

# Contamination and Risk Assessment of Heavy Metals in surface sediments of the Montenegrin coast

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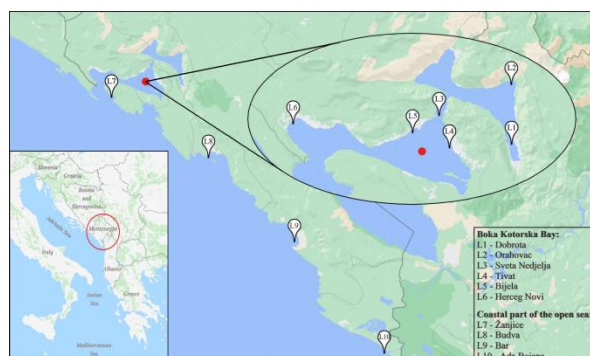
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**Introduction:** One of the most challenging environmental concerns is heavy metal pollution in aquatic ecosystems because of their persistence, environmental toxicity as well as bioaccumulation [1, 2]. Heavy metal contamination in sediments is one of the most important quality indicators for the assessment of potential ecological risks in coastal marine ecosystems [3]. Heavy metals in marine sediments have natural and anthropogenic origins: distribution and accumulation are influenced by sediment texture, mineralogical composition, reduction/oxidation state, desorption processes, and physical transport. Montenegro is a popular destination, and tourism development is one of the most important activities related to the pollution of marine areas, and heavy metals have negatively affected their natural environment [3, 4].

**Methods:** The sediment samples were collected from 10 sites along the Montenegrin coast: Dobrota (L1), Orahovac (L2), Sveta Nedelja (L3), Tivat (L4), Shipyard of Bijela (L5), Herceg Novi (L6), Žanjice (L7), Budva (L8), Port of Bar (L9), and Ada Bojana (L10) (Fig. 1). The sediment samples were taken in the autumn of 2020. Determinations of heavy metals in sediment (Fe, Mn, Zn, Cu, Ni, Pb, Cr, Cd, As and Hg) were measured according to methods Laboratory Procedure Book, IAEA (International Atomic Energy Agency), Marine Environment Laboratory, Monaco 2009 [5]. All measurements are performed on Shimadzu AA 7000.



**Fig. 1:** Map of the investigated area

**Results:** The values of Fe, Mn, Zn, Cu, Ni, Cd, As, Pb, Cr and Hg (mg/kg dw) at a different location from the Montenegrin coast decrease in the following order Fe > Mn > Cr > Ni > Zn > Pb > Cu > As > Hg > Cd. The most abundant elements in the sediments from the Montenegrin littoral are Fe and Mn, which is not surprising considering that these two elements are the most abundant metals in the Earth's crust. In general, the results of the research show that higher concentrations of Zn, Cu, Pb, As, and Hg are mainly found in sediments from locations inside the Bay of Kotor, while higher concentrations of Fe, Mn, Cr, Ni, and Cd are mainly found in sediments from locations in the open area, which is in agreement with earlier research [6]. The PLI values in this study were > 1 for all investigated locations during the sampling, except for the Žanjica and Budva locations where the PLI values were < 1. Igeo values indicate that the examined locations are mostly categorized as unpolluted or slightly to moderately polluted with the examined heavy metals. Higher Igeo values were observed for Pb and Hg in Tivat; Pb and Cd in Bar and Cr on Ada Bojana.

**Discussion:** Comparing the results obtained for 10 selected heavy metals in sediment samples, collected from 10 locations along the Montenegrin coast, it can be concluded that the high concentrations of metals in the sediment may be the result of port activities, municipal and industrial wastewater, tourist and recreational activities in the coastal area, as well as pollution from former industrial activities whose pollution consequences are still visible. Also, differences between the concentrations of certain examined heavy metals in sediments may be the result of geographic, hydro morphological characteristics, sea currents, and waves, the sampling season as well as the precision during sampling.

**References:** [1] Arisekar et al (2022) *Chemosphere* 294; [2] Stamatis et al. (2019) *Toxics* 7(2):30 [3] Wang et al (2022) *Environ. Pollut. Bioavailab.* 34(1):180–189 [4] Romano et al (2021) *Sci Total Environ* 755 [5] IAEA (2003) Iaea-tecdoc 1360 [6] Joksimović et al (2020) *JSS*, 20 (6): 2598-2607.