Annals of Agrarian Science xxx (2017) 1–9

Contents lists available at ScienceDirect

Annals of Agrarian Science

journal homepage: http://www.journals.elsevier.com/annals-of-agrarian-science

Research on heavy metal pollution of river Ganga: A review

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ARTICLE INFO

Article history:
Received 24 November 2016
Received in revised form
2 April 2017
Accepted 3 April 2017
Available online xxx

Keywords:
Heavy metals
River Ganga
Pollution
Sediment
India

ABSTRACT

River Ganga is considered sacred by people of India for providing life sustenance to environment and ecology. Anthropogenic activities have generated important transformations in aquatic environments during the last few decades. Advancement of human civilization has put serious questions to the safe use of river water for drinking and other purposes. The river water pollution due to heavy metals is one of the major concerns in most of the metropolitan cities of developing countries. These toxic heavy metals entering the environment may lead to bioaccumulation and biomagnifications. These heavy metals are not readily degradable in nature and accumulate in the animal as well as human bodies to a very high toxic amount leading to undesirable effects beyond a certain limit. Heavy metals in riverine environment represent an abiding threat to human health. Exposure to heavy metals has been linked to developmental retardation, kidney damage, various cancers, and even death in instances of very high exposure. The following review article presents the findings of the work carried out by the various researchers in the past on the heavy metal pollution of river Ganga.

Introduction

Water is the most key resource required to sustain the life on this planet. The river Ganga is the most important river system in India. Due to the copious availability of water throughout the year, it has played a major role in the growth of Indian civilization and economy [1]. It accounts for 25% of India's water resources. The Ganga is the thirtieth longest river in the world, covering a basin area of 861,404 km^2 [2]. The Ganga basin is among the most heavily populated areas in the world with an average density of 520 persons/km^2 [3]. The basin sustains more than 300 million people in India, Nepal, and Bangladesh [4]. The basin of river Ganga, which has very rich heritage, cultural and religious values, drains about 1,060,000 km^2 area and it is the fifth largest in the world [5]. The river system drains about one-fourth of the Indian subcontinents. In India, the river Ganga passes along 29 class I cities, 23 class II cities and approximately 50 towns because of which different types wastes such as industrial, sewage etc are released into this mighty river eco-system [6,7].

The river Ganga originates from the Gangotri glacier at Gomukh (30°36′ N; 79°04′ E) in the Uttar Kashi district of Uttarakhand province in India, at an altitude of about 3800 m above mean sea level in the Garhwal Himalaya [8] (Fig. 1). The length of the main channel from the traditional source of the Gangotri glacier in India is about 2550 km. After flowing through the Sivalik hills it enters plains at Haridwar. Then it flows southwards, passing through the plains of Uttar Pradesh. After leaving Uttar Pradesh, the Ganga enters Bihar in the Rohtas district. From Bihar, it enters West Bengal province and starts flowing south. Nearly 40 km below Farakka it is divided into two arms. The left arm flows eastwards into Bangladesh and the right arm, called Bhagirathi, continues to flow south through West Bengal. The Bhagirathi flowing west and south-west of Kolkata is known as Hooghly. After reaching Diamond Harbour, it attains a southward direction and is split into two streams before reaching the Bay of Bengal [9]. The mean annual water discharge is the fifth highest in the earth with a mean of 18,700 m^3/s. High variation in flow exists within the catchment area, to the extent that the mean maximum flow of the river Ganga is 468.7×10^9 m^3 which is 25.2% of India's total water resources [10]. The freshwater flow in the river system is mostly from the tributaries and therefore, the water availability greatly varies from 59,000 million m^3 at Allahabad, before the confluence with the Yamuna, to 459,000 million m^3 at Farakka in the lower stretch [11]. The source of water is the melting of snow in the Himalayas and monsoon rains. The river system covers cool upland streams and warm water stretches, including deltaic habitats [8]. Ganga river water is used routinely for drinking and outdoor bathing by millions of people who take a holy dip at least once a year throughout

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Peer review under responsibility of Journal Annals of Agrarian Science.

http://dx.doi.org/10.1016/j.aasci.2017.04.001

Please cite this article in press as: D. Paul, Research on heavy metal pollution of river Ganga: A review, Annals of Agrarian Science (2017), http://dx.doi.org/10.1016/j.aasci.2017.04.001

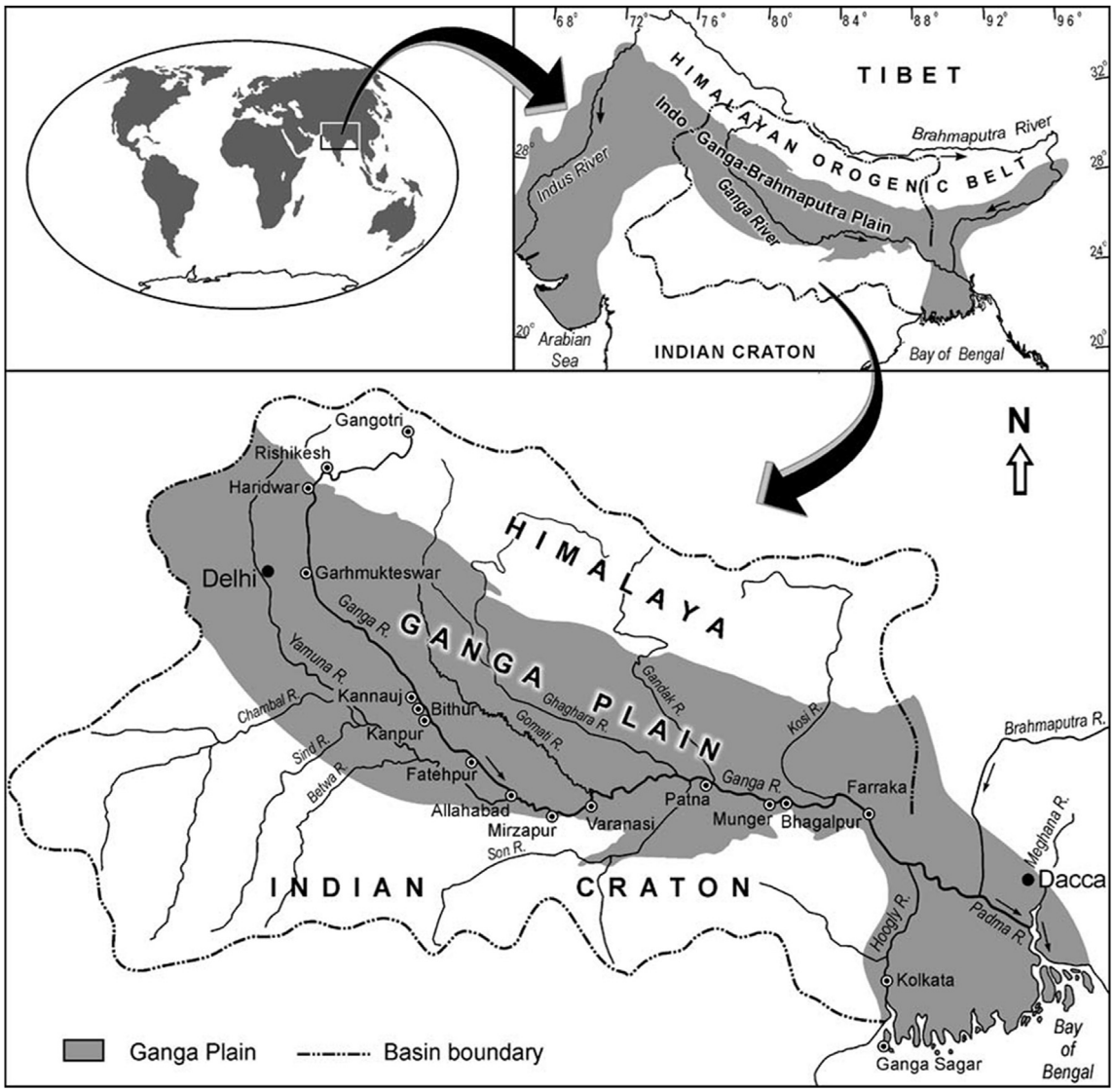

Fig. 1. Map of the river Ganga (adopted from Singh and Singh) [13].

the course of the river, from Gangotri to Ganga Sagar, owing to its socio-religious significance [12].

In present-day, river pollution is a serious and emerging problem in the majority of developing countries. Due to rapid industrialization, there has been an increase in the amount of effluent being disposed to natural water bodies. Industrial effluents and sewage entering the water bodies are one of the prime sources of environmental toxicity, which endangers aquatic biota and deteriorates water quality [14,15]. The quality of water is a vital concern for mankind since it is directly linked with human welfare [16]. Major pollutants found in water include volatile, biodegradable and recalcitrant organic compounds, toxic metals, plant nutrients, suspended solids, microbial pathogens and parasites [17–19]. Among the pollutants, toxic metals are of serious concern because they accumulate through the food chain and create environmental problems [20,21]. Higher concentrations of heavy metals can form harmful complex compounds, which critically effect different biological functions [22]. The presence of heavy metals in the wastewater of industry is a potential risk to aquatic ecosystem, animal, and human. High concentrations of heavy metals often pose a serious threat to biota and the environment of any ecosystem [23]. Heavy metal pollution can be a much more serious problem because they cannot be degraded by natural processes and persist in soil and sediment from where they are released gradually into water bodies as sink [24]. The following review article presents the findings of the work carried out by the various researchers in the past on the heavy metal pollution of river Ganga.

Sources of heavy metal

"Heavy metals" is a collective term, which applies to the group of metals and metalloids with a atomic density greater than 4 g/cm^3, or 5 times or more, greater than water [25]. Heavy-metal contamination is not a modern problem arising out of industrialization – it began when humans started processing ores [26,27]. Since then the use of metals and their impacts on the environment have accelerated, with a major increase during the 19th and 20th

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