Agricultural land Monitoring in Egypt using NOAA-AVHRR and SPOT Vegetation Data

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Abstract: Land cover change detection is one of the most important trends in which remote sensing data could be used to assist strategists and the planners to decide the best land use policy. Two images of NOAA-AVHRR and SPOT vegetation acquired in November 1992 and 2000 were used to assess the changes of Agricultural lands in Egypt. A supervised classification together with two change images derived from classification result and NDVI were used to evaluate the trend and form of the change. It was found that agricultural areas increased by about 14.3 % during the study period in particular around the River Nile Delta and near the Northern Lakes of Egypt. The new cultivated lands were extracted mainly from the desert and from the salt marches areas. At the same time, parts of the agricultural lands were turned into non-cultivated land because of the urban expansion and soil degradation. An analysis of these changes and how much they affect the total agriculture map of Egypt were discussed in details.

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1. Introduction:

Conversion of desert to productive land has been a worldwide issue in the arid and semi-arid area. In Egypt, agriculture is the core and main goal for any development strategies and sustainable development planning. Increasing the total agricultural product by improving the quality and increasing the area of the cultivated land has been the national target of Egypt during the last two decades. At the same time, desert represent a vast amount of Egyptian territory; these require continuous public and private reclamation efforts in the reformation of these lands from desert to productive lands. 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.

Many studies have discussed the land cover and land use changes in arid, semi-arid and agricultural productive land. Lambin and Ehrlich (1997) used ten years of NOAA-AVHRR data to assess and analyze land cover changes in the African continent between1982 to 1991. The study showed that continuous unidirectional change process affected less than 4% of Sub- Saharan regions during the study period. Rembold et al. (2000) studied land cover changes in lake regions of central/ south Ethiopia using aerial photographs dated 1972 and 1994 Landsat TM image. Mendoza and Etter (2002) combined black and white aerial photographs with fieldwork and GIS to monitor land cover changes covering 56 years (1940-1996) in parts of Bogota, Colombia. Palmer and Rooyen (1998) used Landsat TM data to explore the impacts of land management policies on vegetation structure in two study areas in southern Kalhari desert in South Africa in the period from 1989 to 1994. Ram and Kolarkar (1993) studied land use changes in arid areas in India by visual comparison of satellite imagery, maps and aerial photographs. In Egypt, Sadek (1993) used satellite imagery to highlight agricultural boundaries and monitor reclamation process. Lenney et al. (1996) used field calibrated, multi-temporal NDVI features derived from 10 Landsat TM images dating from 1984 to 1993 to assess land cover changes in Egypt. The study showed a high rate of reclamation in the period from 1986 to 1993 and low rate of conversion from agricultural productive land to new urban areas between 1984 to1990.

In this study, NDVI derived from NOAA-AVHRR and SPOT Vegetation data were used to map the vegetation dynamics in the Nile River Valley and Nile Delta of Egypt from 1992 to 2000. The objectives of this work are using low resolution remote sensing data to view the agricultural changes in the last eight years and to study the form and the rate of conversion among the different land cover types.

2. Study area

Basically, Egypt has long been an agricultural country with cultivated areas concentrated along the main stream of the River Nile following regular irrigation systems and two main agricultural seasons. This situation caused unbalanced population density and other detrimental environmental impacts in and around the Nile valley and Delta. From 1970s, this problem started to be seriously observed. Governmental effort to adjust this situation focused on two main directions; protecting the highly productive lands from urban encroachment and establishing new agricultural and industrial communities far from the main stream of the River Nile. From this time, continuous governmental and private reclamation efforts are easily noticeable in many areas in Egypt. The study area covered the Egyptian territories between 22 and 33 North and 25 and 37 East. The main soil types present in Egypt are Vertisols, which represent the old and highly productive agricultural lands, and Aridisols, which represent the newly reclaimed lands (Abdulla et al. 1997). Egypt belongs to Mediterranean climate with two main seasons; hot dry summer and cool winter.

Approach

In this study, both NOAA AVHRR and SPOT VEGETATION data were used. The data are in form of NDVI provided by the Global Land Cover 1 km AVHRR and VEGETATION dataset programs. Both the two types of data are ten-day composites from 10-20 November 1992 and 10-20 November 2000. The images were prepared in geographic projection. Radiometric correction was carried out in order to reduce image differences caused by atmospheric conditions. Maximum likelihood supervised classification was applied for each satellite image individually using NDVI band. The classification was led by land cover maps, classified high-resolution satellite images for many regions in the country beside the personal experience. The classification was clustered into three main classes according to the different resources of ground truth data: agriculture lands, non-agriculture lands and water bodies. At the same time regrouping processing was made for both two NDVI images. The NDVI values for the images were classified into high and low groups. Change detection images were extracted from two types of input images; the classified images and NDVI group's images. Finally, accuracy assessment was carried out for the change images using land cover maps.

3. Results and Discussion:

The visual interpretation showed the main land covers for the two dates. Generally, a noticeable increase in the cultivated lands concentrated around The Nile Delta and new water bodies occurred in the southern part of Egypt. The classification results (as shown in table 1 and figures 1 and 2) mapped the total cultivated and non-cultivated lands. The classification results illustrated the total amount of change between the two dates. The total cultivated lands increased by approximately 25.8% due to land reclamation of desert and salt marches during the last eight years, meanwhile, 11% of old agriculture lands were lost due to urban expansion and land degradation hence, the net increase in agricultural lands was about 14.3% from 1992 until 2000. From this result, it is clear that in spite of the continuous effort to convert desert into agricultural lands, the loss of highly productive land is still unbroken. The lost agriculture lands were highly fertile and had the maximum level of productivity. However, the gained agriculture lands from reclamation efforts still require a significant capital and time investment in order to reach the same level of productivity as the old agriculture lands. In general, change image using post classification method was more logical and understandable than the change image derived from NDVI grouping. The two change images together with the classification result enlightened the land cover changes in detail.

Table (1): The classification results for the two images (Area by Hectare)

Year	Cultivated land	Non–cultivated land
1992	3527956	95128590
2000	4033932	94616502

The change images extracted from the two classified images and NDVI grouping (Figure 3 and 4) with statistical analysis shown in tables 2, 3 and 4 clarified that the largest conversion among the land cover classes is the desert changed into agricultural productive lands.

The change image showed the water bodies changed to be cultivated land. This form of land cover change concentrated around the Northern lakes where many Sabkhas and salt marches were altered to agricultural lands and cultivated with crops tolerant to high salinity. Urban encroachment and lost of the highly productive lands and soil degradation were also translated in the change images as converting from cultivated to non- cultivated or converting from high to low NDVI areas. Sedimentation and erosion are considered as very important natural phenomenon affecting the land cover form near the north cost of Egypt. These phenomena were highlighted in the change images by opposite change operation between water and non- cultivated lands. Also, the erosion process appeared in the northern part of the River Nile as conversion of agricultural lands to water. An increase in the water bodies appeared in the southern part of Egypt due to high flood during the late ninetieth. The NDVI images showed the same trend as explained by the supervised classification. Increases in the areas with high NDVI values and decreasing in the areas with low NDVI values were found.

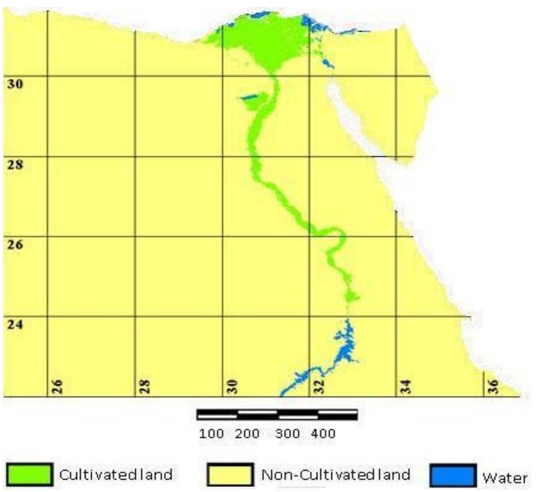

Figure (1) Supervised classification of NOAA-AVHRR 1992

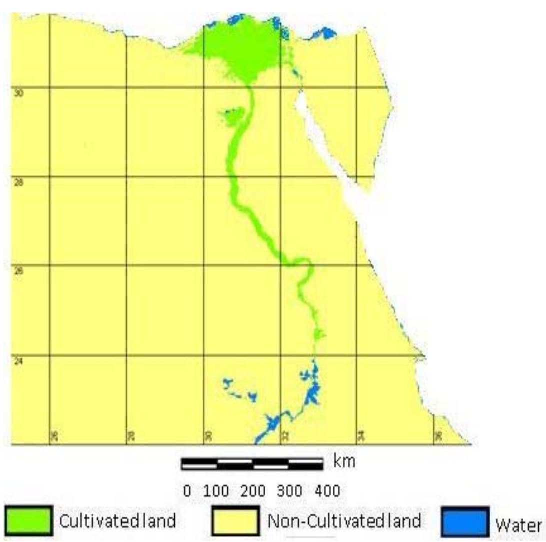

Figure (2) Supervised classification of SPOT Vegetation 2000

Table (2): Changes of different land cover classes using Post-classification change detection

Category	Area (Hectare)
Change from non- cultivated to cultivated land	708986
Change from water to cultivated land	202469
Change from cultivated to non-cultivated land	403794
Change from cultivated land to water	1685
Change from non- cultivated land to water	151000

Table (3): NDVI groups for the two images (Area in Hectare)

Year	High NDVI	Low NDVI
1992	3517525	138164757
2000	4094220	137584953

Table (4): Changes between the two NDVI classes

Category	Area (Hectare)
Change from Low to High NDVI	1162954
Change from NDVI High to Low	586458

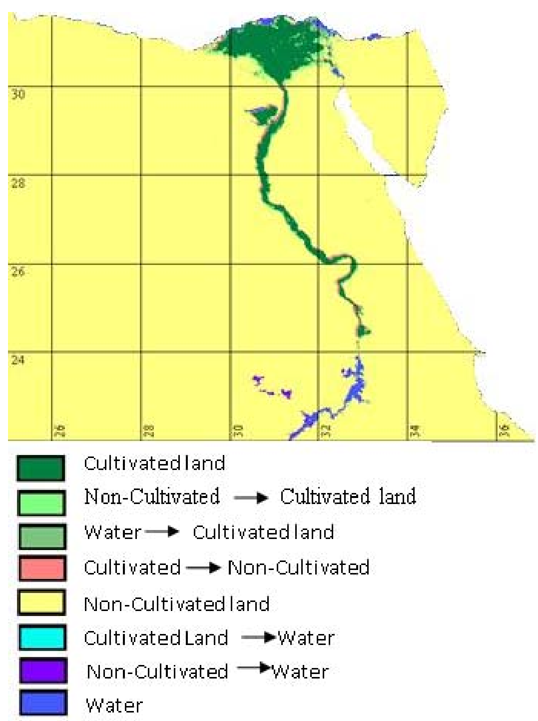

Figure (3) Post classification Change detection image of NOAA-AVHRR 1992 and SPOT Vegetation 2000

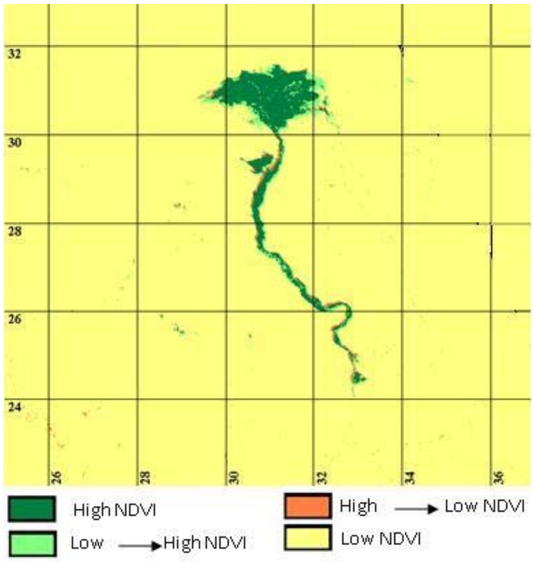

Figure (4) NDVI Change detection image of NOAA-AVHRR 1992 and SPOT Vegetation 2000

4. Conclusion:

Egyptian agricultural changes were assessed in the period from 1992 to 2000 by low-resolution remote sensing data. Increase in the cultivated lands from both desert and water bodies were found. About 1% of the Egyptian deserts changed to urban and/or agricultural areas. A part from this desert was converted to water bodies in the south part of Egypt. Sedimentation and erosion of the north coast could be considered as the opposite converting process between cultivated and non-cultivated lands and water.

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