Assiut J. Agric. Sci., (45) No. (2) 2014 (125-143) (Special Issue)
(The 7th Conference of Young Scientists) Fac. of Agric. Assiut University April, 28, 2014.

Land Use Change Detection using RS Data and GIS Application A case study Aswan Governorate

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Abstract:

The Egyptian government and the private sector in Aswan are interested in developing Aswan governorate, which represents a large future sustainable zone for different types of land use including agricultural, urbanization, wastewater disposal, landfill and industrial sites. The governorate area is about 62726 km². However, the inhabited area does not exceed 2%. The current study focus on the analysis of the land use changes in the area since 1986 till 2003, by using modern techniques, which include RS data and GIS programs.

The results showed that there were obvious changes in land use in the study area of 46382.25 km², since 1986 till 2003 where it was found a lack of arable land as much as 445.25 km² (0.96% of the study area) and a shortage of the desert lands as far as 1752.86 km² (3.78%). On the other hand, the urbanized area increased by 2571.39 km² (5.54%). These lands were utilized for building and other activities.

The results also showed that although the reclaimed area increased but the old agricultural land changed to other uses such as building construction and other activities. This was clarified by producing maps showing the changes in land use.

Keywords: RS, GIS, Land use map, Change detection, Aswan governorate.

Received on:17/4/2014 **Accepted for publication on:** 26/4/2014

Referees: Prof. Mohamed A. El-Desoky Prof. Kamal K. Attia

Introduction:

Remote Sensing (RS) and Geographic Information Systems (GIS) have become prevalent methods in the analysis, compile, and process spatial data. They are considered powerful tools in the geological and environmental engineering applications. Data from remote sensing satellites are important in different aspects such as monitoring, mapping, infrastructure, environmental land use studies, and sustainable development, as well as to create a model of the different conditions and considerations facing any future developments (Youssef and Ghallab, 2007).

Remote sensing technique coupled with GIS is gainfully used for such comprehensive analyses, and can support decision makers to develop successful strategies for sustainable projects. (Youssef and Ghallab, 2007).

Prakasam. (2010) states that land use and land cover are important components in understanding the interactions of the human activities with the environment. It is necessary to be able to simulate land use/land cover changes in the past 40 years and to identify the main forces behind the changes by using RS data and GIS application with multi-temporal satellite images and he found that the forest lands were reserved and dense forest. But day by day forest lands were converted to build-up settlements, road, tourists amenities and agricultural land.

Recently, the Egyptian Governorate has selected many regions all over the country for different types of developments. One of these regions is Aswan governorate in upper Egypt, which is considered one of the most promising development areas. The governorate estimated by 62726 km² but the percentage of the populated area does not exceed 2%.

The objective of this study is use of remote sensing and geographic information systems in Aswan governorate to produce maps of the changes in the land use since 1986 till 2003 and to predict possible changes in the land use in the coming years to help the decision makers to be in the right direction of possibilities for development in the region. The interpretation and analysis of satellite images will be done through using the multi-temporal resolution images including Landsat Thematic Mapper (TM 1986), (TM 1998) as well as Enhanced Thematic Mapper Plus (ETM+ 2003).

Environmental Setting of the Area

Location

Aswan governorate is located at latitude 22^{o} north of the equator. It is bordered by Luxor governorate in the north, and Red Sea governorate in the east, and Lake Nasser in south, and New Valley in the west. The study area is located between latitudes 23^{o} 45$^{/}$ and 25^{o} 15$^{/}$ N, and longitudes 32^{o} 30$^{/}$ and 34^{o} 40$^{/}$ E. (Figures 1 and 2).

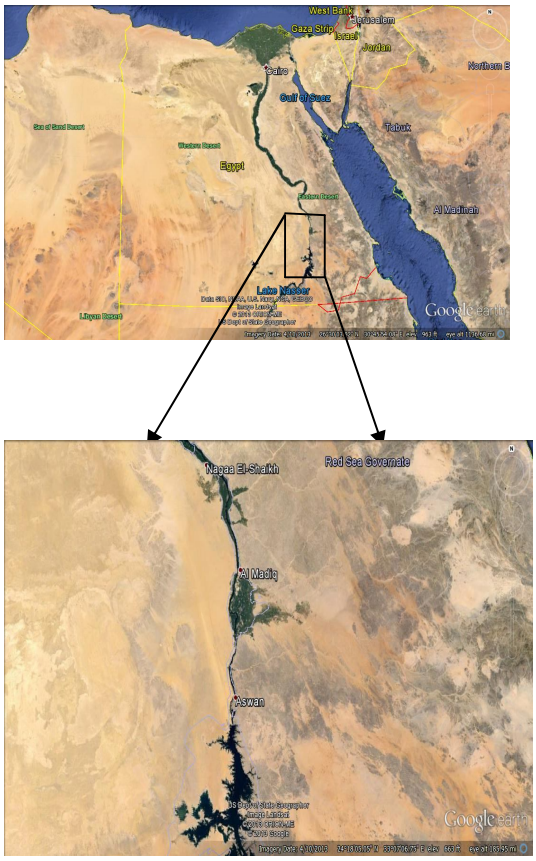

Fig. (1): Location map of the study area.

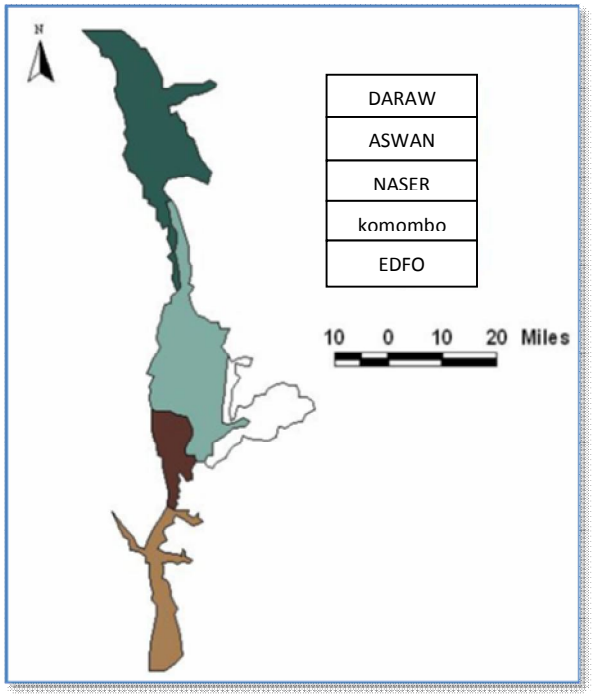

Fig.(2): Administrative division of the province of Aswan.

Climate:

Aswan governorate in the winter the maximum temperature ranges between 19 and 26 C^o and the minimum one is between 0 and 10 C^o. In the spring the maximum temperature ranges from 30 to 39 C^o while the minimum one is between 13 and 18 C^o. In the summer the maximum temperature rises to be between 31 and 41 C^o and the minimum one to be between 20 and 25 C^o. In the autumn the maximum temperature is between 30 and 39 C^o and the minimum one is between 18 and 35 C^o.

The relative humidity rises to the maximum level up to 33% in the winter, up to 2% - 3% in the spring, up to 16% in the summer and up to 25% in the autumn. (Egyptian Metrological Authority, 1996-2006).

Table 1 illustrates the average temperature and relative humidity during the seasons in Aswan governorate.

Table (1): The average temperature and relative humidity during the seasons in Aswan governorate.

Season	Average Temperature (C^o)	Humidity (%)
Winter	14 – 19	33
Spring	24.5 – 28.8	2 - 3
Summer	31.1 – 35.4	16
Autumn	11 – 30	25

Geology:

In Aswan there are geological formations that appear on the surface depending on the geological times. (EGPC, 1987).

In Aswan governorate we found the Archite (pre-Cambrian) formations in the east of Lake Nasser and the Nile river which is a mixture of igneous and metamorphic rocks origin of sedimentary like schist, gneiss and granite, as well as in the rocky islands in the Nile.

There are configurations of the Cretaceous Nubian Sandstone in the north of Sudan thickness of 500 meters and after the latest layer of limestone and clay.

The Eocene formations of limestone in Sebaa, Oligocene formations of basaltic rocks in the Nubia region, are represents the geological province.

Geomorphology:

Geomorphology is the science that specialized shapes terrain to study the earth's surface which study the general appearance of the shape on the earth, and the analysis of the evolution of this shape and relative age of the study geomorphological phenomena of the earth's surface.

Impact of geomorphology diversity address the rock composition and structure layer and do weathering and erosion processes in the formation of the earth's surface and serves many sciences related to the earth's surface such as pedology, hydrology and air photography interpretation.

In Aswan governorate, multiple landforms and geomorphological phenomena, especially in the genesis and evolution of the Nile river inside and landforms associated with it , such as sedimentary shores , lakes and valleys , bays and islands sedimentary and sedimentary plains and

river bends and islands , and the emergence of easy spate on both banks of the Nile river, which is controlled by plateau either the eastern and western slope or covered with sand or off and spread it cracks and does not accommodate only in river bends or behind the prominent rocky outcrops .

In Aswan river terraces appear on the western edge and on the island of Aswan one of the islands installed base of granite rock and loam deposits summit.

Lake Nasser, one of the largest artificial lakes in the world and its associated with the emergence of the High Dam which was formed behind the dam in an area with a solid stable geology Fireworks formation and the morphological changes in the lake region of the Delta Nubian and bays formation to the penetration of water into the mouths of valley and the heads flooring and island sedimentary.

Abound swirls of water and drilling vascular on rocky islands which paint varnish black, And much different weathering processes their impact in shaping the surface of the earth spreading phenomena and scaling and disintegration of rocks and mud cracks and melting operations and coloring. (Tolba, 2006).

Water resources in Aswan Governorate

Water represents the main objective part in the sustainable development of an area.

In Aswan governorate, most important sources of water is Nile river and the groundwater stored in the bottom of the stone rock in El Shalal area and West Kom Ombo. The rainfall and floods do not represent a major source of water for a few quantities which fall than in the winter.

The bulk of the water use is in agricultural use, which represents more than 85% and the rest of the uses include drinking water, health and industrial purposes.

Methodology:

Data and Software Used

In the present study, various types of data have been used including multi-temporal satellite images including, (TM 1986), (TM 1989), and (ETM+ 2003), and other relevant published information software's were principally used, including ENVI 4.7 digital image processing software and ArcGIS 9.3.

Image Pre-processing

The Environment for visualizing images (ENVI 4.7) was used to process and analyze the data on a personal computer (PC) environment. Multi temporal satellite images for landsat-5 and landsat-7 including (TM 1986), (TM 1998), (ETM+ 2003) were used and had been geometric and radiometric correction for the image based on topographic map and image to image registration, transformation and image enhancement was applied to improve the appearance of images for human visual analysis. These are shown in Figures 3, 4 and 5.

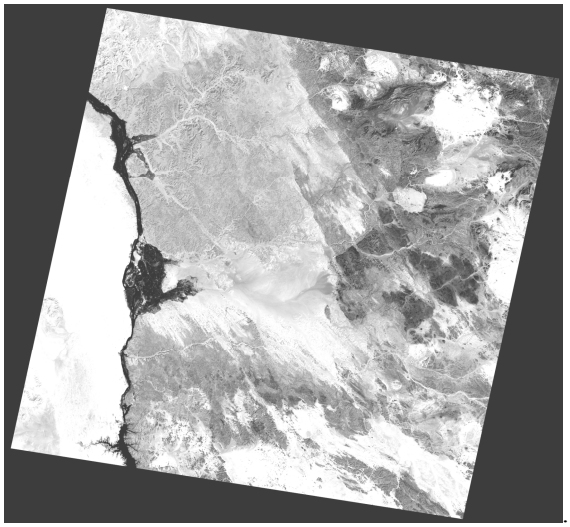

Fig.(3) Gray image, Aswan 1986.

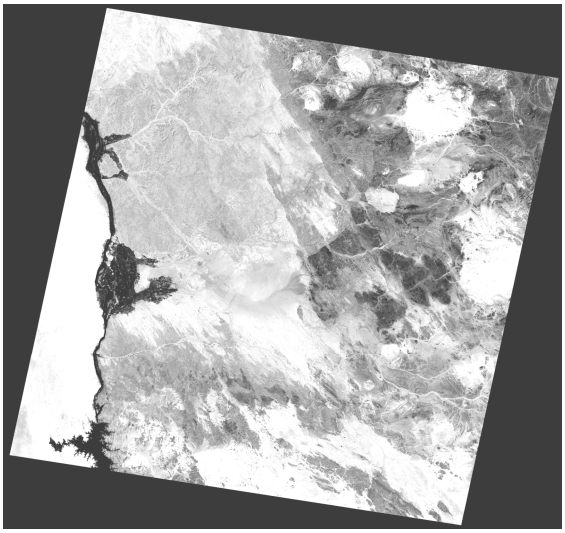

Fig.(4) Gray image, Aswan 1998.

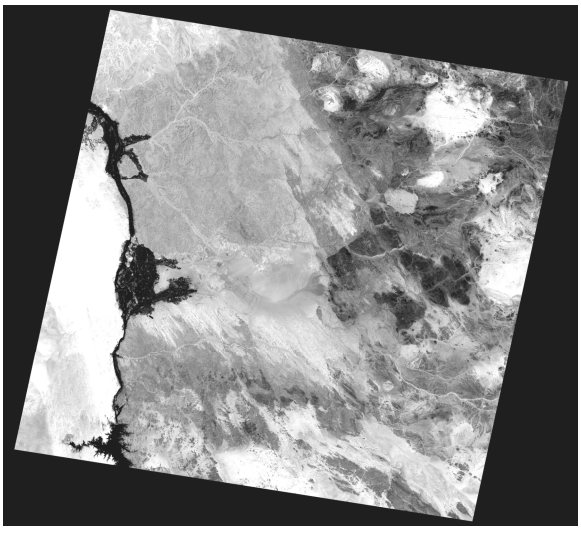

Fig. (5) Gray image, Aswan 2003.

Image processing has been done to improve the image false color composites (FCC) band 7, 4 and 2 in RGB, which used for visual interpretation.

Table (2): Characteristics image false color composites (FCC) band 7, 4 and 2 in RGB.

	Color	Band	SPECTRAL RESOLUTION (µm)	SPATIAL RESOLUTION (m)	UTILIZATION
R	Red	7	2.08 – 2.35	30	The study of the earth
G	Green	4	0.76 – 0.90	30	Studies vividness
B	Blue	2	0.52 – 0.60	30	The study of vegetation

An area for each image from different years of (Columns) by (Rows) pixels covering the region of interest (ROI) was selected for this study which was done by ENVI 4.7 to make the images more suitable for visual interpretation. Training ROI selections were used to perform land use cover classification.

Image classification:

The supervised classification by the minimum distance method used in the study was processed in ENVI 4.7. Land use / cover of the study area for each image was categorized into five land types: Urban land, sand, agriculture, water, unclassified using the five classifiers with the same ROIs training samples.

Urban land composed of built-up land, rocks and unused land. The agriculture land included all kinds of forest, arable land, cropland, grassland, greenbelt and garden land. The water area consisted of Nile river, ponds and canals. The training polygons or regions of interest (ROIs) selected as representative of each class throughout the study area were digitized on-screen based on the prior knowledge and visual interpretation. The methodology steps for image processing are shown in Figure 6.

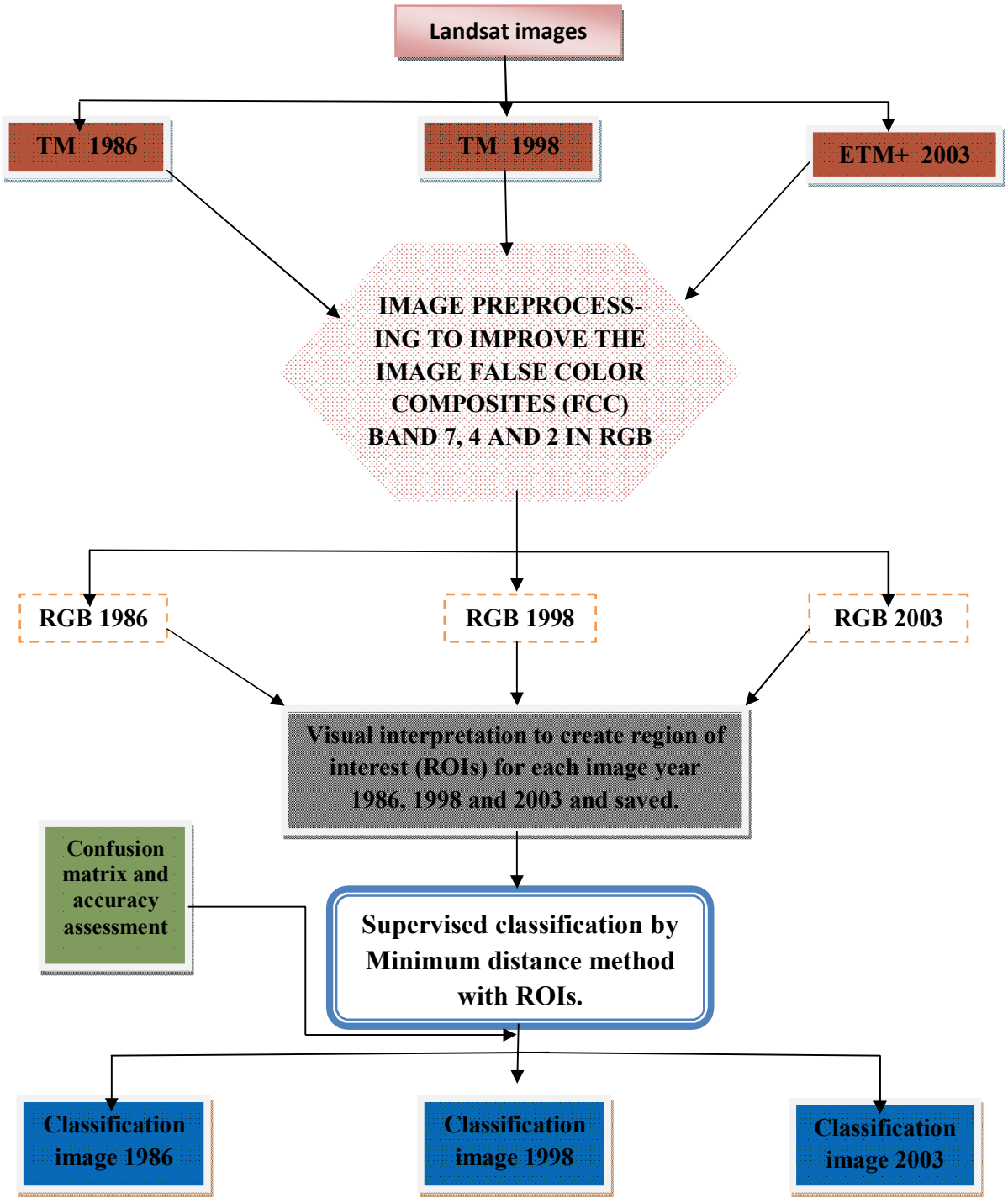

Fig.(6): Flow chart showing the methodology steps of image processing and classification.

All images after classification were opened with Arc-map in Arc GIS 9.3 for analyzing and presenting the results. In Arc-map, images were re-projected to a common projection, Universal Transverse Mercator (UTM) with WGS-84 datum and zone 36 north, and export images as a file JPEG. Figures 7, 8 and 9 show the classification images of 1986, 1998 and 2003, respectively.

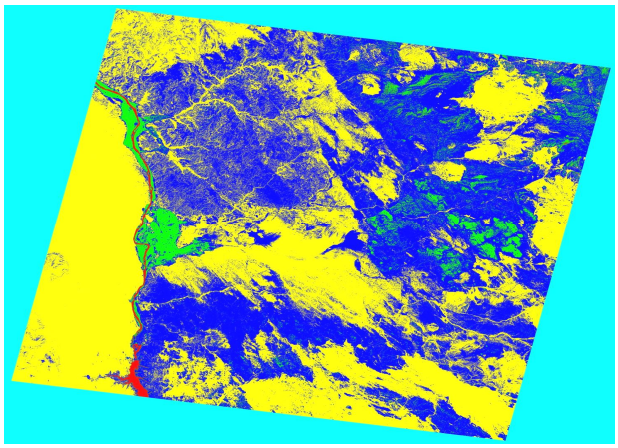

Fig.(7): classification image (year of 1986).

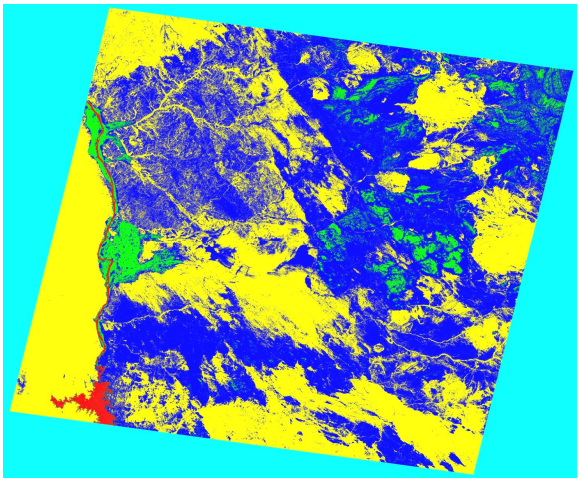

Fig.(8): classification image (year of 1998).

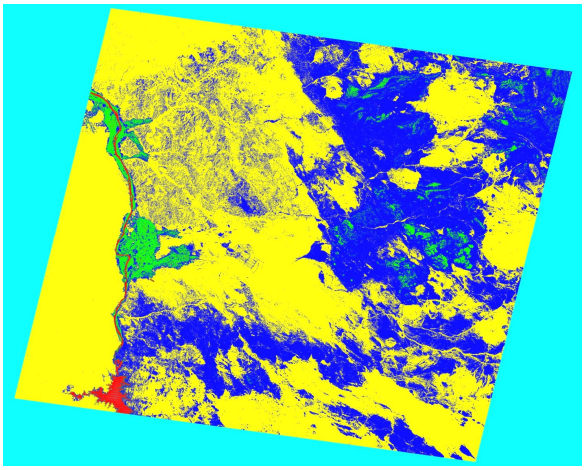

Fig.(9): classification image (year of 2003).

After the classification process all images for each year were converted with post-classification in ENVI 4.7 classification to vector using the five classifiers with the same ROIs training samples for each year were opened in Arc-map to create shapfile for each year and export images to JPEG, and were saved to produce land use map. The methodology steps to create land use map are shown in Figure 10

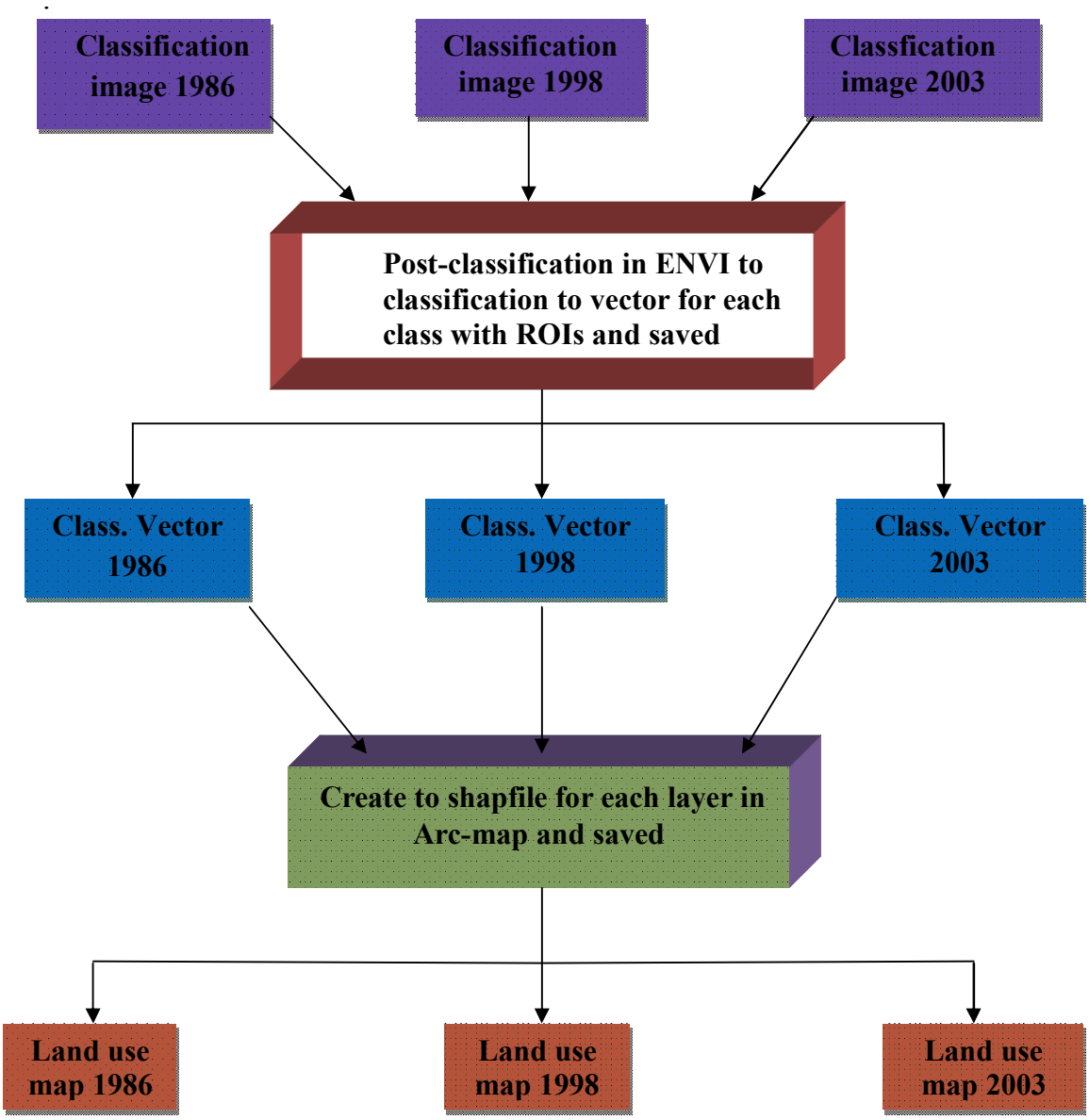

Fig. (10): Flow chart showing the methodology steps of land use map.

Accuracy Assessment:

The last stage of image processing is the calculation of accuracy assessment of the classification that was performed. The accuracy assessment gives insight into 'how good the classified image' is. In fact, any map should be accompanied by an indication of the accuracy. Therefore, an accuracy assessment should be performed and the resulting cross tables have to be interpreted. Accuracy assessments determine the quality of the information derived from remotely sensed data.

A random distribution of such sampling points over the whole region must be sought (Van Genderen et al., 1978). The accuracy assessment was conducted through a standard method described by Congalton (1991). Accuracy assessment of classification was calculated using an error matrix (Lillesand and Kiefer,

2003) which showed the accuaracy of both the producer and the user.

All points for each class for each image were taken through a sampling scheme. For accuracy assessment, all pixels were selected from the ground truth coverage. Land use maps and photographs for each year taken for documentary purposes were used as reference data to observe true classes. The overall accuracy and a Kappa analysis were used to perform a classification accuracy assessment based on error matrix analysis. A standard for land use maps was set between 85 (Anderson et al., 1976 and Bektas, 2003) and 90 % overall accuracy.

Change detection:

The change detection after the classification method is the most simple change detection analysis technique based on the classification. Each image of multi-temporal images is classified separately and after that the classification result images were compared. If the corresponding pixels have the same category lable, the pixel will not change, or else the pixel will change. The advantage of this method is that it does not only ascertain the spatial distribution of changes but also gives the nature of changes; in other words the information on the transition changes from one class to another.

ENVI 4.7 was used to change detection by compute difference map and enter the previous images where they are prepared from old images and then latest image. That mean enter image classified year 1986 then image classifies year 1998 and repeat it to enter image classified year 1998 then image classified year 2003 and repeat it to enter image classified year 1986 then image classified year 2003, and input parameters for each class, and open the result images in Arcmap to export land use change maps, (ESRI, 2008)

Post-classification was used to change detection statistics for each class or layer to produce a report about changes in land use between different images.

The methodology steps of change detection in land use to create land use map are shown in Figure 11.

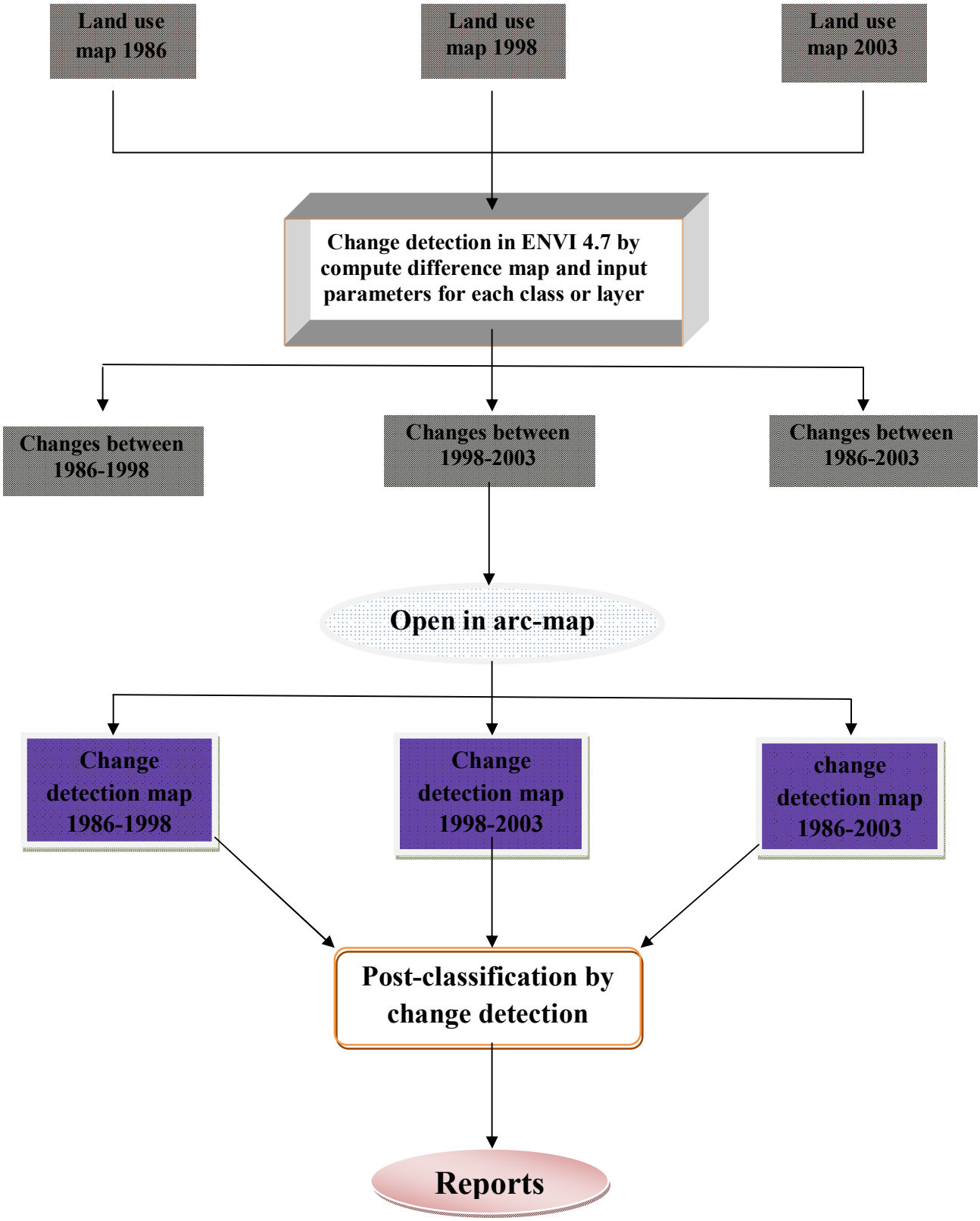

Fig.(11): Flow chart showing the methodology for change detection in land use.

Results and Discussion:

Land use is the human use of land and this is the manner in which human beings employ the lands and its resources.

Land use change is a process by which human activities make changes in the landscape.

In general, change detection involves the application of multi – temporal datasets to quantitatively analyze the temporal effects and Understanding the relationships and the interactions to better manage and use resources.

Change detection is useful in many applications such as land use changes, habitat fragmentation, rate of deforestation, coastal change, urban sprawl, and other cumulative changes.

Prabaharan (2010) reported that it has been observed that important coastal land use types of Vedaranniyam coast (Creeks, Rivers) like wetlands, lagoons drastically reduced. Proper land use management strategies need to protect the important of coastal zone land use types before extinction.

Land use change detection results (Table 4) are based on classification multi-temporal resolution images including (TM 1986), (TM 1998) and (ETM+ 2003) by using ENVI 4.7 digital processing software and ArcGIS9.3 with accuracy of 89.13%, 88.31% , and 86.80% , respectively, and Kappa coefficient of 0.8541 , 0.8375 , and 0.8153, respectively (Table 5).

Table (3): Total land use (km²) in Aswan during years of 1986, 1998 and 2003.

Land use	1986		1998		2003	
	Area (km²)	%	Area (km²)	%	Area (km²)	%
Water	183.92	0.40	249.31	0.54	217.72	0.47
Agriculture	1773.46	3.82	1690.10	3.64	1328.21	2.86
Urban	15261.54	32.91	16449.40	35.46	17832.93	38.45
Sand	15813.04	34.09	14929.89	32.19	14060.18	30.31
Unclassified	13350.29	28.78	13063.55	28.17	12943.21	27.91
Total	46382.25	100	46382.25	100	46382.25	100

Table (4): Total land use change (km²) in Aswan during years of 1986-1998, 1998-2003 and 1986-2003

Land use change	1986 -1998		1998 - 2003		1986 - 2003	
	Area (km²)	%	Area (km²)	%	Area (km²)	%
Water	+65.39	+0.14	-31.59	-0.07	+33.80	+0.07
Agriculture	-83.36	-0.18	-361.89	-0.78	-445.25	-0.96
Urban	+1187.86	+2.55	+1383.53	+2.99	+2571.39	+5.54
Sand	-883.15	-1.90	-869.71	-1.88	-1752.86	-3.78
Unclassified	-286.74	-0.61	-120.34	-0.26	-407.08	-0.87
total	0	0	0	0	0	0

Table (5): Accuracy Assessment results of classification images.

Image	Accuracy assessment (%)	Kappa coefficient
TM 1986	89.13	0.8541
TM 1998	88.31	0.8375
ETM+ 2003	86.80	0.8153

The results of this research show that the land use in Aswan governorate of agriculture activity was 1773.46 km² accounting for 3.82% in 1986, 1690.10 km² accounting for 3.64% in 1998 and 1328.21 km² accounting for 2.86% in 2003. There is a decrease in the agriculture activity from 1986 to 2003 that is estimated by 445.25 km² representing 0.96% of the total area. On the other side, that there is an increase in the establishment of housing and other activities (Tables 3 and 4). Where it was 15261.54 km² accounting for 32.91% in 1986, 16449.40 km² accounting for 35.46% in 1998 and 17832.93 km² accounting for 38.45% in 2003. This increase is estimated by 2571.39 km² representing 5.54% of the total area.

Although reclaimed new land involved in the deserts on both sides of the Nile river this area decrease from 15813.04 km² in 1986 to became 14060.18 km² in 2003 that account for 1752.86 km² (3.78%), (Table 4), increases in land use in the establishment of housing and other activities on agricultural land in the province were found during the period from 1986 to 2003. Maps of land use for each year are shown in Figures 12, 13 and 14. Moreover the changes in the land use are described by land use change maps (Figures 15, 16 and 17).

Distribution of land use area (Km²) and percentage (%) during years of 1986, 1998 and 2003 in the study area are shown in Figures 18 and 19.

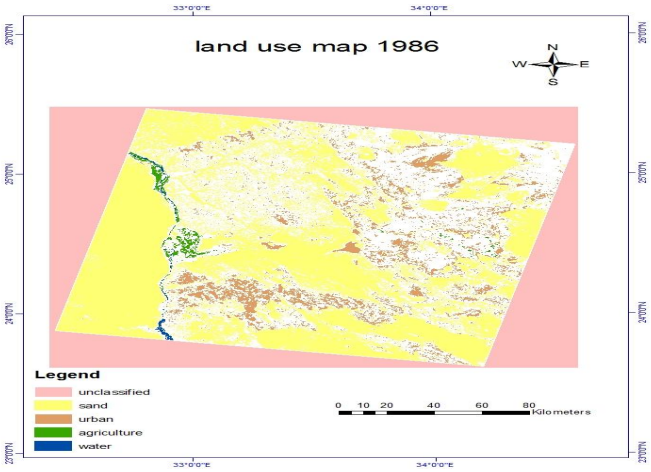

Fig.(12): A land use map in Aswan 1986**.**

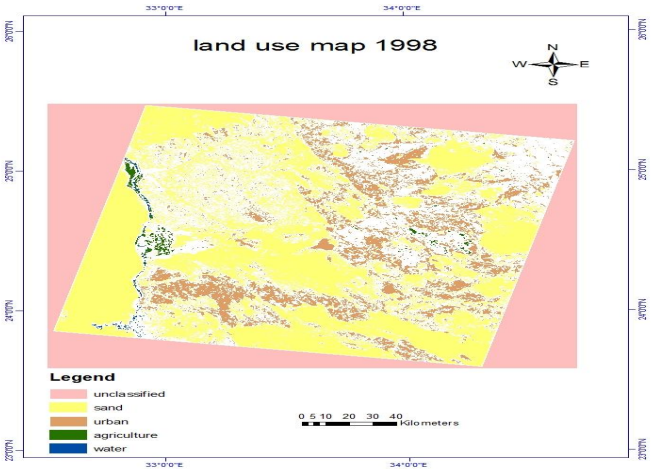

Fig.(13): A land use map in Aswan 1998.

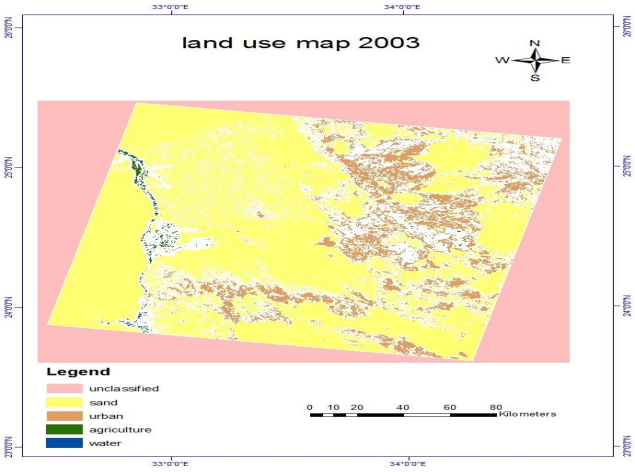

Fig.(14): A land use map in Aswan 2003.

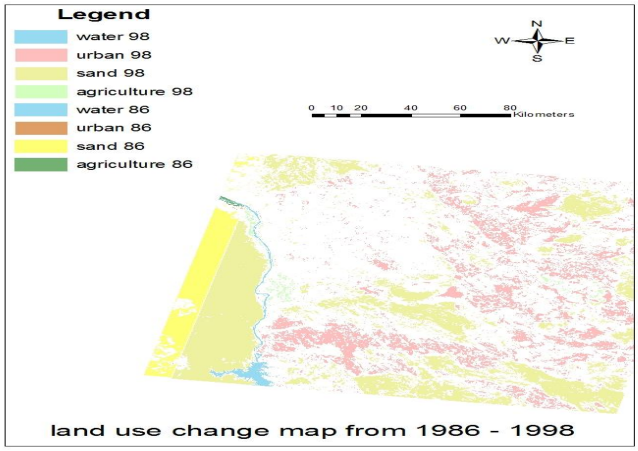

Fig. (15): A land use change map from 1986 – 1998**.**

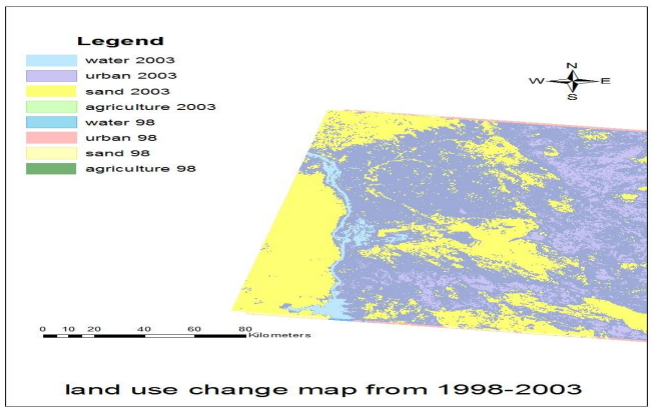

Fig. (16): A land use change map from 1998 – 2003.

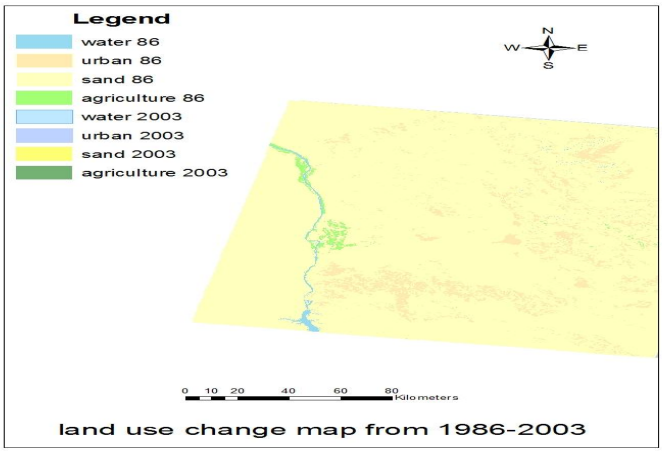

Fig. (17): A land use change map from 1986 – 2003.

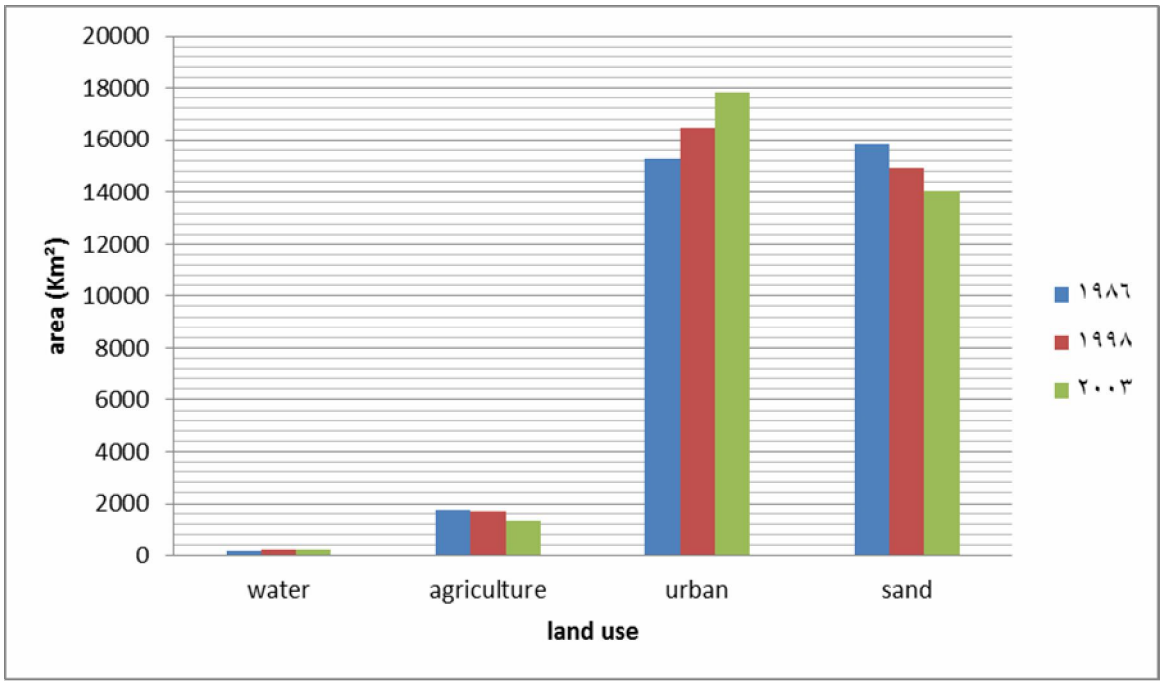

Fig. (18): Distribution of land use area during years of 1986, 1998 and 2003 in the study area.

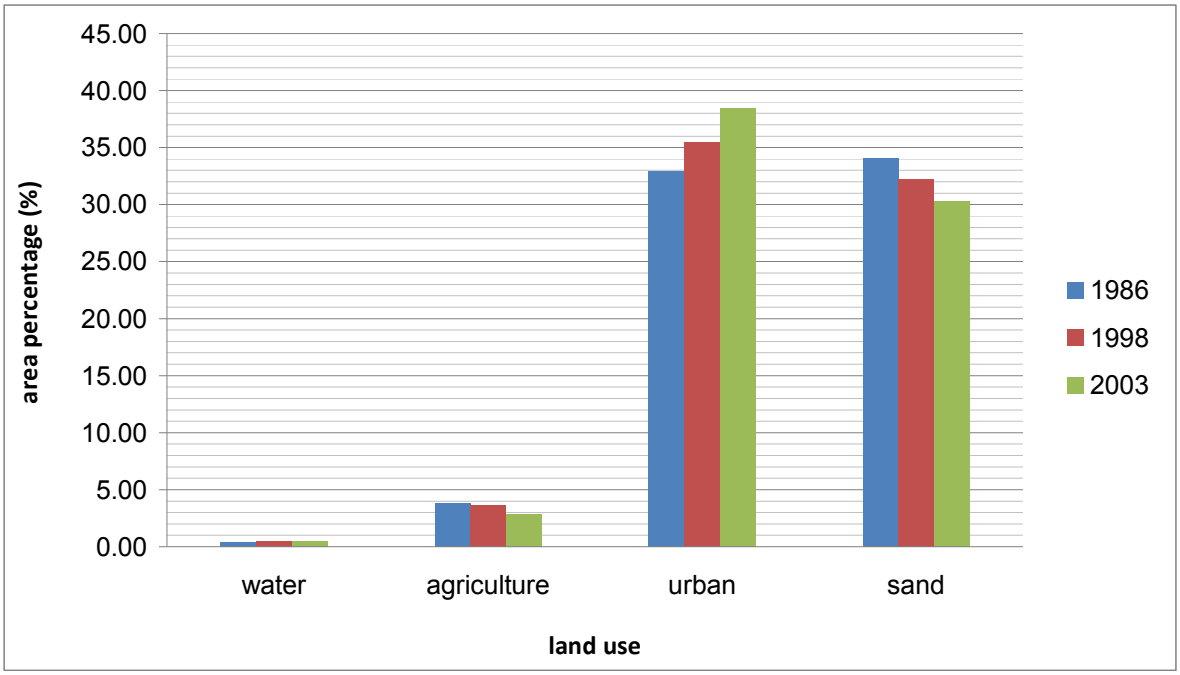

Fig. (19): Distribution of land use percentage during years of 1986, 1998 and 2003 in the study area**.**

Conclusion:

Interdependence between remote sensing data and GIS application has been employed in the current study to detect the land use changes in Aswan governorate since 1986.The change detection has been mapped by using multi-temporal resolution images which were classified and analyzed with ENVI 4.7 digital image processing software and ArcGIS 9.3.

Recomindations:

Aswan governorate needs more attention for the reclamation and expand the network of irrigation and attention to irrigation and drainage projects, and enact laws that actually prevent encroachment on farmland preservation and working on the development of land uses in various fields.

Aswan governorate and large area of its special character and the populated area percentage not exceeding 2% (agriculture, housing and other activities) and you need to pay more attention with decision-makers for development of land use planning in the future.

References:

Anderson, J.F., E.E. Hardy, J.T. Roash and R.E. Witmer 1976, A land use and land cover classification system for use with remote sensor data. U.S. Geological Survey Professional Paper 964. U.S. Geological Survey, pp. 28. Washington, DC.

Bektas, F., 2003, Remote Sensing and Geographic Information Integration: A Case Study; Bozcaada & Gokseada Island, M.Sc Thesis, Institute of Science and Technology, Istanbul Technical University.

Congalton, R.G., 1991, A Review of Assessing the Accuracy of Classification of Remotely Sensed Data. Remote Sensing of Environment, Vol. 37, No (1): 35 – 46.

Egyption Metrological Authority 1996-2006 Climatic Atlas of Eygpt. Puplished Arab Republic of Eygpt, Ministry of Transport, Cairo, Eygpt.

Eygption General Petroleum Corporation (EGPC) – Conco Coral (1987): Geological map of Eygpt scale 1 : 500,000.

Economic and Social Research Institute *(*ESRI*),* 2008. ArcMap version 9.3 use Manual. Redlands, CA, USA.

Lillesand, T.M. and R.W. Kiefer 2003, Remote Sensing and Image Interpretation. Second ed. John Wiley and Sons, New York, 724p.

Prakasam, C. 2010, Land use land cover change detection through remote sensing approach: A case study of Kodaikanal taluk, Tamil nadu, Inter. J. of Geomatics and Geosciences Vol. 1, No (2): ISSN 0976 – 4380.

Prapaharan, S., K. Srinivasa Raju, G. Lakshumanan, and M. Ramalingam. 2010. Remote Sensing and GIS Application on Change Detection Study in Coastal Zone Using Multi Temporal Satellite Data, International Journal of Geomatics and Geosciences Vol. 1, No (2): ISSN 0976 – 4380.

Van Genderen, J.L., B.F. Lock and P.A. Vass. 1978, Remote sensing: statistical testing of thematic map accuracy. Remote Sensing of Environment, 7:3 – 14.

Youssef, M. A. and A. Ghallab, 2007, Using remote sensing data, GIS, and filed investigation for preliminary consideration of sustainable development: West Qena area, Eygpt. Ass. Univ. Bull. Environ. Res. Vol. 10 No. (2), October 2007

.

مراجع باللغة العربية:

١- برهام، طلبة طلبة (٢٠٠٦) دراسة جغرافية بأستخدام نظم المعلومات الجغرافية – منطقة أسوان، منشور على شبكة الانترنت ، شعبة الخرائط، قسم الجغرافيا، كلية الأداب، جامعة المنصورة

Assiut J. Agric. Sci., (45) No. (2) 2014 (125-143) (Special Issue)
(The 7th Conference of Young Scientists) Fac. of Agric. Assiut University April, 28, 2014.

رصد التغير فى إستخدام الاراضى بإستخدام بيانات الاستشعار عن بعد وتطبيقات نظم المعلومات الجغرافيه ــ دراسة حالة محافظة أسوان

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الملخص:

أخذت محافظة أسوان فى الوقت الحالى الاهتمامات الجادة من جانب الحكومة المصرية وكذلك المجتمع المدنى لدفع عمليىة التنمية فى أسوان. حيث تعتبر محافظة أسوان من أهم المناطق المؤهلة للتنمية المستدامة المستقبلية فى العديد من المشروعات الكبرى ومن أهمها التنمية الزراعية، المدن السكنية، مشروعات الصرف الصحى والمخلفات الصلبة، وكذلك المشروعات الصناعية، وتقدر مساحة المحافظة بحوالى ٦٢٧٢٦ كيلو متر مربع لكن النسبة المئوية للمساحة المأهولة منها لا تتجاوز ٢%.

تركز الدراسة الحالية على دراسة التغيرات الحادثة فى إستخدامات الاراضى بالمحافظه منذ عام ١٩٨٦ وحتى عام ٢٠٠٣ وذلك بالاعتماد على إستخدام التقنيات الحديثة مثل تقنيات الاستشعار عن بعد ونظم المعلومات الجغرافية .

وقد بينت نتائج هذه الدراسة أن هناك تغيرات واضحة فى إستخدامات الاراضى منذ عام ١٩٨٦ وحتى عام ٢٠٠٣ فى منطقة الدراسة البالغ مساحتها ٤٦٣٨٢,٢٥ كيلو متر مربع . حيث تبين نقص فى الاراضى الزراعية بحوالى ٤٤٥,٢٥ كيلو متر مربع (بنسبة ٠,٩٥٩ % من المساحة الكلية لمنطقة الدراسة) ونقص فى مساحة الاراضى الصحراوية بقدر ١٧٥٢,٨٦ كيلو متر مربع (بنسبة ٣,٧٧٩%) ويرجع ذلك الى زيادة مساحات الاراضى المستخدمة فى البناء والإستخدامات الاخرى مثل الطرق والمبانى السكنية والخدمية ومشروعات الرى والصرف بمقدار ٢٥٧١,٣٩ كيلو متر مربع (بنسبة ٥,٥٤٣%) وهذه النتائج بينت أنه بالرغم من انه تم إستصلاح مساحات جديدة من الاراضى فى الصحراء والوديان إلا أن مساحات الاراضى الزراعية القديمة تغيرت الى إستخدامات أخرى فى إقامة المبانى والإستخدامات الاخرى المختلفة خلال تلك الفترة .

وتم توضيح هذه التغيرات بإنتاج خرائط إستخدامات الاراضى والتغيرات الحادثة فيها .