

PHTHALATE ESTERS IN THE GOLDEN HORN ESTUARY SEDIMENTS, TURKEY

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Abstract

Surface sediments from the Golden Horn Estuary, Turkey, were analyzed for 4 phthalate esters (PEs); namely diethyl phthalate (DEP), di-n-butyl phthalate (DnBP), di-(2-ethylhexyl) phthalate (DEHP) and di-n-octylphthalate (DnOP). The DEHP was found to be dominant (97% of total) with concentrations ranged from 2.23 to 166.9 µg/g dry weight (dw), increasing towards the inner estuary and mostly related with domestic and industrial sewage waters transported by the rivers. Non-point sources such as surface runoff and marine traffic are also responsible sources. DEHP is correlated with TOC% in sediment ($r^2=0.274$, $n=15$), while bottom water salinity has a significant impact on the solubility and sorption behavior of DEHP ($r^2=-0.354$, $n=15$).

Keywords: Pollution, Marmara Sea, Plastics

Introduction

The global production of phthalate esters (PEs) is more than 6.0 million tones [1] and used mostly as non-reactive additives in plastics, rubber, cellulose and styrene production. As PEs can enter the environment directly or indirectly with production or after disposal, they are ubiquitous in air, water, soil and sediment. Some PEs have low- water solubility and high octanol partition coefficient, and concentrated in suspended matter and sediment. The main objectives of the present study are to investigate the levels of 4 PEs in the sediments from the Golden Horn Estuary, Turkey, and to discuss the possible sources and the ecological effects of PEs.

2012, bottom surface sediment samples were recovered with a snapper along the thalweg line of the Golden Horn estuary (Figure 1a). The samples, all mud, were stored in a freezer at -20°C until analysis. Extraction of samples with Soxhlet apparatus and PEs analyses by GC/MS (Finnigan, Thermo, Trace DSQ) were given in [2]. The standard mixture was obtained from Dr. Ehrenstorfer GmbH Inc. The recoveries of spiked blanks ($n=3$) varied from 78.2 to 108.2%. The organic carbon content of sediment samples were measured by Shimadzu TOC-V cph + SSM-5000 A (solid sample module) using the method TS 12089 EN 13137.

Results and Discussion

The \sum_4 PEs concentrations ranged from 2.28 to 166.9 µg/g dw; median 25.31 µg/g-dw. DEHP is the dominant PE congener with a maximum concentration of 166.9 µg/g-dw and accounted for 97% of the \sum_4 PEs concentrations (Figure 1b). It is followed by DnBP with a maximum of 10.40 µg/g-dw and accounted for 3% of the total. DEHP and DnBP are the most commonly used plasticizers worldwide. Their main sources in the study area are the domestic and industrial sewage waters mostly transported by the Alibey and Kagithane rivers. In addition non-point sources such as surface runoff and marine traffic are also responsible for the major pollutants discharging into the estuary. The correlation coefficients were 0.27 ($p<0.01$) for total PEs concentrations and for DEHP. On the other hand, a negative correlation exists between the levels of \sum_4 PEs (or DEHP) with bottom water salinity ($r^2=-0.355$, $n=15$). Principal component analysis (PCA) identified the relationship among contaminants in sediments and their probable sources (Figure 1c). Two factors explain 79.8% of the total variance in the 15 sediment samples analyzed. The first principal component explains 55.2% of the total variance and separates high level of DEHP and TOC. The second principal component explains 24.6% of the total variance and exhibits positive loadings for bottom water salinity and therefore the water depth decreasing along the estuary. Based on ecotoxicology and environmental chemistry the environmental risk limits (ERLs) in sediment was reported 1.0 and 0.7 µg/g for DEHP and DnBP [3]. So the median value of the DEHP concentrations measured in the sediments of the Golden Horn estuary (24.67 µg/g) exceeds the ERL risk limit about 25 times, while that of DnBP concentrations (0.69 µg/g) is very comparable to the environmental risk limits. These first results also emphasize the need for adequate monitoring along the feeding rivers.

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References

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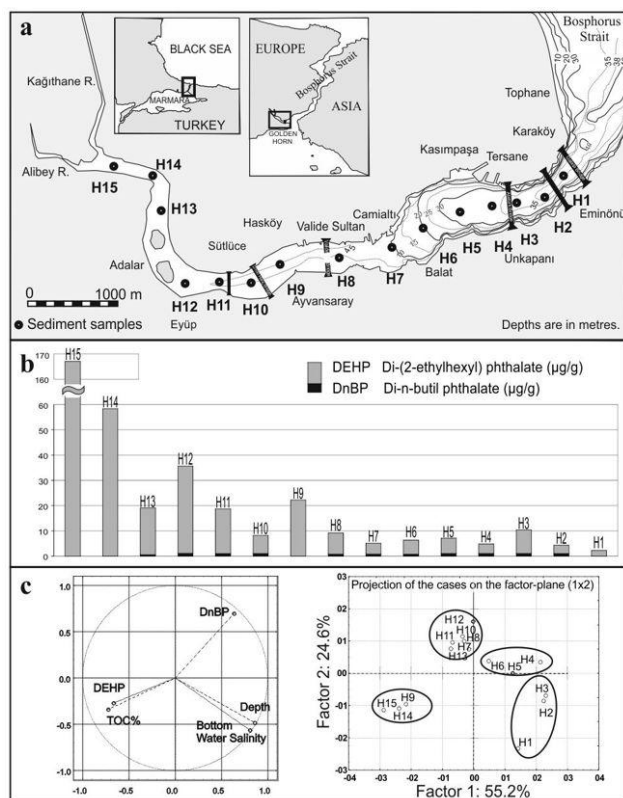


Fig. 1. a) Study area and sampling stations b) the distribution of DEHP and DnBP in sediment along the Golden Horn estuary, c) PCA analysis among the PEs, TOC% in sediment, bottom water salinity and water depth.

Material and Method

The Golden Horn is a highly dynamic estuary at the southern end of the Strait of Istanbul, entangled with coastal and fresh water discharges (Figure 1a). The inner part of the estuary is shallower than 10 m where the Alibey and Kagithane rivers carry their load, whilst the maximum is 40 m at the mouth. In December