International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 01, January-2021

Monitoring Degradation of Agricultural Areas for Delta Region in Egypt using Remote Sensing and GIS Techniques

* Emam H. Abd El Hady
Survey Research Institute,
National Water Research Center, Giza, Egypt

***Abstract*:- Changes that have occurred in both urban and vegetation areas were monitored in study area (about 20,000 km^2) in the Delta region of Egypt throughout the years: 2003, 2009, and 2014 . Four Landsat images were adopted for every year in this study . Landsat 8 (2014) ,ETM (2009), and TM 5(2003) were preprocessed. Different approaches: DeltaCue ,Objective, different Classifications, Change Detection , were investigated and tested to follow these changes. The change in vegetation and urban areas was calculated at the level of the entire study area and then at the provincial level . The results showed that there was an increase in urban areas in conjunction with decrease in the agricultural areas. Urban areas increased from 2003 to 2009 by 124.8 thousand feddans and from 2009 to 2014 by 61.6 thousand feddans, hence the areas of urban blocks increased by 186.34 thousand feddans in 11 years on the other hand, agricultural areas decreased from 2003 to 2009 by 95 .73 thousand feddans and continued to decreased from 2009 to 2014 by 90.63 thousand feddans ,reaching a total decreased values of 186.35 thousand feddanes over a period of 11 years. Accuracy assessments were done for the three years based on ground truth points deduced from Google Earth. Overall accuracy for 2003 classification was 93% with kappa= 80.9%, for 2009 classification was 95% with kappa= 88.7%, and for 2014 classification was 92% with kappa= 82.7% . Finally it can be concluded that there was a real degradation and decline in agricultural areas in Delta, thus representing a real danger to food security and Egyptian agricultural wealth.**

Keywords: Landsat ; vegetation ; Urban ; Classification ;Delta region

1. INTRODUCTION

In Egypt, agriculture is the core and main goal for any development strategies and sustainable development planning. Urbanization is an inevitable process due to progress and development however the encroachments of urban settlements on expense of agricultural lands may pose dire consequences. Therefore, changes of the land covers and the environmental impact of these changes should be carefully considered. For this purpose, land cover change information derived from the dynamics and multi temporal remote sensing data could be the most suitable way to assess and analyze these changes (Shalaby, A. , R. R. Ali,2010).

Remote sensing "RS" provides an efficient tool to monitor land-cover and environmental changes. Long-term monitoring of environment changes is usually accomplished by spatially comparing multi-temporal satellite images, a technique known as change detection. A number of change detection techniques have been developed in recent years as: Transparency compositing, DeltaCue , Unsupervised classification comparison, Band rationing change. Also, prior to multi temporal image change detection, images should be radiometricly corrected to account for atmospheric, sensor, and sun angle anomalies. Landsat satellites (series 1 to 7) have been providing repetitive, synoptic, global coverage of multispectral imagery (Burrough and McDonnel, 1998). Landsat data have potential applications for monitoring the conditions of the Earth's land surface and the environment components. Satellite can repeatedly observe the wide area at once and continuously acquire the information about the ground features and environmental changes. Satellite sensors can detect the electro-magnetic radiation energy reflected from the earth over a wide range of spectrum with a visible and infrared wavelength, and record it in digital image. The Objectives of this work are monitoring degradation of agricultural areas for Delta region (about 20,000 km^2) using medium resolution satellite images and GIS techniques .

2.STUDY AREA

The study site of this research is Delta region . The extent of the study area is located between latitude 29°35'46.618"N to 31°36'57.392"N and longitude 29°53'23.827"E to 32°18'57.563"E. (Figure 1).

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 01, January-2021

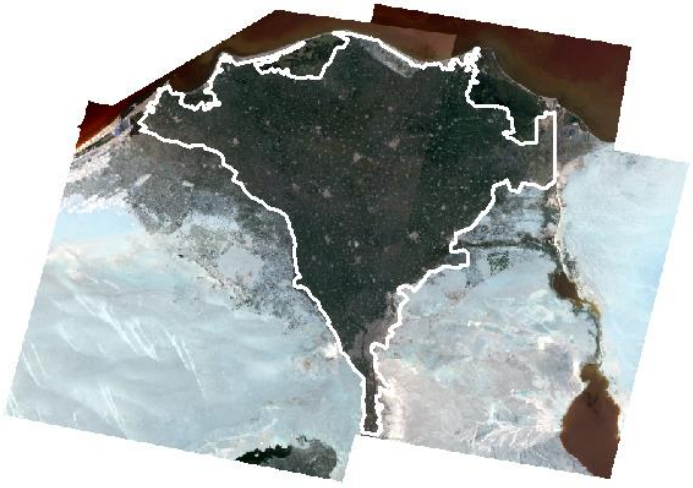

Figure1: Study area

3. DATA

Four images that cover the study area with paths /rows: :176/38 , 176/39, 177/38, and 177/39 were used in each date: LANDSAT_5 in 2003, Landsat7 in 2009, and LANDSAT_8 in 2014.

4.METHODOLGY

4.1 Images processing :

- Landsat images were download from www/http://earthexplorer.usgs.gov.
-Layers stack for all spectral bands for each image and each date were performed
- The landsat images were corrected radiomatically because they were obtained at different seasons under different atmospheric conditions.
- Mosaic was conducted for the four landsat images, which comprises the study area
- All images with different dates have been corrected geometrically to unify the datum to WGS84, Projection to UTM 36, Ellipsoid to WGS84. The Geometric_RMSE ranges between (4.05- 9.957) for all images .

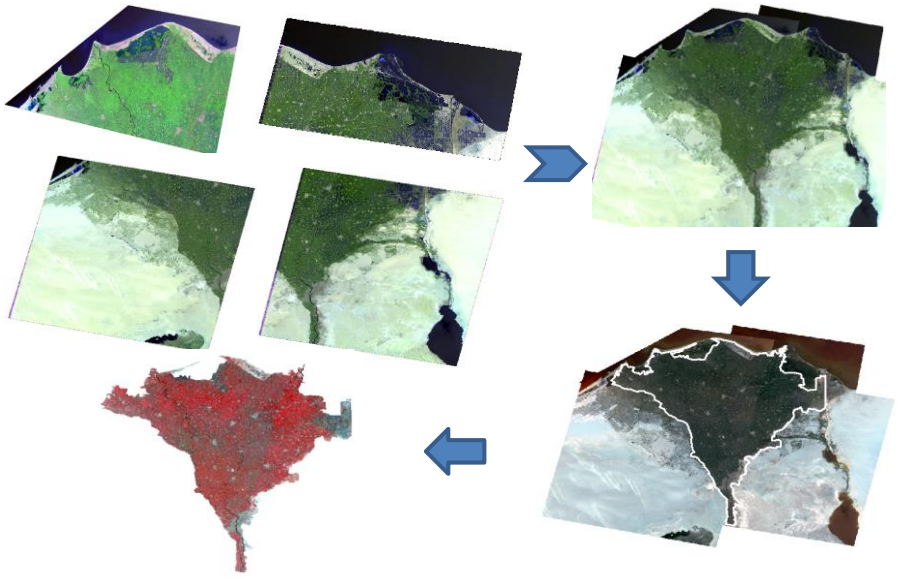

Figure 2: Images Preprocessing steps

- A specific study area of the Delta was subset which represent about 19, 611 km^2 , and consider the main part of the Delta.
- Reflectance layers for all spectral bands were conducted using equations to convert the Row data into Top of Atmospheric Reflectance to discriminate easily between vegetation and urban areas.
- Resolution merge has been carried out for images 2009, 2014

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 01, January-2021

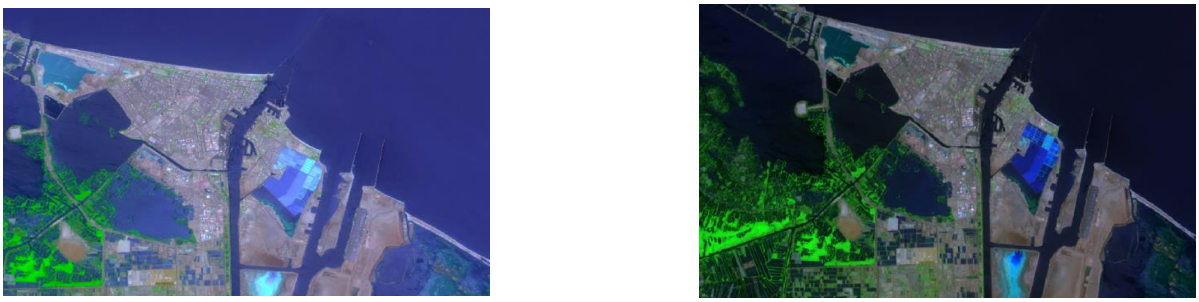

Figure 3: Image before (L) and after reflectance(R)

- Different change detection methods were tested on the images to monitor the degradation of agricultural areas for Delta study area. Iso cluster unsupervised classification under ArcGIS environment was chosen to use in this study **,** which consider as the most effective and accurate `method for such enormous study area .All governorates contained by this study area were classified
- The change in vegetation and urban areas was calculated at the level of the entire study area and at the provincial level.

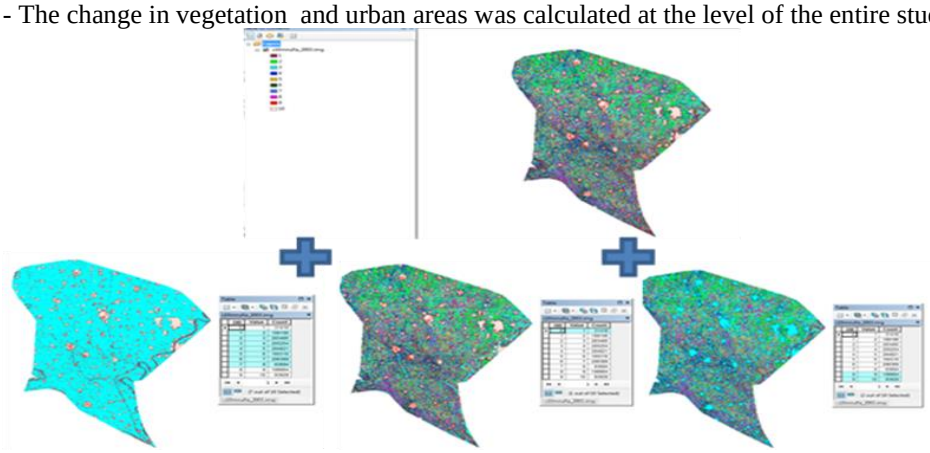

Figure 4: Classification of Mnufia Governorate

- Error matrix was performed for each year , from which overall accuracy assessment and kappa were calculated .

Results and Discussion

Table 1: cultivated and urban areas of the study area for the three years

Date	Areas (1000 fed.) for Delta study area	
	Urban	Vegetation
2003	666	3688
2009	791	3593
2014	853	3502

Figure 5 show continuous increase in the urban areas and decrease in agricultural areas for delta during 2003, 2009.2014.

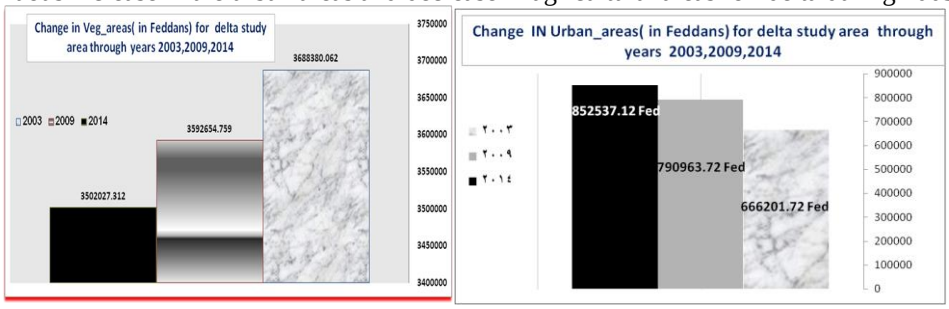

Figure 5: show continuous increase in the urban areas and decrease in agricultural areas through study duration

Table 2: Shows changes in cultivated and urban areas for Delta study area during the years 2003, 2009 and 2014

Years	Increase in urban areas (1000 fed.)	Decrease in vegetation areas (1000 fed.)
2003-2009	124,76	95,73
2009-2014	61,57	90,63
2003-2014	186,34	186,35

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 01, January-2021

The table and the figure below show urban areas at the provincial level
years: 2003,2009,2014

Table 3 shows the urban areas in the provinces of Delta (within the study area)

Governorates	Urban Areas		
	2003 Fed.	**2009 in Fed.**	**2014 in Fed.**
Alex .	4939.75	6873.48	8315.32
Behera	70430.12	73995.73	89533.96
cairo	56480.05	56480.05	56499.55
Dakahlia	74361.65	119859.52	106392.56
Damitta	12006.69	12145.52	16693.85
Gharbia	51044.34	55191.40	72082.77
Giza	42052.87	56265.17	64753.60
Ismailia	12116.38	14742.11	15362.13
kafr Elshiekh	94168.63	97460.07	103661.85
Mnufia	42975.18	75533.76	78283.97
Qalubia	52806.47	61466.93	63293.55
Sharkia	152613.70	160875.89	177664.01

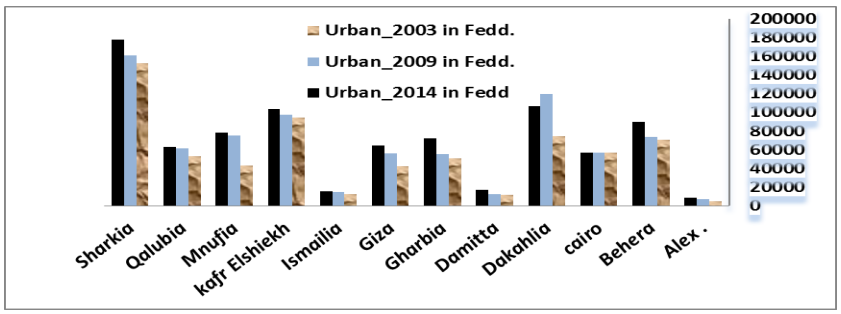

Figure 6: Urban areas at the provincial level for the study area
in 2014,2009,2003

The table and the figure illustrate show agricultural land areas at the provincial level

Table 4 shows the agricultural land at the provincial level for the study area for the years 2014,2009,2003

Governorates	Vegetation areas		
	2003 in Fed.	2009 in Fed.	2014 in Fed.
Alex .	30451.10	28243.13	26768.73
Behera	584588.67	574469.65	564872.31
cairo	5299.46	8815.58	9199.07
Dakahlia	708735.57	671522.18	692445.56
Damitta	97013.96	87047.70	87534.67
Gharbia	384177.02	380037.03	328567.21
Giza	123465.40	119819.88	111840.06
Ismailia	48962.99	48567.29	44256.34
kafr Elshiekh	591399.59	588870.48	590183.35
Mnufia	302729.57	270516.98	267943.74
Qalubia	162166.48	152832.65	149312.68
Sharkia	649390.26	661912.20	629103.60

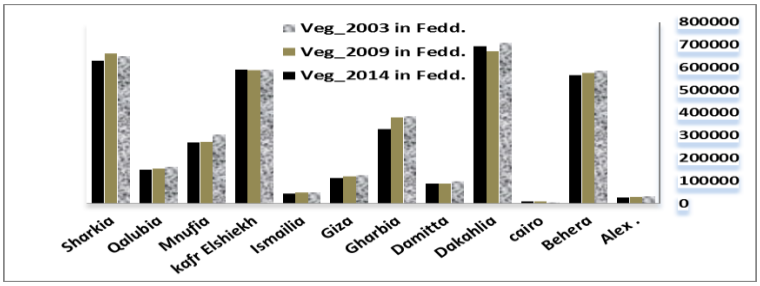

Figure 7: Vegetation areas at the provincial level in 2014,2009,2003

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 01, January-2021

The annual rate of change (feddans / year) for agricultural and urban areas of the provinces within the study area are described below (figure 8).

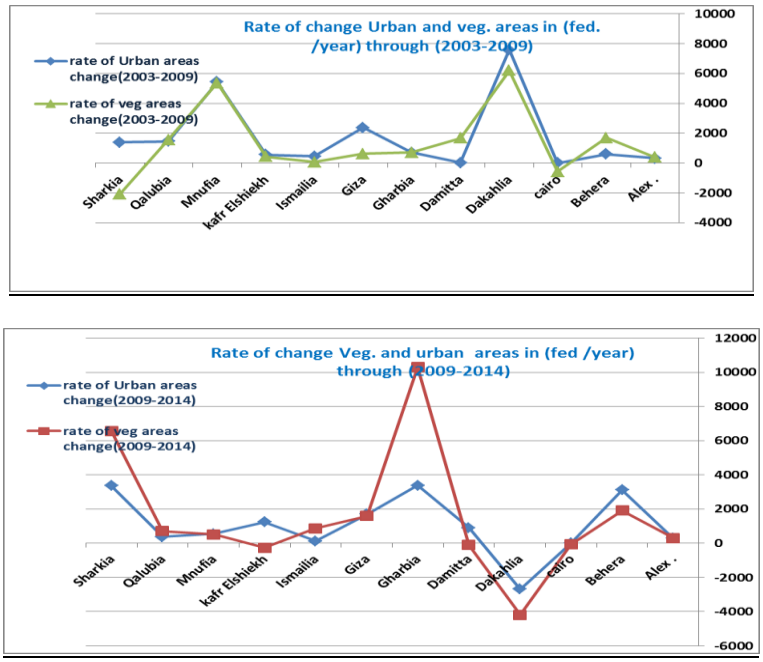

Figure 8:Annual rates of change (feddans / year) for the areas of agricultural land and urban of the provinces

Figure 9 shows an increase in residential blocks constructed on cultivated areas ,being considered as a great degradation of .vegetation areas in the upper part of the Delta region from year 2003 to year 2014.

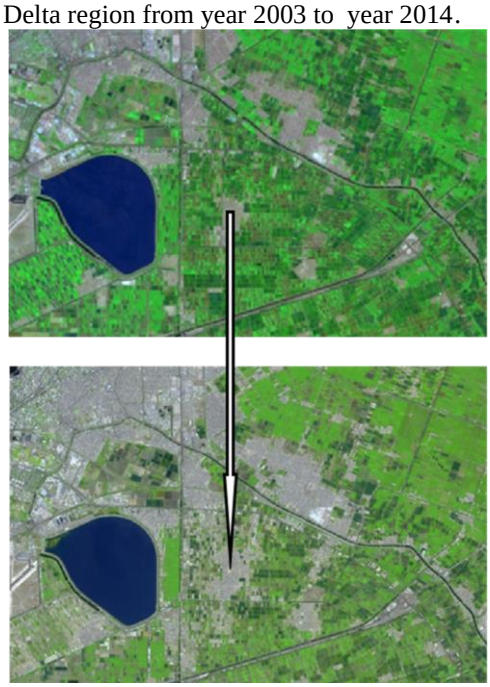

Figure 9:Increasing in residential blocks constructed on cultivated areas

Classification assessment

A layer of 100 random points was constructed as shape layer and converted to KML format and open on Google Earth for the 3 dates(Figure 10 , 11) to get features ground truth which are corresponding to the random points , then stored under ArcGIS environment and compared with the predicted values of classification ,the feature class may be (water or vegetation or urban),Error matrix was constructed and from which, Overall accuracy assessment and Kappa were deduced.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 01, January-2021

Figure 10: The distribution of the random points on Delta region on Google earth pro

Figure 11: The ground truth which corresponds to of the random points on Google Earth

Table 5 : Error matrix of classification for year 2003

	veg2003 Reality	Urban 2003 Reality	water 2003 Reality	
veg2003 predicted	74	3	0	77
Urban2003 Predicted	4	14	0	18
water2003 predicted	0	0	5	5
	78	17	5	93

The resulted Overall accuracy for 2003 classification is 93% with kappa=80.9% , overall accuracy for 2009 classification is 95% with kappa=88.7%, and overall accuracy for 2014 classification is 92% with kappa=82.7% .

CONCLUSION

In this work urban and vegetation areas were monitored for study area in Delta region (about 20,000 km^2) for years: 2003 , 2009 , and 2014, to follow the changes that have occurred. Unsupervised classification technique proved to be the most effective and accurate method for such enormous region. The change in vegetation and urban areas was calculated at the level of the entire study area and then at the provincial level . The results showed that there was an increase in urban areas in conjunction with decrease in the agricultural areas. . Urban areas in delta region were increased from 2003 to 2009 by 124.8 thousand feddans and were increased from 2009 to 2014 by 61.6 thousand feddans and hence the areas of urban blocks were increased by 186.34 thousand feddans for 11 years and on the other hand, agricultural areas have decreased from 2003 to 2009 by 95 .73 thousand feddans and continued decreased from 2009 to 2014 by 90.63 thousand feddans with total decreased values of 186.35 thousand feddanes over 11 years. It can be concluded that there is a real degradation and decline in agricultural areas in Delta , which represents a real danger to food security and Egyptian agricultural wealth.

REFERENCES

[1] Burrough, P.A. and R.A. Mcdonnel. 1998. Principal of Geographical Information System. (Oxford University Press, USA).
[2] -Shalaby, A. , R. R. Ali , Agricultural land Monitoring in Egypt using NOAA-AVHRR and SPOT Vegetation Data , 2010 ,Nature and Science Journal
[3] http://earthexplorer.usgs.govwww/
[4] -Fabian Löw, Chandrashekhar Biradar, Elisabeth Fliemann, John P.A. Lamers, Christopher Conrad, 2017,Assessing gaps in irrigated agricultural productivity through satellite earth observations—A case study of the Fergana Valley, Central Asia,
[5] International Journal of Applied Earth Observation and Geoinformation ,Volume 59,
[6] -Satoshi Uchida, 2015, Applicability of Satellite Remote Sensing for Mapping Hazardous State of Land Degradation by Soil Erosion on Agricultural Areas,
[7] Procedia Environmental Sciences,
[8] Alex Okiemute Onojeghuo, George Alan Blackburn, Jingfeng Huang, Daniel Kindred, Wenjiang Huang, 2018
[9] Applications of satellite 'hyper-sensing' in Chinese agriculture: Challenges and opportunities,
[10] International Journal of Applied Earth Observation and Geoinformation, Volume 64,