Anthropogenic Activities in Creeping Death of River Ganga: An Alarming Situation

*Prashant Pandey
**Akanksha Joshi
***Swanti Sharma

ABSTRACT

Ganga is the largest river in India with the cultural, economic and environmental values.Their fragile ecosystem is more sensitive to the waste discharged to the river by anthropogenic activities like industrial effluents and sewage. Pollutants like heavy metals, pharmaceuticals and plastics especially microplastics are always being the serious threat to river ecosystem. Their higher amount and concentration leads them to entre in food chain and cause various health issues.The improper treatment of industrial waste water, untreated sewage and agricultural runoff having fertilizers, pesticides etc. are the major source for the pollutants in Ganga river. In the present paper we are intended to discuss such issues that degrade the quality of Ganag river. We additionally focused on future aspects and approaches to overcome from polluted Ganga to holy Ganga.

Key Words: Ganga, waste water, heavy metals, pharmaceuticals, plastics

1. Introduction

Ganga has been a cradle of human civilization since time immemorial and regarded as national river of India. Millions be subject to this great river for physical and spiritual sustenance with immense faith in the powers of healing and regeneration of the Ganga. The River plays a vital role in religious ceremonies and rituals. To bathe in Ganga is a lifelong ambition of many who congregate in large numbers for several rivers centered festivals such as Kumbh Mela and numerous Snan (bath) festivals.We can say, Ganga is one of the most sacred rivers in the world and is deeply revered by the people of this country.

In context of India, Ganga is the largest river instituting the largest river basin in terms of catchment area, constituting 26% of the country's land mass (8,61,404 Sq. km) and supporting about 43% of its population (448.3 million as per 2001 census). The basin lies between East longitudes 73°30and 89° 0 and North latitudes of 22°30 and 31°30, covering an area of 1,086,000 sq km, extending over India, Nepal and Bangladesh. About 79% area of Ganga basin is in India. The basin covers major states of nationviz., Uttarakhand, Uttar Pradesh, Madhya Pradesh, Rajasthan, Haryana, Himachal Pradesh, Chhattisgarh, Jharkhand, Bihar, West Bengal and Delhi.

The melting of snow in the Himalayas and monsoon rains are the major source of water in Ganga. Bhagirathi is the main source and it emanates from Gangotri Glacier at Gaumukh at an elevation of 3,892 m (12,770 feet). Headwater of Ganga is comprising of many streams such as: Alaknanda, Dhauliganga, Pindar, Mandakini andBhilangana, figure 1 shows the main stream and tributaries of river Ganga. Alaknanda joins Bhagirathi at Devprayag, where, the river acquires the name Ganga. It traverses a course of 2525 km before flowing into the Bay of Bengal. It has a large number of tributaries joining it during the journey.

In respect toIndia, agriculture sector has been always a center for economic source and Ganges provides a perennial source of irrigation.In addition to, recharging the groundwater table all along the course of river Ganga. By supporting agriculture, animal husbandry and fisheries, tourism, river-based trade and transport, the Ganga contributes significantly to the livelihood, food and nutritional security for one-third of Indian. The states, through which River Ganga flows amount to about 40% of the total cultivated area in India. Ganga river water is used

* Assistant Professor, IMS Unison University, Dehradun, Uttarakhand
** Student M.Tech (Environmental Technology) Doon University, School of Environment and Natural Resources, Dehradun, Uttarakhand
***Research Associate Wildlife Institute of India, Dehradun, Uttarakhand

routinely for drinking and outdoor bathing by millions of people showing its socio-religious significance too. Beside all these values of Ganga, a unique characteristic of self-cleaning and self-purification, river Ganga has been reversed for centuries. In 1896, Ernst Hankin, a British bacteriologist explained the antibacterial property of Ganges water against Vibrio cholera. Further, in 1916, Felix d'Herelle, French microbiologist introduced the world with "bacteriophage or phages" virus which is associated with the special property of river Ganges. Bacteriophages are the prokaryotic viruses that solely infect and/or destroy the bacteria and can retain high amounts of dissolved oxygen, even in extremely polluted conditions.

The Ganga Basin is home to a wide variety of relic, rare and threatened species. These include the Gangetic dolphin (Platanista gangetica), three species of otters viz. the Smooth-coated otter (Lutrogaleperspicillata), Eurasian otter (Lutralutra) and the Small clawed otter (Aonyx cinereus), the Critically Endangered Gharial (Gavialis gangeticus), Mugger or Indian marsh crocodile (Crocodylus palustris), Estuarine crocodile (Crocodylusporosus) and at least 12 species of freshwater turtles, including the Critically Endangered Batagurkachuga. Within the Ganga River system, 143 different freshwater fish species, belonging to 11 orders, 32 families and 72 genera have been reported including the Critically Endangered Ganges shark (Glyphis gangeticus), Gangetic stingray (Himantura fluviotilis), Golden mahseer (Tor putitora) and Hilsa (Tenualosailisha). The ganga rising in Himalayas and drains one-fourth of the territory of India, before entering in Bay of Bengal. The greater part of the Indo-Gangetic Plain, across which it flows, is the heartland of the region and has been the cradle of successive civilizations from the Mauryan Empire of Ashoka in the 3rd century BCE to the Mughal Empire, founded in the 16th century.

Now days, rapid industrialization, urbanization, steep demand of water and lack of exposure to people results river water pollution, which is a serious and emerging problem in the country like India.This is because Ganga water is a lifeline for large population, covers 26% of country's area. Industrial effluents, sewage waste, loss in forest cover, sprawling towards Ganga flood plains and human activities to dispose plastic related waste to the water bodies are major sources of environmental toxicity, which deteriorates river water quality and further endangers aquatic biota. The quantity and quality of water is a vital concern for mankind since it is directly linked with human welfare. Major pollutants found in industrial waste and sewage areheavy metals, volatile organic compounds (VOCs), biodegradable and recalcitrant organic compounds, plastics related waste, microbial pathogens and parasites. Among them heavy metals, pharmaceutical and plastic wastes are considered most serious issue. The presence of heavy metals with their high atomic density than water results their settlement in river sediments and enter to food chain as a consequence. It is important to discuss here that some heavy metals like are required in trace amount for the biological functions and development. However, their concentration beyond the permissible limit leads to several health issues in human body. They show acute or chronic effects and can alter the effectivity of body organs such as the brain, lungs, liver, kidney, and blood. Heavy metal toxicity can either be acute or chronic effects. Their long-term exposure progressively leads to muscular, physical and neurological degenerative processes and can cause cancer.

2. Factors influencing biodiversity

About 80% of the original forest cover in the Gangabasin has been lost, according to a joint study carried out in 2003 by IUCN, International Water Management Institute, World Resources Institute and the Ramsar secretariat. This means loss of habitat for terrestrial species, plus the freshwater species dependent on them. It also means a higher sediment load in the rivers, as the tree roots that used to hold the soil together are no longer there. The water becomes even more turbid, and many species are unable to cope.

Another problem is that in the upper stretches of the river; only about 10% of the original floodplains of the Ganga remain, the rest having been taken over for farming, factories or houses. That is a serious loss of habitat. With 532 people per square kilometre, this is already one of the most densely populated river basins in the world, and that figure is projected to rise.

3. Pollution sources

The Ganga passes by 30 major cities with more than 300,000 residents and many other smaller towns. The Ganga is the major source for their municipal and industrial water. As per Central Pollution Control Board report around three-fourths of the pollution of the river comes from the discharge of untreated municipal sewage draining from these urban centers. About 12,222 million litres per day (mld) of domestic wastewater is generated in the entire basin, out of which about 2573 mld of wastewater is generated along its bank.

Industrial effluents

We can say Uttar Pradesh a home to sugar factories, leather tanneries, textile industries of cotton, wool, jute and silk, food processing industries related with rice, dal and edible oils, paper and pulp industries, heavy chemical

factories, and fertilizer and rubber manufacturing units. All these industries release wastewater and discharge them to river Ganga, and some of them contains hazardous chemicals and pathogens. It is estimated that about 2500 mld of industrial wastewater is generated in the entire basin and only a small portion of the total pollution load generated in a city or region are treated.

4. Pollution and their sources

Without any argument the quality of water is a vital concern for mankind since it is directly linked with human welfare. The rapid industrialization and human development results in increased amount of effluents being discharged to water bodies. The sewage and industrial effluents contains various types of pollutants such as: toxic metals, pharmaceuticals, pesticides, volatile, biodegradable and non-biodegradable compounds such as plastics and hence, are considered to be the primary source of pollution in river ganga.

4.1. Heavy metals

The metals and metalloids having atomic density 5 times or more than water are considered as heavy metals. These toxic metals from various sources are discharged to river which are then enter to food chain and results in negative impact on aquatic ecosystem.However, some metals such as Cu, Zn, Fe, Mn, Co, Mo, Cr, and Se are essential nutrient for aquatic organism at low concentrations and called as micronutrients whereas metals like-Ca, Mg, Na, P, and S are considered as macronutrients. The wide distribution of metals in the river ecosystem could be a hazard for their functions due to their toxic effects, long persistence, bioaccumulative proprieties, and biomagnification in the food chain and can disturb entire trophic chain, including humans. In addition, the non-essential metals such as Pb, Cd, Ni, As, and Hg enhance the overall toxic effect on organisms even at very low concentrations. Various research articles have been published emphasizing on the presence of heavy metals, their source and toxic effects on Ganga river. Different heavy metals such as: As, Cd, Cu, Cr, Fe, Hg, Mn, Ni, Pb, Zn have been documented in literature. In spite of anthropogenic activities, natural phenomena like weathering, sedimentation, erosion, and dissolution of water-soluble salts add the heavy metals the river..Nevertheless, the anthropogenic activities substantially escalateheavy metals concentrations leading to long-term ecosystem level effect. Some heavy metals like Pb and Cd are even at low concentration damage the river ecosystem. In a study by Ajmal et al. shows the substaintial presence of various heavy metals such ascadmium, cobalt, chromium, copper, iron, manganese, nickel, lead and zinc in the sediments of the river Ganga in Uttar Pradesh. They reportthe considerable variation in their concentrationin different sampling station. Many studies are also conducted to evaluate their regional concentration. In the context, Sharma et al. assessed the availability of heavy meals in Ganga river in Mirzapur region, Uttar Pradesh. A similar study was also conducted for the Kanpur region, Uttar Pradesh. In their study, they determined the concentrations of Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Sn and Zn in sediments of the river Ganga which are consequences of the anthropogenic activities.Various studies were also conducted for the presence of heavy metals in the ganga river at Lucknow, Agra, Delhi, Varanasi, West Bengal.

Goswami and Sanjay in their study suggested the alarming situation at Narora Barrage and Jajmau Kanpur. In a stretch between Rishikesh to Allahabad, they determined and assessed the concentration of Cd,Cu, Pb and Zn ions in the different matrices of the river Ganga through differential pulse anodic stripping voltammetry. Some heavy metals shows adverse effects on microbial community of the Ganga river that regulated the nutrients cycle and helps in breaking of organic compounds. In the context Deepa Jaiswal, Jitendra Pandey (2018) relates the enzymatic activity of the riverbed with the heavy metals. The increase in concentration of heavy metals results in reduction in enzyme activities which suggests the bioavailability decreases with increase in organic matter. It is important to discuss here that high organic matter load promotes microbial/enzyme activitiesin the sediment, reduces bioavailability, and consequently, the toxiceffect.Deepa Jaiswal, Jitendra Pandey (2019) further explore high concentration ofheavy metals and subsequent high pollution load, although limits theutility of CO2 emission as a predictor of C-enrichment, facilitates ourunderstanding of heavy metal pollution and associated toxicity in termsof negative shifts in microbial/enzyme activities.

The presence of heavy metals in river ecosystem involve to the food chain by transferring to the fishes. However, the accumulation of heavy metal depends on fish species whereas their concentration also governed by the topography, hydrology, geology, local climate, anthropogenic influences, pH, alkalinity, water hardness, season, sex, and locality in the aquatic organism.

The various health effects and source to Ganga river of some heavy metals are highlighted in table 1.

Table 1: Presence of heavy metals in Ganga river, their sources and health effects

S.No.	Heavy metals	Sources	Health effects	References
1	Arsenic	Metal smelters, pesticides	Destruction of blood vessels, gastrointestinal tissue, heart and brain. Their long term exposure leads to neurological problems, peripheral vascular disease, pulmonary disease, and cardiovascular disease	(Brown, Chaney, & Hettiarachchi, 2016; Chakraborti et al., 2003)
2	Lead	Batteries, Paint, pesticides,	sleeplessness, hallucinations, vertigo, renal dysfunction, arthritis whereas their chronic exposure can result in birth defects, mental retardation, paralysis, dyslexia, kidney damage, brain damage, coma and even can cause death	(Brown et al., 2016)
3	Mercury	Paper industries, battery	Can damage kidney, brain and developing fetuswhile methyl mercury are considered as carcinogenic	(R. Sinha et al., 2007)
4	Cadmium	Electroplating, fertilizers, pesticides	Damage bones, lungs and leads to itai-itai disease	(Leena, Choudhary, & Singh, 2012)
5	Chromium	Tannery, textiles, mining	They has cardiovascular, respiratory, hematological, gastrointestinal, renal, hepatic, and neurological effects	(Handa, 1988)
6	Iron	Mining, electroplating	hypotension, tachycardia, metabolic acidosis, shocks, lethargy, hepatic necrosis, and may lead to death	(Purushothaman & Chakrapani, 2007)
7	Manganese	Ferromanganese production, mining	Gait disturbances, micrographiabradykinesia, memory and cognitive dysfunction	(Purushothaman & Chakrapani, 2007)

4.2. Pharmaceuticals

Pharmaceuticals gain a lot attention as an emerging contaminant discharged into the river by human activities, industrial waste waters, and animal husbandry activities. These compounds even at low concentration deteriorate the Ganges River ecosystem. Many of these chemicals are endocrine disruptors. Endocrine disruption effects of hormonal pharmaceuticals, due to their high potency at extremely low concentrations, are of particular concern for humans and animals. Antibiotics are also especially important because of their potential to form and promote antibiotic resistance for human pathogens, and their potential to significantly impact natural microbial consortia. Other classes of pharmaceuticals, such as analgesics and psychopharmacologicals, may also be important due to their strength and common use.

Paromita Chakraborty (2019) studied the various organic micro pollutant pollutants in the HRS varied between 3 and 519 ng/g for carbamazepine, 5–407 ng/g for non-steroidal anti-inflammatory drugs (NSAIDs), 2–26 ng/g for musk ketone, 2–84 ng/g for triclosan, 2–199 ng/g for bisphenol A (BPA), 2–422 ng/g for plasticizers (phthalic acid esters (PAEs) and bis (2-ethylhexyl) adipate (DEHA)) and 87–593 ng/g for parabens. Carbamazepine concentration in sediment was an useful marker for untreated wastewater in urban waterways. High concentrations of BPA and PAEs in the suburban industrial corridor together with significant correlation between these two type of OMPs ($r2 = 0.5$; $p < 0.01$) likely reflect a common source, possibly associated with the plastic and electronic scrap recycling industries. Among all the categories of OMPs, plasticizers seems to exhibit maximum screening level ecological risk throughout the study area.

Plastics

In India, the disposal of plastic waste needs to be urgently enhanced and managed. The generated plastic wastes ultimately end up in the rivers, affects the river water ecosystem. Each year around 1.2 billion pounds of discarded soft and hard plastic are discarded to Ganga. The Ministry of Environment, Forests and Climate Change (MoEF & CC), estimated that in our country, over 25,000 tonnes of plastics are generated every day and only 9,000 tonnes are recycled.To address this situation, in 2016, Plastic Waste Management Rules were introduced by the MoEF & CC. The rules put the responsibility squarely on the manufacturers of plastic both to manage the waste system as well as to buy back the plastic waste generated.

5. Future prospects and strategies

The waste water release from industries can be treated by various techniques for the removal of heavy metals or to lower down their concentration below the prescribed limit. Some of the techniques are:

Adsorption is the oldest and most reliable technique to adsorb the pollutants from liquid phase. In this technique adsorbent play the most critical part in phenomena. Various types of adsorbent such as activated carbon, MOFs, clays, pillared clays, porous clay heterostructures, zeolites could be employed for the heavy metals adsorption. Among them activated carbon is most popular adsorbent, however their smaller pore size and regeneration property limits their application. Materials like ordered mesoporous materials having high surface area, selectivity, and higher adsorption capacity could be the alternative. Chemical precipitation; which is the most employed strategy because of the volume of waste water. In this technique soluble cations are removed by precipitation with the help of an agent. Coagulation and flocculation are also being an approach to separate the heavy metals with the help of the various coagulants that leads to destabilization of colloids into aggregation and sedimentation. Ion exchange is another technique could be effective because of the charge on heavy metals which can be separated by exchanging.

In future here some strategies are discussed to clean and avoid pollution in Ganga. Artificial aeration can be done that enhance the dissolved oxygen and provides the proper functional of biological system. A barricading of plastic nets at upstream and downstream of the river can be hold across the river that can restrict the larger particles. A special legislation is needed and to follow strictly for to make clean and healthy Ganga.

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