

A univariate statistical approach to the interpretation of chemical analyses data from the coastal environment of Alexandria (Egypt)
2- Analysis of Variance (ANOVA)

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Alexandria is the principal summer resort of Egypt. It is one of the relatively densel populated regions of the Eastern Mediterranean (about 3.5 million inhabitants receiving about 1 million tourists in summer who come to use its beaches for recreation). Alexandria coastal waters are highly polluted with untreated domestic sewage and waste waters, discharged into the sea through several outfalls along the coast, thus presenting a serious source of pollution in that region. In 1985-1986, research project has been done to assess the impact of sewage disposal on the water quality of the Eastern Harbor of Alexandria. A necessary condition for any efficient water pollution study is the dominance of the inter sample concentration change over the intra sampling site dispersion. The repeated sampling of the water network performed in the present study affords in principle a statistical differentiation between these two major causes of variation. The concentration changes can be studied in terms of environmentally significant factors such as sewage influence, distance from the source points, water depth and time of collection.

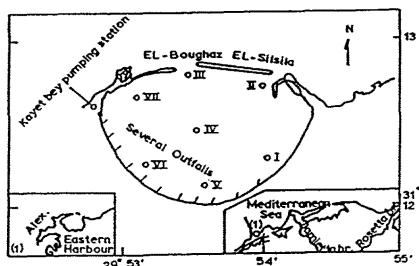


Fig. 1. Stations sampled in the Eastern Harbour (EH) during the period 1985-1986.

The study area (Eastern Harbor) is a shallow semi-closed basin (Figure 1), sheltered from the sea by an artificial break water leaving two openings through which the exchange of water between the harbor and the neritic Mediterranean water takes place. Our data set consists of 256 samples (cases) with 37 environmental parameter (variables) studied.

In this paper, we will use a powerful univariate statistical technique as ANOVA to analyze the inter/intra sample variation. The technique was performed to measure the significant difference between:

- 1- different stations,
- 2- different months, and
- 3- different water levels.

Based on the T-test (0.05) and F-test (0.05) values, the significant variables ONLY have entered the program as dependent variables.

ANOVA between stations

The variables which recorded significant differences between stations are:

a- Transparency:

Stations III & IV (located near the entrance of the unpolluted Mediterranean water) recorded significant difference from stations VII & II as well as I, V, VI (located close to sewage disposal).

b- Salinity:

Significant difference in salinity occurred between stations (III & VII) and (I, V, VI).

c- Chlorophyll a:

Stations (V & I) recorded significant difference with (II, III, IV, VII).

d- Particulate organic carbon (POC):

Stations V varies with station IV, VII, III and station III differs from I, VI, V.

e- Nitrate:

Station I recorded significant difference with the other 6 stations.

f- Particulate organic matter (POM):

Stations I differs from III, IV and VII, while station V recorded significant difference from stations III, IV.

ANOVA between different depths

Significant variations between surface (S) and bottom (B) water levels occurred between the following variables: O₂, S%, CHL A, DIP, DOC, POC, NO₃, DOP, PP, DON and PN were recorded. Most of the cases recorded insignificant difference between bottom (B) and middle (M) water levels.

ANOVA between different months

The following variables recorded significant differences between months: O₂, S%, CHL, DIP, DOC, POC, NO₃, NO₂, DOP, PP, DON, DIC, PIC, NH₃, DON and PN. Months of the warm season including May, June, August and September recorded insignificant differences between themselves and significant differences with the other months.

Conclusion

The significant differences recorded between stations located close to sewage outfall (I, V & VI) and the other stations are due to the effect of the domestic sewage disposal and its variability within the different stations. The significant difference between surface and bottom/middle water levels is due to the effect of mixing between the low density sewage water with the surface water of the bay. The difference between summer season and the rest of the other months is coinciding with periods of high sewage discharge rate in Alexandria city.