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# Role of Land Use and Change Detection Techniques in Sustainability in Kafr El Sheikh Governorate at Northern of Egypt by using Remote Sensing Data

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**ABSTRACT-** Land use/land cover (LULC) and their changes are utilized for the sustainable development policies. In this study, in Kafr El-Sheikh (KFS) governorate, northern Nile Delta, Egypt, the (LULC) changes were studied. In this research, the supervised classification and the change detection are used to discover the (LULC) changes by using the ERDAS IMAGINE software. Four satellite images are chosen to observe the settlement, vegetation, Barren and the water through the periods 2005, 2010, 2015 and 2018 using Landsat (TM and OLI). The results showed that the settlement areas registered the highest ratio through the period from 2005 to 2018 increase from 58.8% to 71.5%. Furthermore, the vegetation areas are decreased. From the analysis of the results, it is observed that that Kafr El-Sheikh governorate is obviously affected by the different classes of (LULC) cover changes due to agriculture activities, urban growth and human activities.

**Index Terms** Land use, Land cover, sustainability, Change dictation, Accuracy assessment.

## 1. INTRODUCTION

THe Changes in (LU/LC) are fundamental in the study of development and understand the interaction of the human activities against the environment.

The Nile Delta in Egypt faced urban expansion over the last years due to some reasons; one of them is the economic growth. The growth of services is less than the rate of population growth [1]. Variation in (LULC) produces the effect on the socio-economic biological, climatic and hydrological systems [2]. Remote sensing is one of the most important ways for detecting the variation in LU/LC wide geographic areas [3]. It is important to find information on what, where and when changes happen and the rates of changes [4]. The Different sensors are available as a data source for the study of (LULC) change. Much of techniques are applied in the (LULC) classification and change detection (e.g., pixel-based classification [5], object-oriented classification [6], artificial neural network classification [7], post-classification comparison change detection [8], and visual interpretation [9].

In this research, the variable techniques are used to discover the change using ERDAS IMAGINE. The used techniques were supervised classification, unsupervised classification, indices and Post-classification comparison change detection. Landsat TM images are used in 2005 and 2010. Landsat OLI image are used in 2015 and 2018 respectively to monitor changes in Kafr El-Sheikh governorate. The objective of this study is to give a rating of the land use, land cover, and predict the future situation.

## 2. STUDY AREA: Kafr El-Sheikh governorate

Kafr El-Sheikh governorate is located in the northernmost of Egypt and in the middle of Nile Delta where the Nile River spreads out and drains into the Mediterranean Sea [10]. It is located between longitudes 29° 37′ 52″ E and 32° 55′ 49″ E and latitudes 29° 37′ 49″ N and 31° 41′ 2″ N. It extends over an area about 240 $km^2$ (4167007 ha) on the Mediterranean coast [11]. The Governorate is divided into 10 centers. The main economic activity of the governorates is agriculture, fishing and industrial. It includes Burullus Lake in the central northern section of the governorate between longitudes of 30°34′ and 31°06′ E and latitude of 31°22′ and 31°34′ N.


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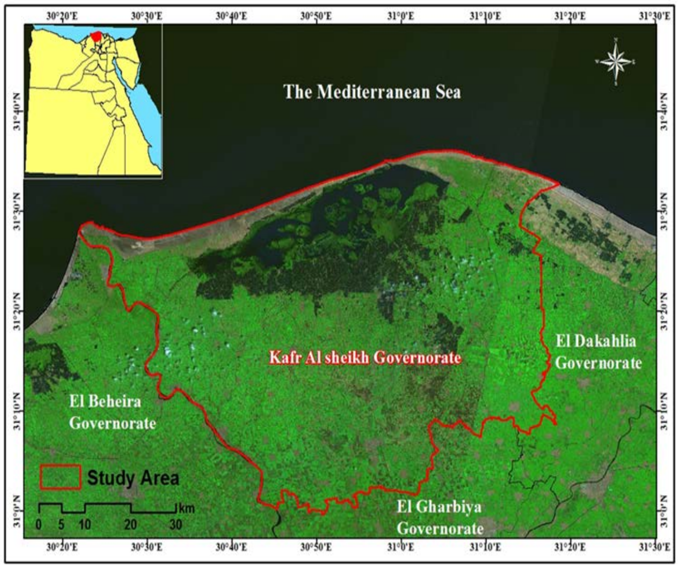



**Figure (1):** The location of KFS governorate, Egypt.

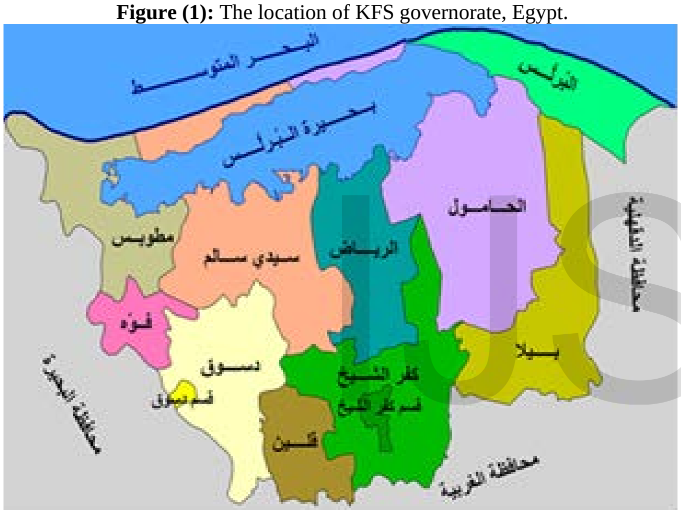
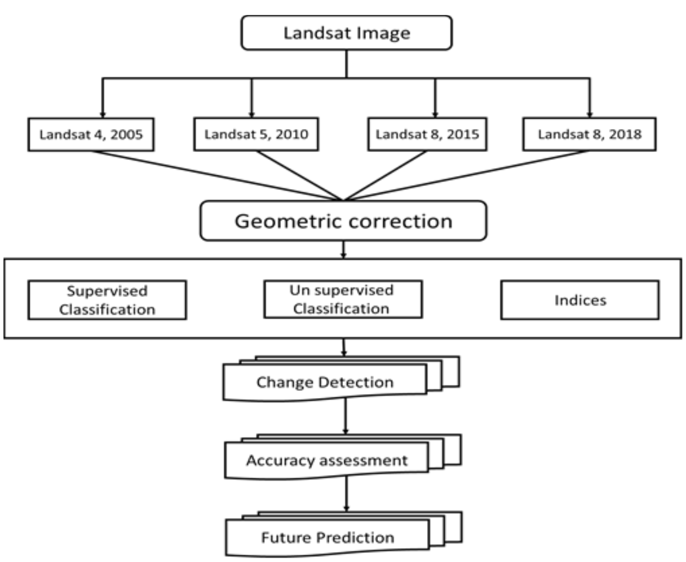



**Figure (2):** Administrative division

## 3. METHODOLOGY

### 3.1. Research workflow




### 3.2. Satellite Data

The satellite Data of the two sensors (TM, OLI) are used for the analysis. The sensor (TM) and (OLI) have a resolution of 30 m and 15m respectively. Table (1) presents the data characteristics.

**Table (1):** properties of data

| satellite | sensor | Bands | Data of Acquisition | sources |
|---|---|---|---|---|
| **Landsat -4** | TM | 7 | 21/12/1987 | USGS |
| **Landsat -5** | TM | 7 | 3/8/2000 | USGS |
| **Landsat -8** | OLI | 11 | 14/2/2017 | USGS |

The collected data are used in 2005 and 2010 from Landsat 4-5 satellite and 2015, 2018 from Landsat 8. From (USGS) Earth explorer service, we can observe any data required.

### 3.3. Classification

In this research, the various techniques are utilized for detecting the alteration in the four land cover classes such as supervised, unsupervised classification and indices. It could be concluded from the accuracy assessment analysis that land uses in the studied area were classified with high accuracy. However, the Super classification has the highest accuracy when compared with the other systems as presented in Table (2).

**Table (2):** Result of accuracy assessment for various techniques

| Face comparison | Super classification | Un super classification | indices |
|---|---|---|---|
| **User's Accuracy** | 97.06 | 83.9 | 96.49 |
| **Over all Accuracy** | 97 | 84.5 | 95.3 |
| **Kappa coefficient** | 0.9594 | 0.7937 | 0.823 |

The supervised classification is used for classify the four images of years 2005, 2010, 2015 and 2018. In to four land cover classes (settlement, vegetation, Barren and water). The areas are computed in the classified image in acres unit.

## 4. Post-classification Comparison Change Detection

It is one of the most important techniques for detecting changes. It was used for comparing the types of land cover for the two classified maps by pixels through periods (2005-2010), (2010-2015) and (2015 -2018). The produced change maps were used to check the variation in the settlement and vegetation areas in terms of increase or decrease.

## 5. Results and discussion

The percentage coverage for each of land use and land cover is one of the objectives of this research and it was done after the classification process. Figures (3) to (6) present the image classified of the area studied in years of 2005, 2010, 2015and 2018 respectively.

Data in Table (3) shows the area of the settlement were about 542125, 554571.97, 649630 and 658594 acres in 2005, 2010, 2015 and 2018, respectively and their percentages were about 58.8%, 60.2%, 70.5% and 71.5% respectively. The vegetation areas were about 247764, 232766, 208621 and 167355 acres respectively and their percentages were about 26.9, 25.2, 22.6 and 18.2% respectively. These results proved that the settlement areas in KFS governorate were increased through the period from 2005 to 2018. This could be attributed to the loss of governmental control over that period. That increase in the settlement areas was on the account of the vegetation areas, which were significantly decreased.

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**Table (3):** land cover changes for the four classes in 2005, 2010, 2015 and 2018

| Land use /cover categories | 2005 | | 2010 | | 2015 | | 2018 | |
|---|---|---|---|---|---|---|---|---|
| | Area acres | % | Area acres | % | Area acres | % | Area acres | % |
| **settlement** | 542125 | 58.8 | 554571.97 | 60.2 | 649630 | 70.5 | 658594 | 71.5 |
| **Vegetation** | 247764 | 26.9 | 232766 | 25.2 | 208621 | 22.6 | 167355 | 18.2 |
| **Barren** | 48742.5 | 5.3 | 46982.01 | 5.1 | 8557.98 | 0.9 | 5058.6 | 0.5 |
| **Water** | 82584.4 | 9 | 87515.5 | 9.5 | 55804 | 6 | 91226 | 9.8 |
| **Total** | 921215.9 | 100 | 921215.9 | 100 | 921215.9 | 100 | 921215.9 | 100 |

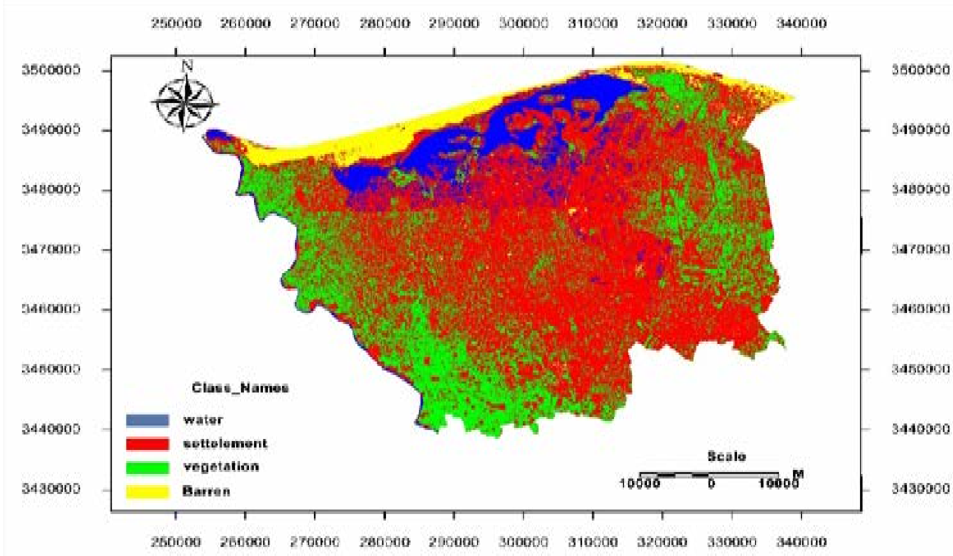


**Figure (3):** (LULC) in KFS governorate in 2005.

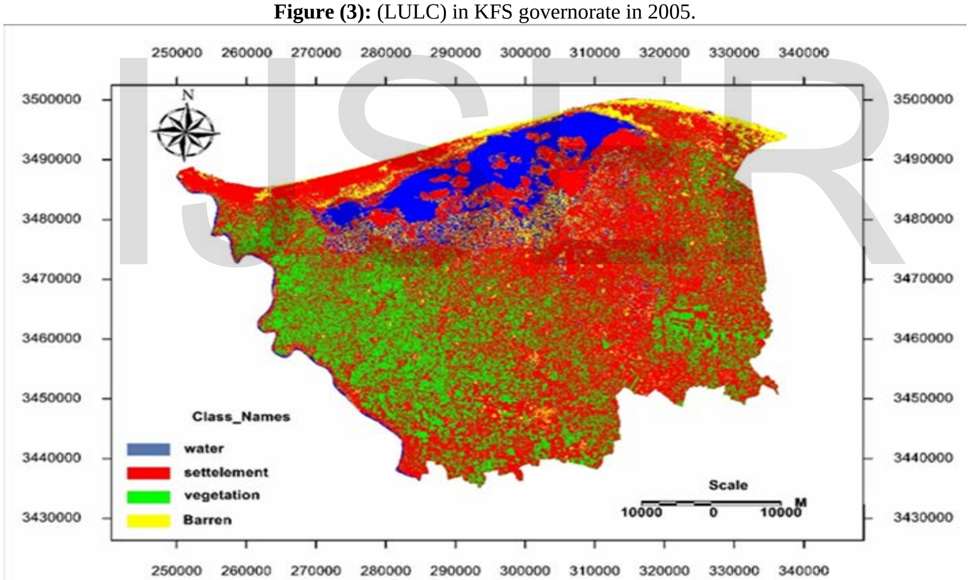


**Figure (4):** (LULC) in KFS governorate in 2010

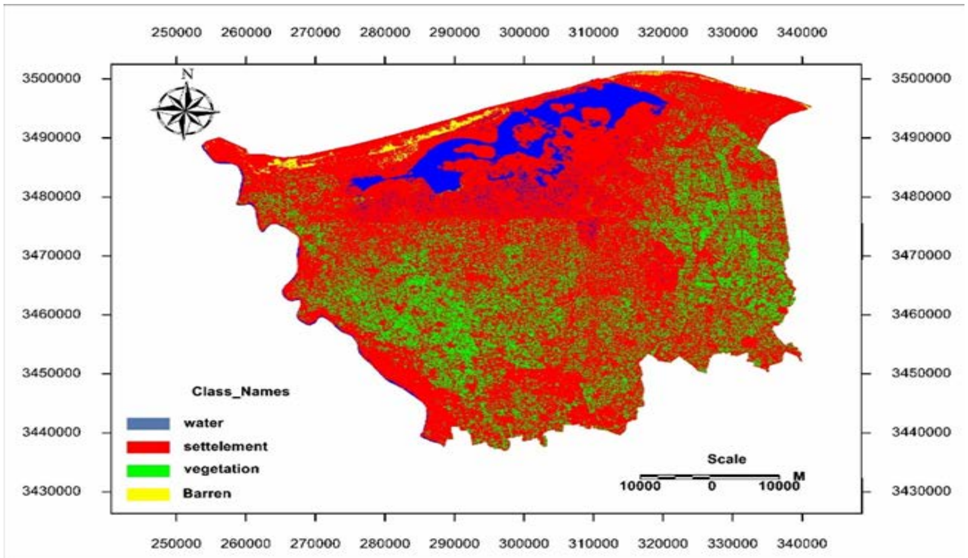


**Figure (5):** (LULC) in KFS governorate in 2015

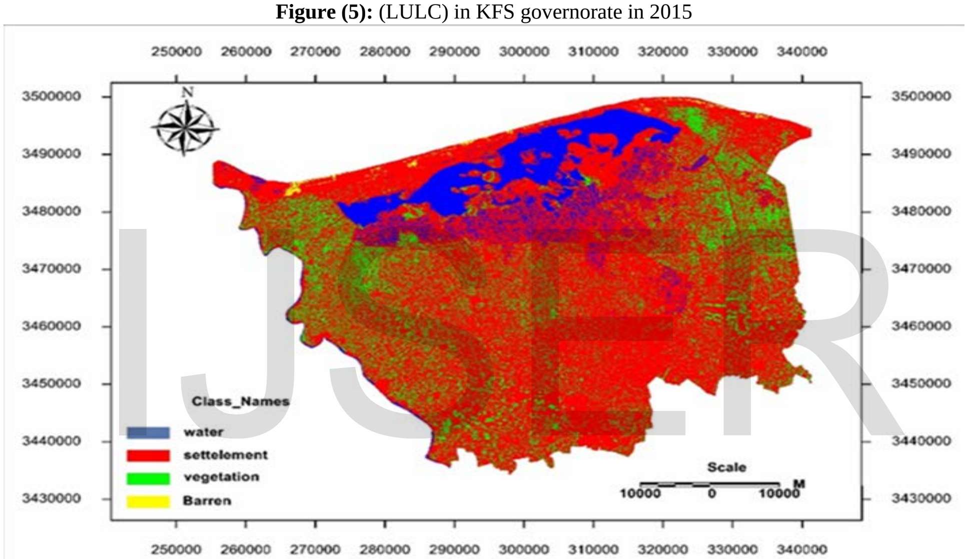


**Figure (6):** (LULC) in KFS governorate in 2018

The distribution of settlement, barren, water and the vegetation in Kafr El sheikh governorate based on supervised classification in 2005, 2010, 2015 and 2018 is represented in Figure (7).

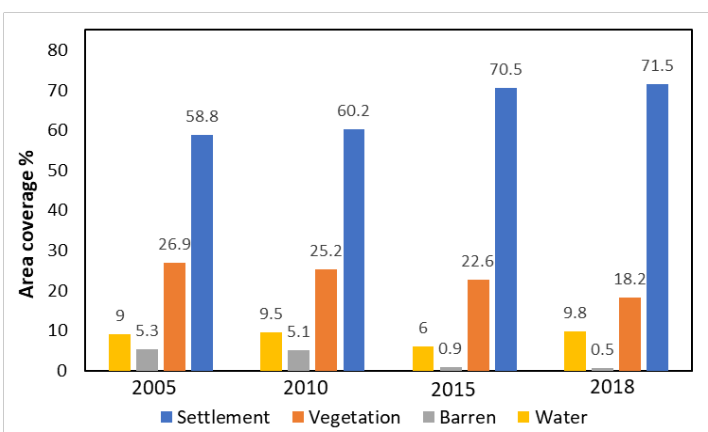


**Figure (7):** Areas percentage of the four classes at different years.

Figure (8) and Table (4) presents the settlement change detection map to explore changing direction in the settlement areas from 2005 to 2010. From the results, it is noticed that the settlement areas were increased by about 20.4% and decreased by 3.69% due to the conversion of 8191acres of the vegetation areas and Barren into the settlement areas.

Figure (9) and Table (5) presents the settlement change detection map to explore changing direction in the settlement areas from 2010 to 2015. From the results, it is observed that the settlement areas were increased by about 34.88% and decreased by 9.42% due to the conversion of 115696 acres of the vegetation and Barren areas into the settlement areas.

Figure (10) and Table (5) shows the settlement change detection map to explore changing direction in the settlement areas from 2015 to 2018. From the results, it is clear that the settlement areas were increased by 13.3% and had no decrease in the settlement areas due to the conversion of 8964 acres of the vegetation and Barren areas into the settlement areas.

**Table (4):** The analysis results according to the settlement from year 2005 to 2010, 2010 to 2015 and 2015 to 2018.

ISSN 2229-5518

| Class name | 2005 to 2010 | | 2010 to 2015 | | 2015 to 2018 | |
|---|---|---|---|---|---|---|
| | Area (acres) | Change % | Area (acres) | Change % | Area (acres) | Change % |
| Other classes | 353262.4 | 38.34 | 184833.4 | 20.06 | 262621.9 | 28.5 |
| Increased | 188371 | 20.44 | 320357 | 34.77 | 122545 | 13.3 |
| Decreased | 34019.5 | 3.69 | 86752.5 | 9.42 | 0 | 0 |
| No change | 345563 | 37.51 | 329273 | 35.74 | 536019 | 58.2 |

Figure (11) and Table (5) presents the vegetation change detection map to explore changing direction in the vegetation areas from 2005 to 2010. From the results, it is observed that the vegetation areas were decreased by 16.25% and increased by 25.3% due to the conversion of 14998 acres of the vegetation areas into the settlement and Barren areas.

Figure (12) and Table (6) presents the vegetation change detection map to explore changing direction in the vegetation areas from 2010 to 2015. From the results, it is clear that the vegetation areas were decreased by 41.33% and increased by 2.47% of the vegetation areas due to the conversion of 25145 acres from the vegetation areas into the settlement and Barren areas.

Figure (13) and Table (6) shows the vegetation change detection map to explore changing direction in the vegetation areas from 2015to 2018. From the results, the vegetation areas were increased by 0.24% and decreased by 17.4% in the vegetation areas as observed due to the conversion of 41266 acres from the vegetation areas into the settlement and Barren areas.

**Table (5):** The analysis results according to the vegetation from year 2005 to 2010, 2010 to 2015 and 2015 to 2018.

| Class name | 2005 to 2010 | | 2010 to 2015 | | 2015 to 2018 | |
|---|---|---|---|---|---|---|
| | Area (acres) | Change % | Area (acres) | Change % | Area (acres) | Change % |
| Other classes | 455364.9 | 49.43 | 331850.9 | 36.02 | 751686.4 | 81.6 |
| Increased | 233085 | 25.3 | 22737.4 | 2.47 | 2174.5 | 0.24 |
| decreased | 149669 | 16.25 | 380744 | 41.33 | 160100.5 | 17.4 |
| No change | 83097 | 9.02 | 185883.6 | 20.18 | 7254.5 | 0.79 |

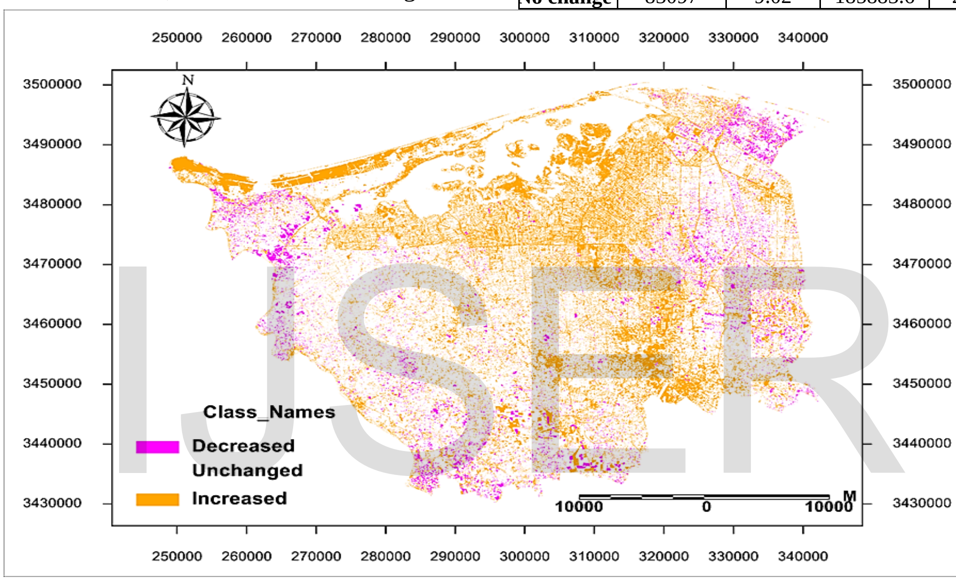



**Figure (8):** Settlement change detection map from year 2005 to 2010.

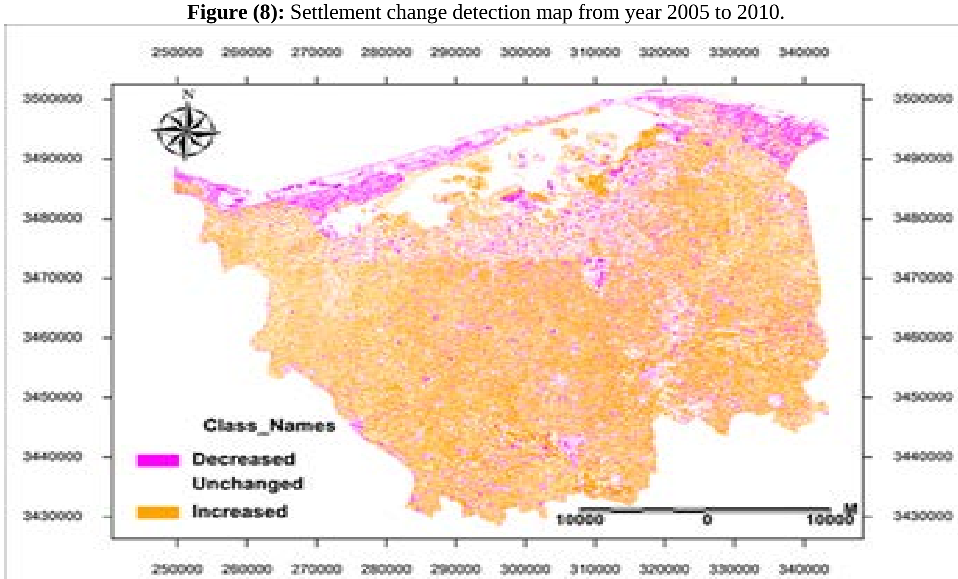


**Figure (9):** Settlement change detection map from year 2010 to 2015.

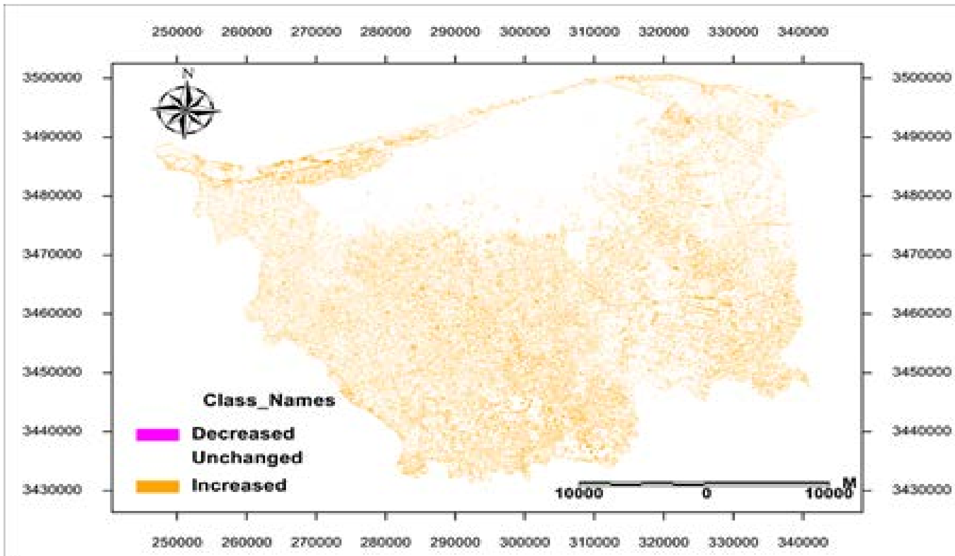


**Figure (10):** Settlement change detection map from year 2015 to 2018.

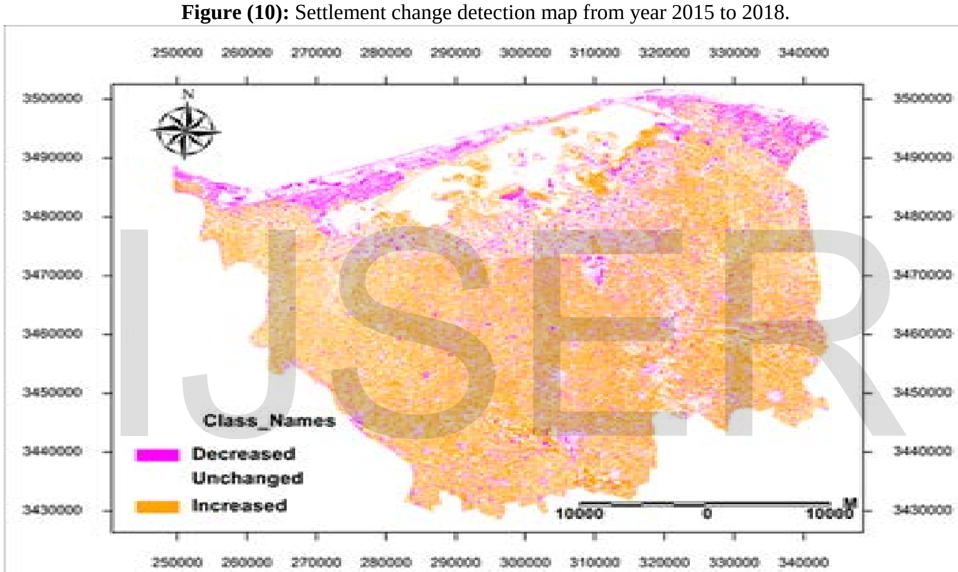


**Figure (11):** Vegetation change detection map from year 2005 to 2010.

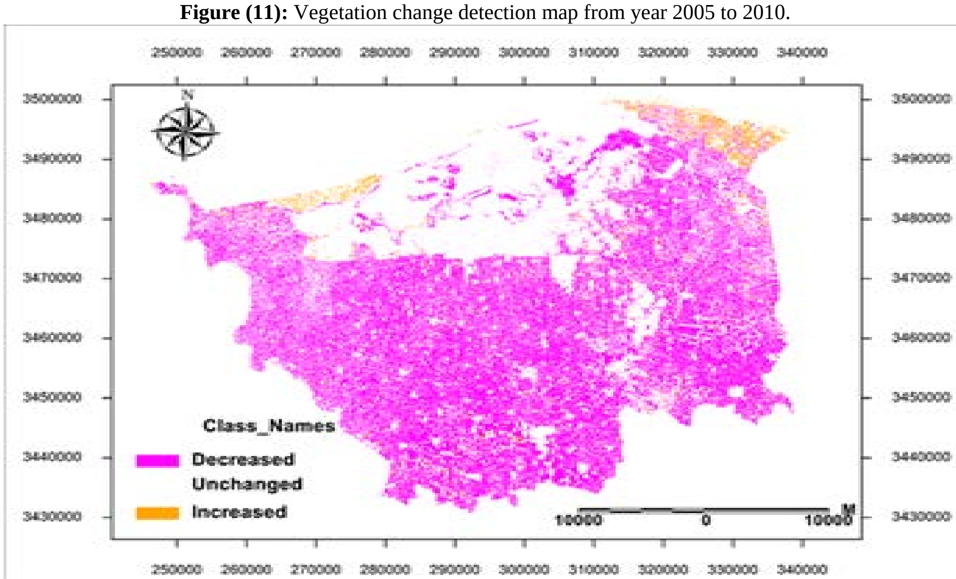


**Figure (12):** Vegetation change detection map from year 2010 to 2015.

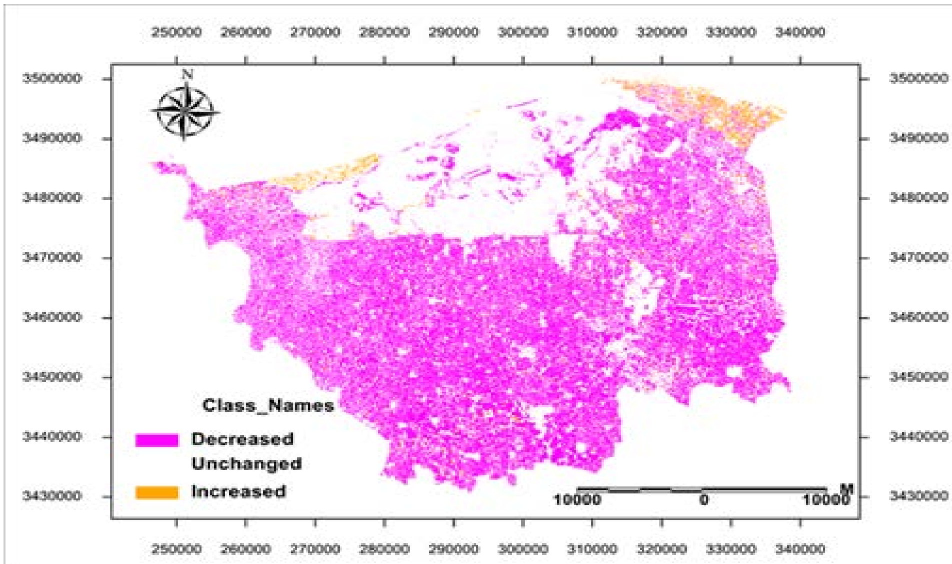


**Figure (13):** Vegetation change detection map from year 2015 to 2018.

## 6. The prediction in the future for the different classes in Kafr El-Sheikh governorate.

In this part of the research, it is examined the future prediction for settlement, vegetation and population theoretically and by using statically models in order to predict the amount of change occurring and find solutions and alternatives to overcome the changing accident. Table (6, 7) presents the land cover changes in acres in 2005 to 2010 and 2010 to 2015 and the average of change per year. It can be noticed that, the settlement is increase after January 25 revolution in Egypt during the period 2005 to 2010 by 0.27% per year of the total area while, after the January 25 revolution in Egypt the settlement has a high increase during the period 2010 to 2015 by 2.06% per year of the total area. Then regularity begins to some extent this increase was at the expense of the other classes and most importantly vegetation and barren. The vegetation areas are decreased by -0.33% per year of total area during the period 2005 to 2010 and a high decrease from 2010 to 2015 by -0.524 % per year of the total area. In addition, the barren areas are decrease from 2010 to 2015 by -0.834% per year of the total area. Figures (14 to16) and Table (8, 9) show the future prediction for settlement, vegetation and population. It is observed that the settlement areas increased to 88.63% of the total area and the vegetation areas decreased to 8.41%. In addition to the number of population increased to 5820000 million. It is also clear that the settlement and population have a high increase at the expense of the vegetation areas.

**Table (6):** Land cover changes in acres in 2005 and 2010 and the average of change per year

| Class | Area in 2005 | Area in 2010 | Total change | % total change of total area | Change / year |
|---|---|---|---|---|---|
| **Settlement** | 542125 | 554571.9 | 12446.9 | 1.35 | 0.27 |
| **Vegetation** | 247764 | 232766 | -14998 | -1.63 | -0.33 |
| **Barren** | 48742.5 | 46982.01 | -1760.49 | -0.19 | -0.038 |
| **Water** | 82584.4 | 87515.5 | 4931.1 | 0.54 | 0.107 |
| **Total area** | 921215.9 | 921215.9 | ---------- | ------------ | ---------- |

**Table (7):** Land cover changes in acres in 2005 and 2010 and the average of change per year

| Class | Area in 2010 | Area in 2015 | Total change | % total change of total area | Change / year |
|---|---|---|---|---|---|
| **Settlement** | 554571.97 | 649630 | 95058.03 | 10.32 | 2.06 |
| **Vegetation** | 232766 | 208621 | -24145 | -2.62 | -0.524 |
| **Barren** | 46982.01 | 8557.98 | -38424.03 | -4.17 | -0.834 |
| **Water** | 87515.5 | 55804 | -31711.5 | -3.44 | -0.69 |
| **Total area** | 921215.9 | 921215.9 | ---------- | ------------ | ---------- |

**Table (8):** Statically models for the different classes and the land cover area will be expected in the year 2030.

| Class | Area in 2018 | % | The equation used to predict | Area in 2030 | % |
|---|---|---|---|---|---|
| **Settlement** | 658594 | 71.5 | y = 0.0001x + 1948.6 | 814000 | 88.36 |
| **Vegetation** | 167355 | 18.2 | y = -0.0002x + 2045 | 75000 | 8.41 |

**Table (9):** Statistical model for the population and the future prediction in the year 2030.

| Class | 2006 | 2015 | 2018 | The equation that was used to predict | 2030 |
|---|---|---|---|---|---|
| **Population** | 1040274 | 3172753 | 3325608 | y = 5E-06x + 2000.9 | 5820000 |

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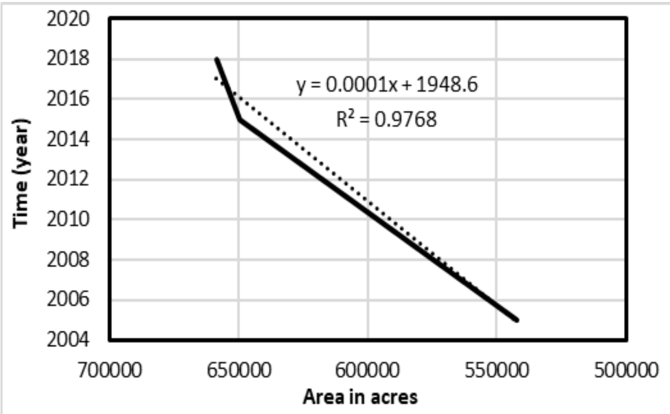


**Figure (14):** The statically model used to predict the change for settlement in kafr el sheikh.

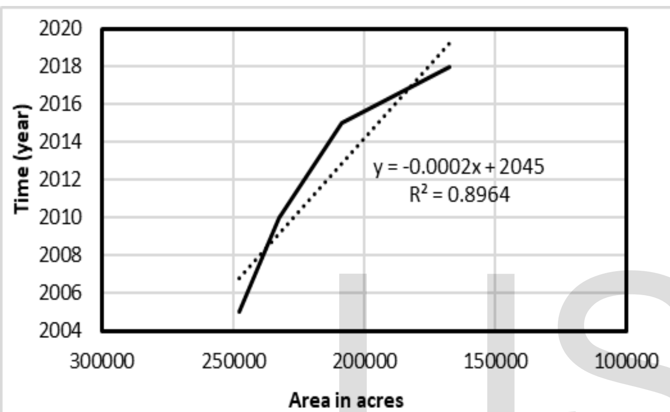


**Figure (15):** The statically model used to predict the change for vegetation in kafr el sheikh.

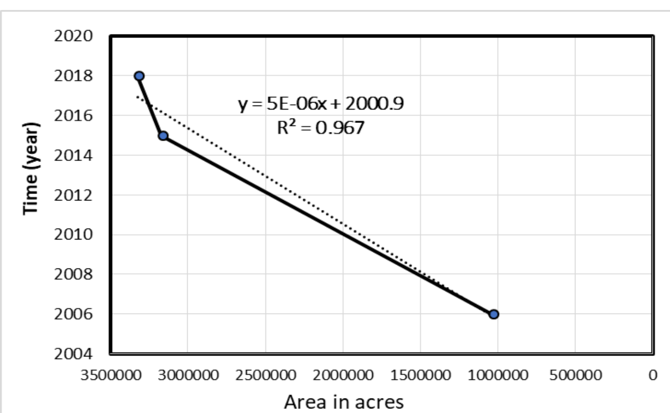


**Figure (16):** The statically model used to predict the change for population in kafr el sheikh.

## 7. CONCLUSIONS

In this paper, the supervised classification and the change detection techniques are applied for the landsat observations to study the Land Use and the Land Cover changes during the periods 2005, 2010, 2015 and 2018 in Kafr El-Sheikh governorate. Based on the results, the following conclusions can be drawn:

1. The settlement is increase after January 25 revolution in Egypt during the period 2005 to 2010 by 0.27% per year of the total area while, after the January 25 revolution in Egypt the settlement has a high increase during the period 2010 to 2015 by 2.06% per year of the total area. Then regularity begins to some extent this increase was at the expense of the other classes and most importantly vegetation and barren. The vegetation areas are decreased by -0.33% per year of total area during the period 2005 to 2010 and a high decrease from 2010 to 2015 by -0.524 % per year of the total area. In addition, the barren areas are decrease from 2010 to 2015 by -0.834% per year of the total area.
2. The supervised classification recorded the highest accuracy for the study the overall accuracy for the classification in 2005, 2010, 2015 and 2018 are 95 %, 95.5 %, 96.88 % and 97 % respectively.
3. Future predictions have been studied theoretically and by using stoical models. The model indicated that the settlement will be increased to 88.36% (813986. of the total area in year 2030 and the vegetation will be decreased to 8.41% of the total area in year 2030 in kafr el-sheikh governorate, However Statistical model for the population indicated that the population will be increased to 5820000 million in year 2030.
4. The study highlighted the need for guidance to reform the applied regional agricultural land reclamation policy, performing technical monitoring, and presenting a technical support to the policy makers.

### Recommendations

Alternative solutions should be developed for agricultural land reclamation to overcome the problem of increasing population.

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