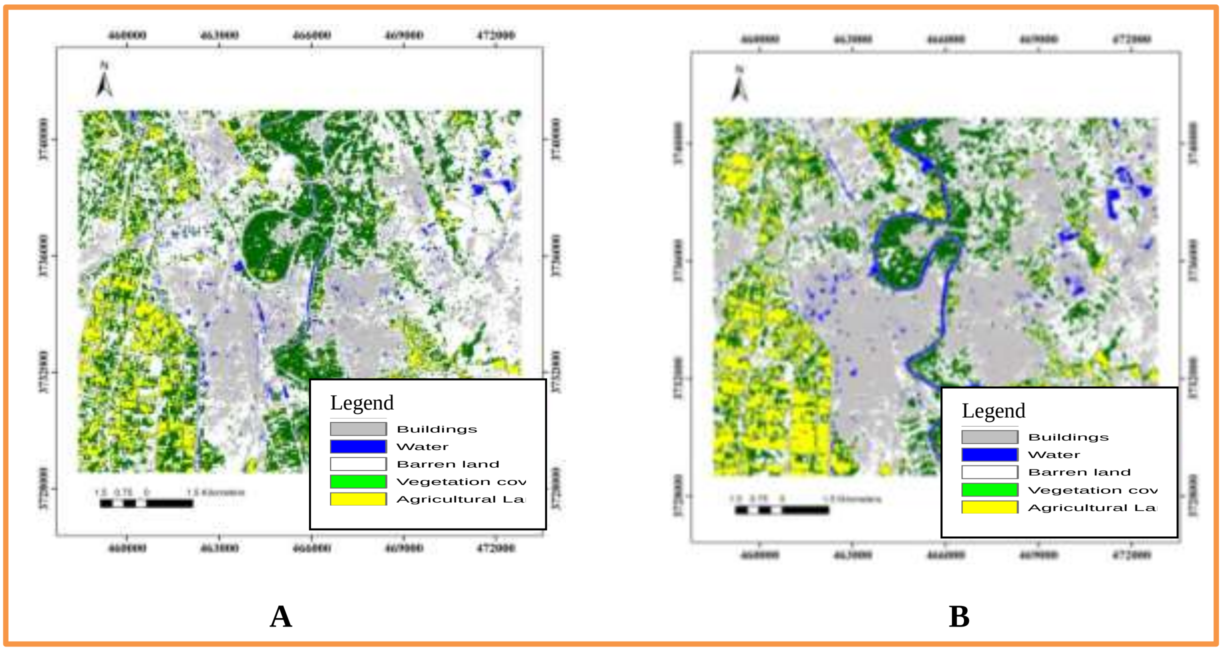


Figure 6.NDWI map of the study area and for the two periods 2014 (A) and 2019 (B).

Normalized Differences Built- up the Index(NDBI): This manual is used for urban or building-intensive urbanization (Marina and Bogdan, 2016), which represents the ratio between the spectral reflectance at the near infrared (NIR) (0.76 -0.90) and the medium infrared wavelength (MIR) (1.55-1.75) µm, and its equivalent is (19, 23):

NDBI= (MIR-NIR)/ (MIR+NIR)…..3

Using the Erdas Imagine V.14 program and the ArcMap 10.3.1 program, the NDBI map of the study area and for the periods 2014 and 2019 has been prepared and categorized as in Figs. 7 and 8.

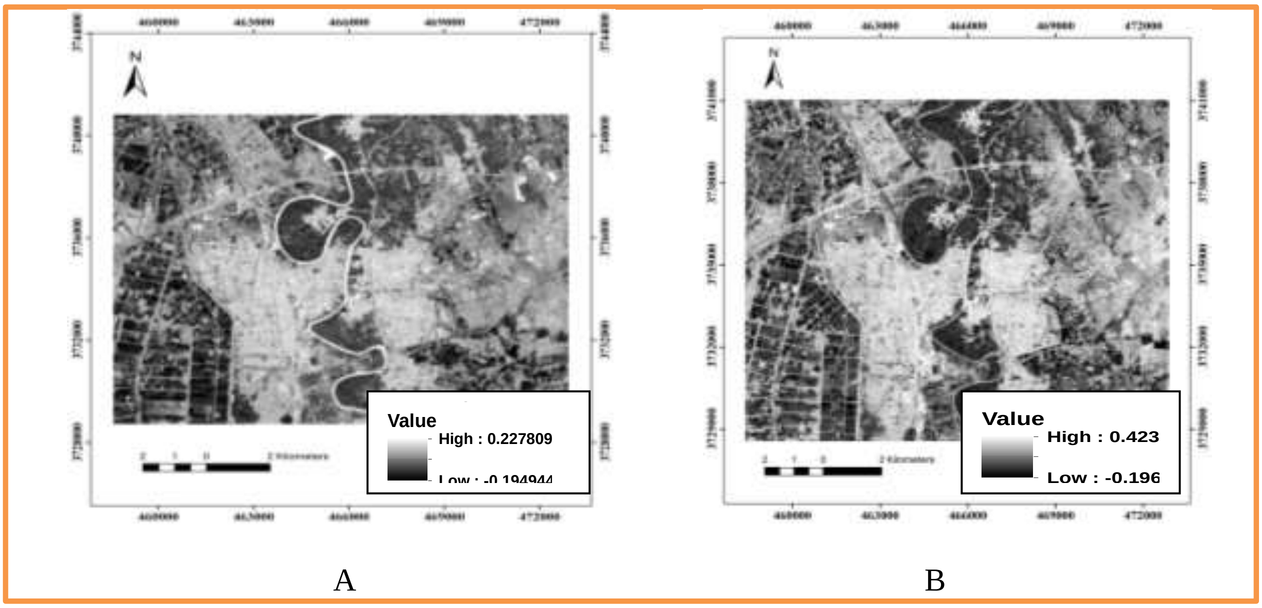


Figure 7. NDBI map of the study area and for the two periods 2014 (A) and 2019 (B).

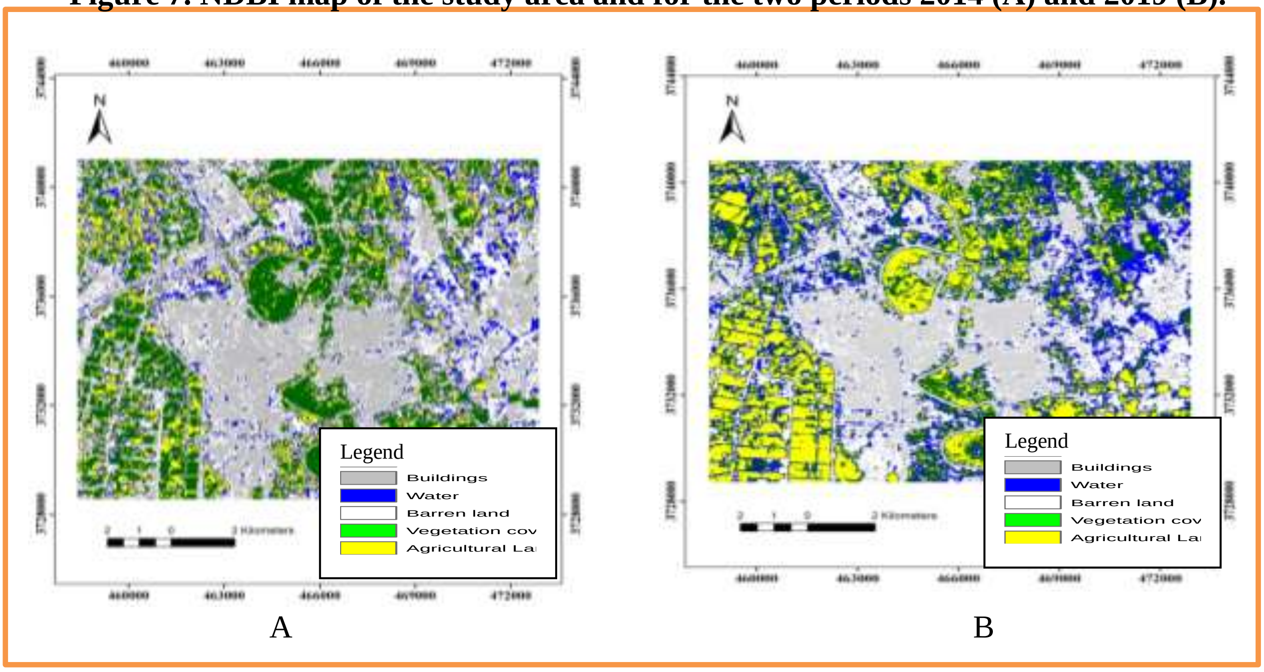


Figure 8. NDBI classified map of the study area and for the two periods 2014 (A) and 2019 (B)

RESULTS AND DISCUSSION

Normalized Difference Vegetation Index (NDVI): The values of NDVI have a range ranging from (+1 to -1). In general, the result if positive is an indication that the cell has a plant cover. The higher the resulting positive value, the greater the vegetative and density of the plant as show in Table 1 and Figure 9.

Normalized Differences Built- up the Index(NDBI): Development of the NDBI manual is based on the distinct spectral response of the built-up areas that have high reflectivity at the intermediate infrared wavelength and reflectivity Less at wavelengths Near Infrared. Therefore, when NDBI applies to satellite Image, urban or built-up areas appear to be bright white and positive digital values, while other areas appear dark with negative or zero numerical values .

Normalized Differences Water Index (NDWI)

Higher values of NDWI indicate that water is larger than other covers And are shown with positive values. Table 1 show the values of the indics used in the study and for the periods 2014 and 2019.

Table 1. Statistical values of NDVI, NDWI, NDBI indices used in the study

The Index	Maximum		Minimum		Mean		Stan. Deviation	
	2014	2019	2014	2019	2014	2019	2014	2019
NDVI	0.5729	0.5682	-0.2433	-0.2190	0.1647	0.1745	0.2370	0.2286
NDWI	0.4032	0.4143	-0.3413	-0.3629	0.03093	-0.3413	0.2162	0.2257
NDBI	0.2261	0.4211	-0.1949	-0.1966	0.0156	0.1122	0.1222	0.1793

Tables 2,3 and 4 were prepared in areas occupied by land items through the classification maps of the spectral indices used for the study and for the periods 2014 and 2019.

Table 2. Number of Pixels for the Land coverings of the study area in Baquba for each category and area and according to the categorized NDVI map.

No	Category	2014		2019		Amount of change / km^2	Percentage change %
		Number of Pixels	Area km ^{2}	Number of Pixels	Area km ^{2}		
1	Building	179128	40.304	199035	44.783	4.479	11.11
2	water	188906	42.504	168360	37.881	-4.623	10.88
3	Barren land	155384	34.961	139608	31.412	-3.550	10.15
4	Vegetation cover	173088	38.945	164103	36.923	-2.022	2.19
5	Agricultural Land	107204	24.121	132606	29.836	5.715	23.69
	Total	803712	180.835	803712	180.835	0.000	

When comparing Table 1 with Table 2, it is reval a decrease in the area of vegetation 2.022 km^2 (2.19%). This corresponds to the higher value of NDVI to 2014 of 0.5729. This value decreased in 2019 to 0.5682. The higher values of this index reflect vegetation, Or orchards, we deduce from this usefulness of the NDVI guide in controlling the change in vegetation over other species and this is consistent with the findings of many researchers (9, 15).

Table 3. Number of Pixels for the Land coverings of the study area in Baquba for each category and area and according to the categorized NDWI map

No	Category	2014		2019		Amount of change / km^2	Percentage change %
		Number of Pixels	Area km ^{2}	Number of Pixels	Area km ^{2}		
1	Building	163244	36.730	187907	42.279	5.549	15.11
2	water	123841	27.864	136209	30.647	2.783	9.98
3	Barren land	201879	45.423	177896	40.027	-5.396	11.87
4	Vegetation cover	176929	39.809	156743	35.267	-4.542	11.41
5	Agricultural Land	137817	31.009	144958	32.615	1.606	5.18
	Total	803712	180.835	803712	180.835	0.000	

Since the highest values of NDWI refer to water, Table 1 shows that the value of this guide in 2019 exceeds 0.4143 in 2014 (0.4032). When the water area is observed in 2019 (30.647 km2), it is larger than 2014 (27.864) by 2.783 km2. This indicates the importance of the NDWI in monitoring intermittent water change, as we found in our study, which is consistent with many researchers (2, 25).

Table 4. Number of Pixels for the Land coverings of the study area in Baquba for each category and area and according to the categorized NDBI map

No	Category	2014		2019		Amount of change / km²	Percentage change%
		Number of Pixels	Area km ²	Number of Pixels	Area km ²		
1	Building	156718	35.262	170219	38.299	3.013	3.037
2	water	140192	31.543	145291	32.690	1.147	3.63
3	Barren land	179070	40.291	184196	41.444	1.153	2.86
4	Vegetation cover	180458	40.603	150008	33.752	-6.851	16.87
5	Agricultural Land	147273	33.136	153996	34.649	1.513	4.56
	Total	803712	180.835	803712	180.835	0.000	

Table 1 and 4, shows an increases in the value and area of buildings respectively between 2014 and 2019. The importance of the NDBI indices in the study of change in Land coverings is indicated by many researchers (10, 19). Using Excel we were able to represent the values of the indices used in the study in the form of diagrams as reveal in Figure 9. In order to know the areas occupied by the earth cover for the study area more accurately and compare them with the maps of the spectral indices used in the study we conducted the supervised classification of the Landsat 8 satellites for the 2014 and 2019 periods and using the Erdas Imagine program. The areas of the land varieties resulting from the classification were then calculated and as in Table 5.

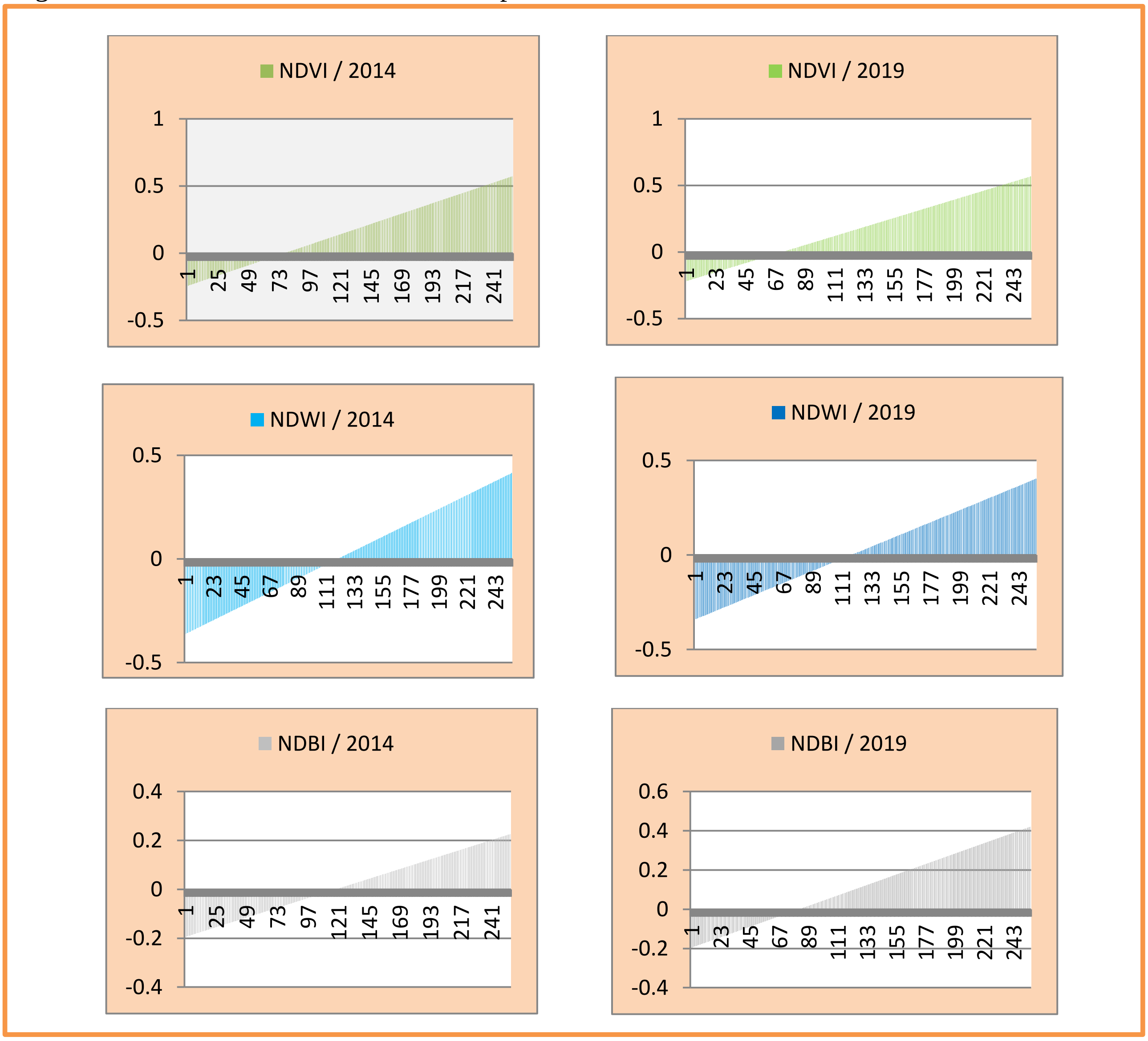
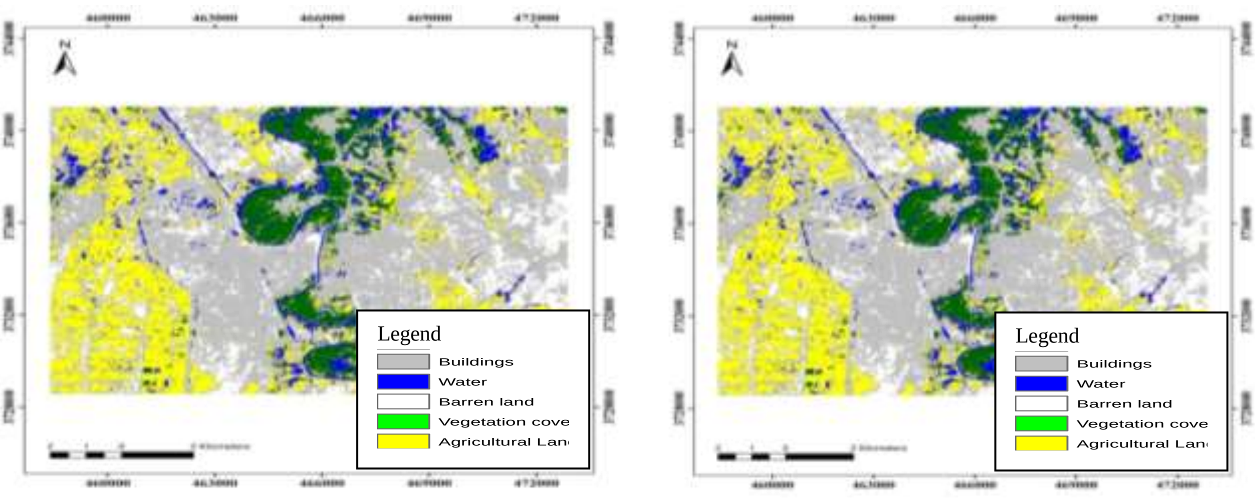


Figure 9. Diagrams of the indices used in the study and for the periods 2014 and 2019.



A B

Figure 10. satellites images classified in the study area 2014 (A) and 2019 (B)

Table 5. Number of Pixels for the Land coverings of the study area in Baquba for each category and area and according to the classification map prepared by the satellites images

No	Category	2014		2019		Amount of change / km^2	Percentage change%
		Number of Pixels	Area km ^{2}	Number of Pixels	Area km ^{2}		
1	Building	157784	35.501	169071	38.041	2.540	7.15
2	water	122995	27.674	135112	30.400	2.726	9.95
3	Barren land	212391	47.788	200121	45.027	-2.761	5.77
4	Vegetation cover	173213	38.975	160381	36.086	-2.889	7.41
5	Agricultural Land	137319	30.897	139027	31.281	0.384	1.24
	Total	803702	180.835	803712	180.835	0.000	

The results in Table 5 shows a deterioration of the vegetation cover by 2,889 km^2 and 7.41%, followed by an increase in the area of buildings, water and agricultural lands by 2.540 km^2, 2.726 km^2 and 0.384 km^2 respectively, As for the barren land, the percentage of decline was 5.77% and an area of 2.761 km^2. When comparing the classification with the classification maps of the indices used in the study, the decrease in the area of the vegetation cover, according to the classification of NDVI classified by 2.022 km^2 is an approach to the result of the supervised classification (2,889 km2), and there is an increase in the water area and according to the NDWI classification by (2.783) An approach to the area obtained from the vector classification (2.726 km^2). The NDBI map showed a decrease in the area of buildings in both cases (11).

Rating accuracy

The process of assessing the accuracy of the classification of the elements of the different satellite image particularly important in the classification of vegetation covers and land classification. Through this accuracy, we can determine the compatibility of the classification with these covers, and the possibility of relying on the map prepared and used in the future. Therefore, the stratified random sampling method was used to evaluate the classification accuracy of the vegetation cover in Baquba by taking 75 ground control points to determine this accuracy. Using Kappa to measure precision, this measure measures the degree of difference between the land-based control points taken and the changes that have been identified in the classification map of the same site and compared them (13). This is a comparative measure. Many researchers have pointed out that the value of Kappa, which is greater than 80%, is a good and appropriate classification and is recommended, whereas this value is limited to 40-80% and a medium rating of the image is shown. 40% show that this classification is poor and unreliable. The classification of 2019 was higher than the 2009 classification and was respectively (0.89, 0.88) as the overall average of the classification and this is considered good as shown in Table (6). Through this scale Kappa showed that there was a higher classification of (water, vegetation and agricultural land) for 2019 while the rest of the varieties were well classified. While the value of this measure for 2014 was also high for good by supervised classification.

Table 6. The Kappa statistical value for the classified images 2014 and 2019

No	Category	The value of kappa 2014	The value of kappa 2019
1	Building	0.85	0.86
2	water	0.88	0.90
3	Barren land	0.89	0.85
4	Vegetation cover	0.90	0.91
5	Agricultural Land	0.91	0.93
	Accuracy%	0.88	0.89

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