Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Spl Issue [3] 2022: 383-389

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

REVIEW ARTICLE **OPEN ACCESS**

Evaluation of the Water Quality Status of Hooghly River (Ganges) in West Bengal, India

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ABSTRACT
Rivers plays important role for the sustenance of life by providing drinking water source and also in the economic growth by serving for irrigation and industrial purposes. The Hooghly River is the tributaries of the river Ganga in West Bengal. The maximum populations of West Bengal are inhabited on the bank of Hooghly River; it also supports various industries and cultural heritage. The present work is conducted to evaluate the water quality of the Hooghly river and to find out the pollutant sources of the Hooghly River of West Bengal. The results reveal that the river is deteriorating rapidly due to the increased rate of pollution from different industrial, transportation, domestic and agricultural sources. In addition to this various religious activities like idol immersion and mass bathing also adds to the source of pollution. The low DO, high BOD, COD and higher values of turbidity is reported in the entire river stretch due to anthropogenic intervenes. Some studies also revealed fecal contamination and high risk of trace and heavy metal pollution. The management of the river needs proper planning along with the people's participation so as to conserve the river water quality and to save the aquatic biodiversity. Only a bridge between the optimum resource utilization, science, technology and culture would help to combat the gap between laws and regulations and their proper implementations.
Keywords: *Water quality; Water Quality Index; Trace Elements; Physicochemical Parameters; Heavy Metal Pollution*

INTRODUCTION

India is river based country, many towns and villages are situated on the river banks. River water is very important among the natural resource for the sustenance of life. [1-2].One of the most important rivers of India is Ganga River. Originating in Gamukh cave, river Ganga travels through many states of India viz. Uttarakhand, Uttarpradesh, Bihar, Jharkhand, and West Bengal [3]. In West Bengal, it is named Hooghly River. It is the most important river of West Bengal, runs through most of the districts where it flows almost 260 km to reach the Bay of Bengal [4]. Maximum populations of West Bengal are inhabited on the bank of the Hooghly River. Almost all the cultural heritage and industries and other anthropogenic activities happen at the banks of the river. West Bengal is mainly an agriculture-based state with major rice and jute production, which fully depended on this river water [4-5].

For the survival of the living components fresh, clean, and safe water is highly needed [6]. Due to various socio-economic circumstances, freshwater scarcity is emerging alarmingly. The rapid rate of urbanization and unplanned population explosion affects the condition adversely. Bullard (1972) inferred that an unhealthy socio-economic environment emerges due to polluted surface water quality. Decreasing water quality is a matter of concern throughout the world; not only does it damages living organisms but also has the probability to change the hydrological cycle [7-8]. Water quality means the chemical, biological as well as physical characteristics of water that is safe for consumption for both humans and other living organisms [9]. Water quality is assessed through a set of standards that is suitable for consumption; physicochemical parameters, biological parameters are used to measure water quality [10].

A large number of studies have been conducted to improve the water quality of the Hooghly river but the success rate is very low. In recent times the holy river is seriously devastated due to the enormous pollution load from the point and non-point sources[11]. Some very populated areas which are situated on the bank of the Hooghly river are Naihati, Dakhineswer, Titagarh, *etc*. where studies have reported some that the physicochemical parameters are much higher than the standards. [12-13]. Many religious activities like; religious festivals, idol immersion, mass bathing, etc. are done in the river which directly discharges flowers, plastics, and many other contaminants into the water body and increases the heavy metal load of the river. Agricultural run-off, domestic sewage, industrial effluents discharged directly into

the river affects the entire aquatic ecology. [12,14]. Many studies found an abundance of fecal coliform, which influence the water quality index by affecting TDS, DO, BOD level [15].
The present review is focused to study the current scenario of the Hooghly River pollution and to summarize the major pollutant sources, including both point and non point sources in the river (Figure 1).

Fig. 1.Hooghly River Map

Major Sources of Water Pollution:

The various pollutants recorded in the river stretch include heavy and trace metals, organic compounds, bio pathogens, inorganic compounds and various other suspended solids. The sources of these pollutants are majorly domestic, agricultural, religious, and industrial sources.

Domestic Sources:

The major sources of pollutants in the river are from the domestic waste water discharge from the urban settlements situated at the bank of the river Hooghly. These kinds of wastes are mostly organic wastes and sewage; dead bodies of cattle's are also sometimes thrown in the river. Most of the studies revealed higher values of fecal coliform and BOD levels. The results suggest that prior treatment measures should be adopted before dumping the domestic and municipal wastes into the river [16].

Agricultural Sources:

The agricultural activities in the River Basin are very prominent and fertilizer and pesticide consumption are quite significant. Pesticides have an adverse effect on human health as well as on the environment [17]. Pesticides are important in the Indian scenario because they help in increasing production to meet the growing need but are also adversely affecting both human health and the environment. These are contaminating the river water by direct discharge and surface run-off from the agricultural land. Fertilizers are used in agricultural land on the Hooghly river basin also cause huge pollution. Due to agricultural runoff, heavy metals and toxic chemicals are mixing in the Hooghly river and affect the aquatic health of the river especially fish [18-19].

*Religious Sources***:**

Religious factors are also a major source of river water pollution because most of the religious activities are done on the banks of the river. River Ganga is considered the holy river in India. People are taking a dip into the Ganga River to earn piety. From the religious faith, people throw various after puja materials like flowers, food particles, plastics, etc. into the river [20]. Mass-bathing on the religious festivals is also contaminating the river water which is dangerous for aquatic animals as well as for human health [21]. Besides this there is a common ritual i.e. idol immersion; paints, chemicals, heavy metals used to make idols are polluting the river every year [22-23]. Cementations are also performed, along the river banks and the remains of these traditional funerals also add to the sources of pollutants.

Industrial Sources:

Industrial waste and urban wastes are the main sources of Hooghly river basin pollution. Most of the industries are situated on the banks of the Hooghly river, as a result, urbanization also took place in these areas. Due to the heavy population density in this area; various drains and canals are draining wastewater directly into the river [24-25]. Various industries like, petrochemical, cement, paint, tannery, diary, paper, etc. are built on the Hooghly river basin. These industries are helping the people of West Bengal economically; and are the financial backbone of the state. However, these industries are also discharging their untreated waste directly into the river and the heavy metals are directly polluting the water body [26-27]. The different industries and their types of effluent discharge are summarized in table 1. Table 2 gives a summary of different heavy metals reported in the Hooghly River and their impacts.

Table 1. Industries and their effluents on the Hooghly River[28]

Types of Industries on Hooghly River Bank	**Contamination**
Electroplating,Metal, thermal power plant	Cadmium, Arsenic, Chromium, Iron, lead, mercury, nickel, titanium, Iron and zinc
Paper mills and Pulp industries	Chlorinated organic compounds and dioxins, sugars and lignocelluloses
Petrochemical industries	Phenols and mineral oils, Cadmium, Chromium, Zinc,Copper, Arsenic, Lead, Nickel
Tannery industries	Chromium, Zinc, Manganese,copper, Nickel, Silver, Aluminium, Iron and Lead

Table 2. The Sources and Effects of Heavy Metals Pollution on the Hooghly River [29]

Heavy Metals	**Sources**	**Effects**
Arsenic	Pesticides, Fungicides, Metal Smelters	Decrease red and white blood cell production, stomach and intestine irritation
Cadmium	Electroplating, Welding, Batteries, Pesticides, Fertilizers	Kidney and Liver Damage, Gastrointestinal and Renal damage
Zinc	Electroplating, Idol immersion	Diarrhea, Liver and Kidney Damage
Chromium	Mines, Electroplating	Gastrointestinal and Renal damage
Lead	Paint, Pesticides, Idol immersion, batteries	Damage central nervous system, Kidney damage, anemia, Arising blood pressure
Mercury	Paint, Idol immersion, batteries, Battery	Effects on child growth and development, Decreased fertility rate
Copper	Electroplating, Pesticides, Mining	Headache, Nausea, Diarrhea,
Nickel	Stainless steel, Electroplating	Neurotoxic, Genotoxic, Carcinogenic

Pollution Status:

The domestic and industrial effluents are directly discharged into the river without proper treatment, and it affects the physicochemical properties of the river water. There are three types of parameters used to determine water quality; physical parameters, chemical parameters, and biological parameters. Physical parameters are pH, temperature, colour, taste and odor, conductivity, TDS, and turbidity these determine the water quality. Pure water is tasteless, colourless, and odorless and does not absorb any light. The variations in the physiochemical parameters affect the water quality and the entire aquatic ecosystem [30]. High TDS and temperature impact the water pureness and it directly impacts the water ecology because high temperature decreases the oxygen level on the water body [31]. Chemical parameters include chloride, ammonia, nitrite, nitrate, BOD, phosphate, hardness, COD, DO, Free CO_2, etc. High BOD directly indicates that there is low in DO and it affects directly water living body. If the water body is high in ammonia, nitrate, chloride, etc. these increased the eutrophication load of the water body. Hence, these parameters play a very important role in water quality [32]. Biological parameters fecal coliform, total coliforms indicate the presence of microbial load on the water body [33].

Various studies were conducted to evaluate the physicochemical parameters of the Hooghly river [34]. A study conducted at the Shyamnagar Ghat reveals a significant inverse relation between DO and free CO_2. The pH is also found to be affected by the CO_2 fluctuations [35]. Another study conducted on the micro-plastic contamination reported conglomeration at Bali Khal, Howrah [36]. A series of studies revealed that the turbidity was high but other parameters were mostly moderate, while some exceeds the limits of

the standards. The water quality of the river water was reported not suitable for any domestic purposes, recommended proper treatment needed of the industrial/municipal/household effluents before discharging in the water body [37]. The abundance of *E. coli* and Streptococcus directly affects the oxygen demand; decreases the DO level and increases the TDS and BOD level. Domestic sewage, industrial effluents, and municipal wastewater directly discharged into the river help to increase the coliform bacteria which are unhealthy for human health [15, 38]. To study the water quality index of the Hooghly river basin, the pH, DO, Faecal coliform, TOC, BOD, and total coliform, Free CO_2, alkalinity, hardness, conductivity, temperature, turbidity, and TDS are analyzed [39]. Most of the studies have found that water quality deteriorates for the anthropogenic activities and the water was not suitable for any kind of usage, people coming in contact with this water will suffer from many diseases, physicochemical parameters were moderate but some heavy metals were high like; fluoride, cadmium [39, 40].The high TDS content of the river water makes it unfit for aquatic life and acts synergistically on other associated water quality parameters. Ghosh *et.al*, 2021 evaluated the WQI and found the value revealed deteriorating quality of the river. [41]. Singha and Paul (2015) studied the pollution indicator bacteria during the diel cycle at the Ganga river in the Ichapore stretch. They collected sample water five times a day with the same interval and used some parameters to check the pollution density like; temperature, pH, DO, total hardness, bicarbonate, calcium, hardness, and electrical conductivity. The results showed that the water quality of the study area is very much polluted due to the continuous sewage discharge into the river [42]. Another study on the Bhagirathi-Hooghly river done by Panigrahiand Pattnaik(2019) in the stretch of West Bengal concluded that proper plans are needed to reduce the pollution load [43]. The heavy metal pollution in rivers leads to bioaccumulation and biomagnifications which results in harmful health effects in the human bodies. Heavy metal exposure can result in kidney damage, cancer and in high doses may even lead to death. Metals can enter into the freshwater through various natural as well as anthropogenic sources. Naturally, it can enter by a volcanic eruption, weathering of rocks and soils, and in an anthropogenic way, it can enter by some human activities such as mining, idol immersion, discharge of domestic/household swages, use of pesticides and fertilizers[44]. The main difference between trace elements and heavy elements is heavy metals are more toxic than trace metals [45]. The common heavy metals are cadmium, copper, nickel, chromium, lead, mercury and the common trace metals are copper, boron, zinc, magnesium, molybdenum, etc.[46].

Kar et al. (2007) assessed the heavy metal pollution of the Ganga river in West Bengal they collected sample water from ninety-four sites and analyzed pH, Fe, Mn, Zn, EC, Cu, Cd, Cr, Pb, and Ni. The result revealed that some sample sites are heavily polluted; they found in order of heavy metal in the sample area was as follows Fe >Mn> Ni > Cr >Pb> Zn > Cu > Cd [47]. An investigation was done by Paul and Singha (2013) on the ecological impact of the lower stretch; they analyzed Zn, Pb, Cr, and Cd. The outcome of the study revealed that the impact of the heavy metals orderly was Zn(0.075-0.280)>Pb(0.033-0.141)> Cr(0.002-0.007)> Cd(0.016- 0.022) and all the heavy metals were over the permissible level [48]. Mandal *et al.* (2021) studied the synergistic effect of sixteen trace elements on human health and their effects and collected their samples from eight different areas of Hooghly river and estimated that high concentration of the trace elements especially Cd and Pb[49]. Another investigation done by Samanta et al. (2017) on the heavy metal enrichment into the Hooghly river revealed mainly elements Co, Cr, Cu, Ni, Zn and in the water body [50-51]. The seasonal assessment was conducted by Mondal et al. (2018) and they selected eight sites of the Hooghly river and three different areas viz. freshwater zone, brackish water zone, and estuary area zone; to test sixteen trace elements and their effects on human health. The study revealed that the trace elements were carcinogenic among them As and Cr have high risk [52]. Mitra *et al*. (2018) analyzed that the industrial effluents polluted the water and increase heavy metals deposition into the river. Increasing trace element in the water body increases cancer risk and children are more vulnerable to such conditions [53].

CONCLUSION

The present review summarizes the current pollution status of the Hooghly River. The studies revealed that the water quality of the Hooghly River is below the standards for human usage and healthy aquatic life; because of various types of contamination loads. The deterioration of the river water can be accounted to numerous reasons; such as agricultural run-off, untreated industrial/household sewages, idol immersion, mass bathing, heavy metal contamination, etc. The decline rate of water quality is increasing the rate of various diseases in humans as well as in aquatic organisms and affecting the entire aquatic biodiversity. The anthropogenic and industrial effluents are resulting in eutrophication. River bank plantation can help in control of erosion, which can prevent excessive sediment deposition in the river bodies. This review suggested that various sources of pollutants in the water of the river Hooghly

should be monitored. The industrial effluent and domestic sewage discharge must be treated before disposal.

It is high time to take proper planning to check these activities and the strict implementation of the planning is highly needed. We have to treat this by establishing a bridge between the scientific community, government protocols, and local people. Proper integrated water pollution management plan should be enforced to protect our rivers and the aquatic life therein.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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CITATION OF THIS ARTICLE

Misha Roy, Rahul Majumder, Farzana Shamim and Chaitali Ghosh.Evaluation of the Water Quality Status of Hooghly River (Ganges) in West Bengal, India. Bull. Env. Pharmacol. Life Sci., Vol Spl Issue [3] 2022: 383-389