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Assessment of chromium and nickel levels in surface sea waters and sediments from industrial marine area in Tuzla Aydinli Bay, Istanbul Turkey

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ABSTRACT

The determination and evaluation of nickel and chromium in Tuzla Aydinli Bay is an important subject since it is an industrial marine area for decades and it is crucial to protect aquatic life which are toxic for the aqueous environment. In this study, 32 samples were collected both from near the coastal shipyard activity to far of the activity areas in Tuzla Aydinli Bay, Istanbul (Turkey) according to the standard guidance. Nickel and chromium were determined in the sea water and sediment samples by graphite furnace atomic absorption spectrometry. The contamination factors and geoaccumulation indices with respect to nickel and chromium were calculated and evaluated. Based on the modified ecological risk assessments, variable results were obtained depending on the selection of control (blank) points.

1. Introduction

Heavy metals are considered serious environmental pollutants due to their toxicity, easy bio-accumulation, and nondegradation. Both natural and anthropogenic sources contribute to the abundance of heavy metals in the environment. However, anthropogenic activities (e.g., industrial and urban discharge, agricultural activities, leaching, and atmospheric deposition) are particularly responsible for the increasing accumulation of heavy metals in sediments and water, causing the pollution of aquatic systems (Islam et al., 2014; Islama et al., 2015; Mortuza and Al-Misned, 2017).

Sediments are important ecosystem components and are the main sink for heavy metals in aquatic environments. They show a high capacity for accumulating heavy metals from water, even when those heavy metals are in low concentrations. Thus sediment quality has been recognized as an important indicator of water pollution (Chaharlang et al., 2017; Zhang et al., 2017; Zhao et al., 2017; Morillo et al., 2004; Santos Bermejo et al., 2003).

Tuzla Aydinli Bay in Istanbul-Turkey is largest ship and shipment repair, building and renovation facility area in Turkey since early 1980s. This area has been identified with remarkable naval work. The Tuzla Aydinli Bay is an area on the south of the Istanbul and north east of the Sea of Marmara at the entrance to the Bosphorus where releases of chemical contaminants to air, land and water from various naval activities have taken place over the last four decades. The bay also covers various industrial areas such as Istanbul Tuzla Chemical Industrials Organisation, Istanbul Tuzla Industrial Organisation etc. As a consequence of increasing population and industrial activities, Tuzla Aydinli Bay is expected to receive increasing quantities of contaminants from both diffuse and point sources. However, to date there has been little or no attempt to assess and determine the extent of contamination in sediments, waters and biota or to characterize the potential impacts of contaminants on aquatic biota. Especially the trading of the bay is mostly constructed and renovated of merchantmans with a heavy industrial process, which especially includes nickel based slag (grit) treatment. The most of the slag wastes includes nickel (Ni) or/and chromium (Cr) residue in this process.

This study aimed to identify Ni and Cr levels in surface sea water and sediments of an important marine region using standard guidance in the Tuzla Aydinli Bay, Istanbul-Turkey.

2. Materials and methods

2.1. Materials and instrumentation

All chemicals were of analytical reagent grade (Merck, Germany). Stock solution (1000 mg/L) of Cr and Ni was prepared from Titrisol concentrates (Merck) and further diluted with distilled-deionized water daily. Sea-water (CRM-SW) certified reference material was bought from High-Purity Standards (USA).

Acid digestion of sediment samples was carried out in CEM MARS closed vessel microwave reaction system (CEM Corporation, USA).

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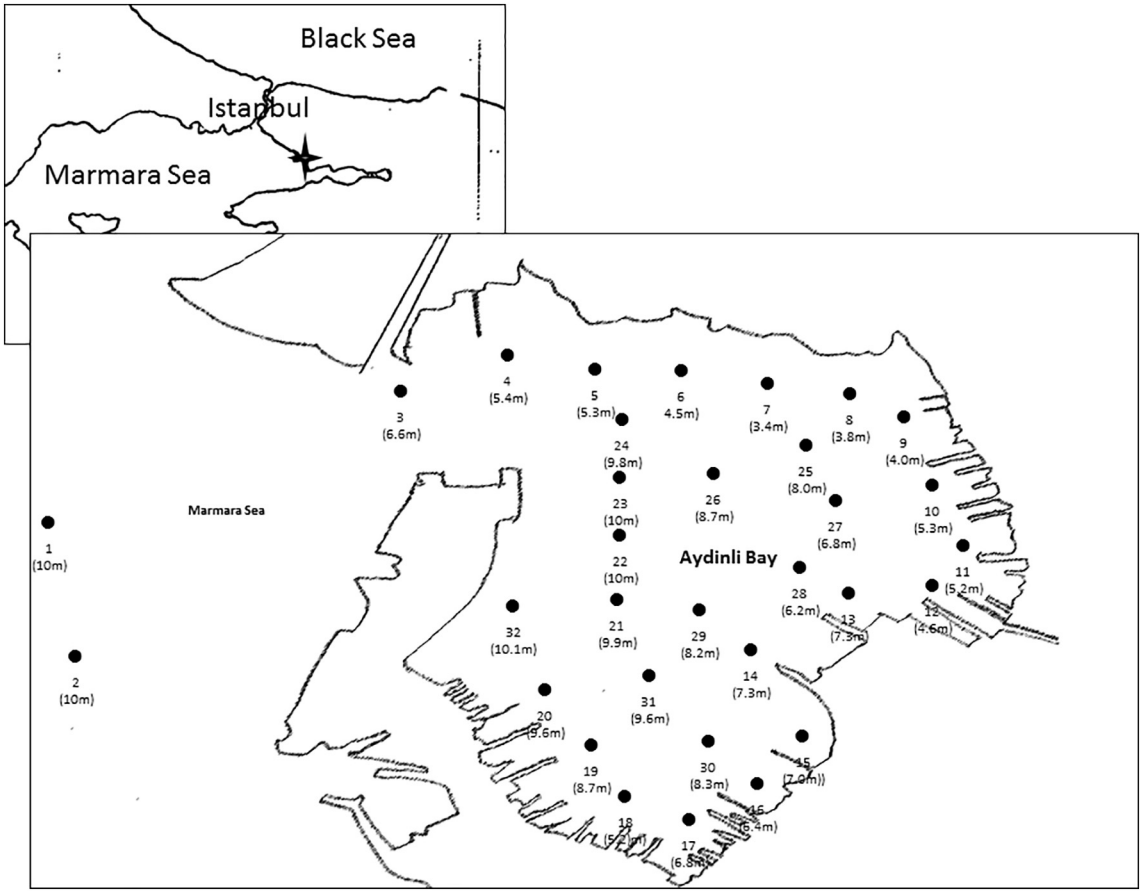

Fig. 1. Location of sampling sites of Tuzla Aydinli Bay, Istanbul Turkey (Parenthetical value indicates the sediment sampling depth).

Varian AA 280Z Zeeman (Varian Inc., Australia) graphite furnace atomic absorption spectrophotometer (GFAAS) equipped with GTA 120 Graphite Tube Atomizer and PSD 120 programmable sample dispenser was used throughout this study. The wavelength and spectral slit width were set to 357.9 nm and 0.2 nm for Cr, and 232.0 nm and 0.2 nm for Ni, respectively. Pyrolytic graphite coated tubes with pyrolytic L'vov platforms were used throughout this work. Argon was used as the purge gas. Samples were introduced into graphite furnace as 10 µL with an autosampler. Results were given as the averages of at least three independent replicate analyses.

2.2. Study design, sample collection and preparation

The study area is a composite marine system located within 40°50′53.5″N 29°17′03.4″E (Fig. 1). The bay is approximately 250,000 m^2, 6300 m cost long, 3–18 m deep. The major component of the bay, two non-flow river merge into a naturally sheltered the bay, which is mostly active on winter time and comes from high industrial areas. Approximately 18 high capacity shipyards are served to construction and renovation in the bay.

This investigation was also designed to examine specific sites of possible contamination and provide an overall assessment of the sediment contamination in the Tuzla Aydinli Bay. This approach allowed to focus on extension and distribution of contamination. To address contamination at specific sites, 32 sampling point were selected from near the coastal shipyard activity to far of the activity in May 2012. The locations were selected from activity sources to non-activity and downstream sites from known industrial and municipal discharges. To compare the activity or status of contamination transport, the sampling area was divided to three zones;

(1) 1st zone - 1st degree of area around the coastal shipyard activity (samples no: S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S32),
(2) 2nd zone - 2nd degree of area around the coastal shipyard activity (samples no: S21, S24, S25, S27, S28, S29, S30, S31),
(3) 3rd zone - 3rd degree of area around the coastal shipyard activity or far the coastal shipyard activity (samples no: S22, S23, S26).

The point of the collected samples were shown in Fig. 1. The 29 of the sediment and 29 of the sea water samples were in the bay and contacted with the bays' industrial activity, 3 sampling sites are non-directly contacted the bays' industrial activity.

Sampling methods were performed according to the protocols described in SW-846 3rd edition (EPA, 1994). The sediment samples were collected in the surface of the marine region using the Van Veenhapper apparatus. This device consists of two bowl-clamp shaped sections which are held open by a catch. When the sampler touches the sediment, the catch is released and the bowl shape sections close together, trapping sediment from a penetration depth of about 20 cm. The samples were collected on pre-cleaned polyethylene containers. In any case, pre-cleaning with diluted nitric acid for several hours and rinsing with clean water afterwards was applied. The containers were rinsed with the water above the sediments immediately before the sampling procedure starts. The collected samples stored at 4 °C in the dark until further analysis. The physical characteristic of the sediments had fine-grain, pH and salinity was 5.0 ± 0.1 and 1.8 dS/m, respectively. Sediment samples transferred to the laboratory. They were air-dried, ground, sieved through 2 mm sized sieve to remove debris, stones and other coarse structures and stored in cleaned polythene bags.

Acid digestion of sediment samples was carried out in closed vessel microwave reaction system according to the international guidances