A Water budget study of the Southeastern Mediterranean off the Egyptian Coast

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Water budget is one of the most important problems with which meteorology and oceanography is concerned. It can be assumed with a very considerable degree of probability that the cycle through which the water passes is closed. For a quantitative assessment of the water budget on the Egyptian Mediterranean coast it is necessary to make estimate of the amount of water circulating through it.

The experimental area (Fig.1) has a surface area of about 154840 km^2 and its water volume of 224801.55 km^3. Striking features of this area are the presence of different water masses which converge and mix. According to the outline of circulation in the Eastern Mediterranean, the incoming flux after passing through the Strait of Sicily follows a cyclonic gyre along the coasts of the Eastern basin. An example of the Egyptian Mediterranean waters circulation pattern was given by GERGES (1981). He used all available surface current measurements collected throughout a period of 50 years, up to the early Seventies, and indicated that the surface currents in the Southeastern Mediterranean are mostly eastward and southward.

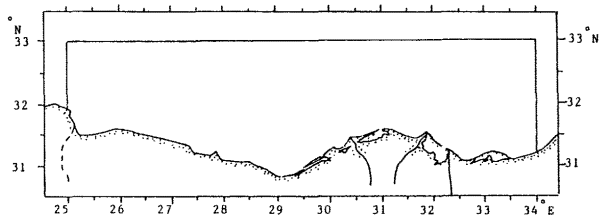
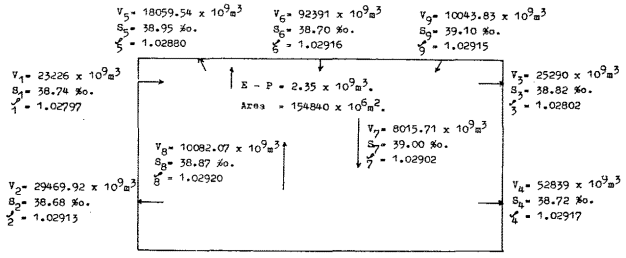


Fig.1. Egyptian Mediterranean Coast.

In the western sector of the experimental area the mean calculated salinity 38.74 ‰ occupies the upper 0-150 m layer. In the eastern sector of the area, according to the results obtained by BETHOUX (1980), the mean surface flux V_3 is about 25290 x 10^{9}m^3 and salinity 38.82 ‰.



Below this level, there exists an intermediate layer of maximum of salinity. The isopycnal analysis of the study area indicated that, the inflowing intermediate water from the Levantine basin (V_9) and the water formed on the Egyptian Mediterranean shelf (V_7) flow away from the continental shelf to the northwest in a high-salinity tongue (V_5) and reaches the open sea with values as low as 38. 95 ‰ . If we suppose as BETHOUX (1980) that the intermediate water conserves its original salinity of 39.10 ‰ up to the Egyptian waters, 39.00 ‰ on the Egyptian shelf and 38.95‰ up to the open sea (SAID and KARAM, 1990).

The horizontal and vertical fluxes, salinities and densities are summed up in diagram 1. Fluxes V_2, V_4, V_6, V_7, V_8 and V_9 and salinities S_2, S_4 and S_8 are initial unknowns and their values are the proposed solutions resulting from the water and salt budgets equations. The deep Eastern Mediterranean waters (V_6) are characterized by 13.60 °C and 38.70 ‰. From the quantitative analysis of the Southeastern Mediterranean waters off the Egyptian coast the mean calculated values of S_2, S_4 and S_8 are 38.68 ‰, 38.72 ‰ and 38.87 ‰ respectively. The mean annual water deficit (evaporation, E-"precipitation + runoff", P) is equal to 2.35 x 10^{9}m^3. The schematic presentation in diagram resumes the annual mean calculated values of the fluxes in the Egyptian Mediterranean coast together with the resulting water deficit.

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Evaporation from the Mediterranean shelf waters off the Egyptian Coast

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Evaporation from the Mediterranean shelf waters off the Egyptian coast was estimated during the period from August 1983 to 1986, using different techniques. The data used were taken from eight cruise, carried out to the Southeastern Mediterranean between longitudes 29° 45'E and 33° 45'E, using RV Noor Ya Nabi. During each cruise, two separate data sets were collected : standard meteorological measurements and hydrographic data, from 26 stations located along eight sections (Fig. 1). In addition, the recorded monthly evaporation data along the Egyptian Mediterranean coast during the period of study were made available through the Egyptian Meteorological Authority-Cairo, Egypt.

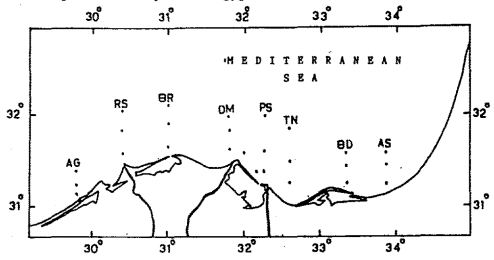

Fig. 1.- Area of investigation.

On the basis of the heat-budget equations, evaporation was computed using Schmidt's ratio R'(1915) and Bowen's ratio R (1926). Also two different forms of the aerodynamic method (SVERDRUP, 1937 and PENMAN, 1956) were used for computing the evaporation. The obtained results were averaged over eight transects and listed in table (1).

The agreement between the observed and calculated values of evaporation by SVERDRUP's formula was good, and considerably better than the cases treated by the other authors. The total evaporation during the year was about 155.6 cm from the observations and 151.5 cm based on SVERDRUP's formula. These values were slightly more than 1450 mm, the mean evaporation for the Mediterranean (SVERDRUP,1942; DAUME,1950; WUST, 1959).

Table (1) Seasonal and annual values of evaporation (cm) from the Egyptian Mediterranean shelf waters using different techniques

year / used method	1983	1984			1985		1986		Annual Evaporation
	August	February	July	October	April	July	February	July	
1. Observations	14.322	11.948	14.353	13.795	12.960	15.624	8.736	14.777	155.60
2. Heat-budget equations using									
a- R' (Schmidt)	16.621	4.225	18.550	6.788	13.978	18.360	4.028	18.492	128.70
b- R (Bowen)	26.200	7.282	32.058	13.864	21.993	27.945	6.618	30.832	216.20
3. Aerodynamic method using :									
a- Sverdrup's formula	14.588	9.379	14.821	12.265	13.375	16.572	9.657	15.338	151.50
b- Penman's formula	20.417	12.765	20.237	17.383	17.951	22.614	13.479	20.788	208.40

The total evaporation from the study area (27,000 km^2) amounts to 42 km^3/year, of which 3.3 km^3 returns to the sea in the form of precipitation and the difference, 38.7 km^3, must be supplied by run-off , since the salinity of the water area remains unchanged. The coastal part of the study area receives about 17 km3/year from the northern Delta lakes, fresh water from the Rosetta Nile Branch as well as large amounts of sewage and industrial wastewater. These amounts represent 37.78 % of the total volume of the coastal waters. Within this area the values of most parameters vary both in time and space, particularly those of salinity.

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