Habbaniyah Land Cover Change Detection Using Geoinformatics

M M Fadhil, S M AL-Juraysi*
Department of Soil and Water Sciences, College of Agriculture, University of Anbar, Anbar, Iraq

*Corresponding author's e-mail: ag.salah.murshid@uoanbar.edu.iq

Abstract: The study area was chosen within the district of Habbaniyah city with an area of 12320 hectares. In order to detect the change in the predominant ground covers and classify the soils of the study area. Using remote sensing and geographic information systems. For the Landsat 7 and 8 satellites, path 169 and Row 37, for the ETM+ sensor for the year 2007 and 2011, and for the OLI sensor for the year 2015 and 2020. All parts of the study area were covered by semi-detailed soil surveying with Free Lance method, And nine pedons were determined and determined by GPS.

The results showed that the classification of soils in the study area included two order of soils: Entisols and Aridisols. Four main classes of land cover were identified: barren land, vegetation cover, Urban Lands and water. As the area of barren lands in 2007 was 6417.5 hectares, 54.09%, accompanied by a decrease in vegetation cover during 2007, with an area of 4360.6 hectares, 35.39%. It was also noted that there was an increase in the areas of Urban Land represented by Urban sprawl, as it was during 2007 with an area of 1104.8 hectares, or 8.97% While it increased during the year 2020, reaching 1927.4 hectares, at a rate of 15.64%, and this is a serious indicator of the desertification of agricultural lands due to Urban sprawl and the transformation of agricultural lands into residential areas. Water bodies decreased during the year 2011 at a rate of 6.3 hectares / year, while the amount of the decrease during the year 2020 was about 2.3 hectares / year due to water scarcity, the construction of dams and the reduction of water flow towards Iraqi lands. It also notes a slight increase in the areas of vegetation cover during the year 2020, at a rate of 27.1 hectares / year during the year 2011. We also note an increase in Urban sprawl during the year 2020, as it was an increase of 5.7 hectares /year and on a continuous basis.

1. Introduction
The concept of land use classification is to list all types of land uses that include used and unused lands, by classifying them into categories, ranks and levels that show the prevailing types and their area. It is an important and auxiliary tool for creating a baseline database that can be referenced in the assessments of available and potential natural resources.

Change detection is defined as “the process of identifying differences in the state of an object or phenomenon by observing it at different times [1]. Change detection is important in many applications related to land use/cover changes, as change detection has been used in many studies of land degradation and desertification, [2]. and that many change detection technologies, It was developed and used to detect and map patterns and changes in land use/cover (LULC) from remote sensing data.
as it is data that has repetition and numerical format suitable for computer programs as well as its spatial accuracy.

The detection of changes in LULC in the western Nile Delta studied by using remote sensing data within four different times (1984-1999-2005-2009) and noted that there are changes from arid lands, lands Agricultural areas with a percentage change of about 28%, 14%, 9% compared to 1984 respectively. He also noted the presence of land degradation processes due to human activities represented by the increase in the areas of water bodies and marshes and the emergence of stone quarries formations [3].

In the Chongqing region of China, [4] studied by determining changes in land cover and land use through the influence of topographical factor. Satellite images of Landsat were used for the years 1993 and 2001, and the results of this study showed an increase in the proportion of urban lands at the expense of the lands allocated for agriculture.

In Mekelle region of northern Ethiopia, the periods 1984-1994, 1994-2004, and 2004-2014, the construction area increased annually by 10%, 9% and 8%, respectively, and farmland conversions, which fell by 39%. [5].

The lands of cultivated settlements, rural and barren lands, and urban construction area have expanded continuously at the expense of forest and shrub lands. During the entire study period (1957-2017) while open land, cultivated settlement and rural land increased by about 59% and 20%, respectively, forest and shrub land decreased by 59% and 57%, respectively. The urban construction area has also expanded. [6] change detection for land use is an important source of information for various decision support systems. Information from land use and land cover change detection is important for land conservation, sustainable development, and water resource management. [7] They studied some cities in India, the LULCC matrix showed that the vegetation cover, agricultural land, wetlands, and water bodies decreased the area under 23%, 7%, 6%, 1.7%, while the area under built-up lands and wastelands increased by 32.2% and 6.3% during the period from 1972 to 2016.[8].

The forest area in 2015 decreased by 7.25%, of which the area of coniferous forests decreased by 25.14%, the area of broadleaf forests increased by 12.65%, and the areas of shrubs increased by 14.62%. Using the Moon Landsat OLI images and for the period 2013 and 2015.[9].

The research aims to: Assessment of land cover change in the Habbaniyah city, east of Ramadi, during the period 2007-2020, using remote sensing data with the help of GIS and ERDAS programs. Which can contribute to providing information to decision makers, land managers and planners for sustainable development and natural resource management.

2. Materials and Methods
The study area was within the Habbaniyah city, and it is located between longitudes (43° 28 '46 "and 43° 37 12") E, and between longitude (33° 28 20 "and 33° 22 07") N, chosen in Figure (1), due to the lack in the number of quantitative and qualitative research and studies on the subject of land coverings and land use. the lack of specific taxonomic maps for it and access to classification and monitoring of the variation of the ground covers using remote sensing technologies and geographic information systems. Satellite images were obtained from the Internet and in a compressed format from the official website of the USGS Global Visualization Viewer and for path 169 and Row 37 of the Landsat 7 and 8 satellites. [10]
2.1. Field procedures.
The study area was visited several times as an initial step to observe the prevailing ground covers within the study area, as well as to note changes in the characteristics of the land/soil perspective. After that, all parts of the study area were covered with semi-detailed soil survey works by the Free Lance method, depending on the nature of the ground variations prevailing in the study area. Field examination sites were selected and (9) examination sites were selected and their locations were determined by GARMIN GPS device. Soil morphology was described according to the principles, after which samples of soil materials were obtained from each of the diagnosed horizons, and they were transferred to the laboratory for preparation and for the purpose of conducting the required analyzes. [11]

2.2. Image Preprocessing.
Four time periods were chosen to study the variations of the floor coverings (Table 1), which are:

2.2.1. A satellite image captured by the Landsat 7 satellite. The ETM sensor, for the year 2007. This image was used in the visual analysis and non-directional classification of the study area before starting the field work.

2.2.2. Satellite image captured by Landsat 7, ETM sensor for the year 2011. It was used to monitor and detect changes in the parameters of the land cover.

2.2.3. Satellite imagery captured by Landsat8, the OLI sensor for the year 2015. In monitoring and detecting the change in the parameters of the land cover

2.2.4. Satellite image captured by Landsat8, the sensor OLI for the year 2020. In monitoring and detecting the change in the parameters of the land cover.
The USGS developed one of the first land use/land cover classification systems designed specifically for use with remotely sensed imagery. The Anderson Land Use/Land Cover Classification system consists of nine land cover classes (urban, agricultural, range, forest, water, wetland, arid, tundra, perennial snow and ice), and 37 subclasses [12] Unsupervised Classification and Supervised Classification were performed and the Guassian Maximum Likelihood method was used.

Table 1. Years of taking satellite images used in the study

| No. | Y ears | satellite | Sensor type |
|-----|--------|-----------|-------------|
| 1   | 2007   | Landsat7  | ETM+        |
| 2   | 2011   | Landsat7  | ETM+        |
| 3   | 2015   | Landsat8  | OLI         |
| 4   | 2020   | Landsat8  | OLI         |

2.3. The evidence used from the spectral reflectivity

Depending on the results of classification and interpretation of space data, and after determining the types of land covers prevailing in the study area, some spectral improvements were made on the satellite images to extract some evidence related to the subject of the research. Here is a brief summary of this evidence:

2.3.1. Normalized Difference Vegetation Index (NDVI). The NDVI index is calculated based on the difference in the reflected radiation in the red and infrared channels divided by the sum of these reflections. The value of the NDVI index is between (-1 and +1), the value is close to 1 or (0.8-0.3) is dense vegetation, The negative values in the case of bare soil, Its equivalent (1)

\[
NDVI = \frac{(NIR - R)}{(NIR + R)}
\]  

Depending on the NDVI values, the vegetation cover was classified according to Table 2.

Table 2. vegetation cover density classes according to the NDVI ranges

| VEGETATION DENSITY  | NDVI      |
|---------------------|-----------|
| barren              | Negative value |
| few                 | 0.0-0.19 |
| moderate            | 0.2-0.49 |
| well density        | 0.5-0.79 |
| high density        | 0.8-1.0 |

2.3.2. Normalized Differences Water Index (NDWI). The NDWI was determined using the same NDVI principle as the spectral reflectivity of the water is high in the green band and very little in the near infrared band. Its equivalent (2)

\[
NDWI = \frac{(G - NIR)}{(G + NIR)}
\]

2.3.3. Normalized Differences Built-up Index (NDBI): It represents the ratio between the spectral reflectance at the near infrared (NIR) and the medium infrared wavelength (MIR) [13] Its equivalent (3)

\[
NDBI = \frac{(MIR-NIR)}{(MIR+NIR)}
\]

As:

G= the Green wave length (0.52-0.60) μm
R = the Red wave length (0.60-0.70) μm
NIR = the Near Infrared wavelength (0.76-0.90) μm
MIR = Medium infrared wavelength (1.55-1.75) μm

3. Results and discussion

3.1. Soil classification

The soils of the region were classified according to the modern American classification [14] within formed soils and undeveloped Entisols. As for the level below the rank, it was Fluvents, as it was formed from the sediments of the Euphrates River. These soils fall within the Great Group Torrifluvents as they are from river sediments within a hot and dry climate and under the Great Typic Torrifluvents group. As for the dry soils, Aridisols, where an accumulation of gypsum appeared in the pydon (p7), forming the gypsum horizon. It contained one series of soils 122XKW, which belonged to the suborder of gypsids because it contained a gypsum horizon within the first meter, and included under the great group Typic Haplogypsids. It is a member of the family: Sandy loame, Mixed, Superactive, Hyperthermic, TypicHaplogypsids.

| order | Family | pedons | Iraqi system |
|-------|--------|--------|--------------|
|       |        | TM1167 | Entisols     |
|       |        | MP4    |              |
|       |        | TW366  |              |
|       |        | DM55   |              |
|       |        | DW97   |              |
|       |        | DM97   |              |
|       |        | MM5    |              |
|        | Fine loamy, Mixed, Superactive, Hyperthermic, Typic Torrifluvents | P1 |
|        | Fine silty, Mixed, Superactive, Hyperthermic, Typic Torrifluvents | P2 |
|        | Coarse loamy, Mixed, Superactive, Hyperthermic, Typic Torrifluvents | P3 |
|        | Sandy loame, Mixed, Superactive, Hyperthermic, Typic Haplogypsids | P7 |

3.2. Detection of the change and the relative extension

It is noticed from Table (4) and Figures (2), (3), (4) and (5) that there is a discrepancy in the areas of the floor coverings during the years of the study as well as their relative extension, as it is noted that there are four main types of floor coverings, as the comparison was made between the year 2007 As a basis for comparison and subsequent years. It is also noted from the same table that there is an increase in the areas of residential areas represented by Urban sprawl, as its area during 2007 was 1104.8 hectares, or 8.97 percent, while that area increased to reach 1927.4 hectares, or 15.64%, and this is a serious indicator of the desertification of agricultural lands due to population encroachment and the transformation of agricultural lands into areas residential. There is also a decrease in the areas of vegetation cover during the year 2007, with an area of 4360.6 hectares, or 35.39%, and it reached its peak during the year 2011, with an area of 9081.5 hectares, or 73.71%, while during the study year 2020 it was an area of 7556.8 hectares, or 61.33%.

It is also noted that there is a decrease in the area of water bodies and wet areas than it was in 2007, reaching 437.1 hectares, or 3.55%, while in 2020 it reached 307.3 hectares, or 2.49%, and this indicates the danger of a decrease in water sources in the study area. As for the barren lands, they varied during the study years and according to the conditions experienced by the study area, as it was higher during the year 2007 with an area of 6417. While barren lands decreased during the year 2020, reaching an area of 2528.5 hectares, or 20.52%, which indicates an improvement in conditions.
Table 4. The area (hectare) of the floor covering types in the study area

| No. | Level1          | Indices | 2007  | 2011  | 2015  | 2020  |
|-----|----------------|---------|-------|-------|-------|-------|
|     |                |         | Area  | %     | Area  | %     | Area  | %     | Area  | %     |
| 1   | Urban Land     | NDBI    | 1104.8| 8.97  | 1429.6| 11.6  | 1721.3| 13.97 | 1927.4| 15.64 |
| 2   | Agricultural   | NDVI    | 4360.6| 35.39 | 9081.5| 73.71 | 5626.7| 45.67 | 7556.8| 61.33 |
| 3   | Water          | NDWI    | 437.1 | 3.55  | 326.6 | 2.65  | 329.9 | 2.68  | 307.3 | 2.49  |
| 4   | Barren Land    | NDVI    | 6417.5| 52.09 | 1482.3| 12.03 | 4642.1| 37.68 | 2528.5| 20.52 |
|     | Total          |         | 12320 | 100   | 12320 | 100   | 12320 | 100   | 12320 | 100   |

3.3. The temporal variation and the rate of change

Table (5) and (6) show the amount of temporal variation between years of study and the percentage of change and output through the difference between the following year and the base year for comparison 2007. It is noted that there is a noticeable increase in residential areas, as they increased during the year 2020 to reach 822.6 hectares, an increase of 74.5% than it was during the year 2007 and this is a serious indication of the presence of Urban sprawl. With an increase in the area of vegetation cover with an area of 3196.2 hectares, or 73.3%. It is also noted that there is a decrease in the area of water bodies during the year 2020 by 129.8 hectares, or by 29.7%. It is also noted that there is a decrease in the area of barren lands by an area of 3889 by 60.6%, and the reason for this is due to the improvement of security conditions during the year 2020.

Table 5. Temporal variation (increase and decrease) of land cover in the study area

| Level1          | 2007  | 2011  | 2015  | 2020  |
|----------------|-------|-------|-------|-------|
| Urban Land      | 1104.8| 324.8 | 616.5 | 822.6 |
| Agricultural Land| 4360.6| 4720.9| 1266.1| 3196.2|
| Water           | 437.1 | -110.5| -107.2| -129.8|
| Barren Land     | 6417.5| -4935.2| -1775.4| -3889 |

Table 6. the percentage change i of land cover in the study area during the study years

| Level1          | 2007  | 2011  | 2015  | 2020  |
|----------------|-------|-------|-------|-------|
| Urban Land      | 1104.8| 29.4  | 55.8  | 74.5  |
| Agricultural Land| 4360.6| 108.3 | 29.0  | 73.3  |
| Water           | 437.1 | -25.3 | -24.5 | -29.7 |
| Barren Land     | 6417.5| -76.9 | -27.7 | -60.6 |

3.4. Rate of change

It is noted from Table (7) that the rates of change in the areas of land-covering varieties at the rate of hectares / year, as it was calculated through the difference of change between the subsequent year and the base year 2007 divided by the number of years between them. We also note that there is an increase in Urban sprawl, as it was at an increase rate of 5.7 hectares / year and on a continuous basis. It also notes a slight increase in the areas of vegetation cover during the year 2020, at a rate of 5.6 hectares / year, which is very little compared to the area of the study area. If the rate of decreasing water bodies reached, then the highest rate of change was in the year 2011, as water bodies decreased at a rate of 6.3 hectares / year, while during the year 2020 it reached about 2.3 hectares / year, and
there appears to be a continuation of decreasing water bodies due to water scarcity, the construction of
dams and the reduction of water flow towards Iraqi territory. While it reached its peak at a rate of 27.1
hectares / year during the year 2011. It is also noted that there is a decrease in barren lands, as it
reached its peak during the year 2011 at a rate of 19.2 hectares / year, while the amount of decline
during the year 2020 was relatively less by 4.7 hectares / year compared to 2007

Table 7. The rate of change in ground cover hectares/year

| Level        | 2007  | 2011  | 2015  | 2020  |
|--------------|-------|-------|-------|-------|
| Urban Land   | 1104.8| 7.3   | 7.0   | 5.7   |
| Agricultural Land | 4360.6| 27.1  | 3.6   | 5.6   |
| Water        | 437.1 | -6.3  | -3.1  | -2.3  |
| Barren Land  | 6417.5| -19.2 | -3.5  | -4.7  |

Figure 2. The spatial distribution of ground covers in the study area

Figure 3. The spatial distribution of ground coverings in the study area, 2011
Figure 4. The spatial distribution of ground covers in the study area, year 2015

Figure 5. The spatial distribution of ground covers in the study area, year 2020

4. Conclusion
This paper focuses on land cover changes in an agriculture area, Habbaniyah, Anbar, using remote sensing data and GIS technology. Our results clearly show that land cover changes were significant during the period from 2007 to 2020. There is significant expansion of built-up area. On the other hand there is decrease in agricultural area and water area.
References

[1] Singh, A 1989, Digital change detection techniques using remote sensed data. *International journal of remote sensing*, **10**(6), 989-1003.

[2] Al-Juraysi, SM and Al-Rubaye, AA 2020, Classifying the Quality of Some Desert Soils in Western Anbar Governorate. *International Journal of Agricultural and Statistical Sciences*, **16**(1): 1083-1088.

[3] Abd Elkawy, OR, Ismaail, HA and Suliman, AS 2010, Land use and land cover change detection in the western Nile delta of Egypt using remote sensing data. *Applied Geography*, **31**, 483-494.

[4] Zhao, Y, Tomita, M and Hara, K 2011, Effect of Topography on Status and Changes in Land – cover Patterns, Chongqing City. *Landscape and Ecological Engineering*, **10**, 1.

[5] Fenta, AA, Yasuda, H, Haregeweyn, N, Belay, AS, Hadush, Z, Gebremedhin, MA and Mekonnen, G 2017, The dynamics of urban expansion and land use/land cover changes using remote sensing and spatial metrics: the case of Mekelle City of northern Ethiopia. *International Journal of Remote Sensing*, **38**(14): 4107-4129.

[6] Ahera, W, Assen, M and Satyal, P 2019, Spatio-temporal land use/cover dynamics and its implication for sustainable land use in Wanka watershed, northwestern highlands of Ethiopia. *Model. Earth Syst. Environ.*, **5**, 571–581.

[7] Dires, T and T 2020, Assessing land use and land cover change detection using remote sensing in the Lake Tana Basin, Northwest Ethiopia. *Cogent Environmental Science*, **6**, 1.

[8] Das, S, Angadi, DP 2021, Land use land cover change detection and monitoring of urban growth using remote sensing and GIS techniques: a micro-level study. *Geo Journal*.

[9] Hao, S, Zhu, F and Cui, Y 2021, Land use and land cover change detection and spatial distribution on the Tibetan Plateau. *Sci Rep.*, **11**, 7531.

[10] USGS. https://www.usgs.gov/centers/eros#/Find_Data/Products_and_Data_Available/LULC.

[11] Al-Juraysi, SM and Mhede IR 2021, Proposing A Table for Weighing the Characteristics of Stratified Samples Instead of Mathematical Equations to Study Soil Characteristics Statistically. *IOP Conference Series: Earth and Environmental Science*, **761**, 1.

[12] Anderson, JR 1971, Land use classification schemes used in selected recent geographic applications of remote sensing. *Photogramm. Eng.*, **37**(4): 379-387.

[13] Marina R and Bogdan B 2016, Mapping land cover using remote sensing data and GIS techniques: A case study of prahova sub Carpathians. *Procedia Environmental Sciences*, **32**, 244-255.

[14] Soil Survey Staff 1993, Soil Survey Manual. *USDA – SCS. Agric. Hand book 18. Washington, DC: U.S. Government printing Office*. 

9