LAKE MARYUT MONITORING USING REMOTE SENSING

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ABSTRACT

Lake Maryut is one of the egyptian northern lakes and the most threatened. The lake has gone over the years to the extent that it became dry in several years. This research aims to identify the rate of land reclamation of the lake over the last three decades. This was undertaken using imagery acquired from GeoEye satellite (google Earth) to employ historical remotely sensed data to reveal the long-term changes in the physical characteristics of the lagoon.Results revealed that the overall size of the lake decreased as mentioned before by the rate of 200,000 square meters per year. The major landfill area violations are clearly identified in the western part of the 6000 basin of the lake while other landfill violations are noticed all over the boundary of the basin.

Keywords: Lake Maryut, GeoEye satellite, land reclamation

1 INTRODUCTION

Remotely sensed images can be used as a tool to map ecosystems and to detect, monitor and evaluate changes within them thereby supporting the development of resource management strategies. Satellite and airborne systems offer major opportunities for monitoring large scale, earth surface characteristics and provide a database for change detection studies. Remotely sensed data can be used to span temporal and spatial scales ranging from local to aggregated global systems (Graetz, 1990). Monitoring global, regional and local areas can be performed by restricting the analysis to a single sensor series or by using different satellite data. With the availability of data from remote sensing satellites such as the Landsat series, it has become cost effective and convenient to acquire multi-date images over a greater array of spatial and temporal scales than was possible with aerial photography. The temporal resolution of data (the ability to obtain repeated coverage of a specific geographic area, 16 days in the case of Landsat TM) from such sources permits regular image acquisition over the same area enabling change detection at relatively high temporal frequency (Lillesand et al., 2008).

Common types of detectable land cover change, which can be monitored using remotely sensed data, include vegetation disturbance and regeneration, agricultural intensification, urban expansion, spatial changes in aquatic ecosystems and hence surface water extent, as well as a variety of soil disturbance processes including overgrazing and soil erosion (e.g. Milne, 1988; Hall et al., 1991). Satellite and/or airborne data has been demonstrated to have particular use for monitoring water and vegetation changes withinaquatic ecosystems including wetlands (Howman, 1988). Remote sensing techniques can enable ecologists and resource managers to monitor the vegetation condition and detect environmental change trends in regions where difficult terrain, poor access, and extreme climate conditions make regular field investigations difficult.

In northern coast of Egypt, remote sensing has made major contributions to monitoring a variety of wetland systems, (Avache, 2009). Lake Maryut is the smallest of the northern lakes and perhaps the most threatened. The Lake was formed at least six thousands year ago. The present Lake represents the ruminant of a huge ancient Pre-historic Lake Mareotis. It covered an area of approximately 700 km2. The lake has gone over the years to the extent that it became dry in several years. GeoEye satellite data, for example, has enabled the identification of the impacts of both natural processes and human interventions on Maryut Lake. Results from studies utilising data from these sources have revealed that pollution resulting from land-use changes, environmental modification and other practices associated with rapid population increase, and change of the lake area due to land fill processes.

2 LAND RECLAMATION IN LAKE MARYUT

The Lake Maryut is located between Latitude 31º 07' N and Longitude 29º57' E along the Mediterranean coast of Egypt, figure (1). It defines the southern boundary of the city ofAlexandria. Lake Mariout is a shallow water lake with a water depth of approximately 1.5m(CEDARE, 2008). Canals divide the lake water body in to several basins. The earthembankments along the canals have several breaches that allow water to flow from thecanals into the basins and vice versa creating interaction between water bodies. Thereare three main inflows to the Lake Maryut: the Qala drain located to the North-eastpart of the lake, the Omum drain located at the east of the lake and the Nubarianavigational canal located at the south of the Lake. Besides, there are two minorinflows: one from the West Nubaria drain and the second, from the West WastewaterTreatment Plant (see Figure 1). The only outflow from the Lake Maryut is El Mexpumping station which consists of two buildings, each housing six pumps with nominalcapacities of 12.5 m^3/s (USAID Project 263-0100, 1996).

Lake Maryut has been subjected to a long series ofland reclamation projectsover the years that cumulatively have had a dramatic impact on the lake. Over the last 65 years,the smallest of the northern lakes has lost approximately 71 percent of its area, decreasing from59,000 feddans in 1935 to between 15,000 to 17,000 feddans today.). Most recently, the so-called 6,000-feddan basin, which fishermen regardas the most productive, was reduced to approximately 4,000 feddans.From the 1940s to 1960s, land reclamation was mostly conducted for agriculture. In addition, aseries of roads and drainage and navigation canals were constructed that etTectively cut LakeMaryut into five individual basins that are named after their former surface areas: 6,000 feddans(the main basin), 5,000 feddans, 3,000 feddans, 2,000 feddans, and 1,000 feddans. Roads andcanals have blocked the movement of water, fish and fishermen, and make each basin functionindependently. As a result, each basin has unique characteristics that requires specificallytailored management activities. In the early 1980s, about 1,400 feddans were dried for severalprojects that included the sewerage facility, electricity plant, and an international park, see figure (2). Sincethen, other parts of the lake have been filled in with garbage.

Today the pressure to reclaim the lake comes from urban development. Lake maryut is located justminutes away from the heart of downtown Alexandria, which has experienced rapid growth inrecent years. With the price of land increasing in the city, real estate developers have set theirsights on the wetland as one of the last large open spaces available for future urban expansion.They estimate that the land is worth billions of Egyptian pounds.periodic proposals arise to reclaim a 30,000 feddan area that would include Y!aryut. With strongfinancial and political pressure to convert the lake for agriculture and urban development. Lake Maryutcould disappear in the next decades. The impacts of drying up the entire lake outside ofthe loss to fishing - including removal of an important drainage area for wastewater treatment.the removal of a buffer for Alexandria between the city and desert, salt-water intrusion ofgroundwater resources, and a buffer for flood waters - have yet to be fully understood oraccounted for in economic valuations.To counter this threat, an informal coalition of public and private groups made up of fishermen.scientists, and environmentalists have periodically rallied together to hold conferences and publicmeetings advocating for the lake. Fishermen have even called strikes to protest. Thesegrassroots efforts have apparently met with some success, (El Sayed et.al, 2000).

Recent plans to reclaim the entire6,OOO-feddan basin were called off after the strike - Only 2,000 feddans were reclaimed.In general, advocates for protecting the lake claim that a great deal of misunderstanding existsabout the condition of the wetland and its ability to be restored. They contend that the publichas been misled to believe that the lake is too polluted to be saved, but the reality is thatrestoration ofMaryut's ecosystem and fisheries are promising under the right conditions.

3 METHODOLOGY

This study employed remotely sensed image processing supported by expert opinion on site characteristics. The aims were to demonstrate the utility of remotely sensed imagery for identifying key environmental features within Lake Maryut. This was undertaken using imagery acquired from GeoEye satellite (google Earth) to employ historical remotely sensed data to reveal the long-term changes in the bio-physical characteristics of the lagoon. The following sections describe the different stages of the analysis.

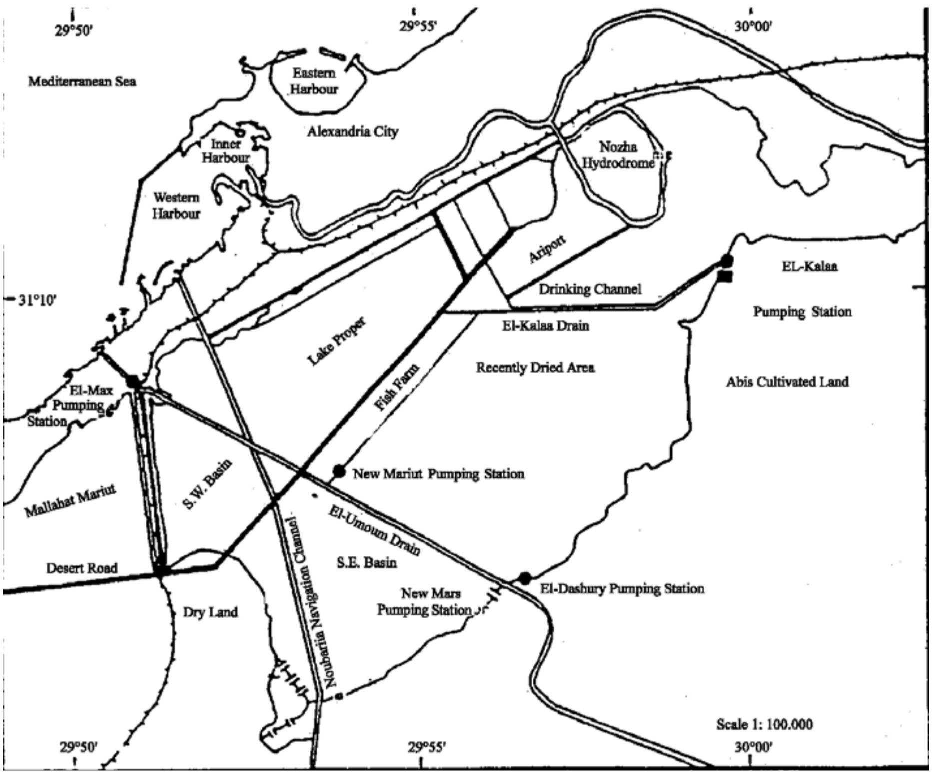

Figure 1.Outline of Lake Maryut indicating the various basins

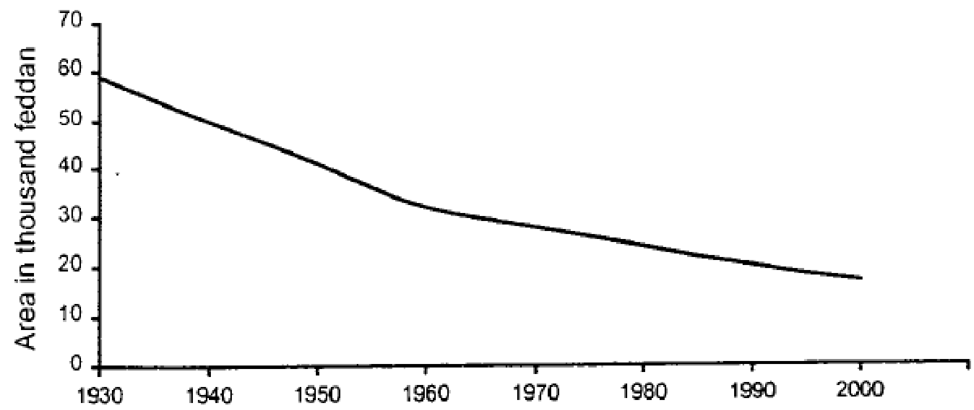

Figure 2 Lake Area decrease from 1930- 2000

3.1 Image identification and acquisition

The initial aim for the analysis of contemporaryimages was to employ data from the same sensor. A suitable, cloud free images of Lake Maryutwere available from this source for 13/5/2002, 6/6/2007 and 16/9/2012. Therefore, historical images for the lagoon were acquired to facilitate the identification ofdecadal scale change. GeoEye satellite images are characterized in the table 1 as follows:

Table 1: Geoeye-1 Imaging Specifications

Imagery			Satellite	
	Panchromatic	*Multispectral*	Swath Width	15.2 km
Spatial Resolution	.41 meter	1.65 meters	Off-Nadir Imaging	Up to 60 degrees
Positional Accuracy	5 meter CE90 (specification) 3 meter CE90 (measured)		Dynamic Range	11 bits per pixel
			Mission Life	Expected > 10 years
			Revisit Time	Less than 3 days
Collection Capacity	350,000 sq km/day (Pan + MSI)		Orbital Altitude	681 km
			Nodal Crossing	10:30 am

3.2 Creation of Colour Composite Images

Colour composite image combinations were produced from the GeoStereo GeoEye-1 images using the ER Mapper and PCI image processing systems: 1) red, green and blue channels fusedwith panchromatic image; 2) near infrared, red, green channels fused with panchromatic image. The image combinations were enhanced using manual contrast stretching.

4 RESULTS AND DISCUSSION

Figure 3 shows a false colour composite of the GeoEye image of Lake Maruit acquired on 16/09/2012. Whereas in Figs. 4 and 5, GeoEye image of Lake Maruit acquired on 6/6/2007 and 15/3/2002. The three images are enhanced using general stretching to discriminate the water body from the land.These three images showing the lake water body delineated by blue colour in year 2012 whereas it is delineated by yellow colour in year 2007 and by red in 2002. Table 2 is demonstrating the resultant area calculation for the lake water body during 10 years. Lake area delineation is showing continuous reduction of the water body. The rate of reduction is approximately one square kilo-meter each five years. This leads to annual reduction of 0.2 square kilo-meters per year (200,000 square meters) as shown in figure 6.

Table 2: Acquired geoEye Satellite images

Date	Lake Area (Km2)	Area Reduction (Km2)
16/09/2012	28.046258	0.951518
06/06/2007	28.997776	0.915468
13/05/2002	29.913244	-

Figure 3: GeoEye image acquired in 16/9/2012

Figure 4.GeoEye image acquired in 6/6/2007

Figure 5. GeoEye image acquired in 15/3/2002

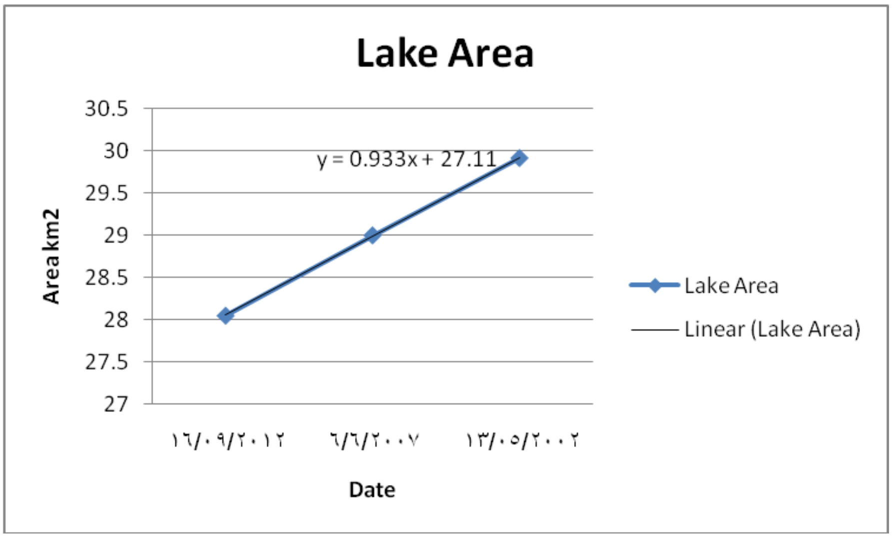

Figure 6. calculated lake area decrease from 2002 to 2012

5 CONCLUSION

The false colour composite of the three images acquired on different dates within a period of up to 10 years duration enable the identification of environmental changes. These changes relate to Lake Maryut boundary and in its surrounding near landscapes.Principal environmental change features can be discussed providing details from the same areas within the earliest and latest images to illustrate the specific changes which can be identified. The most marked changes within the lake are concerning the decrease of the water body due to landfill. The lake water body size measurements made by delineating the lake boundary using on screen digitizing. The overall size of the lake decreased as mentioned before by the rate of 200,000 square meters per year. The major landfill area violations are clearly identified in the western part of the 6000 basin of the lake while other landfill violations are noticed all over the boundary of the basin.

REFERENCES

Ambrose, J. & P. Shah, 1990. The Importance of RemoteSensing and Mapping for Resource Management: A CaseStudy of Nepal. Integrated Surveys Section, TomkcalSurveys Branch, Government of Nepal: 2161–2164.

CEDARE (2007). Alexandria Lake Mariout Integrated Management – Stocktaking Analysis report.

Graetz, R. (1990), Remote Sensing of Terrestrial Ecosystem Structure: An Ecologist's Pragmatic View. In: *Remote Sensing of Biosphere Functioning,* R. Hobbs and H. Mooney, eds. Spring-Verlag, New York, pp 5-30.

Hall, F., D. Botkin, D. Strebel, K. Woods and S. Goetz. (1991), Large-scale Patterns of Forest Succession as Determined by Remote Sensing. *Ecology* 72(2): 628-640.

Howman, A. (1988), The Extrapolation of Spectral Signatures Illustrates' Landsat's Potential to Detect Wetlands. *Proceedings of lCARSS '88 Symposium, Edinburgh, Scotland, September 13-16.* pp 537-539.

Lillesand, T., J. Chipman, D. Nagel, H. Reese, M. Bobo, and R. Goldman. (1998), Upper Midwest gap analysisprogram image processing protocol. Rept. for U.S. Geol. Surv. Environ. Manag. Tech. Ctr., Onalaska, WI, EMTC 98-G001, 25 p. + append.

Milne, A. (1988), Change Detection Analysis Using Landsat Imagery: A Review of Methodology. Proceedings of IGARSS '88 Symposium, Edinburgh, Scotland, Sept. 23-16,, pp 541-544.

TawfikMostafa El Sayed, Mohamed El Shinawy and Magdy Abbas.Report No. 118 Environmental Assesssment to promote the sustainable development of fishery r in the northern delta lakes of Egypt - Resource Economics Section ofAPRPIRDI, August 2000

USAID Project Nº 263-0100, (1996). Hydrologic Studies of Lake Mariout Technical Memorandum Nº8.