CONTENTS OF HEAVY METALS IN COASTAL SURFACE SEDIMENTS FROM MONTENEGRIAN COAST

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Abstract
The aim of the study was to determine the levels and distribution of heavy metals in the sediments in coastal surface sediments, also to assess the extent of anthropogenic impact using geo-accumulation index (Igeo) and enrichment factor (EF). Surface samples were taken from 3 locations: two stations located in the „inner shore“ waters Boka Kotor Bay, and at one station located „off shore“ Montenegrin coast, considered as a reference station. Based on the obtained data we can conclude that significant amounts of heavy metals are deposed in Boka Kotorska Bay sediments.

Keywords: Sediments, Trace elements, Mediterranean Sea

Introduction
Pollution of the natural environment by trace metals is a world-wide problem. Trace elements from natural and anthropogenic sources continuously enter the aquatic ecosystem where they pose a serious threat because of their toxicity, long time persistence and bioaccumulation [1]. Due to rapid industrialization and uncontrolled urbanization around many cites and coastal areas, an alarming level of pollutants have contaminated these aquatic environments [2]. Heavy metals can be introduced into the aquatic environment and accumulate in sediment through disposal of liquid effluents, chemical leachate and runoff originating from domestic, industrial and agricultural activities, as well as atmospheric deposition [3].Trace metals can be released from sediments to the overlying water via natural or anthropogenic processes, consequently causing potential danger to the ecosystem.

Material and Methods
Samples of bottom sediments were taken from a depth of 15-20 cm using an internal diameter plastic gravity corer. The sampling was done during November 2014 / May 2015 at three stations in the Montenegrin coast: 1. IBM, 2. CogiMar and 3. Zanjice, Fig.1.

Fig. 1. Map of investigation area

Dry samples (about 0.5 g) were digested in 10 ml solution of mixture HNO3 and H2O2 in a microwave digestion system (CEM. Corporation, MDS-2100) for 30 min and diluted to 25 ml with deionized water and stored in polyethylene bottles until analysis. A blank digest was performed in the same way. Determinations of heavy metals in sediment were measured according to methods Laboratory Procedure Book, IAEA (International Atomic Energy Agency), Marine Environment Laboratory, Monaco 2009. All measurements are performed on ICP-OES, Spectro Arcos.

Result and Discussion
Improved interpretations are obtained by normalizing metal concentration in sediments to percentage of a given grain sizes or Al, Fe or organic carbon concentrations [4]. Enrichment factor (EF) is good tool to differentiate the metal source between lithogenic and naturally occurring. In this study we used Fe to compute EF because it is the fourth major element in the earth's crust and most often has no contamination concern. The Geoaccumulation Index (Igeo) was calculated to determine metals in sediment of Montenegrin coast. This expression was proposed by M?ller (1997) in order to calculate metals concentrations with undisturbed or crustal sediment (control) levels [5]. The results from the present investigation showed that EF of Mn ranged from 1.59-5.36, EF from 1.03-5.75 for Zn, from 1.02-5.26 for Cu, from 3.24-10.59 for Ni and from 0.54-3.79 for Pb. The average EF values of Zn, Cu and Pb indicated that these metals were caused by minor enrichment, whereas, the average EF value of Mn suggested moderate enrichment. In station CogiMar metals Zn, Cu and Ni caused by moderately severe enrichment and severe enrichment, respectively. Overall, EF of these metals was high in urban-affected area (mostly from domestic source) and mariculture area. The lgeo of Zn and Cu at several locations were of classified to class 1 (unpolluted to moderately polluted), for Mn and Hg to class 2 (moderately polluted) and Igeo for Ni to class 3 (moderately to strongly polluted). The main reasons of higher contamination are anthropogenic factor, harbor activates and anti-corrosion treatment for vessels.

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