ASSESSEMENT OF THE AQUATIC MACROPHYTE ENVIRONMENT WITH ESPECIAL EMPHASIS OF USING LANDSATE SATELLITE IMAGE AND GIS IN KHOR KALABSHA-NASSER LAKE - EGYPT

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ABSTRACT

A method is presented for using Landsate satellite image with global positioning system (GPS) and geographic information system (GIS) technologies in distinguishing and mapping the distribution of submerged and ditchbank aquatic weeds in Khor Kalabsha. Moreover the aquatic weeds environment represented by 20 major parameters (Turbidity, Do, pH, Salinity, Sulfide, Sulfate Phosphate, Nitrate, Nitrite, Ammonia, Nikel, Iron, Chromium, Copper, Calcium, Carbonate and Bicarbonate) are evaluated. In a conclusion, the landsate TM 7 is valuable in detecting spectral differences between the submerged and emerged weeds. The submerged weed *Potamogeton Lucenus* and the emerged weed *Tamarix Nilotica* were dominated at the littoral zone of the khor and the percentages of the submerged and ditchbank weed infestations were 10.6 % and 7.2% of the water surface area respectively. Also, the study revealed that most of the physico-chemical parameters fractions were below the Egyptian standards of the environmental low no. 4/1994. Concerning the relationship between the submerged weed and the physico-chemical variable, the result showed a positive correlation between the aquatic weeds and the concentrations of carbonate and phosphate as well as the light visibility through the water.

KEYWORD: Aquatic Weeds, Satellite Images, GIS, Nasser Lake.

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INTRODUCTION

Since the completion of the Aswan High Dam, the formed Nasser Lake provides about 95% of Egypt's water resources. It is used for water storage, electricity generation, fish production and agriculture. The water level of Lake Nasser fluctuates sometimes dramatically, based upon the annual rainfall in the catchment area of the Nile River, and therefore affects surface area, the length of the shoreline, and water depth in the coastal shallow water. The lake is characterized by its long extension and narrow width with an average area of 5248 km^2. It is located between $22^{\circ}\ 00' - 23^{\circ}\ 58'$ N latitudes, and $31^{\circ}\ 19' - 33^{\circ}\ 19'$ - 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 Nile River. 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, Tushka and Allagi are much wide while others khors as Singari, El-Sabakha and Korosko are considered very steep.

Accordingly, monitoring varies types of aquatic weeds by using remote sensing and GIS is essentially to cover a wide area such as khor Kalabsha in this study. Several authors (Carter 1982, Tiner 1997, Best *et al.* 1981, Mackey *et al.* 1987), have pointed out the value of remote sensing in assessing and managing wetlands as well as differentiating among wetland plant species. Everitte *et al.* 1996 employed the aerial videography and global positioning system (GPS) in detecting and mapping weed species on rangelands and brush species in riparian areas.

The objectives of this research were to evaluate the physico-chemical parameters of water surface with their relationship with the standing crops of the aquatic weeds and employed the Landsate satellite image with the GIS and GPS in deleting and mapping the aquatic weeds environment in Khor Kalabsha.

DESCRIPTION OF THE STUDY AREA

In this study, Khor Kalabsha was selected as a study area to assess the use of remote sensing and GIS. The khor lies 40 km south of High Aswan Dame on the western side of lake Nasser and expends between latitudes 23° 28' - 23° 36' N and longitudes 32° 30' - 32° 52' E. It is about 47.2 km length with a width ranged from 2 to 15 km, and characterized with a sandy bottom hydrosoil and slope gently.

MATERIAL AND METHODS

To achieve the objectives of this research, Landsate satellite image TM7 acquired in May 2001, was introduced and analyzed. The Landsat image covered an area 185 km by 185 km with ground resolution of 30 m. Also, a topography map of (1: 5000 Scale) was used to assure the lat/long coordinates of some fixed points within the study area. During site investigation in May 2001, eleven sampling stations were chosen to represent different ecological habitats of the Khor (see Fig. 1). One site represented the main channel of the lake (station 1), three deep stations (2,3 and 4) located in main channel of the Khor and the other seven stations (5, 6, 7, 8, 9, 10 and 11) were inshore (shallow stations represented the aquatic weeds environment).

To measure the environmental variables, 20 major parameters represented by (Turbidity, DO, pH Salinity, Sulfate, Sulfate, Phosphate, Nitrate, Nitrite, Ammonia, Nikel, Iron, Chromium, Copper, Calcium, Carbonate, and Bicarbonate were assigned. The number of sample sizes and their locations were determined randomly as shown in Figure (1). The water conductivity, pH and O_2 were measured in the field using YSI field probes. The concentration of chemical variables were determined according to the standard methods (APHA, 1989). For identifying the hydrosoil characteristics, 11 random locations were tested (Fig. 1).

To determine the standing crop (Kg/m^2 surface area) ofr the submerged aquatic weeds, the weeds were collected randomly from 2 to 3 m depth zones of the shoreline locations, where the weeds were identified, cleaned, and finally weighted. The relationships between the standing crop (Kg/m2) of submerged weed and the environmental variables were tested using Bivariate correlation (Two-Tailed, 0.05).

RESULTS

With the use of the Canadian software EASI/PACE, the image was processed and

... line correction, image to image registration, and image georeferencd were performed. After that, the selected sites of attribute data such as water, rocks, cultivated zones, submerged weeds and ditchbank weeds, were classified using supervised and unsupervised classification algorithms. In supervised classification process, pixel of similar spectral reflectance was grouped within a scene based on the spectral values of the selected training sites. While the unsupervised classification process was derived digitally by grouping pixels that have similar spectral signatures from measurements of individual bands throughout the spectrum. 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 final step 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 map as shown in Fig. 2.

Also, with the power of GIS, the areas of the interested classes were determined and presented in Table 1. The results revealed that the percentages of submerged weed and ditchbank weed infestations with respect to the area of water surface were 10.6% and 7.2% respectively. The *Potamogeton Lucenus* and *Tamarix Nilotica* weeds were the most prevailing weeds in the khor and the terrestrial vegetation zone was recorded 3% of the water surface area in May 2001.

Concerning the physico-chemical parameters within the surface water area of Khor Kalabsha, the result presented in Table (2) revealed that all major parameters fractions were below the Egyptian standards of low of environment 4/1994 on the Protection of Human Health, except the value of Ammonia at location (11) which represented by 0.88 mg/l. Also, the water surface tended to be more alkaline. On the other side, the total submerged standing crop was made up of 4 species (*Potamogeton lucenus, Potamogeton trichoides, Myriophyllum spicatum* and *Najas minor*) and the total emerged standing crop consisted of 5 species (*Heliotropium supinum, Hyosycyamus muticus, Phragmites australis, Rumex dentatus* and *Tamarix nilotica*). The present study showed that *Potamogeton lucenus* and *Tamarix nilotica* were dominant at the littoral zone of the Khor. Concerning the submerged aquatic weed infestations along the shoreline of the Khor, figure (3) showed that the standing crop (Kg/m^2) ranged between 1.1 and 5 with the minimum value at location (9) and the maximum value at location (8). While the relationships between the standing crop (Kg/m^2) of submerged weed and the environmental variables, Bivariate correlation showed that the standing crops of the submerged weed increased with increasing the value of light visibility through the water (0.759), the carbonate (0.727) and the phosphate (0.755), and generally increased with decreasing the value of calcium (-0.759).

DISCUSSION

Remote sensing such as satellite images play a virtual role in monitoring the aquatic weeds distribution in a wide area such as a reservoir. The classified images indicated that the submerged and emerged weeds could be differentiated quantitatively from associated vegetation, rock, and water. The Landsat TM 7 satellite image has proven valuable in differentiated between the submerged and emerged weeds which fact could be attributed to the specific characteristics of Landsat TM 7 (band 1 through band 7). The final classified images, GPS, and GIS technologies were integrated and used to map the various aquatic weed distribution and terrestrial vegetation zones within the khor.

With respect to the physico-chemical parameters of the water surface samples, The results revealed the temporal variation of the physico-chemical parameters within the surface water area at eleven various sites. However, all major parameters fractions were below the Egyptian standards of low of environment 4/1994 on the Protection of Human Health, except the value of Ammonia at location (11) that represented by 0.88 mg/l. This increased level was due to the presence of a lot of died fishes in this area. The died fishes were mainly *Tilapia* spp and *Latus niloticus* those were leaved by fishermen who preferred to deal with well preserved saline fishes such as *Barbus bynni* and *Hydrocyncus forskalii.* Also, the present study revealed that the water surface tended to be more alkaline. Similarly, Elewa (1976) pointed out that the alkalinity of Lake Nasser was mostly due to bincrbonate and very limited carbonate concentration. Moreover, the standing crop of the submerged weeds was recorded variable along the different locations which indicates that there are many environmental variables may affect the growth and the distribution of such weed community structure. One of those is the transparent condition that insures a wide vertical extension of the submerged aquatic weed zone (Barko, 1980; Vestergaard and Sand-Jehsen, 2000). Similar result was obtained by the present study which showed positive correlation between the standing crops of the submerged weed and the light intensity through the water surface, as well as the same correlation with the phosphorus. This relationship may attribute to the presence of phosphorus which released from decaying submerged tissues and appeared to be very rapid (Nichols and Keeney, 1973; Kistritz, 1978) especially in the presence of high density or due to the presence of rapid P release from microbial colonization on the weed tissue (Howard-Williams, *et al*., 1978). Also, the present correlation indicated that phosphorus commonly lead to an increase in the biomass of the submerged weeds which is coordinating with the results of Ali, (1999) who mentioned that the growth of *Potamogeton crispus* is strongly related to the increase of phosphate concentration. The alkalinity of the khor is mostly due to bicarbonate, while the carbonate value is very limited. This alkaline water provides a good habitat for the growth of many species of submerged weeds (Spence, 1967; Stanley, 1970; Barko, 1980) because the macrophytes use free CO_2 or, in some cases, bicarbonate as their carbon source for photosynthesis (Bowes and Salvucci, 1989), as in the present result. It is assumed, in the study area that in highly alkaline water, the submerged weeds may utilize bicarbonate sources of inorganic carbon in photosynthesis, because free CO_2 concentrations are low. For that reason the value of carbonate showed significant increase with increasing the biomass of submerged weeds. Contrarily, the value of calcium showed significant decrease with increasing the biomass of submerged weeds and both carbonate and calcium may combine with each other in order to form calcium carbonate. In this system, the submerged aquatic weeds must be further able to effectively withstand heavy carbonate precipitation and associated epiphyte development on their leaf surfaces, which were clearly seen in many cases along heavily infested areas.

Finally, integration of satellite data with GIS proved an virtual mean to the decision maker in selecting timing, priority, and the appropriate method of controlling the aquatic weed distributions and their abundance.

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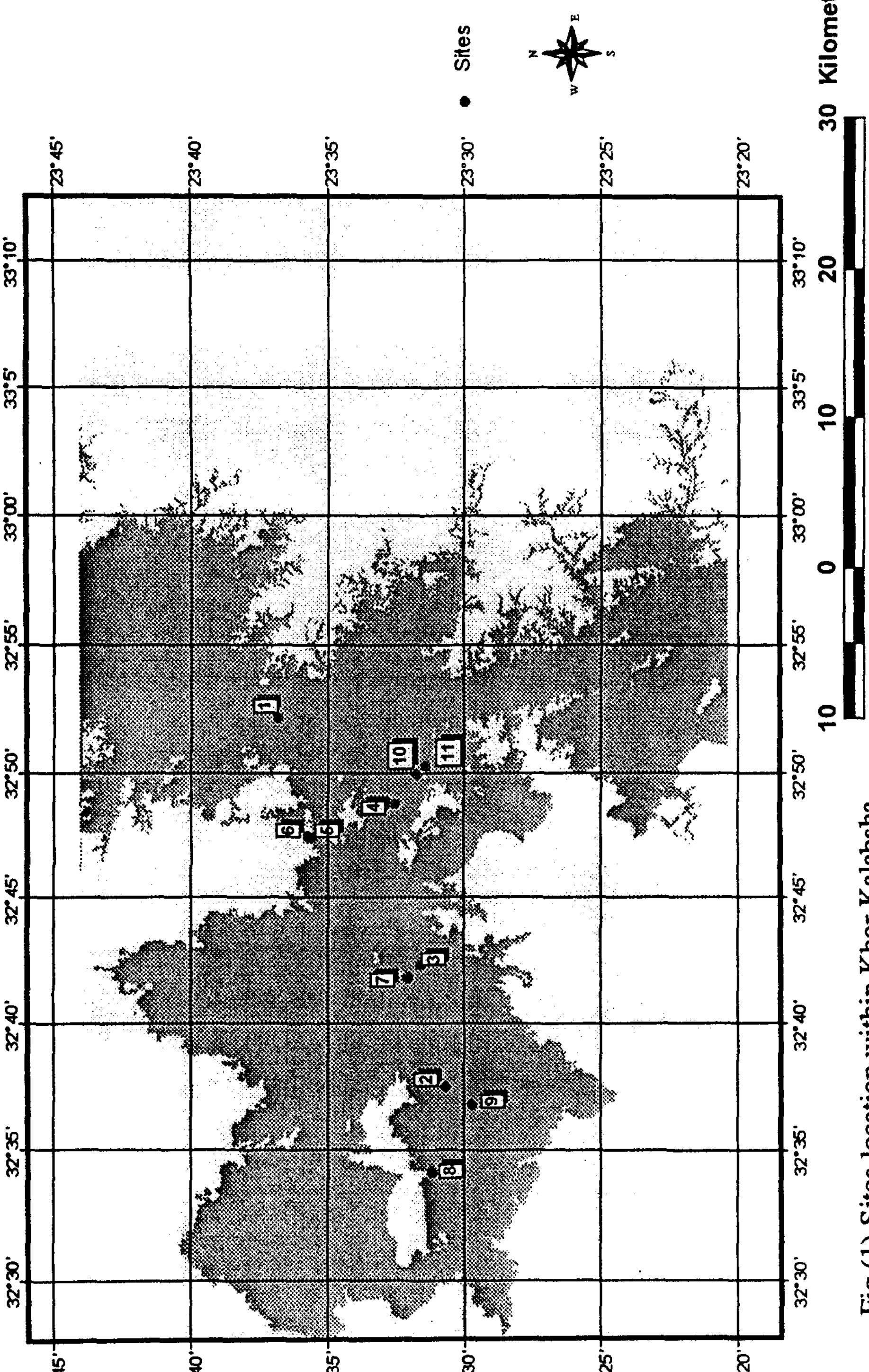

Fig (1) Sites location within Khor Kalabsha

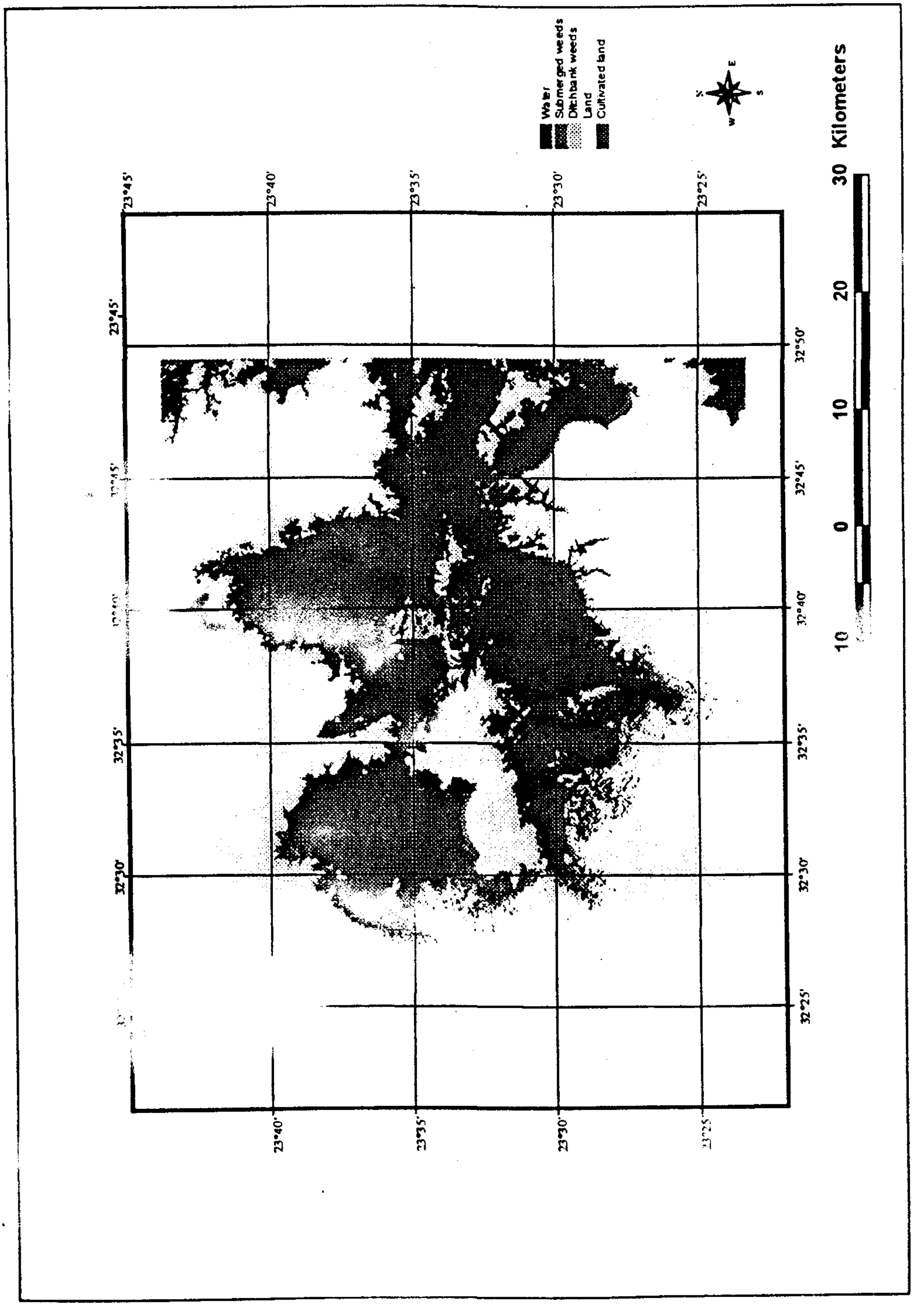

Fig. (2). Distribution of Various Aquatic Weeds in Khor Kalabsha in May 2001.

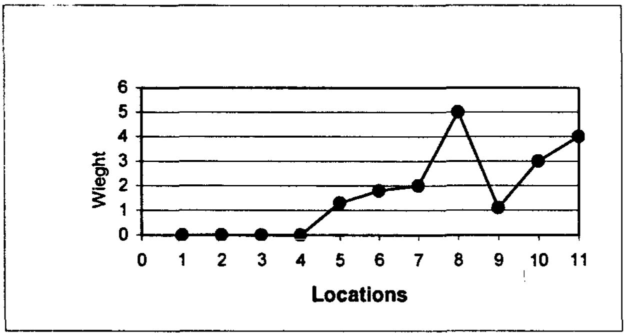

Figure (3) The weight (Kg/m^2) in different locations

Table (1) Summary of the aquatic weed infestations within Khor Kalabsha

Parameter	May 2001
Water level (m)	177.92
Water surface area (m^2)	497.2
Submerged weed (%)	10.6
Ditchbank weed (%)	7.2
Total aquatic weed (%)	3.2
Terrestrial vegetation zone (%)	3

Table (2) Results of water quality parameters within the water surface of Khor Kalabsha

ter on	Turbidity FUT	DO (mg/l)	pH	E.C. (mhos)	Calcium (mg/l)	Carbonate (mg/l)	Bicarbonate (mg/l)	Sulfide (mg/l)	Sulfate (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	Nitrite (mg/l)	Nitrate (mg/l)	Silica (mg/l)	Nickel (mg/l)	Manganese (mg/l)	Iron (mg/l)	Chromium (mg/l)	Copper (mg/l)	Aluminum (mg/l)
	0	8.8	8.5	260	20.04	14	102	0	10	0.05	0.001	0.003	2.61	9	0.2	0	0.84	0.04	0.05	0.07
	6	8	9.1	280	20.04	18	117	0	6	0.09	0.26	0.009	0.88	11	0.1	0.11	0.02	0.04	0.04	0.08
	6	7.2	9.1	275	18.44	18	116	0	6	0.04	0	0.007	0.44	6	0.2	0.25	0	0.03	0.04	0.17
	3	7.5	9.1	270	19.23	16	98	0	10	0.04	0.026	0.009	1.8	8	0.1	0	0	0.03	0.05	0.06
	1	9	9.1	275	19.64	16	112	0.04	11	0.05	0.012	0.003	2.64	9	0.3	0.01	0.14	0.03	0.05	0.1
	3	7.8	9	260	18.04	16	102	0	7	0.05	0.008	0.009	2.64	14	0.1	0	0	0.04	0.05	0.1
	1	8.8	9.3	255	19.64	14	103	0	7	0.06	0.1	0.007	1.76	9	0.1	0	0.01	0.04	0.06	0.1
	8	7.4	9.1	290	16.03	18	98	0	8	0.09	0.013	0.007	0.88	8	0.1	0.02	0	0.04	0.07	0.08
	2	6.4	9.1	300	19.24	16	97	0	7	0.05	0.17	0.013	0.88	9	0.1	0	0.01	0.04	0.04	0.09
	4	5	9	260	17.23	16	97	0	6	0.04	0	0.009	1.3	9	0.1	0	0	0.03	0.01	0.07
	2	7	9.4	260	18.44	18	99	0.03	6	0.07	0.88	0.013	0.88	7	0.2	0.01	0	0.04	0.01	0.09
rd s	≤20	≥5	≥7.5 ≤8.5	N.D	N.D	N.D	N.D	≤1	≤ 200	≤1	≤0.5	N.D	≤45	N.D	≤1	≤0.5	≤1	≤0.05	≤1	N.D

N.D: Not detected