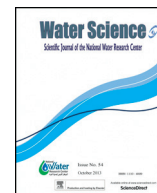




Water Science
ScienceDirect

Water Science xxx (2017) xxx–xxx

journal homepage: www.elsevier.com/locate/wsj



Evaluation of heavy metal contamination using environmetrics and indexing approach for River Yamuna, Delhi stretch, India

Richa Bhardwaj, Anshu Gupta, J.K. Garg*

University School of Environment Management, Guru Gobind Singh Indraprastha University, Sector 16-C, Dwarka 110078, New Delhi, India

Received 11 September 2016; received in revised form 15 January 2017; accepted 20 February 2017

Abstract

The objective of the present study is to investigate the current status of heavy metal pollution in River Yamuna, Delhi stretch. The concentrations of Nickel, Cadmium, Chromium, Copper, Iron, Lead, and Zinc in water samples have been studied during December 2013–August 2015. The overall mean concentration of heavy metals was observed in the following order $Fe > Cu > Zn > Ni > Cr > Pb > Cd$. Correlation analysis formed two distinct groups of heavy metals highlighting similar sources. This was further corroborated by results from principal components analysis that showed similar grouping of heavy metals (Ni, Zn, Fe, Pb, Cd) into PC1 having one common source for these heavy metals and PC2 (Cu, Cr) having another common source. Further, our study pointed out two sites i.e. Najafgarh drain and Shahdara drain outlet in river Yamuna as the two potential sources responsible for the heavy metal contamination. Based on heavy metal pollution index value (1491.15), we concluded that our study area as a whole is critically polluted with heavy metals under study due to pollutant load from various anthropogenic activities.

© 2017 National Water Research Center. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Keywords: River Yamuna; Heavy metal pollution; Principal component analysis; Correlation analysis; Heavy metal pollution index; Industrial effluents

1. Introduction

River water has been cradles of many civilizations and is responsible for supporting and maintaining various forms of life. However, rapid urbanization with associated economical and industrial development has exerted tremendous pressure on this vital resource leading to the impairment of water quality and various ecosystem services. River Yamuna, one of the major rivers of India, is facing serious challenges for its very survival mainly because of the absence of ecological water flow and various other anthropogenic activities. This severely polluted river has an extensive catchment area covering several states and is being widely utilized for various domestic, agricultural, and industrial uses. In addition to this, the river also acts as a sink for sewage, industrial effluents and agricultural runoff. However, lack of common policy for discharge of waste into the river as well as lack of integrated approach by these states towards the restoration of current state of river, has left this river unsuitable for providing its designated ecological use.

* Corresponding author. Fax: +91 11 2530 2111.

E-mail addresses: richa.em@ipu.ac.in, mirabilia.du@gmail.com (R. Bhardwaj), anshurcy@yahoo.com (A. Gupta), gargjk@gmail.com, gargjk113@gmail.com (J.K. Garg).

<http://dx.doi.org/10.1016/j.wsj.2017.02.002>

1110-4929/© 2017 National Water Research Center. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

The situation of River Yamuna worsens when the river leaves National Capital Territory of Delhi. Despite of the fact that this region has only 1% of the river's total catchment area, it contributes more than 50% of the pollutants found in the Yamuna (Sehgal et al., 2012). Delhi, being the capital of India is an important centre for commerce, trade and industry in northern India and has urbanized at a very fast rate with its population increasing from 13.9 million in 2001 to 16.8 million in 2011 (Census of India, 2011). The River Yamuna in Delhi stretch is an only natural resource for sustaining all forms of life in this city. However, the unplanned development and perennial increase of population in the National Capital Territory has placed tremendous pressures of water supply and sanitation on river Yamuna (Kaur, 2007).

Rapid urbanization and population growth in fast growing cities leading to industrialization poses a major threat of Heavy metal pollution for India's rivers flowing through these cities (Sundaray et al., 2006; Karbassi et al., 2007; Akoto et al., 2008; Ahmad et al., 2010). These heavy metals can enter river systems from either natural or anthropogenic sources (Akoto et al., 2008). The main anthropogenic sources are disposal of untreated and partially treated industrial effluents and sewage containing toxic metals, as well as metal chelates from different industries and indiscriminate use of heavy metal-containing fertilizers and pesticides in agricultural fields (Reza and Singh, 2010; Abbasi et al., 1998). Several researchers have studied heavy metal contamination in various Indian rivers with respect to industrial, municipal, and domestic pollution (Sundaray et al., 2012; Aktar et al., 2010; Sundaray, 2009; Prasad et al., 2006; Jain and Sharma, 2006; Patil & Shrivastava, 2003; Nayak et al., 2001; Manjunatha et al., 2001; Jameel, 2001).

The water quality monitoring of River Yamuna has indicated significant presence of several heavy metals in its water (Rawat et al., 2003; CPCB, 2006; Jain, 2009; Kaur & Mehra, 2012; Sehgal et al., 2012; Malik et al., 2014). The Yamuna River stretch in Delhi has been found to be contaminated with moderate to high levels of heavy metals at various sites which could be related to the untreated industrial discharge, lead battery-based industrial units, vehicular pollution, sewage discharge and surface run-off from contaminated areas. Rawat et al. (2003) concluded that there is high concentration of most of the heavy metals suspended in wastewater originating from industrial area, indicating that these industries could be one of the primary sources of heavy metals in the Yamuna, along with fertilizers and pesticides laden agricultural runoff.

The catchment area of River Yamuna in Delhi is highly urbanized and is networked by several drains. Najafgarh and Shahdara drains are the major drains that discharge a heavy load of pollutants into the river. Although, Sewage treatment plants (STPs) have been constructed in various parts of Delhi in order to improve the water quality of the river, the treated, or partially treated sewage from these STPs is continuously being discharged directly or through the carrier drains into the river (CSE India, 2007). Also, many a times untreated sewage goes directly into the river at few locations due to non-operationality of STPs because of power failures, mechanical problems or maintenance issues, which further compounds water quality issues (CPCB, 2006). The accessibility for disposal of wastewaters from various sources into this river makes it vulnerable to heavy metal pollution besides loading with other pollutants.

Monitoring of heavy metal contamination is important because increased concentration of heavy metals in potable water increases the threat to human health and to the environment due to biological magnification. Assessment of monitoring data using multivariate statistical techniques, like principal component analysis coupled with metal concentration analysis and correlation analysis could be used to determine the causes for the deterioration of water quality and to identify highly polluted stretches within a given river system (Nair et al., 2010; Yalcin et al., 2010). In addition to this, the sitewise disposition of heavy metal by producing heavy metal pollution index can be helpful in identifying and quantifying trends in water quality (Reza & Singh, 2010; Prasad & Kumari, 2008) and can provide an accumulated assessment of overall water quality in a form that could be utilized by policy makers for regulation and control of pollution.

Majority of the heavy metal studies conducted on river Yamuna have merely presented the concentrations of various heavy metals in the Yamuna River. However, in our study we have integrated various statistical techniques in order to evolve and validate major sources of heavy metals in Delhi stretch. This will also help in understanding the impacts of various industrial and domestic activities in and around Delhi on heavy metal pollution in the river Yamuna. We also prepared the most recent heavy metal pollution index of River Yamuna, to determine the most critically polluted stretches along the length of river.

Download English Version:

<https://daneshyari.com/en/article/7228460>

Download Persian Version:

<https://daneshyari.com/article/7228460>

[Daneshyari.com](https://daneshyari.com)