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Environmental Risk Assessment of Lake Surface Sediments Using Trace Elements: A Case Study of Wular Lake

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ABSTRACT

Surface sediments were collected from Wular Lake, located in Bandipora district of Kashmir Valley, NW Himalaya to investigate the environmental risk assessment using trace element concentrations. The surface sediments of the lake reveal higher concentration of Cl, Cr, Ni, Cu, Co, Pb, Zn and Th. In order to estimate the impact of metal pollution on the sediments, the trace element data was quantified for enrichment factor (EF), geo-accumulation index (Igeo), pollution load index (PLI) and contamination factor (CF). The average values for Igeo reveal moderate to strong contamination of Ni and Cu. While, Cr and Co exhibit moderate to strong contamination in the central part of the lake. EF reveals minor enrichment of Cu, Ni, Cr, Co and Zn in the lake surface sediments. The CF also suggests moderate contamination of analysed trace metals. PLI indicate moderate pollution from all the sampling sites. Spatial distribution of the metal in the lake reveals their transport through the sewage from the urbanized areas and the Jhelum river. Since metal pollution in the lake is still at nascent stage, it demands attention of the local authority and lake conservation department to take remedial measures for the protection of this freshwater body from further contamination in future.

INTRODUCTION

Heavy metal enrichment in lake sediments is considered hazardous due to possibility of bioaccumulation and toxic effects on environment and human health. Accumulation of trace elements in lake sediments have been used extensively to understand the scale and source of anthropogenic inputs (Lone et al., 2018a). The physicochemical processes functioning close to lake bottom have major impact on the geochemistry of lake sediments (Sheela et al., 2012). The degree of human interference and pollution can be accessed largely by employing various environmental and statistical tools (Yao et al., 2006; Suresh et al., 2012; Li et al., 2013; Xiao et al., 2014; Tang et al., 2014; Wang et al., 2014; Gopal et al., 2016; Iqbal et al., 2016; Kasilingam et al., 2016). The natural and anthropogenic processes operating in the catchment area of a lake principally governs the water quality and sediment chemistry (Tarras -Wahlberg et al., 2002). Furthermore, the physical, chemical and biological activities occurring in the lake are also responsible for the sediment and water chemistry of lake basins (McManus et al., 2015; Lone et al., 2018b). Chemical and physical disintegration of catchment rocks generates huge debris of sediments, which is later transported and accumulated in the lake basins (Kastratovic et al., 2016). However, the sediments which have been modified during transportation and deposition have the signature of local catchment inputs as a consequence of human activities and natural processes (Chapman, 1992; Blumberg and Schutt, 2004). Particulate debris accumulation from human induced and natural processes is the main sources of organic matter and inorganic elements in lacustrine environment (Meyers and Ishiwatari, 1993; Holmer and Storkholm, 2001). Thus, it can be said that sediment geochemistry of lake basins is a combined process of basin lithology, nature of weathering, erosional and depositional processes occurring in the lake system (Minyuk et al., 2007; Khan et al., 2012). Nowadays, surveys on geochemical analysis of surface sediments of lakes is carried out gradually to study the intensity of weathering processes, sediment origin, anthropogenic and ecological impact on lake basins (Meyers, 2003; Boyle et al., 2004; Yao and Xue, 2015). Therefore, a comprehensive and thorough investigation of sediment geochemistry of lakes can help in understanding the factors which are liable for the distributional pattern and accumulation of metals in lake basins (Zhang et al. 2014; Chandrajith et al. 2008). Currently, heavy metal contamination is a serious environmental issue with great impact on the economic growth in different regions of the globe (Gao and Chen, 2012). Heavy metal pollutants are accumulated in microorganisms, floral and faunal species of aquatic habitats and transfer into human's via food chain and create serious health issues (Sakar et al., 2011; Varol 2011; Hosseini Alhashemi et al., 2012). Exposures of heavy metals may result in loss of lives, growth reduction, reproduction and decreases species diversity (Praveena et al., 2007). Heavy metals particles accumulate and stabilize in sediments, because of their low solubility bonded with different organic and inorganic particulate matter (Devesa-Rey et al., 2010; Karbassi et al., 2015). Sometimes the stabilized particulate matter of heavy metals in sediments may return to water columns through chemical and biological processes (Yang et al., 2012). However, in case of change in environmental parameters such as Eh, sediment redox potential, sediments can leach heavy metals in the aquatic environment (Chandra Sekhar et al., 2004; Zamani Hargalani et al., 2014). Thus, in the study of aquatic environmental risk assessment, sediments play a significant role and are used as pollution monitoring tool (Karbassi et al., 2008; Mashiatullah et al., 2013; Vaezi et al., 2015a). Therefore, geochemical study of sediments is an appropriate method to examine the extent of heavy metal pollution of sedimentary basins (Varol, 2011).

Wetlands and lake basins are becoming the store house of anthropogenic pollutants, especially, those derived from industrial, agricultural and urban waste (Caeiro et al., 2005). In past decades, many indices were employed to evaluate the environmental menace

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