VARIATION OF SEA LEVEL AT ALEXANDRIA

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INTRODUCTION

The study of the variation of the mean sea level at Alexandria has not been carried out before, although the value of the mean sea level itself was determined by different authorities for other purposes. The value of the mean sea level at Alexandria was determined by the Survey Department of Egypt when it started its first order levelling in 1906. The observations available at that time covered the years 1898 to 1906. They were used to calculate the mean sea level as the mean between the daily readings of high and low levels. This value of the mean sea level is still used as the reference datum for the network of the precise levelling. Dr. Robert Von STERNECK calculated the harmonic constants for Alexandria from one year of observations (1-7-1916 to 1-7-1917). These values were published on sheet No. 2083 of the International Hydrographic Bureau's Special Publication 26. The object of this paper is to give a general picture of the variation of the mean sea level at Alexandria in relation to the meteorological elements, namely wind speed and pressure.

TIDAL AND METEOROLOGICAL OBSERVATIONS

The hourly heights of the sea level were taken from the records of the tide gauge established in Alexandria Harbour. This tide gauge has been installed in its present location inside the innermost basin of the harbour since 1949 (figure 1). The instrument is an old Hughes machine with one day recording sheets erected in a double well.

The meteorological observations were taken at Ras El Tin station. The wind speed and pressure observations used are those values taken at 0600, 1200 and and 2400 GMT.

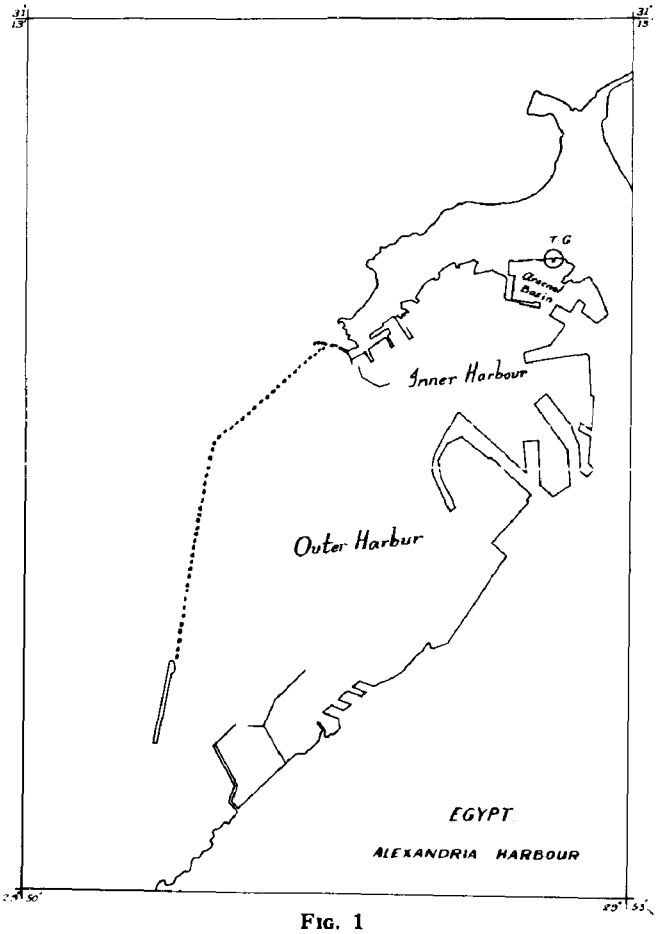

FIG. 1

METHODS OF INVESTIGATION

The tidal records were smoothed by hand to eliminate the superimposed seiches. Figure 2 shows one typical record for twenty-four hours.

The daily mean sea level can be calculated by any of the following methods :

(1) Direct average of 1, 3, 6 or 8 heights per day at fixed hours;
(2) Direct average of 24 or 25 hourly heights;
(3) Numerical filters applied to the hourly heights;
(4) Direct average of high and low water heights;
(5) Integration of daily record by planimeter.

The method with 8 heights per day (ROSSITER 1961) was used to calculate the daily mean sea level for each day of the period from the year 1962 to the year 1966. From these values, the monthly and the annual means were both calculated. The method of averaging 24 or 25 hourly heights per day was also applied to the tidal observations of 1965.

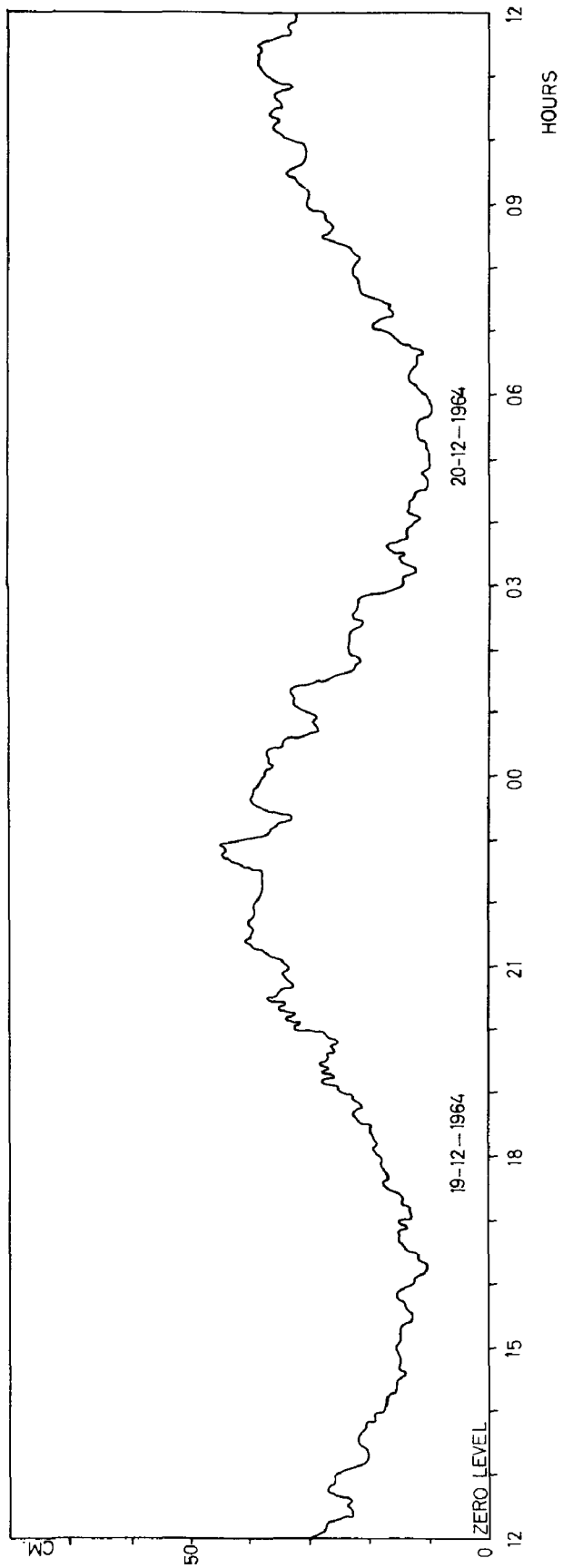

FIG. 2. — Typical tidal record.

The formula used for the correlation coefficient is

$$K = \frac{Z}{\sqrt{XY}}$$

where

$$Z = xy - \frac{(\Sigma x)(\Sigma y)}{n}$$

$$X = x^2 - \frac{(\Sigma x)^2}{n}$$

$$Y = y^2 - \frac{(\Sigma y)^2}{n}$$

and where x is the daily mean sea level, and y is either the pressure or the wind speed. The observations of the year 1965 were used to calculate the correlation coefficients between the daily mean sea level and both the pressure and the wind speed at Alexandria. The same observations were used to calculate the correlation coefficient between the daily mean sea level and the pressure gradient between Crete and Alexandria.

DISCUSSION OF THE RESULTS

The value of the mean sea level calculated from the five years of observations (1962 to 1966) is 45 cm above the zero of the tide gauge at Alexandria harbour. This value is 11.2 cm higher than the one used by the Survey Department of Egypt (33.8 cm) and published on the British Admiralty charts.

From the two methods of obtaining the daily mean sea level which were applied to the tidal records of 1965 it has been shown that the difference between the two methods is negligible (table 1).

TABLE 1

The mean height of sea level every month during 1965

Month	1	2	3	4	5	6	7	8	9	10	11	12
Method 1 : (average of 24 heights)	44.0	40.6	34.4	40.3	37.0	42.0	47.9	46.9	45.5	44.1	44.7	47.0 cm
Method 2 : (average of 8 heights)	44.0	40.7	34.5	40.4	37.0	42.0	47.9	46.9	45.5	44.1	44.7	47.0 cm

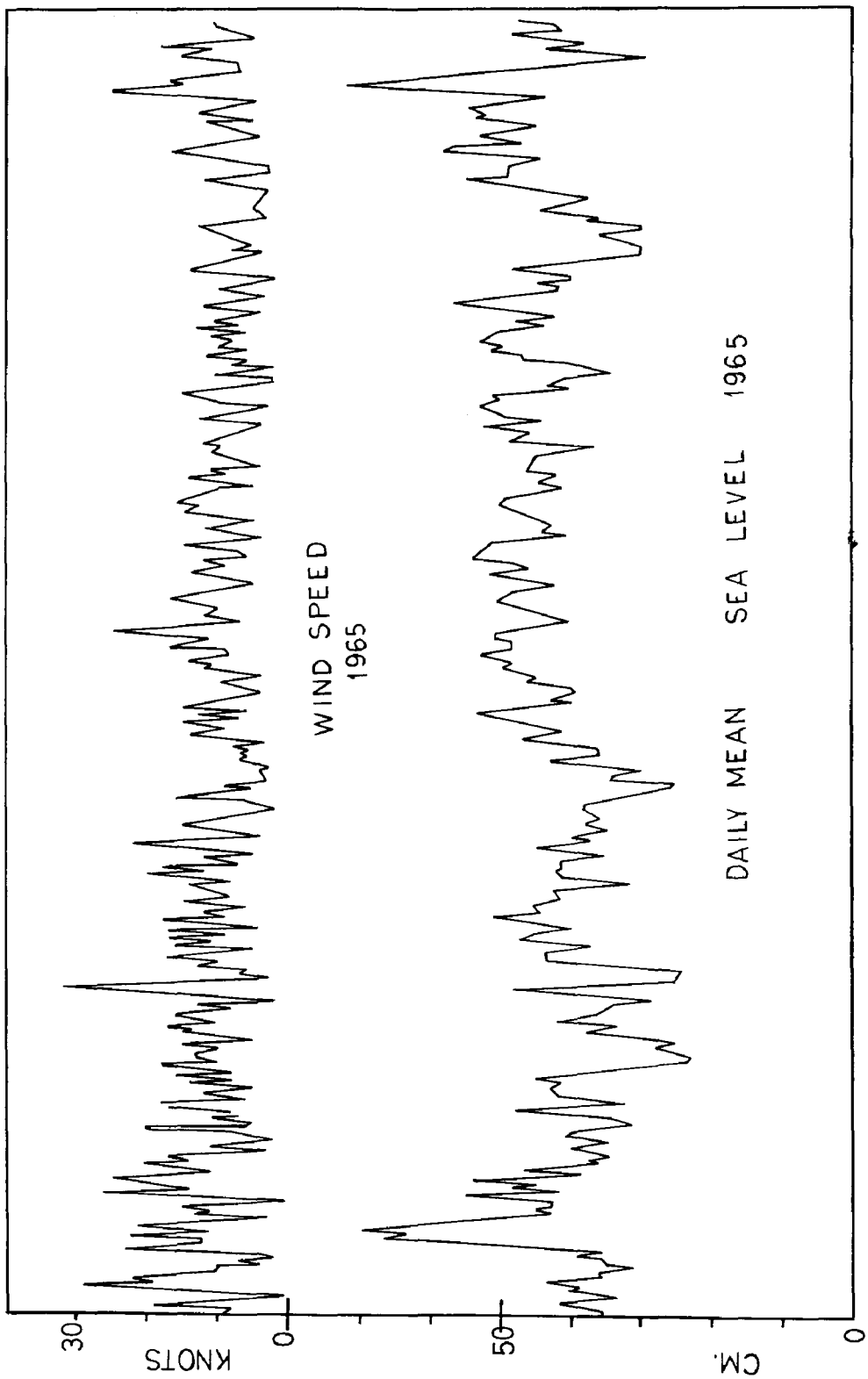
WIND SPEED
1965
KNOTS
30
0
DAILY MEAN SEA LEVEL 1965
CM.
50
0
J F M AP M J J AU S OC N D

Fig. 3

The graphs of the daily mean sea level and the daily mean wind speed for the year 1965 (figure 3) show an immediate response of the sea level to the wind force.

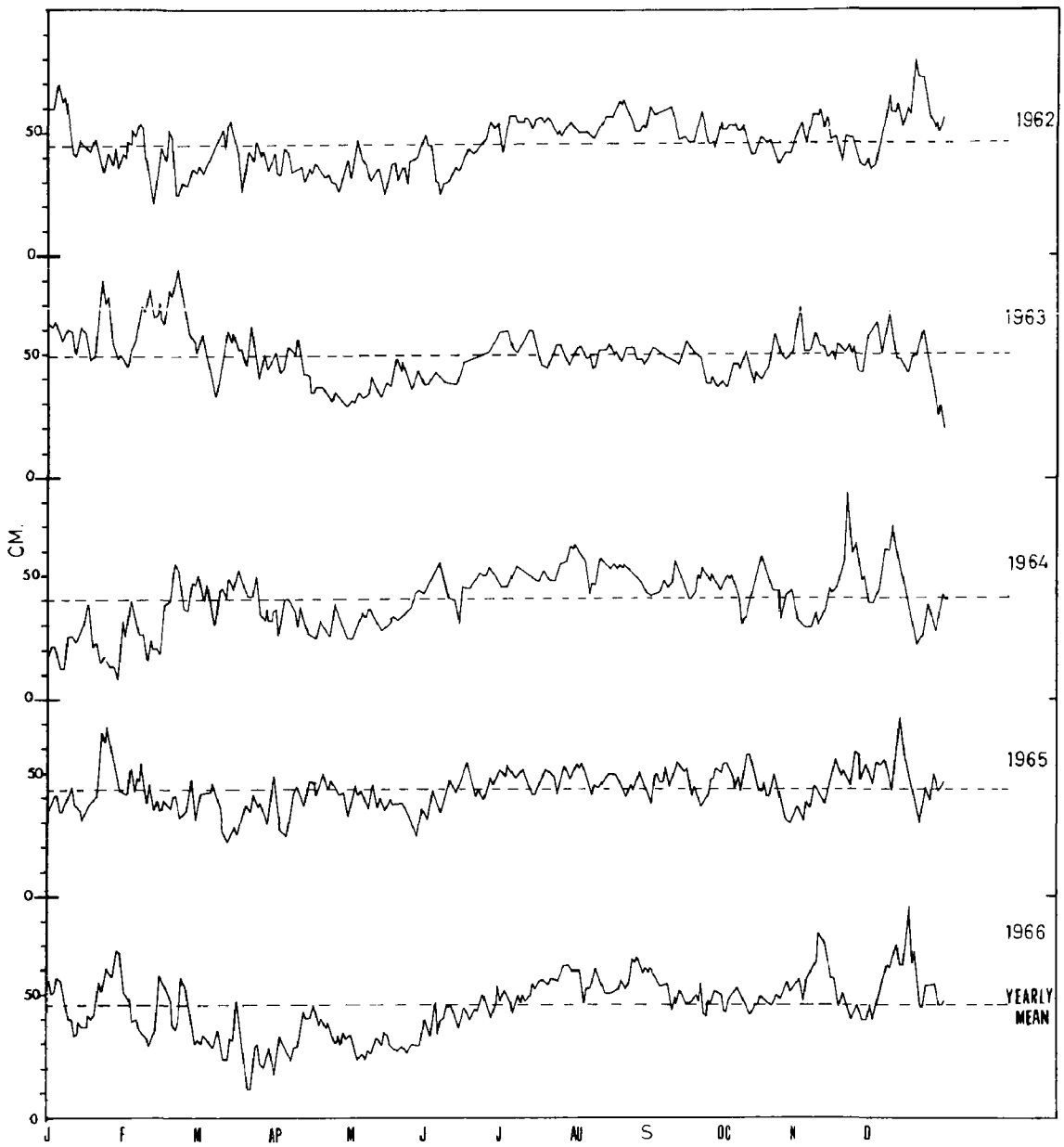

FIG. 4. — Daily mean sea level.

The correlation coefficient between the daily mean sea level and the wind speed is higher (K = 0.25) than that between the daily mean sea level and the pressure.

The correlation coefficient between the daily mean sea level and the pressure gradient from Crete to Alexandria amounts to K = 0.13, which

is not markedly significant. These results cannot be confirmed by one-year observations, but data for at least 5 years will probably give a more clear picture.

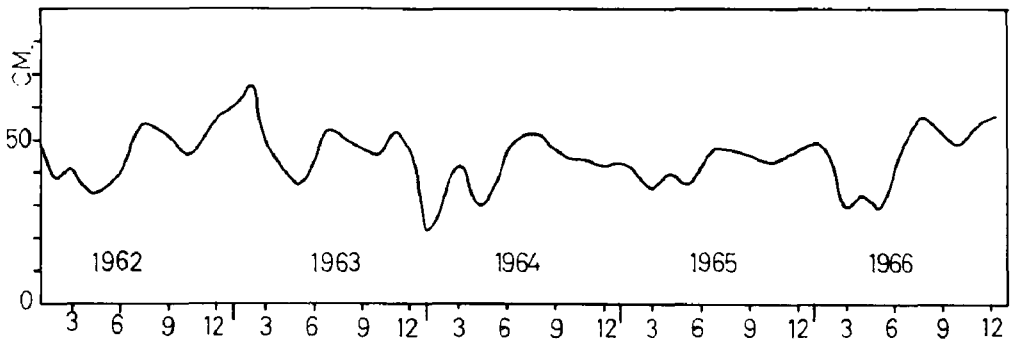

FIG. 5. — Monthly mean sea level.

Figure 4 shows the deviation of the daily mean values from their annual mean during the period from 1962 to 1966. The monthly mean sea level which is represented in figure 5 for each of the years from 1962 to 1966 is more interesting. The monthly mean sea levels as calculated from the whole period of the five-year observations are given in figure 6. This graph shows quite clearly that the lowest monthly mean occurs around May and the highest value between July and August. It can be seen that for each of the years both curves fit quite closely. The year 1963 is rather anomalous.

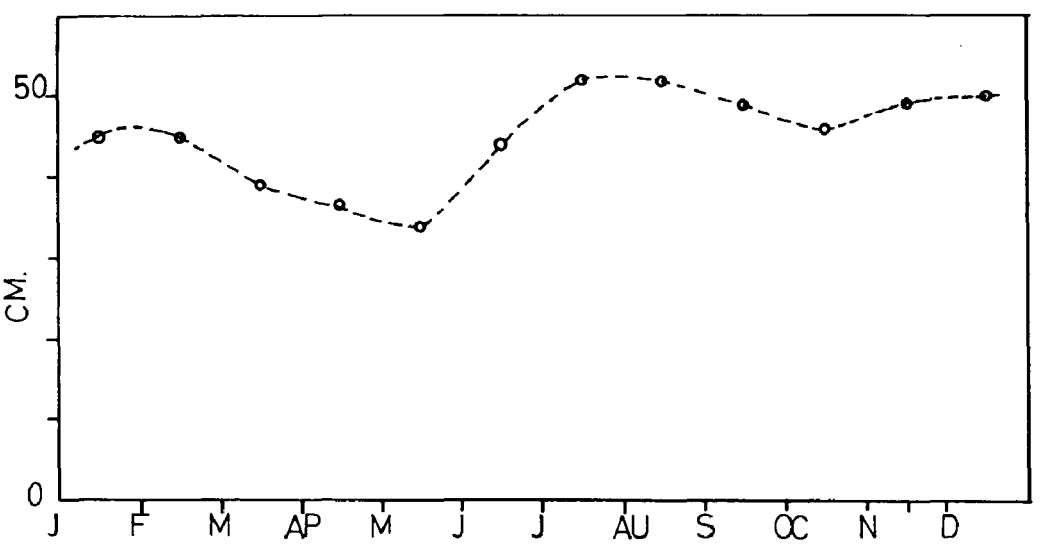

FIG. 6. — Monthly mean sea level from 5 years.

Finally, table 2 — represented graphically in figure 5 — shows the variation of the monthly and annual mean sea level during the five-year period.

TABLE 2

The variation of the monthly and the annual mean sea level during the five years 1962-1966

	1962	1963	1964	1965	1966
January	49	59	22	44	50
February	38	67	35	41	44
March	41	49	43	35	29
April	35	42	32	40	34
May	36	37	33	37	29
June	40	44	47	42	42
July	53	53	51	48	53
August	54	50	52	47	56
September	52	48	47	46	51
October	46	46	44	44	48
November	48	53	44	45	53
December	57	48	42	47	57
Yearly mean	46	50	41	43	46

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