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Health risk associated with some toxic elements in surface water of Ilesha gold mine sites, southwest Nigeria

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ABSTRACT

Health risk assessment of toxic elements in water bodies around gold minesites within southwest Nigeria and implication on the miners and residents was carried out in this study. A total of twenty five surface water samples were analysed for some toxic elements such as Pb, As, Cu, Cd, Zn, Co, Fe, Mn, Cr and Ni using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). The results showed that Fe, Ba, Mn, Pb, Cr and Ni exceeded the recommended standards deem fit for human consumption in 62.5%, 18.25%, 37.5%, 12.5%, 6.25% and 6.25% of the water samples respectively. Contamination Index showed that 20% of the water samples can be classified as highly contaminated, 24% can be classified as slightly contaminated and only 16% as not contaminated. The hazard quotient values calculated for all toxic elements based on ingestion and dermal exposure to water showed value < 1 which is acceptable level of non-carcinogenic adverse health risk for children and adults except Cr and V for only dermal exposure with values > 1. The health risk index calculated for toxic elements through both ingestion and dermal exposure showed that 16% of the water samples were within unacceptable risk for non-carcinogenic adverse health effect based only on dermal exposure route and Cr, V, Mn, Sb, Fe and As contributed highest to the risk. Cancer risk showed that only Arsenic exceeded acceptable risk for carcinogenic adverse health risk for children and adults and this make Arsenic to be carcinogenic in the water of the study area.

1. Introduction

Gold mining all over the world has contributed immensely to the economy of the host country especially at the artisanal level for a long time. Residents within the gold belts region all over the world face a lot of health challenges from the emergence of toxic elements from mining activities and as a result, different measures are being put in place to solve the problem especially in developing countries. Artisanal mining activities have always been responsible for environmental contamination of both soil and water from wastes generated during different stages of mining activities such as extraction, beneficiation and processing of minerals. For instance there is contamination of both ground and surface water from mine tailings and other waste generated during mineral extraction and processing (Moore et al., 1985; Zhang et al., 2007).

Contamination of water with toxic elements generated from mining activities has become a global concern due to the adverse health effects it generates. The sources of these toxic elements can be geogenic, (weathered of the host rocks that constitute the geology of the area) and anthropogenic (activities of man such as mining, wastes generation, agriculture etc) (Ahmet et al., 2006; Chanpiwat et al., 2010; and Mohammad et al., 2010).

World health report in 1998 emphasised the importance of water to the wellbeing of the populace and the fact that 800 million out of one billion people without access to good water reside in rural areas. The contribution of surface water is also vital; because most people in the study area depend directly upon streams for drinking and other domestic usages as a result of non- availability of other source(s) of water as well as their poor condition.

Heavy metals can be categorised as essential and toxic elements. Essential elements include Mo, Cr, Cu, Zn etc and are very important to body metabolic activities and growth while toxic elements like Pb, As, Cd etc have been linked to several diseases and health problems. Human exposure to toxic elements could occur through three pathways which include direct oral ingestion, inhalation by mouth and nose, and dermal absorption through the exposed skin. Ingestion and dermal absorption pathways are common in water (Wu et al., 2009; USEPA, 2014).

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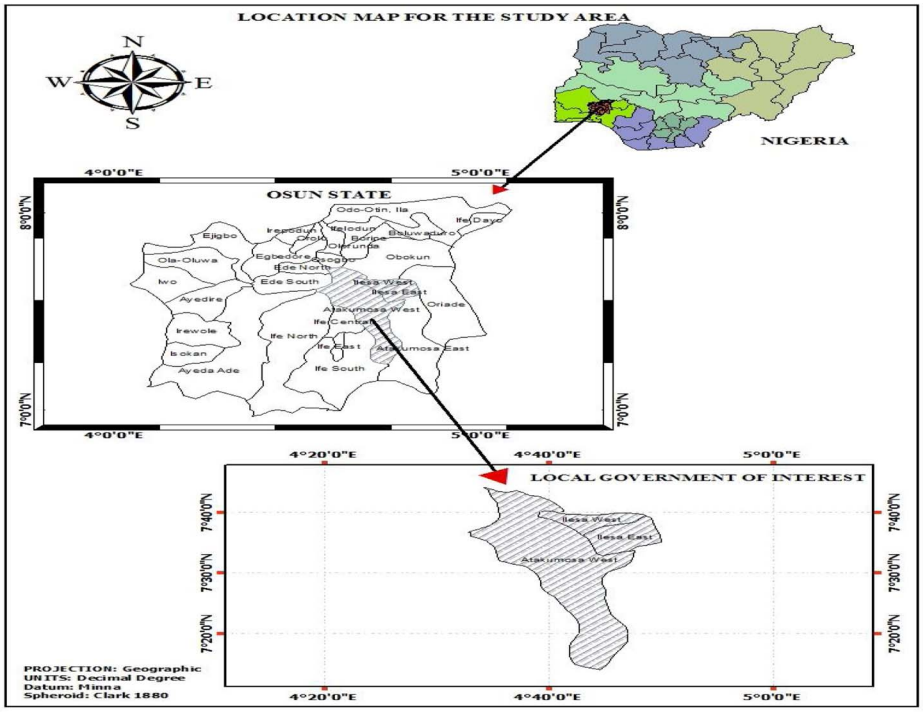

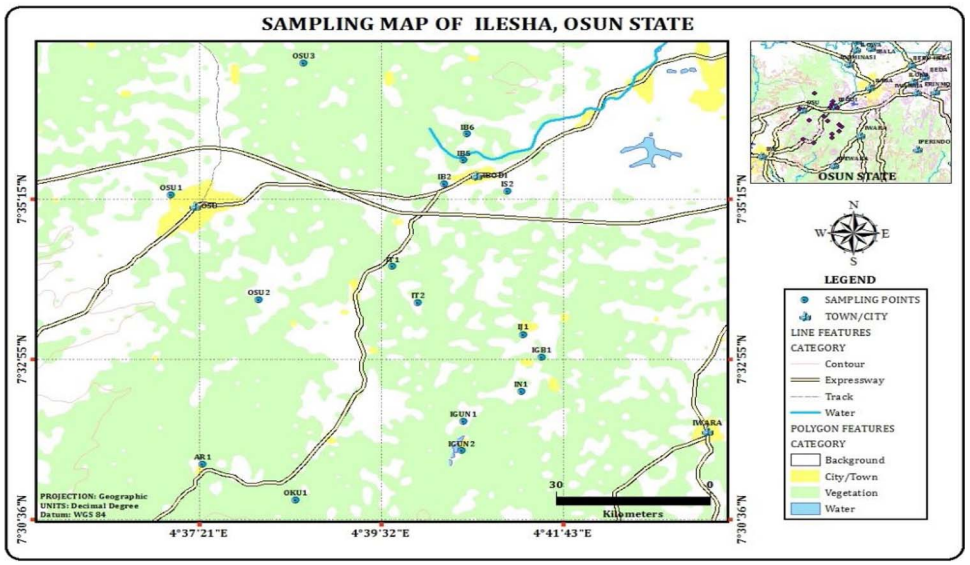

Fig. 1. Map of the study area with sample locations.

Recently, the study on the toxicity and essentiality of elements from contaminated water and the impacts on the human health has become a global focus (Alves et al., 2010, Wyatt et al., 1998 and Narottam et al., 2017). The aim of this research is therefore the determination of some toxic elements in the surface water of the study area and possible health risks assessments from their ingestion and dermal exposure on the residents

2. Material and methods

2.1. Study area

The study area is located in Ilesha which constitutes about ten communities in southwestern part of Nigeria. It lies between longitudes 4 30′ and 4 34′ East and latitudes 7 30′ and 7 35′ North covering a total area of about 73.6 Km^2 with population of 0.21million (Fig. 1). The main rivers in the study area are Owena, Shasha, Aiye and Mukoro which are used for domestic and agricultural purposes. The residents are mainly farmers and miners.

The average rainfall in the study area is 1250 mm while the two prevailing seasons are the rainy (April-October) followed by the dry season (November-March) Adejuwon and Jeje (1975). Topography of the study area shows two main relief forms which reflect strong lithological controls and are characterized by ridges, hills, and valleys and the undulating plains with occasional hills. Generally the ridges vary in height from 400 to 750 m while some of the hills attain a height of 600 m ; Adejuwon and Jeje (1975).

The general drainage pattern is sub-dendritic. This may locally be radial in the region where hills and inselbergs are predominant. The main river is the perennial southward flowing River Owena (a tributary of Shasha River) with its tributaries draining the west and central parts of the area. In addition, River Aiye and its tributaries drain the eastern portion, while the River Mukuro drains the extreme north-western part.

The study area fall within the Schist belts which is part of the