APPLICATION OF NEW TECHNOLIGIES IN AQUATIC WEEDS MANAGEMENT IN KHORS EL-ALAKY AND TOSHKA, NASSER LAKE, EGYPT

Magdy Hosny

Assistant Prof., Channel Maintenance Research Institute, National Water Research Center, Delta Barrage, P.O. Box 13621, Egypt

ABSTRACT

Accurate maps of the aquatic weeds distribution within large open areas or complex shoreline (khors) are essential for an effective weeds control program. In this research, Landsate-7 TM Satellite images covering Khor El-Alaky and Khor Toshka were classified using band ratio technique and compared the results with the supervised and unsupervised classification techniques. In fact, the satellite images and global positioning system (GPS) with the aid of Geographic information system (GIS) are shown to be useful tools for detecting and mapping the aquatic weeds. The final developed maps revealed that the maximum value of aquatic weed infestations occurs during the period of April-March and sharply declines during the period September-November. This can be attributed to the effect of flood occur in the beginning of August each year. In conclusion, the band ration technique has proven to be an effective mean to distinguish between the ditch bank weeds and submerged weeds.

Key Words: Remote Sensing, Nasser Lake, GIS, Landsate Images

INTRODUCTION

Accurate maps of the aquatic weeds distribution within a reservoir or riverine system are powerful tools for many operational and management including decisions that affect budget requests, selection of priority treatment area and control methods, and timing of applications. Traditionally, the aquatic weeds infested areas are estimated by visual inspection or using aerial photographic-based methods. However, the use of these methods, for large open areas or complex shoreline areas, has proven to be unreliable. Utilizing aerial photographic method requires an intensive labor and months to complete and generally too expensive to be repeated every year. Observing the earth and recording those observations as images is a form of remote sensing. Recently, remote sensing data acquired from high altitude platforms has strongly developed during the last three decades and became a very important tool for many applications. Remote sensing of the seafloor from satellites or aircraft is restricted by the fact that water absorbs or reflects most wavelengths of electromagnetic energy. Only visible wavelengths penetrate water, and the depth of penetration is influenced by the turbidity of the water. Penetration is essentially restricted to the visible region

(0.4 to 0.7 µm) and energy at reflected IR wavelengths (greater than 0.7 µm) is almost totally absorbed by water, as illustrated by the black-and-white IR photographs. Ten meters of clear ocean water transmit almost 50 percent of the incident blue and green wavelengths (0.4 to 0.6 µm) but less than 10 percent of the red light (0.6 to 0.7 µn).

Progress success has been achieved in detecting the aquatic weeds infested areas using digital satellite images. Digital image processing (DIP) of true and false colored images has been used to obtain statistical clusters, indicating detailed information about ecological variables (Lehmann and Lachavanne 1997). In the analysis of aquatic weeds distribution, the Global positioning system (GPS) and Geographic information system (GIS) technologies are integrated with the classified images. The GPS is a surveying technology that uses small handheld receivers to capture satellite signals. GIS technology is based on the digital manipulation and analysis of spatial data.

Plant canopy reflectance measurements have been used to differentiate among wetland plant species (Best et. al 1981) and aerial photography has been used extensively to remotely distinguish plant species and communities in wetland environments (Seher and Tueller 1973, Howland 1980). Ishak and Abo Kob (2002) conducted a study of using Landsate-7 TM satellite image in detecting the vegetated area in Gaza strip (Palestine). They introduced the logarithm of the normalized difference vegetation index (NDVI) for detecting the vegetation distribution and intensity as:

$$\text{NDVI} = (\text{band } 4 - \text{band } 3) / (\text{band } 4 + \text{band } 3)$$

Also, they introduced the logarithm of the modified soil adjusted vegetation Index 2 (MSAVI 2) as:

$$\text{MSAVI } 2 = ((2^* \text{ band } 2) (-1 + 4^* \text{ band } 4 + 1)^2 - 8 (\text{band } 4 - \text{band } 3))^{1/2}$$

Abdeen (2002) investigated the capability of using Landsate TM and Shuttle Imaging Radar (SIR-C/X) Synthetic Aperture Radar (SAR) images for penetrating dry soil and mapping subsurface drainage network and structures in Kom Ombo-Aswan area. His results proved that enhancing the Landsate TM and SIR-C/X-SAR images shows some drainage features and structure Lineaments, which are not obvious in Landsate data alone. Coops et al. (1999) used field data and Landsate TM satellite image in classification of lakes in the delta of River Danube based on aquatic vegetation and turbidity. To classify the water types, the reflectance features of spectral band 1-4 were combined in feature spaces using the image analysis programme (ERDAS). Each individual pixel was classified into one of the following categories clear water, algal blooming, suspended solids, submerged vegetation, and floating vegetation. By making a supervised classification technique (using field data), the information was proved to be sufficient to distinguish between clear and turbid water and indicated that the dominance of aquatic weed, algal, blooms or high loads of suspended silt in water.

In fact, the variations of water temperature, water quality, water depth and velocity, have created a suitable environment in lake Nasser for the growth of ditch bank and submerged aquatic weeds The objective of the present study is to test and evaluate different techniques used in the analysis of Landsat-7 TM satellite image as well as identify the status of aquatic weeds in Khors Toshka and El-Alaky.

STUDY AREAS

Generally, Lake Nasser is characterized by its long extension and narrow width with an average area of 5248 km^2. It is located between 22° 00¯ - 23° 58¯ N latitudes, and 31° 19¯ - 33° 19¯ E longitudes. The lake contains around hundred embayments (called as Khors) of which 58 Khors on the Eastern side and 42 Khors on the western side of river Nile. Each Khor is characterized by specific properties in terms of water quality, water depth, water temperature, water velocity, and fluctuation of water level. Some Khors as Kalabsha, Toshka and El-Alaky are much wide while others Khors as Singari, El-Sabakha and Korosko are considered very steep.

In this research, Khor El-Alaky and Khor Toshka, which located in the southern Eastern desert of Egypt, were selected as study areas. Khor El-Alaky lies 90 km south of High Aswan Dam (HAD) on the Eastern side of Lake Nasser with an average length of 64 km, width ranging from 1 to 6 km, and water depth ranging from 3-20 m. Its latitudes extends between 22º 40' and 23º N and longitudes between 32º 55' and 33º 15' E. While Khor Toshka lies 230 km south of HAD on the western side of Nasser Lake with an average length of 38.5 km, width ranging from 1 to 6 km, and water depth ranging from 20 m. Its latitudes extends between 22º 14' and 23º 59' N and longitudes between 31º 38' and 32º 47' E.

DATA USED

In order to detect the aquatic weed infestation areas and distinguish between the submerged and ditch bank weeds within the main two Khors (El-Alaky-Toshka), Landsate-7 TM satellite images covered each Khor were analyzed. The studied Landsate images covered khor El-Alaky were acquired in 15 Sep. 1993, 21 May 2000, 31 Oct. 2001, and 28 April 2003. While the examined images covered khor Toshka dated in 1 Sep. 2000, 28 March 2001, 19 Aug. 2001, and 3 April 2003. Each image covers an area of 180 Km x 180 Km with spatial resolution of 30 m and a spectral resolution of 7 bands. Moreover, an extensive field data were conducted in each Khors. About 17 sites of aquatic weeds communities distributed in Khor El-Alaky were selected and their coordinated (Lat, Long) were recorded in May and Dec. 2003 by using small handheld GPS device. While, in Khor Toshka, the coordinates of 14 sites of aquatic weeds communities were recorded in Dec. 2003 and Sep. 2004. These sites were considered as training sites in analyzing the satellite images by means of supervised classification technique.

METHODOLOGY AND RESULTS

Image processing and classification were conducted with the use of PCT Geometrical Version 9 software. In this paper, band ratio technique was simply performed by dividing the values of digital No. (DN) of one band to the digital No. of other band. By conducting many trials, it can be concluded that the submerged and ditch bank weeds communities can be seen clearly when combined the outputs of the following bands:

$$\frac{Band\ 4}{Band\ 3}+\frac{Band\ 5}{Band\ 4}+\frac{Band\ 7}{Band\ 4}$$

In addition, both unsupervised and supervised classification procedures were performed using the maximum Likelihood classification algorithms. In supervised classification, or man-in-the-loop, process where the user identifies a sample of pixels of each type or class (training sites), and digital processing algorithms are used to assign all similar pixels to one of the classes. While in unsupervised classification process, it is useful to have the computer sort out which pixels have similar characteristics rather than to try to force the pixels into a class based on our culturally driven sense of their similarities. This classification is based on the visible, near infrared and middle-infrared part of the spectrum, and is called clustering because it produces clusters of data with common characteristics.

The last step in producing the desired maps is to label each class with a descriptive name and the final classified images was combined with the GIS (Arc View) to display the desired information maps for Khor Toshka and Khor El-Alaky as shown in Figures 1 and 2 respectively. Also, with the power of GIS, the areas of the interested classes were determined and the percentages of aquatic weed infestation areas and terrestrial zones with respect to the total water surface area are presented in Table 1 and Table 2.

The results of band ratio technique were compared with the results of supervised and unsupervised classification techniques and concluded that the band ratio technique is quite accurate and effective in distinguishing between the ditch bank and submerged weeds. From the final analyzed satellite images of Khor Toshka, the submerged weeds infestations were 11.2, 6.9, 8.1, and 7.2 % in April 2003, Aug. 2001, March 2001, and Sep. 2000, respectively. While the ditch bank weeds were 12.5, 12.3, 8.1, and 10.7 % in the same years. In Khor El-Alaky, the submerged weeds infestations were 3.14, 4.56, 4.77, and 1.1 % in April 2003, Oct. 2001, May 2000, and Sep. 1993, respectively. While the ditch bank weeds were 3.16, 0.52, 0.83, and 1.5 % in the same years. Hence, it can be concluded that the season of rapid growth of aquatic weeds starts from March up till May and sharply declines from September until December due to the incoming flood occurs in springtime of each year.

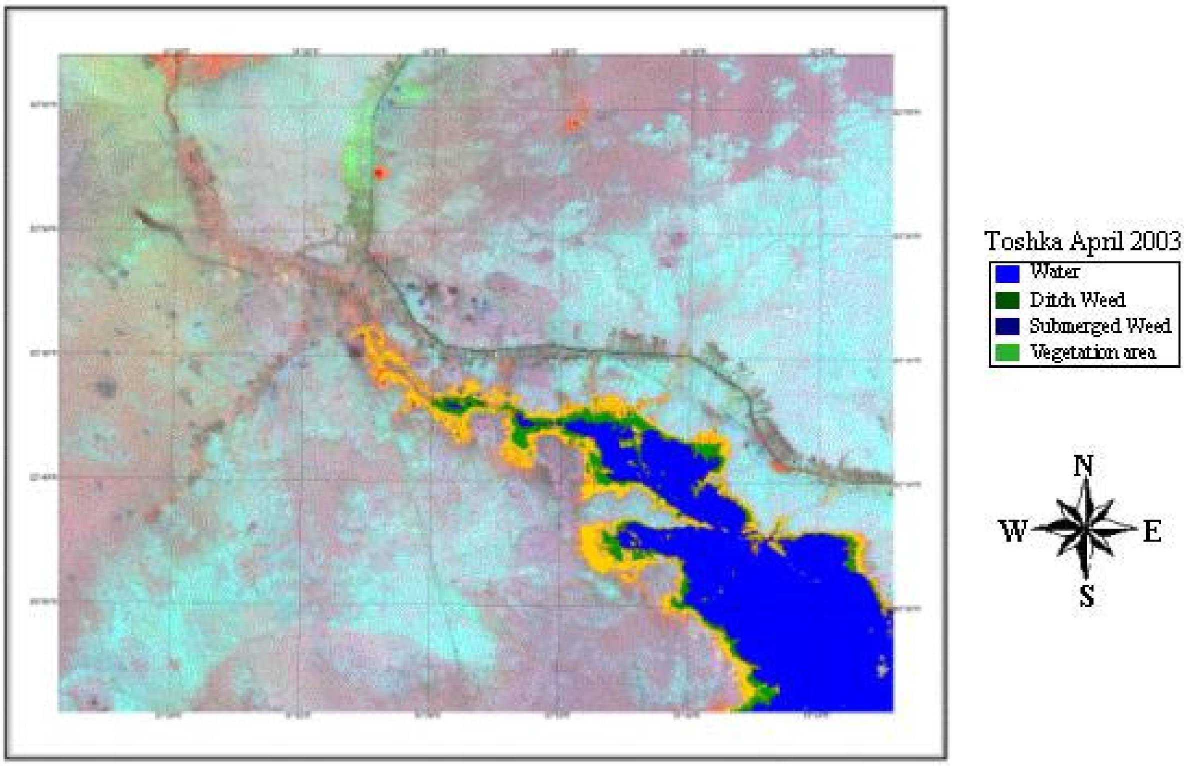

Fig. 1, Status of Aquatic Weeds in Khor Toshka, April 2003

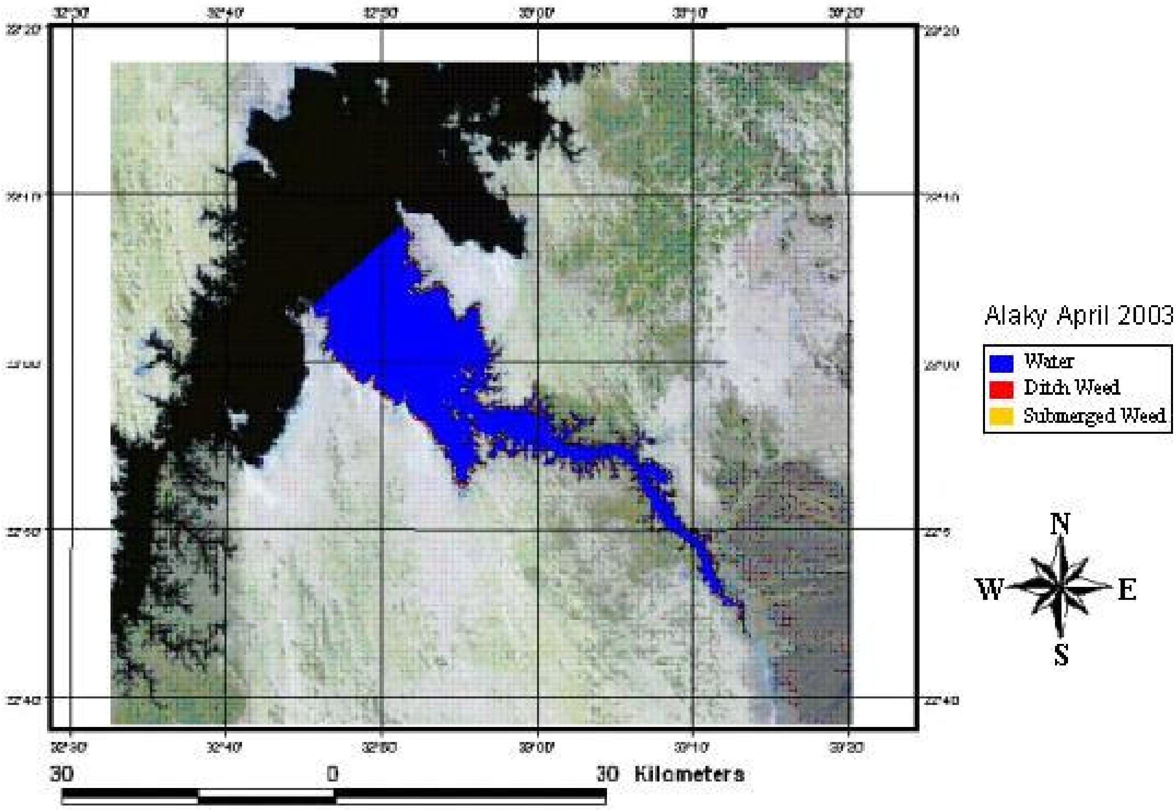

Fig. 2, Status of Aquatic Weeds in Khor EL-Alaky, April 2003

Table 1 Aquatic Weeds Infestation Areas in Khor Toshka

Parameters	Sep. 2000	28 March 2001	19 Aug. 2001	3 April 2003
Water level U/S HAD (m)	177.96	178.72	177.52	175.56
Water surface area (km^2)	318.00	315.23	316.00	267.70
Submerged weeds %	7.2	8.1	6.9	11.2
Ditch bank weeds %	10.7	8.1	12.3	12.5
Total weeds %	17.9	16.2	19.2	23.7
Vegetation area %	7.2	4.8	7.4	7.5

Table 2 Aquatic Weeds Infestation Areas in Khor El-Alaky

Parameters	15 Sep. 1993	21 May 2000	31 Oct. 2001	28 April 2003
Water Level U/S HAD (m)	171.60	177.91	180.21	175.11
Water surface area (km^2)	290.24	391.61	427.75	351.95
Submerged weeds %	1.1	4.77	4.56	3.14
Ditch bank weeds %	1.50	0.83	0.52	3.16
Total weeds %	2.6	5.60	5.08	6.30

ACKNOWLEDGMENT

The present paper illustrates the preliminary results of a joint research project between the Channel Maintenance Research Institute and the High Aswan Dam Authority and funded by Ministry of Water Resources and Irrigation. Thanks are due to these authorities.

REFERENCES

Abdeen, M.M., 2002, "Comparison between Optical Remote Sensing and Radar Imagery for Mapping Fossil Rivers in Arid Regions, Kom Ombo Area, South Egypt" J. Remote Sensing & Space Sci., V. 5, pp. 99-108.

Abdel-Rahman, S. I., Gad, A. and Younes, H. A. 1990,"Monitoring of Drought on Lake Nasser Region Using Remote Sensing Technology, Nat. Res. Center, Dokki, Giza, Egypt, pp. 161-171.

Best, R.G, Wehde, M.E., and Linder, R.W., 1981, "Spectral Reflectance of Hydrophytes Remote Sensing", Environ, 11: 27-35.

El-Baz, F., 1989, "Monitoring Lake Nasser by Space Photography, Remote Sensing and Large-Scale Global Processes", Proceeding of Third Int. Assembly, Baltimore, 186: 177-181.

Garter, V., 1982. "Application of Remote Sensing to Wetlands", In: C.J. Johannsen and J.L. Sanders (Eds.) Remote Sensing in Resource Management. Soil Conser. Soc. Am., Ankeny, IA. pp. 284-300

Hamed, A.F., 2000, "Early Warning on the Blooming of Phytoplankton Inhabiting Lake Nasser-Toshka Area Monitored By Remote Sensing Imagery", Botany Department, Faculty of Science, Ain Shams University, Cairo, Egypt.

Howland, W.G., 1980. "Multispectral Aerial Photography for Wetland Vegetation Mapping. Photogramm", Eng. Remote Sens. 46: pp. 87-99.

Coops, H., Hanganu, J., Tudor, M., and Oosterberg, W., 1999, Classification of Danube Delta Lakes Based on Aquatic Vegetation and Turbidity" Institute for Inland Water Management and Waste Water Treatment (RIZA), P.O. Box 17, NL-8200, AA Lelystad, The Netherlands.

Ishak, G., and Abo Kob, M., 2002, "Using Technology of Remote Sensing in Studying the Changes of Land Use in Palestine", Applied Research Institute, Jerusalem.

Sabins, F.F., 1997, "Remote Sensing", Principles and Interpretation, Third edition, New York.

Schott, J.R., 1997, "Remote Sensing, the Image Chain Approach", Oxford University Press.

Seher, J.S., and Tueller, P.T., 1973, "Color Aerial Photos for Marshland. Photogramm", Eng. 39: pp. 489-499.

Tiner, R.W., 1997. Wetlands. In: W.R. Philipson (Ed.). Manual of Photographic Interpretation. Amer. Soc. Photogramm. and Remote Sens. Bethesda, MD. pp. 475-494.

Tiner, R.W., 1997, Wetlands. In: W. R. Philipson (Ed.). Manual of Photographic Interpretation. Amer. Soc. Photogramm. and Remote Sens. Bethesda, MD, pp. 475-494.

Yacobi, Y.Z., Gitelson, A., and Mayo, M., 1995, "Remote Sensing of Chlorophyll in Lake Kinnert Using High Spectral Resolution Radiometer and Landsate TM: Spectral Features of Reflectance and Algorithm Development", J. of Plankton Research, 17: pp. 2155-2173.