MONITORING FOR PROTECTION OF THE MARINE ENVIRONMENT USING LANDSAT-TM DATA

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This paper presents results from a joint project between the University of Dundee and the University of the Aegean. The project deals with the monitoring of the quality of the sea water environment using *in situ* measurements and satellite image data. The study was carried out using Landsat-TM data in Mytilene harbour and the surrounding water areas. *In situ* water samples were collected and analysed at the University of the Aegean during the year 1992 for the dates : 5 March, 9 June, 11 July and 28 August. Water samples were collected with a Van Dormsampler from the depth 0-1m. The water samples were used for chlorophyll and suspended matter determinations. Temperature and salinity was measured by a CTD instrument Model YSI 6000. Light transparency was recorded using a secchi disk and a KALSHICO digital underwater irradiameter model 268 WA 305. Samples for chlorophyll determinations were filtered immediately through millipore filters (pore size 0.45 um) after collection and the pigments of the filter were extracted overnight in 90% acetone. The samples were then centrifuged (3000 g for 30 min) and the chlorophyll absorption was measured in a double beam spectrometer Model Varian DMS-80. The detailed procedure is described by elsewhere (UNESCO-SCOR, 1966).

Suspended matter was measured gravimetrically according to the procedure described by STRICKLAND & PARSONS (1972). Estimates of suspended matter were also carried out by turbidity measurements using a Hach turbidity meter. Four cloudless Landsat-TM cloudless mini scenes (50x50 km coverage) were purchased corresponding to the *in situ* sampling dates. The position of the sampling boat was determined by photogrammetry and later by GPS. The image processing was performed at the University of Dundee (CRACKNELL *et al.*, 1994) in the following steps: (a) image rectification to a UTM 1:25000 scale map, (b) transformation from the sample location to image pixel scan lines, (c) the pixel values for bands 1, 2 and 3 were extracted for a 3 pixel by 3 pixel area corresponding to the sites of the *in situ* measurements and then they were converted to (i) radiance values and (ii) exoatmospheric reflectance values, and, the atmospheric correction was performed to the data using the darkest pixel method, (d) transformations such as the principal component, characteristic vector (using reflectance data) and chromaticity (using radiance data) were performed on the data sets, (e) multiple regression analyses were performed with dependent variables chlorophyll and suspended matter concentrations and their reflectance values. Two algorithms were then derived given by the Equations :

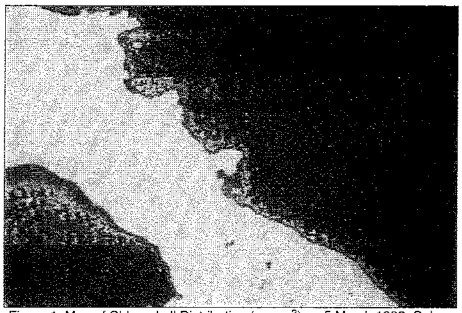

Figure 1. Map of Chlorophyll Distribution (mg m^{-3}) on 5 March 1992. Colour code: blue <0.1; green 0.1-0.4; yellow 0.4-0.7; orange 0.7-0.1; and red>1.1.

Figure 2. Temperature Distribution (°C) on 5 March 1992. Colour code: blue 12-13; green 13-14; yellow14- 15 and red>15.

$$y = a + b_1r_1 + b_2r_2 + b_3r_3 \qquad (1)$$

$$y = a + \sum_{i=1}^{3} b_ir_i + b_4r_1r_2 + b_5r_1r_3 + b_6r_1r_3 \qquad (2)$$

Where y is the concentration of chlorophyll or suspended matter, r_i is the reflectance value for band i and the coefficients a, b_i (i=1 to 6) are selected empirically and determined by the regression. Water quality maps were then generated by applying Equation (2) to all sets of data except June where Equation (1) was used. The distribution patterns of chlorophyll show that in March (Figure 1) a higher concentration occurred in the vicinity of Mytilene harbour and at some locations along the coast to the north and also in the coastal waters in the north eastern part of Kolpos Geras. Figure 2 shows the chlorophyll distribution for 11 July. Separate processing was applied to TM images of channel 6 to produce sea surface temperature (SST) maps which are shown in Figure 3 for the 5 March data set and Figure 4 for the 11 July data set. The algorithm used had the following form for all data sets (T_{sat} is the TM channel 6 value) :

$$SST = 11.1620 - 11.3132 \log(T_{sat}) \qquad (3)$$

This equation was produced by regression with correlation coefficient of 0.98 andan RMS error of ±0.8°C

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COASTAL LAGOONS ALONG THE COAST OF EGYPT WITH EMPHASIS ON BARDAWIL LAGOON

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Egypt have a coast on the Mediterranean sea about 450 km long. 50% to 60% of the coast of Egypt is a low lying barrier beaches backed by large water lakes. There are one lake and 4 lagoons along the coast of Egypt. These are Lake Maryut and Idku, Burullus, Manzala and Bardawil Lagoons (Figure 1). All the lagoons are shallow with mean water depth about 2 m. Lake Maryut is not connected to the sea, however the other lagoons have channels to the Mediterranean sea (inlets) and when these inlets are open there are considerable circulation between open sea and these lagoons. The object of this paper is to give descriptions of these lagoons, their habitat value and to discuss their general hydrological characteristics.

The habitat value and productivity of shallow water lagoons are largely controlled by the circulations with the open ocean and within them. Often these circulations are determined by episodic tidal exchange with the open ocean. Typically shallow lagoons are closed to the ocean by the natural extension of beach berms across their inlet as a result of littoral sand transport along the neighbouring beaches. Occasionally these berms are broached by either high tides or excessive fresh water runoff. During periods of inlet closures, these lagoons progressively evaporate and become increasingly hypersaline.

Of special interest among these lagoons is the Bardawil lagoon. There is often vertical and lateral stratification in the Bardawil lagoon during this evaporative cycle with average rate of 2 m/year the salinities varies from 40 ppt to 90 ppt (Figure 2).

The Bardawil lagoon is 84 km length along the sea cost, 22 km maximum width and 1.75 to 2.6 m average depth. Its surface area is about 600 km at mean sea water level. This lagoon differs from the Nile Delta Lagoons in that it is of tectonic origin and not a deltatic lagoon. The only source of water into Bardawil Lagoon is the Mediterranean Sea through 3 inlets.

Measurements of water salinities, level and velocities were taken in the lagoon in 1972, 1973 and 1986 (BEN-TUVIA, 1984; CRI, 1988) in order to search for a method to keep the inlets open to the daily tidal flushing. The results of these measurements were utilized in this study along with a numerical model which use winds and tides time series as an input in order to attempt to explain the observed salinity structure of the lagoon.

Figure 1. Coast of Egypt. Notice the three inlets of the Bardawil Lagoon.

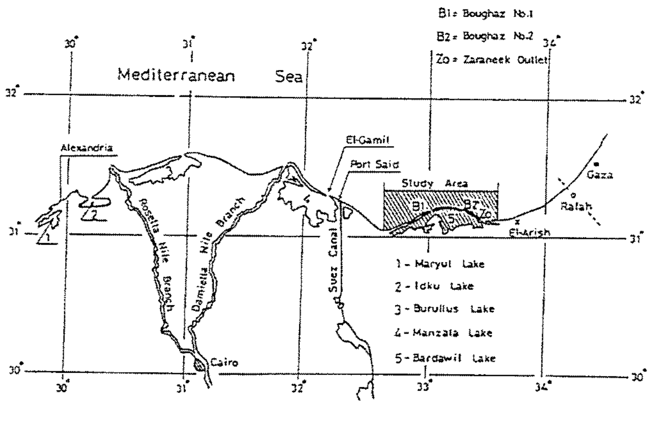
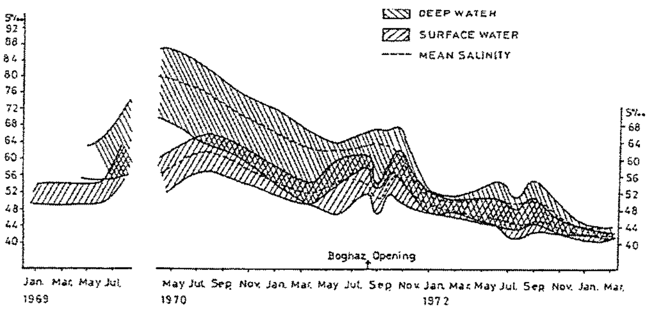


Figure 2. Time-series plot of salinity at Bardawil lagoon about 10 km east of B1.



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