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Model of Sediments Movement in Montazah, A Semi-Enclosed Bay, Alexandria, Egypt

A. El-Sammak*

Oceanography Department, Faculty of Science, Alexandria University, Egypt

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The Alexandria waterfront beach is located along the northwestern border of the Nile delta coast. It is about 41 km long extending from El-Agami in the west to Abu-Qir in the east. Montazah beach is one of the most beautiful and famous beaches in Alexandria. It was before a private beach being the summer residence of the former royal family. The estimated area of the bay that calculated from admiralty chart is about 0.075 km^2. It receives about 1000 m^3 of sewage per day (El-Rayis *et al*, 1997). Most of the Alexandria beaches appear to be experiencing mild erosion with evidence of sand losses (Frihy and Dean, 1992). The background erosion rate at Alexandria is fairly small on the order 20 cm/year (Frihy and Dean, 1992, El-Sayed, 1988). Artificial beach nourishment projects were completed during the last few years (Frihy and Dean, 1992). Montazah beach accomplished some nourishment plan. Sand compatibility analysis indicated that the inland desert sources would be a suitable source for direct stockpiling and fill placement method applied to Alexandria. The quality of offshore source some near Alexandria have not been evaluated. The nearest sand quarries are located 120 km from Alexandria, along the desert highway and midway to Cairo (Frihy and Dean, 1992).

The aims of this study were to estimate sediment movements in the bay as well as to assess the degree of pollution in Montazah Bay using organic matter as an indicator.

MATERIALS AND METHODS

Seventeen bottom sediment samples were collected either by hand (beach sediments), free diving or grab sampler. Sample's locations were selected based on the field observations taking into account covering the whole bay (Figure 1).

*Present address: United Arab Emirates University, Faculty of Science, Geology Department, Post Office Box 17551 Al-Ain, United Arab Emirates

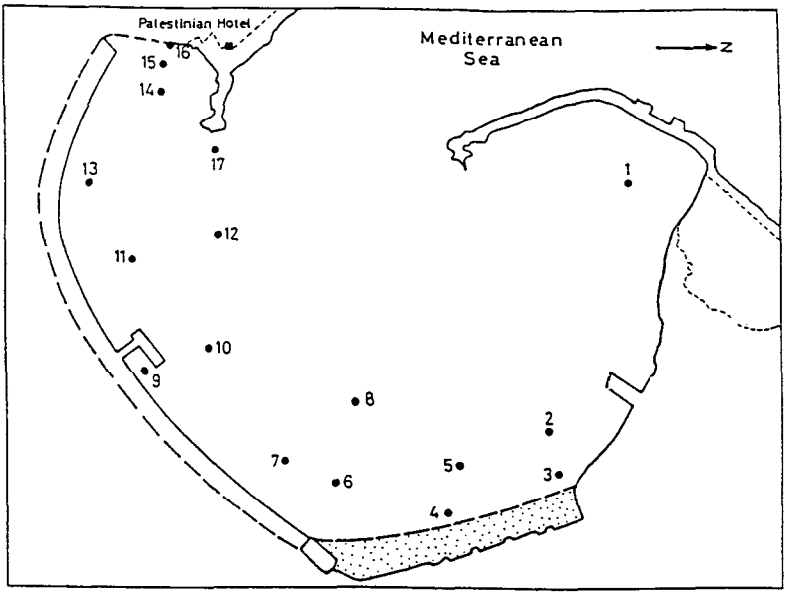

Figure 1. Study Area and sampling locations.

Standard sieving method was used for grain size analysis. Organic carbon was determined using a standard Chromic acid oxidation method (Gaudette *et al*, 1974). Samples also were subjected to visual description under binocular microscope.

RESULTS AND DISCUSSION

Table (1) presents the values of organic matter as well as the percentages of coarse, medium and fine sand and mud fractions at different stations. Fine sand is the most dominant size fraction followed by coarse sand, medium sand and mud (table 2). The microscopic examination of different samples indicates that coarse sand grains are rounded to well rounded quartz grains. The amount of skeletal materials increases in the fine sand fractions. Terrigenous fine grains are almost angular to subangualr. In general the degree of roundness increases with increasing grain size. Rounded grains indicate that the source of these materials is dune (desert) rather than beach. In fact these coarse materials are the artificial sand brought to the beach to compensate lose of the original beach materials during stormy winter seasons, Mean grain sizes of borrow desert sands used for nourishment project for Alexandria beaches are in the range of coarse sand ($0.68\ \phi \pm 0.21$) (Frihy and Dean, 1992).

Table 1. Results of the grain size analysis as well as Organic Carbon (OC), Organic Matter (OM) and Organic Nitrogen (ON).

Sample #	CS	MS	FS	Mud	OM %	OC %	ON %	C/N
#1	27.88	42.80	28.62	0.70	2.14	1.19	0.20	6.10
#2	4.40	8.60	79.60	7.40	2.04	1.14	0.19	6.14
#3	2.80	36.28	59.46	1.46	2.45	1.36	0.21	6.44
#4	77.20	5.40	15.30	2.10	1.04	0.58	0.09	6.16
#5	3.90	13.88	79.66	5.56	1.24	0.69	0.11	6.17
#6	29.70	55.30	15.20	1.22	0.86	0.48	0.08	6.11
#7	59.40	28.00	5.78	6.81	0.77	0.43	0.07	6.32
#8	0.10	9.20	90.24	0.48	1.65	0.92	0.14	6.74
#9	98.30	1.30	0.04	0.36	0.73	0.40	0.06	6.40
#10	30.52	42.74	26.00	0.74	0.86	0.48	0.08	6.18
#11	12.60	25.66	60.58	1.46	1.24	0.69	0.11	6.16
#12	65.96	17.88	0.64	15.52	1.78	0.99	0.16	6.07
#13	26.76	20.26	51.76	1.22	1.91	1.06	0.17	6.15
#14	33.78	44.28	21.82	0.12	2.29	1.27	0.20	6.15
#15	1.58	16.20	81.94	0.28	1.51	0.84	0.14	6.14
#16	4.38	5.32	89.08	1.22	2.30	1.28	0.21	6.16
#17	14.90	53.70	29.16	2.24	2.52	1.40	0.23	6.16

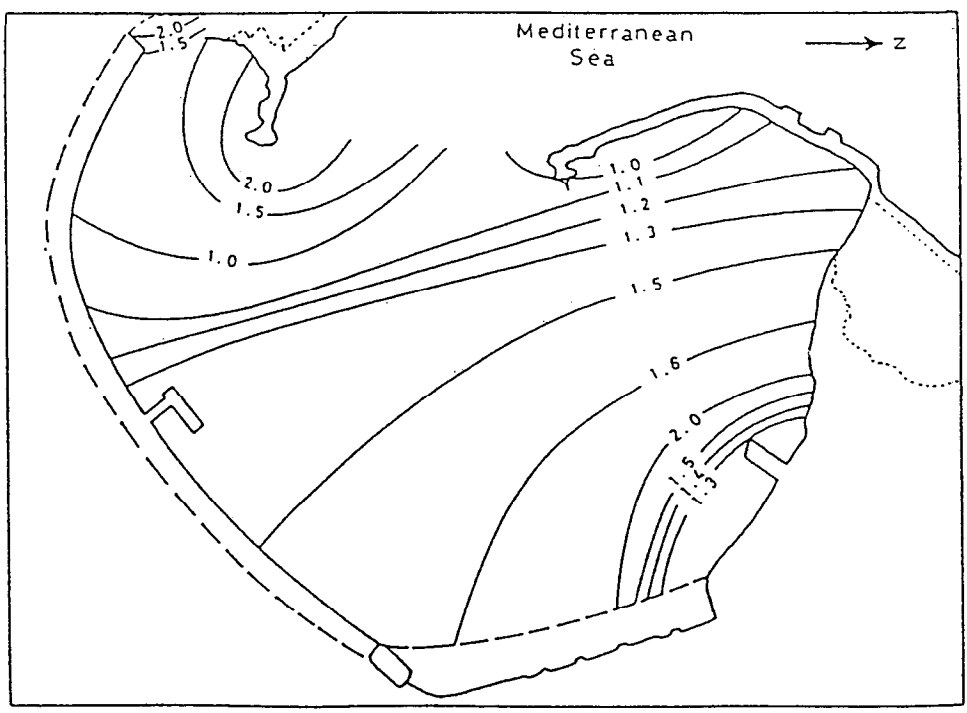

Figure 2. Distribution of organic matter in sediments of Montazah Bay.

Figure (2) shows the distribution of organic matter in the bay. In general the levels of organic matter in the bay sediments are coincided with the normal values for the coastal semienclosed areas. Organic matter in the sediments ranges between 0.726% and 2.52% with an average of 1.61% ± 0.63. Organic nitrogen ranges from 0.063% to 0.227% with an average of 0.143% ± 0.56. The mean C/N ratio in the studied bay is about 6.22 ± 0.17. This value is similar to the mean C/N ratio for marine zoo- and phytoplankton (about 6) (Stein, 1991). This value indicates normal marine conditions and that; the organic matter in the bay is almost autochthonous in origin.

Figure (3) shows the relations of organic matter contents with the different grain size classes. Organic carbon shows a positive relations with mud, medium sand and fine sand and negative relations with coarse sand. These relations are mostly due to the fact that coarse sand is, mainly, derived from desert to counterbalance the eroded sand from the beach. The correlations between different studied variables are shown in table (3).

Based on the ratio of coarse sand, medium sand and fine sand as well as mud, a sediment budget and movement could be estimated. Although this estimation is particularly rough, it can be considered as an accurate estimate since it agrees with the spatial distribution of organic matter.

Figure 4, shows the developed model for the sediments budget and movements in the bay. In general materials imported (credited materials) move in westward direction toward Palestinian Hotel. Gained materials deposited of some area near the Hotel. Longshore current is the transporting agent carrying the credited materials to the area where they deposited. The relatively high organic matter in the beach sediments close to the hotel may be possibly due to stagnant conditions. Fine materials also characterize this area. High organic matter may produced by the accumulation of dead seagrass.

Microscopic examination of the sediments indicates that skeletal (Forams, Echinoids, Mollusks fragments and others), nonskeletal and terrigenous particles (Mica, angular quartz grains) are found. Dried fresh seagrass was also observed.

The imported desert materials that brought during spring season to

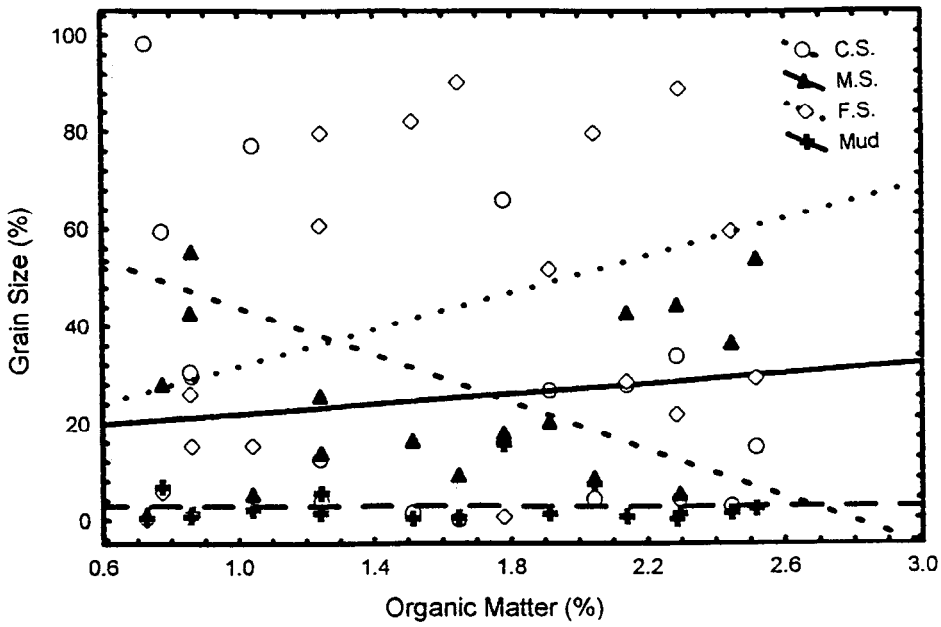

Figure 3. Relations between O.M. and different grain size classes.

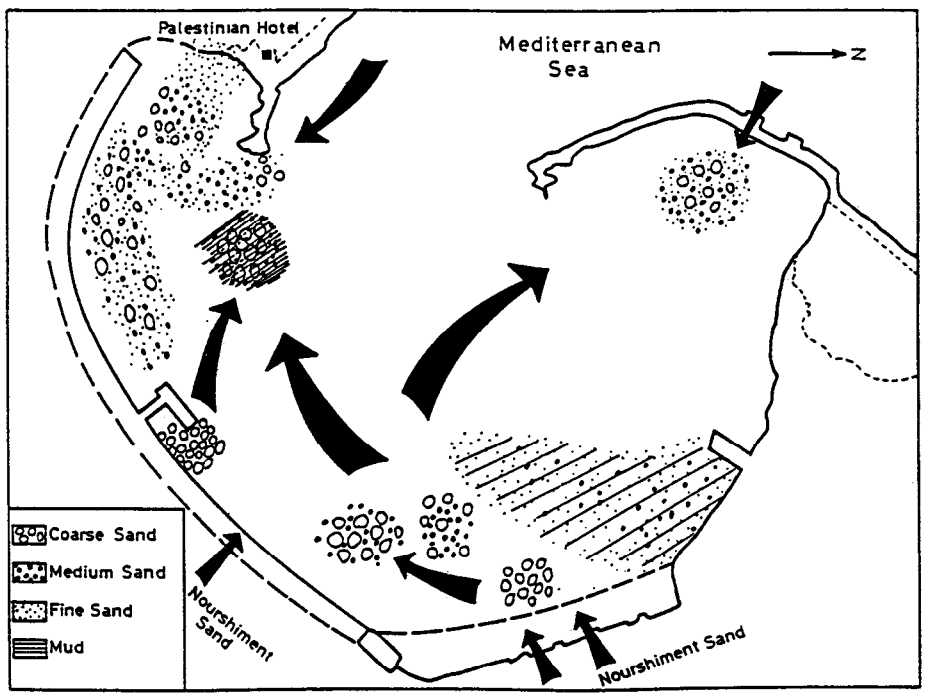

Figure 4. Sediment model and transport in the studied bay.

Table 2. Descriptive statistics for the calculated variables.

Variable	Maximum	Minimum	Average (± Standard Deviation)
Coarse Sand	98.3	0.1	29.07 ± 29.6
Medium Sand	55.3	1.3	25.11 ± 17.69
Fine Sand	90.2	0.04	43.23 ± 32.51
Mud	15.5	0.12	2.88 ± 3.97
Organic Matter	2.5	0.726	1.61 ± 0.63
Organic Carbon	1.4	0.40	0.89 ± 0.35
Organic Nitrogen	0.227	0.063	0.14 ± 0.05
C/N ratio	6.7	6.07	6.22 ± 0.17

Table 3. Correlation matrix between different variables.

	MS	FS	Mud	OM	ON
CS	-0.18	-0.85	0.23	-0.52	-0.51
MS		-0.36	-0.20	0.18	0.18
FS			-0.22	0.37	0.36
Mud				-0.01	0.02
OM					0.996

compensate the materials lose due to stormy winter season are easy to eroded due to the heterogeneity in sediment characters. Sediments' movement verifies that no sediments transport occurs in the eastward direction. Most of the credited sediments move toward the Hotel, in westward direction by the action of longshore current. On the other hand, the variation in organic matter contents may possibly due to contribution from seagrass rather than pollution effect. However, the organic matter content is considered as normal values compared with the values for the semienclosed coastal areas. C/N values indicate normal marine conditions.

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