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MONITORING TEMPORAL CHANGES IN EAST DELTA USING SPOT SATELLITE IMAGERY

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ABSTRACT

Soil, Water and Environment Research Institute (SWERI) acquired multidate data of SPOT panchromatic, Multispectral, and LANDSAT TM scenes which are considered a very valuable source of information. Change detection involves the use of multi-temporal data sets to discriminate areas of land cover variations at different dates of imaging. The aim of the study is to compute these variations and provide a global view of the development in the agricultural land in the east delta up to 1997 using the existing scenes archive. The study used Maximum Likelihood classification technique to detect and monitor the variations of land cover.

INTRODUCTION

Increasing agricultural land is a national goal in Egypt. The Ministry of Agriculture and Land Reclamation has a mandate to increase agricultural yields, acquire new reclaimed land, monitor and protect agricultural land. Thus, better information concerning agriculture land must be collected to improve land management. Remote Sensing satellite images are the best tool for many applications such as production and generation of land use as well as monitoring of variations & land cover over certain period of time. Change detection involves the use of multi-temporal data sets to discriminate areas of land cover variations at different dates of imaging, Ismail (1998). The multi-data classification approach entails the simultaneous classification of different images to be merged into a single multi-date set. The aim of the study is to provide a global view of the developments in the agricultural land in the east delta area up to 1997. The SPOT scenes of 1986 are not available in the SWERI archive for that we used the existing LANDSAT TM scene to cover the study area in 1986. The TM scene was registered using the SPOT level 2B scenes of the same area acquired in 1991 using an Image-to-Image registration process, using PCI software, Bernstein (1983). Then, the image was classified using a supervised classification, into four main land cover types, Ismail (1998). The land cover maps (produced in 1992 through ALIS project) was taken as a guide. The four main land cover types (Water, Desert, Urban areas, and Agricultural lands) are classified SPOT multispectral scenes of 1997 registered using SPOT level 2B and SPOT data imaged at 1991 and 1995. A model is applied to transfer the classified channels to one image. Hue-Intensity Saturation (HIS) technique was applied to merge the classified output with image layer.

EXPERIMENTAL WORK

STUDY AREA

The study area is located in east delta region and is showm in the rectangle in Fig. (1) shows the study area. The total area is 595,238.10 feddans covering the study area. Its location is described by the following coordinates:

Point	X-coordinate	Y-coordinate
1	360000	3400000
2	410000	3400000
3	410000	3350000
4	360000	3350000

SATELLITE DATA

1-SPOT Image multispectral scenes covering the study area as follows:
k, j: 112/288 dates: summer 1991, 1995 & 1997,
k, j: 112/289 dates: summer 1991, 1995 & 1997, and
k, j: 113/289 dates: summer 1991, 1995 & 1997.

2-LANDSAT scene of Path / Row: 176 / 39, date: summer 1986.

3-Topographic maps provided by the Egyptian Survey Authority (ESA), of date: 1931.

4-Land cover maps produced during ALIS Phase I Project, of scale 1:100000, using SPOT images (P+XS) acquired in summer 1991.

HARDWARE AND SOFTWARE

Hardware are HP workstation, PC's, printer and plotter. Software contains ARC/Info, PCI, and office 97.

GROUND TRUTH

Many field trips were carried out to the study area to collect the required samples (as ground truth) necessary for the classification process. Collected data are (urban, water, agriculture land and desert). The main characteristics of the training areas must be homogenous and clear.

METHODOLOGY

The following methodology was adopted in carrying out the required tasks:

1- Landsat TM scene was registered using SPOT level 2B scenes of the same area acquired in 1991 using an Image-to-Image registration process with PCI software.

2- The reference for the old cultivated areas topographic maps produced by the Egyptian Survey Authority (ESA) and land use maps produced during ALIS I project. These maps are used as a guide for the on screen digitizing process to create a mask covering the old agricultural areas, Fig. (2).

3- The classification process: is applied by entering the collected data from the ground truth collection stage and applying the Maximum likelihood classification techniques using the same training areas.
4- The TM image was classified using a supervised classification into four main land cover types, Fig. (3):
   i. Water
   ii. Desert
   iii. Urban areas
   iv. Agricultural lands
5- SPOT multispectral scenes of 1991 and 1995 of level 2B, existing in SWERI archive, were geocoded using PCI with coordinates in the leader file associated with the SPOT 2B. They were classified using the same supervised maximum likelihood classification Figs. (5 and 6).
6- SPOT multispectral scenes of 1997 level 1A were registered using the SPOT scenes of 1991 of level 2B.
7- SPOT images (1991,1992,1997) are mosaiked together to form one large radiometrically balanced image. Fig. (4) shows the mosaic of SPOT scenes (K, J: 112, 288-112, 289-113, 289) level 2B dated 1991 covering the study area.
8- A LUT for one image is created to match another image radiometrically. If color matching is used, the input values were changed using LUT.
9- The study area is extracted by determining the number of pixels and lines of study area for three dates (1991, 1995 and 1997)
10- The purpose of image enhancement is to adjust an image to improve visually the features of interest on an image. The user often defines a good enhancement and these operations can produce virtually limitless results. To produce the ideal enhancement, several iterations are done until the operator is satisfied with the results
11- Classify the SPOT data dated (1991, 1995 and 1997) are classified using a supervised classification technique into four main land cover types, Fig. (3):
   i. Water
   ii. Desert
   iii. Urban areas
   iv. Agricultural lands
12- A model was developed to extract the agricultural expansion between each two dates. Thematic layers for each interval were transferred to the same image channel with different values representing each interval as follows:
   - Green Cultivated lands before 1986,
   - Orange Cultivated lands between 1986 and 1991,
   - Purple Cultivated lands between 1991 and 1995,
   - Red Cultivated lands between 1995 and 1997.
13- A SPOT panchromatic rectified image is then used as a background to locate the positions of the variations. As the output of the change detection process cannot be displayed directly on the SPOT image, many transformations must be done first. In the beginning, the pseudo color (classified) image is transformed to HIS (Hue-Intensity saturation) intensity format to allow for substituting of the intensity component by the SPOT

panchromatic image. Figures (3 and 4) show the merged SPOT image with the output from the change detection process. The classification results for each date is shown in Figs (3, 5, 6 and 7).

14- Vector layers were added to highlight the main roads and canals. Some annotations were added for the main cities and roads in the area.

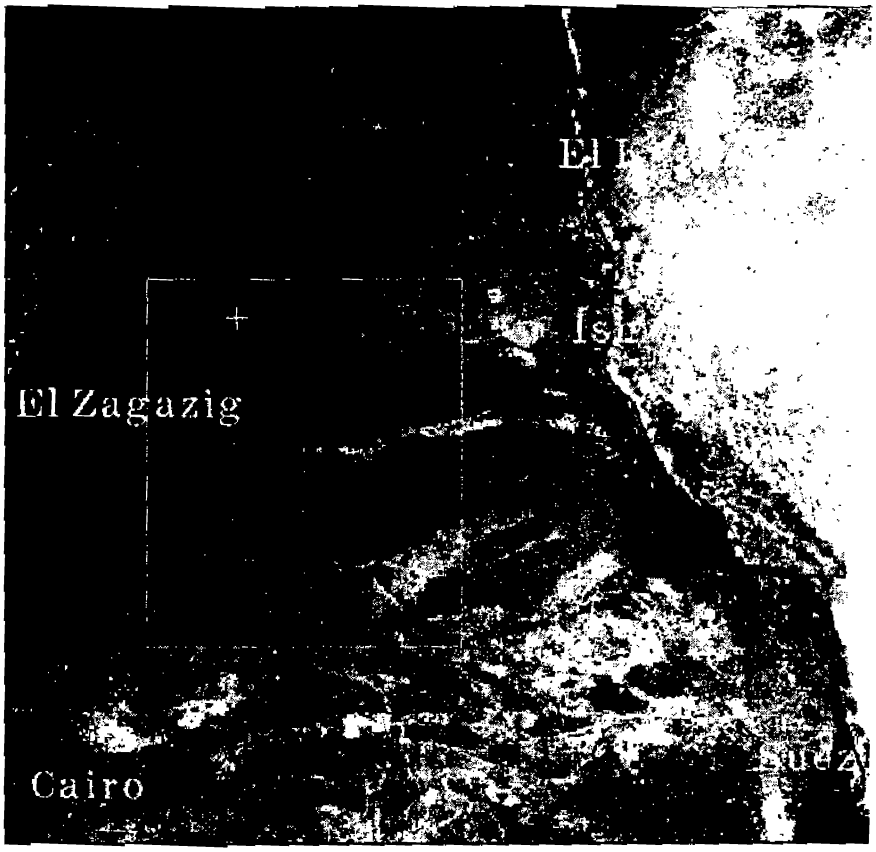

Fig. (1): Sub-scene From TM Image 176 / 39 Dated 1986 After Geometric Correction Using SPOT Level 2B Scene Dated 1991

Fig. (2): Sub-scene From TM Image 176 / 39 Dated 1986 After Applying a Mask On The Old Agricultural Areas Extracted From Topographic Maps

Fig. (3): Land Use Classes (1986)

Green: Agricultural areas
Orange: Urban areas
Yellow: Desert
Blue: Water

Fig. (4): Mosaic Of SPOT Scenes (K, J: 112, 288-112, 289-113, 289) Covering The Study Area

Fig. (5): Land Use Classes (1991)

Green: Agricultural areas
Orange: Urban areas
Yellow: Desert
Blue: Water

Fig. (6): Land Use Classes (1995)

Green: Agricultural areas
Orange: Urban areas
Yellow: Desert
Blue: Water

Fig. (7): Land Use Classes (1997)

Green: Agricultural areas
Orange: Urban areas
Yellow: Desert
Blue: Water

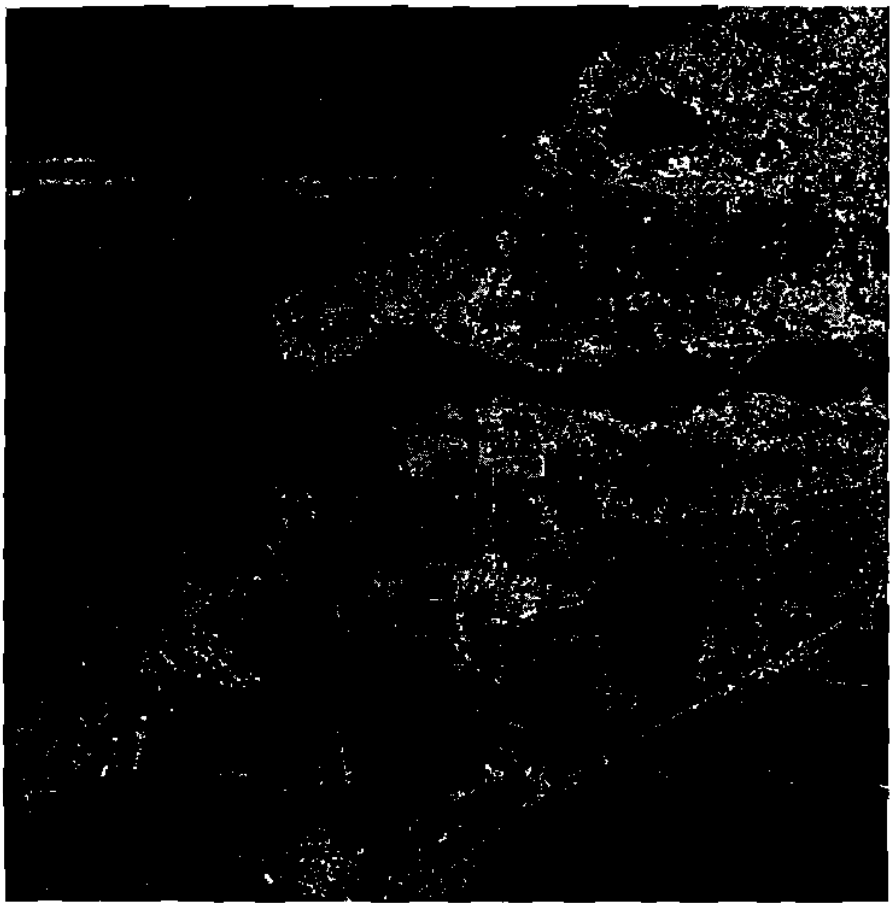

Fig. (8): Overlay Of Cultivated Areas Between Each Two Dates Of Study

Green:	Cultivated land in 1986
Orange:	Cultivated land in 1991
Purple:	Cultivated land in 1995
Red:	Cultivated land in 1997

RESULTS AND DISCUSSION

From the classification report, the area of different classes for the reference base map are subtracted from the area of different classified images to determine the variations in different dates, Tables (1 and 4). Then, the area cultivated in different dates are calculated and given in Table (5).

Table (1): Land Use 1986 Statistics In The Study Area:

Land Use Statistics 1986			
Land Use	**Color**	**Area in M^2**	**Area in Feddans**
Agricultural Areas	Green	465,686,400.00	110,877.71
Urban	Grey	52,196,800.00	12,427.81
Water	Blue	3,700.00	0.88
Desert	Yellow	1,982,113,100.00	471,931.69
Total Area		2,500,000,000.00	595,238.10

Table (2): Land Use 1991 Statistics In The Study Area:

Land Use Statistics 1991			
Land Use	**Color**	**Area in M^2**	**Area in Feddans**
Agricultural Areas	Green	492,399,616.00	117,238.00
Urban	Grey	63,721,200.00	15,171.71
Water	Blue	3,600.00	0.86
Desert	Yellow	1,943,875,584.00	462,827.52
Total Area		2,500,000,000.00	595,238.10

Table (3): Land Use 1995 Statistics In The Study Area

Land Use Classification 1995			
Land Use	**Color**	**Area in M^2**	**Area in Feddans**
Agricultural Areas	Green	531,726,016.00	126,601.43
Urban	Grey	81,670,430.00	19,445.34
Water	Blue	3,600.00	0.86
Desert	Yellow	1,886,599,954.00	449,190.47
Total Area		2,500,000,000.00	595,238.10

Table (4): Land Use 1997 Statistics In The Study Area

Report of Land Use Classification 1997			
Land Use	**Color**	**Area in M^2**	**Area in Feddans**
Agricultural Areas	Green	599,901,184.00	142,833.62
Urabn	Grey	94,931,600.00	22,602.76
Water	Blue	3,100.00	0.74
Desert	Yellow	1,805,164,116.00	429,800.98
Total Area		2,500,000,000.00	595,238.10

Table (5): Summary Of Newly Reclaimed Areas In The Study Area.

Summary of Newly Reclaimed areas in the study area.			
Dates	**Color**	**Area in M^2**	**Area in Feddan**
Cultivated land 1931	B / W	829013184	197384.0914
1931 - 1986	Green	465686400	110877.7143
1986 - 1991	Orange	99009200	23573.61905
1991 - 1995	Purple	103376000	24613.33333
1995 - 1997	Red	84431600	20102.7619
Desert	B/W	918483616	218686.5752
Total Area		2500000000	595238.0952
New cultivated land up 1997		752503200	179168

Fig. (9) shows the overlay of agricultural extensions between each two dates of study over a B/W background. The B/W background is from the XS3 channel of the SPOT scenes dated 1997. Figs (10 and 11) are the graphical representations of cultivated land areas at different intervals and different dates respectively. Ascending increase in cultivated land in different dates (1986-1997) is shown in Fig. (11)

Output products (photo maps) are given with black and white image background overlaid with colors representing the reclaimed areas between each two covered dates. The old cultivated land is shown in black and white, and each successive interval has a different color as shown in the map legend. This product will help Ministry of Agriculture to evaluate the reclaimed planning and increase new reclaimed land and also increase the old land productivity. It also allows for the production of land use maps. The outputs from the change detection process can be utilized for updating the spatial and attribute components adding new information to the National Soil Information System (NSIS).

Fig. (9): Overlay Of Agricultural Extensione Between Each Two Dates Of Study Over a B/W background. The B/W background from the XS3 channel of the SPOT scenes dated 1997

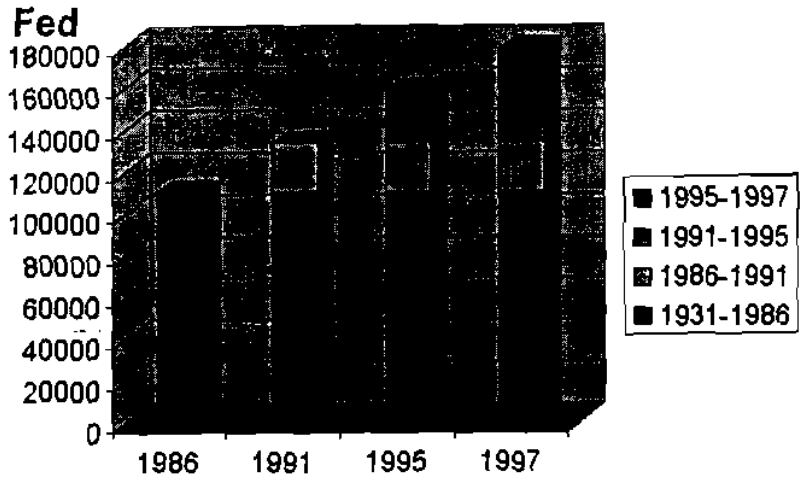

Fig. (10): Cultivated Land Areas At Different Intervals

Fig. (10): Cultivated Land Areas At Different Intervals

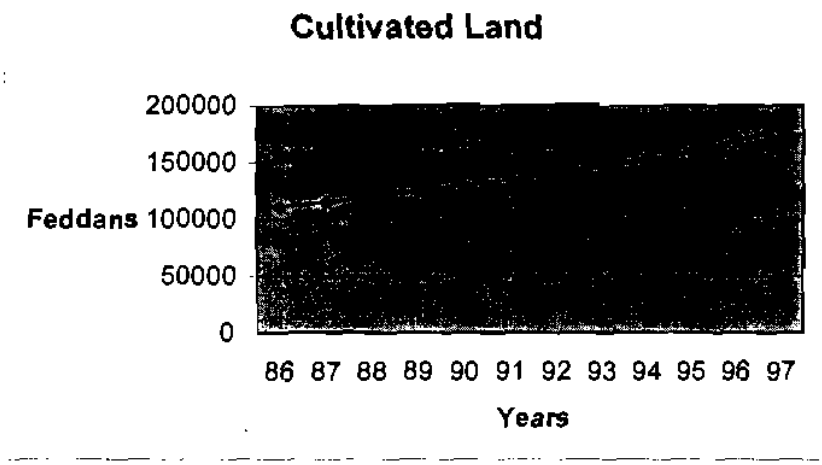

Fig. (11): Cultivated Land Areas At Different Dates

Fig. (11): Cultivated Land Areas At Different Dates

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استنباط التغيرات الزمنية لمنطقة شرق الدلتا باستخدام بيانات القمر الصناعي الفرنسي سبوت

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يقوم معهد بحوث الاراضى والمياه والبيئة بتجميع واستخدام بيانات صور القمر الصناعى الفرنسى سبوت والقمر الصناعى الامريكى لاندسات فى ازمنة مختلفة سواء الاحادية الطيف او المتعددة الاطياف والتى تتميز باحتوائها على بيانات رقمية مفيدة. وتستخدم طريقة تحديد التغيرات لتحديد الاراضى التى حدث بها تغير فى الغطاء الارضى واستخدامات الاراضى فى ازمنة مختلفة من بيانات صور الاقمار الصناعية الملتقطة فى ازمنة مختلفة. ويهدف هذا البحث الى تحديد التغيرات على المستوى القومى لمنطقة شرق الدلتا حتى عام ١٩٩٧ باستخدام صور الاقمار الصناعية المخزنة بأرشيف المعهد وذلك باستخدام طريقة تصنيف اقصى احتمال.