The Use of Geospatial Technologies to Monitor the Variation of LULC for the Period from 1990 to 2020 for Some Agricultural Districts of Ramadi in Anbar Governorate – Iraq

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Abstract: Geospatial technologies were used in the study of variability in LULC for four years 1990, 2000, 2010 and 2020 in 15 agricultural districts, located on the left bank of the Euphrates River, within the area bounded between the cities of Ramadi and Khalidiya in Anbar Governorate, located between longitudes 43° 36' 22" -43° 15' 22" E and 33° 31' 05" - 33° 23' 25" N, covering an area of 18,163.5 hectares. The results showed a large variation in the types of ground covers between 1990 and 2020. Albu-Farraj recorded a very large decrease in its agricultural lands with an area of 567.45 hectares, offset by an increase in the urban or built-up area of 28.84%. While it was noted that Mahoz district recorded the largest increase in the area of the barren lands type during the study period by 30.78%. And that the classification accuracy for the LULC indicator was 100% for the types of buildings and water, while it was 83% for the agricultural lands category, and barren lands ranked last, with an accuracy rate of 75%. And that the overall accuracy of the directed rating was 86.7%, while the Kappa Coefficient was 81.1% for this rating.

1. Introduction
The traditional process of mapping land cover using interpretation of aerial images and land samples is costly and relatively time-consuming, and over the past decades the development of remote sensing technology has provided a more automated and efficient method for data collection and land cover and land use management. The data derived from satellite imagery is currently effective in detecting the variability of the land cover over time, by comparing a set of temporally different visuals covering the duration of the study, using specific algorithms to detect variance [1], and that the principle detection heterogeneity through remote sensing is to identify changes in spectral fingerprints that are commensurate with the change in land use and land cover, and the change is accurately detected through GIS technology, as GIS technology has a large volume of special ability to process data [2].

Several studies have used geospatial technologies in detecting LULC heterogeneity. [3] studied the temporal variability of the areas of palm orchards in Al-Muthanna Governorate using remote sensing methods using the TM images carried on the landsat 4 and 5 and ETM+ satellites.
carried on the landsat 7. He noticed the presence of three types of vegetation, namely grasses, shrubs, and palm trees, in addition to the abandoned land.

[4] indicated that the NDVI evidence proved the possibility of determining plant varieties with high accuracy and the possibility of monitoring the state of their temporal variability, and that this evidence was accurate in the results achieved in the field of identifying and diagnosing water bodies and waterlogged lands. In a study conducted by [5] using a number of spectral indices in Spain for the years 2009-2010, it was found that the use of spectral indices, especially NDVI and NDWI index, was a good detection of land cover variance in the study area. [6] also confirmed the effectiveness of the Plant Variation Index (NDVI), the Vertical Vegetation Cover Index (PVI) and the Weighted Plant Variation Index (WDI) in detecting and controlling vegetation cover for the period between 2001-2002 in Al-Fatha area north of Salah Al-Din Governorate.

[7] analyzed the lunar visuals Landsat 5 (TM) and Landsat 8 for multiple time periods of 1993, 1998, 2003 and 2008 to predict the spatio-temporal distributions of LULC categories in the Halgurd National Park in the Kurdistan Region of Iraq, and they concluded that this region tends to be environmentally stable and homogeneous in the next six years.

As for [8], they conducted studies evaluating the spatio-temporal variations of the land cover in the areas of the Al-Ahsa Oasis in the Kingdom of Saudi Arabia during three successive phases between 1985 and 2017. They found that during the first phase, a large urban encroachment (3200 hectares) occurred on the barren lands within the old oasis, while the urban cover occupied only 590 hectares of the vegetation area in the oasis, and in the final stage it showed a rapid urban expansion by 2017, at an amount of 1270 hectares within the vegetation cover of the oasis, while there was no urban encroachment on barren lands with an area of only 1900 hectares.

[9] used geospatial technologies to monitor LULC variability in the western part of Tarim River Basin - China for the period from 1990 to 2030. The results showed that the forest, grassland, wetland and arid land cover decreased from 50.01, 13.06, 8.24 and 1.06% in 1990 to 32.03, 3.06, 6.26 and 0.97% in 2015 respectively. While agricultural land and urban land have been increased, their areas have doubled from 25.5 and 2.13% in 1990 to 53.71 and 3.86% respectively of the total area in 2015. The researcher predicted that forests and wetlands will lose more than half of their area by 2030, and land will be removed fully grassland, while urban areas will increase by 4.4% and attribute these results to population growth and the expansion of land use for agricultural purposes at the expense of grasslands.

The results of [10] study of the land degradation of the Maimouna project within the Iraqi alluvial plain in Maysan Governorate using remote sensing, showed a high deterioration of 86% of the project area compared to the moderate and non-degraded deterioration, which showed rates of 12% and 2%, respectively, and that was evident through the low density of vegetation cover and high soil salinity, leaving the land without agricultural exploitation.

[11] observed when studying the spatio-temporal dynamics of LULC and determining the suitability of land for agricultural use in Ma’an Governorate - the Hashemite Kingdom of Jordan through landsat satellite visuals for three different years 1990, 2000 and 2018 based on five criteria: Quantity Rainfall, temperature, slope percentage, soil types and water well distribution. Three main categories of LULC were identified during the three years of the study, and they indicated a decrease in forest areas by 0.26%, 0.32% and 0.31% for the three years, respectively, while residential areas increased by 0.07%, 0.13% and 0.21%, during the years. The three studies in a row. As for the suitability of the land for agricultural use, the results showed that only about 0.2% of the total area of Ma’an Governorate is highly suitable for agriculture, which depends on rain, while about 1.4% is suitable for irrigating crops. They attributed the main reason for the low levels of land suitability for agriculture to the low soil fertility and water scarcity.
Therefore, this study aims to document the variations in the land covers and land uses of some agricultural districts of the city of Ramadi in Anbar Governorate for the period from 1990 to 2020, using geospatial technologies.

2. Materials and Methods
The study area is located between the cities of Ramadi and Khalidiya within the Euphrates River valley, which lies between longitudes 43° 36' 22" - 43° 15' 22" east and latitudes 33° 31' 05" - 33° 23' 25" north. This area represents the beginning of the sedimentary plain, and includes 15 agricultural districts located on the left bank of the river as in Table (1), bounded on the north by the international highway and on the south by the Euphrates River, with a total area of 18163.5 hectares (Figure 1).

![Fig.1. The location of the study area administratively](image)

| District Name | District Area (ha.) | District Name | District Area (ha.) | District Name | District Area (ha.) |
|---------------|---------------------|---------------|---------------------|---------------|---------------------|
| Albu-Farraj   | 1760.2              | Al-Hamidhiyah | 929.3               | Al-Qertaan    | 781.4               |
| Albu-Theab    | 1455.3              | Albu-Obaid    | 1783.2              | Al-Hamamiyat  | 1701.4              |
| Al-Sahalat    | 550.6               | Abu-Alroos    | 1015.6              | Al-Ghazwan    | 1178.6              |
| Al-Jareeshiah | 1269.4              | Albu-Bali     | 345.5               | Al-Malahma    | 1853.5              |
| Al-Mooh       | 982.4               | Mahoz         | 1445.4              | Al-Namala     | 1111.7              |

The preliminary procedures included collecting the available data on the region, including satellite visuals, topographical and cadastral maps, the digital elevation model (DEM) and climatic data, as well as conducting a reconnaissance tour of the region to be used in determining the course of action.

Satellite visualizations of the study area were obtained from 1990 to 2020 for four years, the time period between one and another ten years, namely 1990, 2000, 2010 and 2020, as they were obtained from the USGS website (https://earthexplorer.usgs.gov and include lunar data). Industrial Landsat 5 TM and Landsat 8, taken during May of each academic year, according to
Path 169 and Row 37 and presented to Universal Transverse Mercator (UTM) 38 N on WGS84. All visuals are downloaded in the format GeoTIFF tagged image file, from which the study area was cropped, using ArcGIS 10.8 program, as well as DEM data from ALOS PALSAR to distinguish and identify the different physiographic units, and Table (2) shows the specifications of the visuals used in the study.

| Satellite Images No. | Date of Image | Satellite          | Resolution (m) | Bands | Thermal Band | Path/ Row |
|----------------------|---------------|--------------------|----------------|-------|--------------|-----------|
| 1                    | 15/05/1990    | Landsat-5 TM       | 30             | 7     | 6            | 169/037   |
| 2                    | 10/05/2000    | Landsat-5 TM       |                |       |              |           |
| 3                    | 06/05/2010    | Landsat-5 TM       |                |       |              |           |
| 4                    | 01/05/2020    | Landsat 8          |                |       | 8            |           |
| 5                    | 21/06/2007    | ALOS PALSAR (DEM)  | 12.5           | -     | -            | Path 586  Frame 660 |

The process of comparing satellite visuals during different time periods requires processing for these visuals, and these processes are described in (Using the USGS Landsat 8 Product) and (Landsat 7 Users Handbook). It included the registration spatial correction, then DN was converted to Radiance, and finally Radiance was converted to ToA Reflectance.

Also, the presence of atmospheric gases such as water vapor, ozone, oxygen, dispersed atmospheric dust particles, and clouds between objects on the Earth's surface and satellite sensors, caused a distortion effect on the original reflection caused by the target objects, which could cause a false signal or hide the real pixel units [12]. Therefore, in order to avoid these errors, the satellite images under study were processed to obtain more accurate results, using the Landsat Tool Box to correct damaged, unclear or exposed satellite images (lines), as this tool was downloaded from Internet website: (http://www.mediafire.com/file/0yqddp589b6nnpwjl/landsat_toolbox.tbx/file) And then linked with ArcGIS 10.8.

The classification of land uses and vegetation cover based on the system developed by [13] within the first level, where the classification techniques supervised according to the Maximum likelihood classification (MLC) algorithm were used to classify the land use categories within the study area. This MLC technology relies on the similarity of the spectral fingerprints of the target pixels with a specific category, and Training Sample models were adopted by observing ground facts, field observations and DN values (digital number) for the selected pixel for the particular LULC types. Hence, classifying the results will give different LULC categories and thus create a post-classification for each image to detect changes in LULC for each time period, make a comparison of changes between two time periods based on the pixel-based information, and calculate the differences within each category.

The Image Differencing algorithm was used to study the covariance, which includes subtracting each numeric value (DN) of the second image from that of the first image and adding a specific positive constant to avoid negative values, thus producing three levels of information: positive and negative values in the regions where variations occurred, and the zero value in the region in which no changes occurred. This algorithm can be expressed mathematically as follows:

\[ CD(i,j) = DN2(i,j) - DN1(i,j) + C \]
Where:

CD (i, j): Produced image of changes.
DN1 (i, j): First time image.
DN2 (i, j): Second time image.
C: Positive constant ranging from (0 to 255) for 8- bit image.
(i, j): Row’s and column’s number, respectively

Assessment of classification accuracy, during which the classified images were compared with another data source, such as ground truth data. The ground facts data were collected in the field, and then the Kappa Coefficient was applied for the purpose of completing the assessment. This process included creating a matrix between the variables on the space visual and ground facts according to the method [14], and then applying the following equations, respectively:

- Users Accuracy = \( \frac{\text{No. of Correctly Classified Pixels in each Category}}{\text{(The Row Total)}} \times 100 \) …..(2)
- Produced Accuracy = \( \frac{\text{No. of Correctly classified Pixels in each Category}}{\text{(The column Total)}} \times 100 \) ....(3)
- Overall accuracy = \( \frac{\text{Total Number of Correctly Classified Pixels (Diagonal)}}{\text{Total Number of Reference Pixels \times 100 \) ....(4)
- Kappa Coefficient (T) = \( \frac{(TS \times TCS) - \sum (\text{Column Total} \times \text{Row Total})}{TS^2 - \sum (\text{Column Total} - \text{Row Total})} \times 100 \) .....(5)

Where:

TS: Total Sample.
TCS: Total Corrected Sample.

The LULC classification was evaluated for one year only, 2020, by comparing it with the natural color data of the Landsat8 satellite visual and combining the bands of these visuals and displaying them in the combination RGB 4,3,2 [15].

The results were subjected to scientific interpretation and statistical comparisons, and statistical relationships were found, as required for each of the measurement cases, and the arithmetic averages were compared using the t-test and finding the coefficient of variation C.V, according to the methods mentioned in [16].

MINITAB, 1996, and SPSS programs were used to analyze correlations and extract the statistical relationship.

3. Results and Discussion
The study area is characterized by a hot, dry climate in summer and cold and rainy in winter, with a wide temperature difference between night and day, as well as winter and summer. 3) Analyzing the climatic characteristics of the study area, it is clear that the annual average of temperatures is 21.9 °C, as the temperatures begin to rise from April to September, where their rates range between 13.9-25.4 °C and temperatures rise to 31.5-34.1 °C during The months of June, July and August [17] (General Authority for Meteorology and Seismic Monitoring, 2020).
Table 3. Monthly averages of climatic elements data during the period from 1990 - 2020 for the study area*

| Months | Ave. Min. Temp. (°C) | Ave. Max. Temp. (°C) | Ave. Monthly Temp. (°C) | Ave. Relative Humidity (%) | Evap. Rate (class A pan) (mm) | Ave. monthly rainfall (mm) | Ave. monthly soil temp. (°C) at a depth of 50 cm |
|--------|----------------------|----------------------|--------------------------|----------------------------|----------------------------|---------------------------|---------------------------------|
| Jan.   | 4.1                  | 15.7                 | 8.6                      | 70.7                       | 68.9                       | 24.3                      | 3.6                             |
| Feb.   | 5.8                  | 18.7                 | 11.1                     | 59.4                       | 99.8                       | 17.1                      | 14.5                            |
| Mar.   | 10                   | 23.8                 | 15.5                     | 49.8                       | 180                        | 16.2                      | 14.7                            |
| Apr.   | 15.5                 | 30.1                 | 21.2                     | 41.4                       | 258.7                      | 15.4                      | 25.9                            |
| May    | 20.5                 | 36.7                 | 27.1                     | 31.4                       | 364.4                      | 3                         | 25.6                            |
| Jun.   | 23.8                 | 41.6                 | 31.5                     | 25.1                       | 479.6                      | 0                         | 30.8                            |
| Jul.   | 26                   | 44.3                 | 34.1                     | 24.5                       | 525                        | 0                         | 34.5                            |
| Aug.   | 25.2                 | 43.7                 | 32.7                     | 26.6                       | 475.4                      | 0                         | 35.1                            |
| Sep.   | 21.1                 | 40.1                 | 30.1                     | 32.1                       | 354.4                      | 0.1                       | 32.2                            |
| Oct.   | 16.5                 | 33.5                 | 24                       | 42                         | 232.9                      | 4.1                       | 27.4                            |
| Nov.   | 9.8                  | 23.8                 | 16.3                     | 58                         | 114.6                      | 13.3                      | 22.3                            |
| Dec.   | 5.5                  | 17.5                 | 10.3                     | 69.5                       | 75.4                       | 16.6                      | 16                              |
| Annual average | 15.3               | 30.8                 | 21.9                     | 44.2                       | 3222                       | 110.1                     | 24.4                            |

* Ramadi Weather Station (33°.27333 N - 43°.01667 E), 48m above sea level.

Rainfall in the region is characterized by fluctuation in its quantities, as its fall is limited to the fall and winter seasons and does not fall in the summer months, as the annual amount of precipitation reaches 110.1 mm. As for the data on evaporation, it indicated a high rate in the summer, with indications of an increase in the annual evaporation amount in the region, which amounted to 3,229.2 mm.

According to the map of the vegetation cover of Iraq prepared by Guest and Townsend (1966), the study area is located within the semi-desert region, and it was noted through field surveys that there are many types of natural plants within the study area, the most common natural perennial plants, the most important of which were Lagomychium factum and Alhagi mannifera. As for the other species whose presence was diagnosed in the study area, they are Imperata cylindrica, Malva barker, aeluropus crest, Carthamus tinctorius, Cressa cretica, Tamarix manifera, and Phragmites communis reed.

Agriculture in the region depends entirely on irrigation water, as the Euphrates River represents the main source of this water in addition to some underground wells. The availability of water is the main limiting factor for agricultural expansion in the region, especially during the summer. The region depends mainly on the cultivation of grains of wheat and barley, which are widely cultivated, in addition to the cultivation of vegetables, yellow corn, jet and alfalfa, but with less areas than the areas allocated for grains, especially in the summer for self-sufficiency, due to the scarcity of water.

Figure (2) shows the variation in LULC during the years 1990, 2000, 2010 and 2020, and the results of Table (4) indicate the variation in the LULC areas of the agricultural districts within the study area, as it is clear that Al-Ghazwan district had the largest area of agricultural land.
(agricultural land) in 1990, amounted to 995.13 hectares (84.43%). It was followed by Al-Namala district with an area of 938.52 hectares, while Al-Jareesheiah district had the least area of agricultural land during the same year, which amounted to 530.01 hectares. It is noticeable from the results of Table (4) for 1990 data that Al-Ghazwan district was only 0.36 hectares. Of its lands within the category of barren land (Barren land), which is the least area compared to Al-Jareesheiah district, which recorded the highest percentage of area of this type of land amounting to 51.57% of the total area of this district, and the reason for this may be attributed to the fact that the northern areas of this district are far from water sources and the salinity of its soil is high, and this is what was diagnosed in field visits.

While the results showed that Albu-Farraj district has the largest area of land in the category of buildings compared to the rest of the district under study, as it reached 331.29 hectares (18.82 percent). And that the Al-Qertaan district did not indicate any bodies of water. Whereas, Al-Ghazwan district recorded the highest water body area and constituted 2.92% of the total area of this district.

A study of visuals dating back to the year 2000 showed that Al-Namala district scored an outperformance with its agricultural land with an area of 923.85 hectares, while Al-Jareesheiah district remained registered with the least area of agricultural land with 39.93% of the total area of the district, with this district remaining Outperforming the largest area of the Barren land class by 4.51%.

In 2010, it showed an increase in the area of agricultural land in Al-Namala district to become 94.94% of the total area of the district, which is greater than what was recorded in 2000. But the dominance of agricultural land during the year 2010 was for Al-Ghazwan district with an area of 1123.29 hectares, although of decreasing areas of this variety in many other agricultural districts.
Figure 2. Temporal covariance maps of LULC taxa for study periods.
Table 4. The area of the land covers within the districts under study in hectares during the years of monitoring

| Year | LULC classes | Albu-Farraj | Albu-Theab | Al-Sahalat | Al-Jarashalat | Al-Moah | Al-Hasanly | Al-Moah | Al-Abra | Al-Bali | Makhat | Al-Moah | Al-Malahma | Al-Namala | Al-Malahma | Al-Namala |
|------|--------------|-------------|------------|------------|--------------|--------|-----------|--------|--------|--------|--------|--------|------------|-----------|------------|-----------|
|      | Agricultural land | 1296.18     | 1129.77    | 452.61     | 530.01       | 782.01 | 1878.89   | 630.36 | 288.09 | 1010.16 | 636.66 | 1299.33 | 995.13     | 1253.70    | 938.52     |
| 1990 | Barren land    | 110.43      | 131.40     | 16.29      | 654.66       | 24.66  | 196.74    | 310.50 | 2.61   | 189.54  | 36.54  | 216.81  | 0.63       | 402.93     | 15.03      |
|      | Urban or Built-up area | 331.29      | 189.99     | 78.30      | 84.15        | 53.91  | 116.10    | 73.53  | 42.39  | 234.00  | 126.00 | 183.15  | 148.68     | 178.20     | 151.83     |
| 2000 | Agricultural land | 21.51       | 4.41       | 4.68       | 0.81         | 4.50   | 6.03      | 7.56   | 1.35   | 12.06   | 11.25  | 0.00    | 1.80       | 34.47      | 6.30       |
|      | Water body     | 213.60      | 1048.77    | 419.94     | 506.88       | 634.68 | 678.51    | 1263.96| 499.23 | 252.54  | 992.52 | 121.81  | 929.52     | 1162.62    | 923.85     |
| 2010 | Agricultural land | 121.50      | 85.32      | 14.31      | 572.58       | 181.71 | 63.81     | 240.30 | 395.55 | 0.00    | 255.96 | 314.11  | 414.54     | 178.73     | 15.19      |
|      | Barren land    | 462.06      | 314.91     | 114.93     | 190.17       | 163.98 | 182.61    | 128.69 | 82.53  | 191.07  | 269.73 | 230.13  | 673.10     | 1055.21    | 21.96      |
|      | Urban or Built-up area | 338.04      | 375.57     | 27.54      | 106.65       | 204.21 | 104.94    | 199.71 | 67.59  | 49.05   | 33.03  | 42.48   | 30.60      | 178.73     | 15.19      |
| 2020 | Agricultural land | 13.14       | 13.77      | 3.96       | 7.02         | 8.28   | 6.48      | 9.81   | 4.59   | 7.92    | 0.18   | 0.89    | 14.22      | 9.36       | 3.60       |
|      | Water body     | 728.73      | 931.86     | 505.98     | 563.85       | 533.79 | 664.74    | 123.10 | 495.99 | 311.04  | 733.10 | 691.47  | 1410.84    | 1351.71    | 1055.21    |
|      | Barren land    | 251.64      | 249.30     | 14.40      | 538.38       | 235.80 | 339.66    | 447.87 | 13.77  | 599.58  | 33.94  | 241.11  | 8.37       | 450.72     | 21.96      |
|      | Urban or Built-up area | 338.04      | 375.57     | 27.54      | 106.65       | 204.21 | 104.94    | 199.71 | 67.59  | 49.05   | 33.03  | 42.48   | 30.60      | 178.73     | 15.19      |
| 2020 | Agricultural land | 33.75       | 13.05      | 13.23      | 11.07        | 12.42  | 8.91      | 18.99  | 4.41   | 14.49   | 4.23   | 1.98    | 9.54       | 32.31      | 32.58      |
|      | Water body     | 728.73      | 931.86     | 505.98     | 563.85       | 533.79 | 664.74    | 123.10 | 495.99 | 311.04  | 733.10 | 691.47  | 1410.84    | 1351.71    | 1055.21    |
| Change from 1990 - 2020 | 1224       | 8.64       | 8.55       | 10.26       | 7.92   | 2.88      | 11.43  | 3.06   | 2.43   | -7.02  | 1.98    | 7.74       | 2.16       | 13.14      | 28.62      |
It is noticeable from the results of visual pickling in 2010 that the district Al-Jareesheiah, Abu-Alroos and Al-Qertaan recorded an increase in the areas of the Barren land, as this variety constituted 42.41%, 43.98% and 41.48% of its total area, which is greater than it was previously in year 2000.

The results of Table (4) indicated that there is a fluctuation in the urban or built-up area areas in all agricultural districts, despite the increase that appeared in Albu-Theab district, by 4.17% in 2010 compared to 2000.

Satellite visual analysis for the year 2020 showed that Al-Qertaan district has the largest area of agricultural land with an amount of 649.44 hectares, but it is less than it was in 2010. Also, Al-Jareesheiah district has increased the area of this type (Agricultural land) to 47.19 This is attributed to the farmers in this district and some other districts using center pivot irrigation methods, which was confirmed by field observations during field visits. Urban or built-up area was classified as an increase of 28.46% in 2020 compared to 2010, which is an indicator that indicates the increase in housing construction or population sprawl in this district due to its proximity to the city of Ramadi, which caused the conversion of agricultural lands to this district for residential purposes.

It is observed from Figure (3) that there is significant heterogeneity between 1990 and 2020 in LULC cultivars. As Albu-Farraj district witnessed a very large decrease in its agricultural lands, with a total area of 567.45 hectares (32.24%), and this was offset by an increase in the urban or built-up area of 28.84%, which represents the largest variation in this category between 1990 and 2020. While the district Mahoz witnessed the largest increase in the area of the barren lands category between the two mentioned years, amounting to 30.78%.

Which indicates the presence of deterioration in agricultural lands and their movement towards the barren land category, and that this deterioration reflects the agricultural reality that the lands are going through within these districts, the human factors represented by the security reality faced by the region, poor land management and population increase as well as factors Natural deterioration in the quality of water quantity, lack of rain precipitation and high temperatures, all of these factors represent real challenges in the field of conservation and sustainability of agricultural lands in the region.

![Figure 3. Heterogeneity of percentages of LULC cultivars within agricultural districts between 1990 and 2020](image-url)
3.1 Verify Classification Accuracy

A Confusion Matrix was created between LULC classes, Ground Truth data, and matrix production (1), and by applying equations 2, 3, 4 and 5, the results listed in Table (5) were reached, which shows the accuracy of classifying this indicator. The classification accuracy of LULC reached 100% for the categories of buildings and water, while it was 83% for the agricultural lands category, and barren lands came last, with an accuracy rate of 75%. It is reported that 30 locations were selected within the LULC classes and then compared, and despite the low discriminatory ability of Landsat 5, 8 (30 m), the results indicated that an accuracy rate of 100%. This high percentage is due to the fact that the selected sites were far from the boundaries of the taxonomic units, which reduces the possibility of overlap with other taxonomic units, and thus the overall directed classification accuracy was obtained 86.7%, while the Kappa Coefficient was 81.1%.

Matrix (1) Relationship between LULC classes and Ground Truth

|                | Agricultural Land | Barren land | Urban or Built-up area | Water body | Total (User) |
|----------------|-------------------|-------------|------------------------|------------|--------------|
| Agricultural Land | 10                | 1           | 1                      | 0          | 12           |
| Barren land     | 2                 | 6           | 0                      | 0          | 8            |
| Urban or Built-up area | 0          | 0           | 7                      | 0          | 7            |
| Water body      | 0                 | 0           | 0                      | 3          | 3            |
| Total (Producer)| 12                | 7           | 8                      | 3          | 30           |

Table 5. LULC and Ground Truth

| LULC Classes       | % of Accuracy |
|--------------------|---------------|
| User Accuracy       |               |
| Agricultural Land  | 83.3          |
| Barren land        | 75            |
| Urban or Built-up area | 100         |
| Water body         | 100           |
| Producer Accuracy   |               |
| Agricultural Land  | 83.3          |
| Barren land        | 85.7          |
| Urban or Built-up area | 87.5        |
| Water body         | 100           |
| Overall Accuracy   | 86.7          |
| Kappa Coefficient (T) | 81.1         |
4. Conclusions
The study area included four types of LULC, which are agricultural lands, residential areas, barren lands and water bodies, with fluctuations recorded in these types during the years of the study, but the clear curve of their variation is the deterioration and transformation of agricultural lands into types of barren lands and urban sprawl. The low spatial discriminatory accuracy (30m) of the visuals used in this study had no effect on reducing the efficiency of housing units discrimination.

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