Assessment of Heavy Metal (Ni, Cr) Contamination and Spatial Distribution in Surface Sediment and Soil in the Area of Lake Sawa

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Abstract: It is widely accepted that heavy metal contamination in sediment and soil is one of the largest threats to environmental and human health. Sediments are the principle sinks for heavy metals in aquatic environments, and can result in a secondary contamination source affecting the ecosystem. Analysis of heavy metal amounts in sediments and comparison with reference levels is a reliable indicator of ecosystem health. However, understanding the distribution of pollutants is among most essential information for environmental research and critical for environmental management and decision-making. 28 samples were collected from surface (0–15 cm) layers of sediments in the area of Lake Sawa. The level of pollution attributed to heavy metals was evaluated using X-Ray fluorescence analysis and comparison with reference levels of world health organization 2003 (maximum allowable concentrations in soil). Spatial distribution patterns of metals in sediments were demonstrated by employing ordinary kriging interpolation. The Results of heavy metal pollution analysis reveal a significant anthropogenic impact on the area of Lake Sawa with concentrations of several heavy metals in surface layer of sediments exceeding maximum concentrations allowable by WHO. Detected levels of chromium (Cr), nickel (Ni), demonstrate a significant pollution anomaly and high potential threat to the water ecosystem and even human health by exceeding maximum allowable concentration. A comparison of heavy metal amounts and spatial distribution patterns in the layer of sediments reveals much higher pollution levels in the surface (0-15 cm). Spatial distribution analysis demonstrates irregular distribution of most metals due to complexity of influencing physical and chemical processes, but the general trend of high concentration.

Keywords: Heavy metal, Kriging, Spatial distribution, Pollution, Lake

1. Introduction

Decomposition of rock and organic matter for many years has resulted in soil formation. Soils as mentioned are critical environments where rock, air and water interface [1]. Naturally in soils, chemical elements occur as components of minerals though at certain concentrations some may be toxic. The chemical elements such as metals cannot break down, but their characteristics may change so that they can be easily taken up by plants or animals [1]. Soil can be said to be clean where the substance under environmental concern occur in concentrations equal to or lower than the value found in nature, which is used as reference and normally called background concentration. The background concentration is the total element concentration obtained from soils that had not been affected by human activity. However, certain actions such as past land use; current activities on the site, and nearness to pollution sources have all affected soil properties [2], Contamination refers to the condition of land or water where any chemical substance or waste has been added at above background level and represents, or potentially represents, an adverse health or environmental impact. It can result in a potential financial, social and environmental cost [3].

2. Heavy Metals

Several meanings have been assigned to heavy metals. Heavy metals can also be loosely defined as a subset of elements that exhibit metallic properties. It comprises the transition metals, some metalloids, lanthanides, and actinides. Using density as a defining factor, [4] also defined heavy metals as those having a specific density of more than 5 g/cm³ [5]. They can also be chemical elements with the density greater than 4 g/cm³ found in all kinds of soils, rocks and water in terrestrial and freshwater ecosystem [6]. Heavy metals can be said to be referred to as any metallic element that has a relatively high density and is toxic or poisonous even at low concentration [7]. Heavy metals have the ability to enter the human body through inhalation, ingestion and dermal contact absorption [6]. Heavy metals contamination threatens agriculture and other food sources for human population as well as poor vegetation growth and lower plant resistance against forests pests. Thereby having impact on the quality of food, groundwater, microorganisms and plant growth [8]. The toxicity of heavy metals is one of the major current environmental health concerns and potentially dangerous because of bio-accumulation through the food chain [6].

Chromium (Cr)

Chromium (Cr) is a cubic crystal, steel gray, very hard and a d-block metal. It is a transition metal which belongs to period 4 and group 6. On the periodic table chromium (Cr) has atomic number 24, atomic mass 52, density 7.19 g/cm³, melting point 2130 K and boiling point 2755 K. Chromium (Cr) as a primary ore product is mined in the form of mineral chromite, FeCr₂O₄ [9]. Chromium (Cr) is required for carbohydrate and lipid metabolism, utilization of amino acids and as pigments for paints, cement, paper, rubber, metal plating for prevention of corrosion, leather tanning and textile colour pigments [10]. Exposure to chromium (Cr) can lead to allergic dermatitis in humans, bleeding of...
the gastrointestinal tract, cancer of the respiratory tract and ulcers of the skin. Then also damage to the mucus membrane, liver and kidney damage [6].

Nickel (Ni)
Nickel (Ni) is also cubic crystal, silvery and a d-block metal. This is a transition metal belonging to period 4 and group 10. It has atomic number 28, atomic mass 58.7, density 8.9 g/cm3, melting point 1726 K and boiling point of 3005 K. It is an element that occurs in the environment only at very low levels and is essential in small doses, but it can be dangerous when the maximum tolerable amounts are exceeded [11]. It is used in the manufacture of stainless steel, coins, nickel for armor plates, burglarproof vaults, vegetable oils, ceramics and Ni-Cd batteries [10]. Nickel (Ni) can result in lung, liver and kidney damage. In high quantities, Ni can also cause cancer, respiratory failure, birth defects, allergies, dermatitis, eczema, nervous system and heart failure [12]. Cu, Zn and Ni are essential trace metals in the human body, but if the body takes excessive Cu, Zn and Ni from the outside environment, they will damage human health. Ni and Cu are tumor promoting factors, whose carcinogenesis effect has attracted global concerns. Workers who are in close contact with the nickel powder are more likely to suffer from respiratory cancer, and the content of Ni in the environment is positively correlated with nasopharyngeal carcinoma [13].

3. Study Area

Sawa Lake, 23 km west of the city of Samawah, in the southwestern part of the AL-Muthana province. between the latitudes (31 17 43.10) (31 19 49.79) and longitudes ( 45 01 46.61) (44 59 29.01 ) and equivalent to the (Path) 168 and (Row) 38 as satellite coordinates can be accessed by road, which runs parallel to the river which is known AL-A’tshaan as a branch of the Euphrates River.

Lake with an elongated shape, toward the north-west and the south-east, while the study area as a flat land and are considered as part of the southern part of Western Sahara. the lake rises 18 m above sea level while Rising from ground level neighbors about 2 - 5 m which prevents seen only from close distances, Topographic gradient for this region generally increases from north-east to south-west with average about 2.7 meters per kilo meters. There is no source of surface water and feeds the lake water and it is possible that groundwater is the source that Fed. The area of the lake is about more than 5.5 km2 length of about 4.75 km and at the widest point is about 1.75 km. either depth it is the first two radio bands which is parallel to the outside of its barrier with ranging between 2.5 to 4 m and 5 - 5.5 m which covers more than 70% of the area of the lake.The study area characterized by many important phenomena of sabkha and dunes devoid of Lake Sedimentation processes mechanical except micro dust particles from the atmosphere [14].
Nickel is easily mobilized during weathering and co-precipitated with Fe – Mn oxides or organically bound in soil [18]. Nickel content in soil is highly dependent on climate and parent rock composition. Nickel (Ni) was detected in samples of the surface layer. The identified value exceed maximum allowable concentration of world health organization concentrations and values its about (30-75) ppm. Nickel in the soil samples of the lake area varied within a wide range: Cr from 0.5 to 191.9 ppm. Cr concentrations in soil sample is higher in the south-west parts of the lake.

Distribution of Ni in the surface (0–15cm) sediments (mg/kg).

Figure 2: Distribution of Cr in the surface (0–15cm) sediments (mg/kg).

Furthermore, different metals exhibit different affinities for the various solid-phase fractions of sediments [20]. This variability of factors may explain the fact that detected levels of heavy metals in Lake sawa.

6. Conclusions

1) Detected levels of heavy metals in sediments of Lake sawa varied within a wide range: Cr from 0.5 to 191.9 mg/kg, Ni from 13.3 to 93.98 mg/kg.
2) Detected levels of most heavy metals: (Cr,Ni) exceeded maximum allowable concentrations of world health
organization 2003, thus high potential threat to the water ecosystem and even human health may be assumed.

3) A comparison of heavy metal amounts and spatial distribution patterns in the two layers of sediments reveals higher pollution levels in the surface layer of soil in the area.

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