



Pollution from organic contaminants in Greek marine areas, receiving anthropogenic pressures from intense activities in the coastal zone

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Polycyclic aromatic hydrocarbons (PAHs) are widespread pollutants in marine sediments, receiving the pressures from various anthropogenic activities in the coastal zone. Due to their mutagenic and carcinogenic behaviour, PAHs are classified as priority contaminants to be monitored in environmental quality control schemes. The purpose of this study was to determine the levels of PAHs in coastal areas of Greece directly influenced from the operation of major industrial units in the coastal zone, investigate their sources and evaluate their potential toxicity by comparison against effect – based sediment quality guidelines.

Thirty two surface sediment samples were collected from three areas of the Hellenic coastline: a) Antikyra bay in Korinthiakos gulf, influenced from the operation of an alumina and aluminium production plant b) Larymna bay in Noth Evoikos gulf, influenced from the operation of a nickel production plant and c) Aliveri bay in South Evoikos Gulf, influenced from a cement production plant. In all the areas studied, aquaculture and fishing activities have been also developed in the coastal zone. PAH concentrations were determined by GC-MS, after soxhlet extraction and fractionation by silica column chromatography. PAH sources and origin were investigated by applying several isomeric ratio diagnostic criteria. The mean quotient Effect- Range Median (m-ERM) was used to evaluate the potential of adverse effects posed to benthic organisms. Three m-ERM-q values were used to differentiate the probability of observing toxicity and classify sites into four categories: sediments with $m\text{-ERM} < 0.1$ have the lowest probability (9%) of being toxic, those with m-ERM from 0.11 to 0.5 have a 21% probability of toxicity, those with m-ERM from 0.51 to 1.5 a 49% probability of toxicity, while sediments with $m\text{-ERM} > 1.5$ have the highest probability (76%) of toxicity.

Extremely high PAH concentrations more than 100,000 ng/g were found in the close vicinity of the alumina production plant in Antikyra bay. High levels of PAHs up to 22,000 ng/g were also found in Aliveri bay, whereas lowest values, but still indicating significant pollution, were measured close to the nickel production plant in Larymna bay (PAHs concentrations up to 7500 ng/g). The examination of PAH molecular indices revealed that in Antikyra and Larymna bays more than 80% of the PAHs have pyrolytic origin coming from various combustion sources. On the contrary, in Aliveri bay about 60% of the PAHs are related to petrogenic/petroleum inputs. With respect to ecotoxicological effects, m-ERM values higher than 1.5 were calculated in Antikyra bay indicating that the sediments in this area have a high probability (76%) of being toxic. In Aliveri and Larymna bays the m-ERM values were between 0.11 and 0.5 bay suggesting a lower probability (21%) of toxicity.

Overall, the results of our study reveal that high quantities of PAHs produced from land point sources can enter into small coastal marine areas supporting activities such as aquaculture and fishing. Thus, desirable and permitted uses must be well defined and regulatory frameworks must be established.