



Source Contributions to Sediment Trace Element Levels in Izmir Bay (Turkey)

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Abstract

Izmir bay is a heavily polluted water body located on the Aegean coast of Turkey. In this study sources affecting sediment trace element levels in different parts of the bay is investigated using chemometric tools. Approximately 100 surface sediment samples were collected from inner, middle and outer bay and analyzed using X-ray fluorescence and atomic absorption spectrometry. Distribution maps were generated for pollution derived elements. Sources responsible for the observed distributions were investigated using positive matrix factorization (PMF). The PMF is recently being used in air pollution studies to time series data generated at one location. In this study it is used to spatially distributed data corresponding the same time.

Introduction

Positive matrix factorization is being used in air pollution studies in only last ten years (for example [1]). It proved to have some advantages over conventional multivariate statistical tools, such as factor analysis (FA) or principal component analysis (PCA). The most important advantage for a practical user is that it can handle missing values much better compared to FA or PCA. It also has some disadvantages. In most of its environmental applications, PMF is applied to data collected at one location, but for a certain period in the time space (for example [2]). In this study we wanted to test the power of this technique when it is applied to spatially distributed data corresponding to the same exact time.

The technique is applied to sediment concentrations of trace elements measured in the Izmir Bay. Izmir bay is a heavily polluted bay on the Aegean cost of Turkey. The two main source of pollution in the bay are the sewage discharges and 5 streams flowing to the bay. These two group of sources have different chemical composition and because of this multivariate source apportionment techniques were expected to be useful to determine contribution of these sources to measured concentrations of trace elements at different parts of the bay.

Materials & Methods

100 surface sediment samples were collected from Izmir bay (38°26'N, 27°02'E). Sampling was not homogenous throughout the bay. Approximately half of the sampling points were located in the inner bay where most of the pollution discharges occur. Sampling stations in the middle and outer bay were not as closely spaced as they are in the inner bay. Collected samples were analyzed by energy dispersive x-ray fluorescence (EDXRF) and atomic absorption spectrometry (AAS). Concentrations of 16 elements (Cd, Zn, Fe, Cr, Mn, Mg, Al, K, Na, Ti, Pb, Cu, Ca, Ni, Si and S) were determined by these techniques. Ten of the collected samples were also analyzed by INAA for approximately 30 additional elements. Details of the sampling and analytical methods are given elsewhere [3].

Results

The Izmir Bay, particularly the inner bay are strongly influenced by two main types of pollution sources, namely, sewage discharges and streams flowing to the inner bay. Both the chemical composition of discharges from these two sources and physical locations are not the same. The sewage discharges occurs along the coast, whereas 3 most polluted streams discharge to the east of the bay. Contribution of these two sources on sediment pollution at different locations in the bay is important as it determines priority of the actions that needs to be taken.

A source apportionment study was performed on the generated trace element data set using positive matrix factorization (PMF) as the multivariate statistical tool. The PMF was run first for the

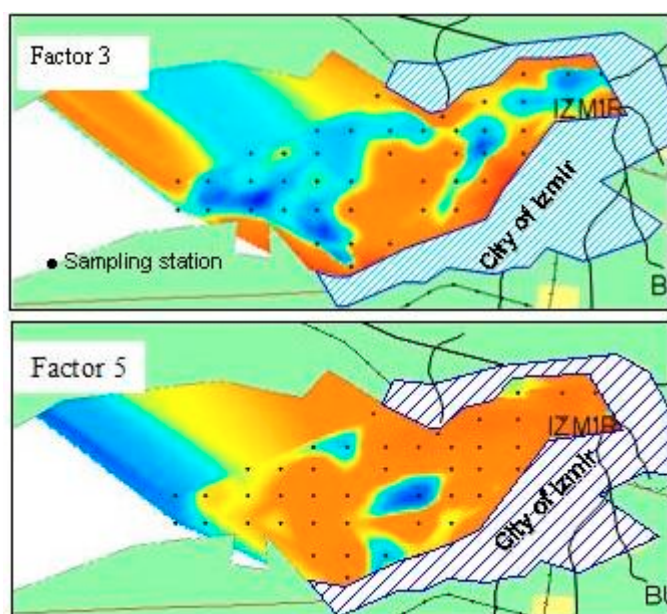


Fig. 1; Distributions of factor 3 and factor 5 scores

inner bay, then for the whole bay. The PMF output was optimized taking into account Q values, rotations, scaled residuals. The PMF revealed five factors, or components, in sediments of Izmir Bay. Composition of three of the five factors suggested that they represent unpolluted sediment with different mineralogy. These three different mineral types occur in different parts of the bay. Two of the five factors were loaded with anthropogenic elements. The distribution of factor scores (g-scores in PMF) are given in figure 1. Factor three scores are high along the coast where most of the sewage discharges occur. The composition (F-loading in PMF) of this factor closely resemble the composition of sediment samples taken at the outlets of sewages. Factor 5 scores, however are high in most of the inner bay and particularly high at the east part of the bay where most polluted streams discharge.

The composition of factor 5 were close to the composition of samples collected at stream discharge points. Contributions of each of these sources to every element at each sampling station was also calculated.

Conclusions

Positive matrix factorization which is a statistical tool frequently used in source apportionment studies in atmospheric studies is applied to trace element concentrations in 100 sediment samples collected from Izmir Bay. Results demonstrated that the PMF can be used in spatially distributed data.

References

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