Review -Water Quality Challenges in Ganga River Basin, India

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***Abstract*-With its unique economic, environmental, and cultural significance in India, the Ganga is regarded as the world's most significant and sacred river. Rapid urbanization and industrialization over the past few decades have put the quality of surface and groundwater at grave risk. The Ganga basin is experiencing severe water scarcity in a number of areas due to its very irregular precipitation pattern. The water table has dropped at an alarming rate as a result of the river basin's widespread usage of groundwater, which has caused most of the streams' flows to diminish. Wastewater production has increased as a result of growing urbanization and income. The Ganga River and its tributaries receive a significant amount of treated and untreated sewage from municipal discharges and industrial processes. As a result, the combined effect of higher waste loads and lower water flows presents significant problems for the river basin's water quality. Using data from the Central Water Commission (CWC) for the years 2010–2013, the physicochemical characteristics in the river water, such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Dissolved Oxygen (DO), were investigated at different sample locations. New contamination levels published in the literature are also included to the water quality data. The Ganga River's water quality continues to deteriorate due to the presence of industrial waste, household trash, heavy metals, sewage, and human and animal skeletons, according to an examination of research data. The presence of numerous deadly substances like Cr, Zn, Cu, Pb, Fe, Ni, and Cd further demonstrates how unclean the Ganga's water is. Faecal coliform and total coliform were among the bacteria species found in the Ganga water, according to a water quality analysis. The government's attempts to clean up the Ganga are commendable. However, an accurate inventory of the streams and drains that enter the Ganga River as well as the pollution potential of each of them must yet be completed in order to guarantee the effectiveness of such programs. Additionally, wherever possible, the Ganga basin should encourage the use of eco-friendly technologies.**

***Keywords*- Ganga basin, Biochemical oxygen demand (BOD), Urbanization, Faecal coliform**

I. Introduction

One of India's most important rivers is the Ganga. It empties into the Indian Ocean from the Himalayan Mountains. Gaumukh is where the Ganga River originates. Since several cities are situated close to the Ganga Riverbank, the river has enormous religious significance. The Ganga, which covers an area of over 861,404 km2, is the only river that supplies the densest population in the world. Numerous research were conducted in the Ganga basin about the evaluation of water quality and quantity because the Ganga is extremely important to all living things in its proximity. For instance, Singh (2010) investigated the effects of pollution on the Ganga at various locations in Varanasi as well as the physicochemical characteristics of the water in the river, including acidity, alkalinity, temperature, pH, BOD, COD, DO, Cl−, electrical conductance, NO3−, and PO43−. Over the course of two years, from 2007 to 2008, Singh et al. (2012) measured the amounts of heavy metals, including Cd, Zn, Cu, Cr, and Ni, in the river water and sediments of the Ganga in the middle Ganga plain. The concentrations found in the river water were Zn (up to 0.87 mg/L); Ni (up to 0.12 mg/L); Cr (up to 1.09 mg/L); Cu (up to 0.12 mg/L); and in the sediments, the range was Zn (up to 0.87 mg/g); Ni (up to 0.09 mg/g); Cr (up to 0.14 mg/g); and Cu (up to 0.09 mg/g). Beg and Ali (2008) evaluated the Ganga River's sediment quality in Kanpur, a city notorious for river water contamination due to tannery industry discharges. The findings were startling since the amounts of chromium (Cr) in downstream river reach were thirty times greater than those in upstream river sediment. Bhatnagar et al. (2013) conducted a study identical to this one, except they evaluated and discovered a large quantity of Ni, Cd, Pb, Zn, Mn, Cu, Fe, Co, As, and Cr. Numerous of them pose health risks. There aren't many studies on mercury (Hg) pollution of water. The degree of mercury pollution in the Ganga River near Varanasi has been evaluated by Sinha et al. (2006). The amounts and quantities of accumulated mercury in river water were among the observations. Water, sediment, fish, benthic macro-invertebrates, aquatic macrophytes of the Ganga River, soil, and vegetation found in the nearby floodplain were all covered in this study. The average annual concentration of mercury in the Ganga River was up to 91.679 ppm in fish, 0.00023 ppm in river water, 0.067 ppm in sediment, and 0.118 ppm in benthic-invertebrate biota. Plain soil was found to have up to 0.269 ppm during the flood. Pal et al. (2012) discovered elevated levels of methyl mercury (MeHg) in freshwater fish samples taken from West Bengal's Ganga River. About 50–84% of the high concentrations of accumulated mercury that were discovered in some fish muscles were organic mercury. The maximum detected level of organic mercury was 0.93 ± 0.61 µg Hg/g, which was unexpectedly high and hazardous. Early nervous dysfunction could be caused by the ingestion. Because of this, it is imperative that such dangerous pollution be properly monitored.

The literature also includes some research on arsenic (As) poisoning in the Ganga basin. It has been investigated for the alluvial Ganga aquifer in Bangladesh and West Bengal by Nickson et al. (1998) and Acharyya et al. (1999). It was examined for the Middle Ganga Plain in Bihar by Chakraborti et al. (2003). In these instances, naturally existing arsenic in alluvial Ganga aquifers was found to be the cause of the river's pollution. Ahamed et al. (2006) found that groundwater in the upper and middle Ganga plain was contaminated by arsenic, primarily in the three Uttar Pradesh districts of Varanasi, Ballia, and Gazipur.

Eleven impacted villages—ten from the Balliadistrict and one from the Gazipur district—were subjected to an initial medical examination by Ahamed et al. (2006). The degree of arsenic exposure in the community was demonstrated by the observation of typical arsenical skin lesions, arsenical neuropathy, and unfavorable obstetric outcomes. These research provide insight into the serious consequences of arsenic, which should be addressed more urgently. As a result, it is clear from some of these water quality studies that the Ganga's sediment, the water in it, the water near its course, and the river's living species have all been impacted. In light of this, the chapter's objectives and structure are as follows:

(i) To look into the effects on the Ganga River basin's surface water quality;
(ii) To implement certain preventive actions to both regulate and improve the Ganga River's water quality.

II. Study Area and Its Water Resources

The Ganga-Brahmaputra-Meghna river basin makes up the Ganga River system.

With a total drainage area of 1,086,000 km2, the Ganga River spans India, Nepal, Bangladesh, and China. It is bordered to the east by the Brahmaputra range and to the west by the Aravalli hills, which divide the Indus basin from the Ganga basin. The Vindhyas and Chhotanagpur Plateau encircle the Himalayas, which are situated in the north and south. According to Tripathi and Tripathi (2012), this basin includes the entire states of Uttar Pradesh (240,798 km2), Uttarakhand (53,566 km2), West Bengal (71,485 km2), Bihar (143,961 km2), and Delhi (1484 km2), as well as a portion of Rajasthan (112,490 km2), Madhya Pradesh (198,962 km2), Himachal Pradesh (4317 km2), and Haryana (34,341 km2). The Ganga River basin's size and monitoring stations are depicted in Figure 1. The basin's climate ranges from tropical monsoon in the south to moderate in the north. The Ganga River is vital to its people, especially in terms of water supplies. The Indian Meteorological Department reports that the river basin typically receives 1051 mm of rain annually, with about three-quarters of that amount falling during the monsoon season (Jain and Kumar 2012). The process of evaporation and transpiration results in a significant loss of water, with the remainder being used for land uses. in the upper Himalayan region to roughly 1600 mm in West Bengal's Kolkata and Alipore.

Flash floods occur during the monsoon season when the surplus water available from rainfall exceeds the capacity of natural and man-made structures throughout the basin.

Figyre1-Study area map showing the monitoring stations of the Ganga River basin

On the other hand, drought conditions are brought on by the basin's high evaporation rates and increased water needs throughout the summer, necessitating the import of water. Droughts and floods are signs of the Ganga River basin's hydrological cycle's severity. The situation is made worse by the basin's rapidly growing population and depleting forest cover.

The average annual flow for the Ganga basin is 525 km3, according to the Central Water Commission's 2005 assessment of catchment-wise average annual flow in Indian river systems.

Utilizing all of the surface water that is accessible is not feasible due to hydrological, topographical, and other constraints. Approximately 250 km3 of the basin's surface water can be effectively utilized for a variety of purposes using traditional development techniques. According to a research on the Ganga River's catchment-wise groundwater potential by the Ministry of Water Resources, these catchments have an extreme groundwater potential of roughly 171 km3 when compared to other watersheds in the nation. The country's Ganga basin has a surplus groundwater potential of 39%. Compared to other watersheds in the nation, groundwater consumption is higher in these catchments due to the high accessibility of groundwater. The Ganga River's principal streams are not all perennial. Sone, Betwa, Chambal, Khan, Yamuna, and Kshipra were among the significant sub-tributaries that persisted. However, it has become seasonal during the past few decades as a result of overexploitation of groundwater in the catchments, which lowers baseflow during the non-monsoon period and causes the groundwater table to drop at an alarming rate.

III. Water Quality Variations

Water quality in rivers is commonly evaluated using indicators such as **Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO),** and **Faecal Coliform**. Data collected over four years from four monitoring stations reveal notable differences in water quality. Among the studied locations, **Kanpur** showed the highest BOD levels, indicating greater pollution. This is largely attributed to the presence of tannery and other industrial activities in the region. Despite regulatory measures and wastewater treatment requirements, untreated industrial and domestic discharges may still enter the river, contributing to contamination.

Similarly, the lowest DO levels were recorded at Kanpur, reflecting poor water quality conditions. Although recent observations suggest some improvement in the Ganga River's water quality, pollution remains a major concern. Rapid urbanization and industrial development along the river and its tributaries continue to generate large volumes of treated and untreated wastewater, leading to ongoing degradation of the river ecosystem.

Studies indicate that nearly **75% of the pollution load in the Ganga River originates from untreated domestic sewage** discharged by urban settlements. The river receives around **900 million liters of sewage daily**, significantly affecting its water quality. The **Kanpur–Buxar stretch**, characterized by high levels of urbanization and industrial activity, is considered the most polluted section of the basin. The discharge of municipal waste and industrial effluents in this region poses serious environmental and public health risks.

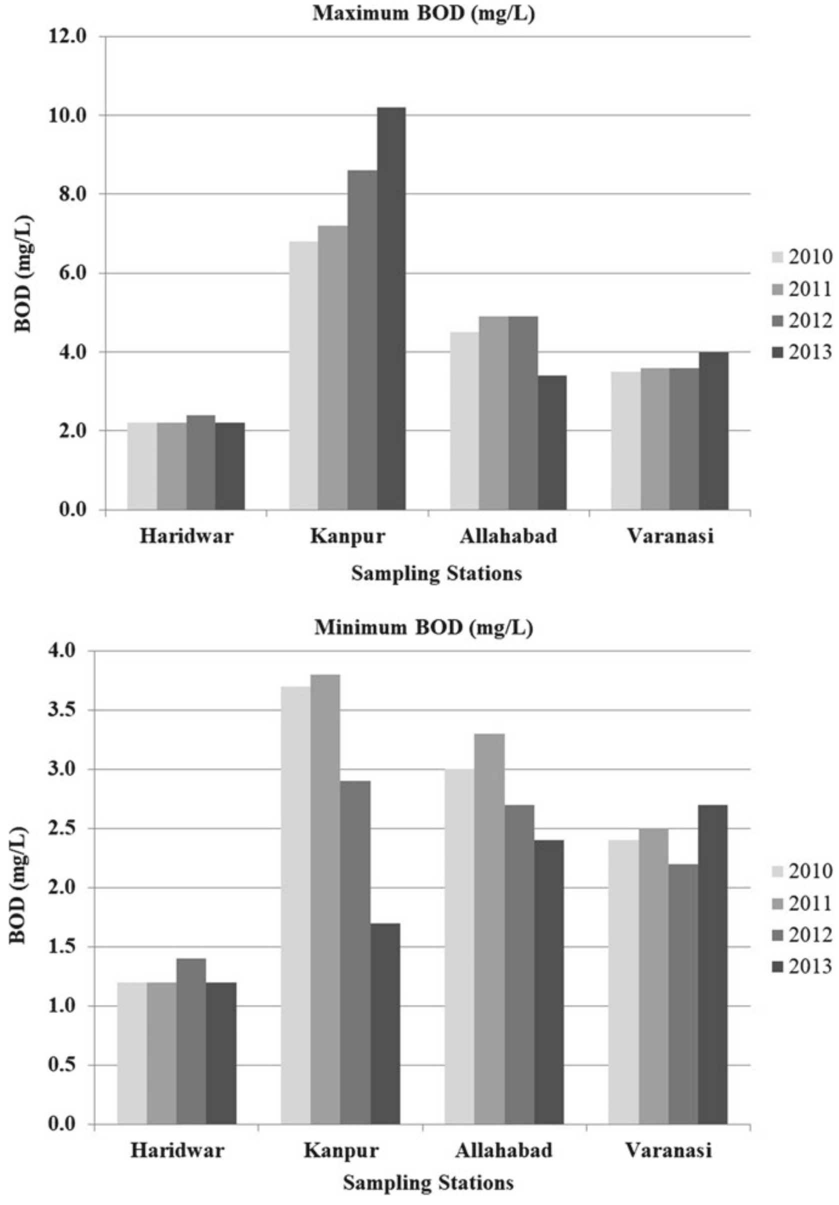

Fig. 2 BOD, COD and DO at Haridwar, Kanpur, Allahabad and Varanasi sites for the year 2010– 2013

In contrast, the upper reaches of the Ganga, particularly up to **Rishikesh**, remain relatively clean except for natural sediment loads. Beyond Rishikesh, pollution levels increase due to the inflow of municipal sewage and partially treated industrial wastewater from nearby urban centers such as **Haridwar** and **Rishikesh**. Haridwar, a major religious destination with a resident population of about **1.5 lakh**, attracts nearly **60,000 visitors daily**. During large religious gatherings such as the **Kumbh Mela**, the number of visitors can rise to **15 lakh**, placing additional pressure on the river's water quality.

The sediments that come in from the nearby hilly areas clog the massive sewer systems in this location. The Ganga River passes through places like Bijnor, Garhmukteshwar, Narora, and Kannauj after Haridwar. The lack of significant industry in this area contributes to the low level of pollution in the river water. The river's water becomes extremely contaminated as it reaches Kanpur further downstream. Severe degradation of the water quality is caused by untreated hazardous industrial effluents dumped into the river water from around 150 industrial units and municipal sewage from Kanpur city, which has a population of 2.7 million.

In the **Jajmau industrial area of Kanpur**, the average dissolved oxygen (DO) level is about **3 mg/L**, indicating significant organic pollution caused mainly by effluents from numerous tanneries and other industries. As the Ganga flows downstream to **Allahabad (Prayagraj)**, pollution increases due to the discharge of urban sewage. The situation worsens at the **Sangam**, where the highly polluted **Yamuna River** merges with the Ganga, adding a substantial pollution load.

Further downstream in **Varanasi**, the **Varuna River** and several drainage channels carry large quantities of waste into the Ganga. With a population exceeding **1.2 million**, Varanasi generates considerable domestic and industrial waste. Religious practices, including the cremation of over **40,000 bodies annually** and disposal of remains into the river, also contribute to water quality deterioration.

As the river enters **Bihar**, **Patna** becomes a major source of pollution through the discharge of untreated domestic sewage. Industrial activities, particularly fertilizer plants and oil refineries along the riverbanks, further affect water quality. In the lower reaches, **Kolkata** and the surrounding **Hooghly basin** contribute additional pollution through municipal wastewater and industrial effluents. Similar trends of water quality degradation in the Ganga basin have been reported in previous studies.

The decline in water quality of the Ganga River is primarily caused by the discharge of untreated or partially treated domestic wastewater from rapidly growing urban areas and settlements along the river and its tributaries. A study by **Chaudhary et al. (2017)** assessed water quality at nine locations between **Haridwar and Garhmukteswar** during pre- and post-monsoon periods (2014–2015). The findings suggested that the river water was generally suitable for drinking; however, contamination from heavy metals was also detected.

The study examined major drains, including **Haridwar** and **Laksar drains**, as well as tributaries such as the **Solani, Malin, and Chhoiya Rivers**. Among these, the **Chhoiya River** was identified as a major pollution source, exhibiting extremely high values of **BOD (60 mg/L)**, **COD (791 mg/L)**, and **turbidity (354 NTU)**.

Due to pollutant inputs from tributaries and drains, the water quality of the Ganga deteriorated considerably over a 160 km stretch. At **Bhimgoda (Haridwar)**, the river showed relatively low pollution levels with **BOD 2.65 mg/L**, **COD 38 mg/L**, and **turbidity 7.78 NTU**. By the time the river reached **Garhmukteswar**, these values had increased to **BOD 5.18 mg/L**, **COD 112 mg/L**, and **turbidity 22.7 NTU**, indicating significant degradation in water quality.

The degradation of the Ganga River's water quality is mainly caused by pollutants entering through drains, tributaries, and connecting rivers. Therefore, effective management and treatment of wastewater from these sources are essential for improving river health. Without controlling pollution from intermediate drains and tributaries, efforts to restore the Ganga are unlikely to achieve long-term success.

A study by **Paul (2017)** examined the presence of heavy metals in the river water and sediments at five major locations: **Rishikesh, Haridwar, Kanpur, Allahabad, and Varanasi**. The findings revealed that concentrations of **lead (Pb), zinc (Zn), and chromium (Cr)** exceeded permissible limits at several sites, indicating significant heavy metal contamination.

Further research by **Thakur et al. (2017)** showed that **arsenic was generally absent in the Ganga River water**, although nearby groundwater aquifers contained elevated arsenic levels. In such areas, **riverbank filtration technology** has proven effective for producing safer drinking water by naturally filtering river water through riverbank sediments. Earlier studies by **Ojha and Thakur** also demonstrated the benefits of using infiltration wells near the Ganga River at Haridwar to improve water quality for domestic use.

IV. Major Causes of Water Quality Degradation

There is a large body of research outlining important reasons why Indian rivers' water quality is declining. The content in this part is taken from several sources, including publications from the Central Pollution Control Board (2013), which is why we would want to present it here.

A. Wastewater from Metropolitan Cities

There are roughly 29 urban cities (population >100,000), 23 municipalities (population >50,000), and 50 minor towns (population >20,000) on the banks of the Ganga River. These urban areas and municipalities produce about 3000 MLD of residential wastewater. According to a study by Trivedi and Trivedi (2012), 85 of the 150 large companies near the Ganga River's banks are considered to be extremely polluting. The Ganga Riverbank is home to a number of small and large-scale companies in addition to significant ones.

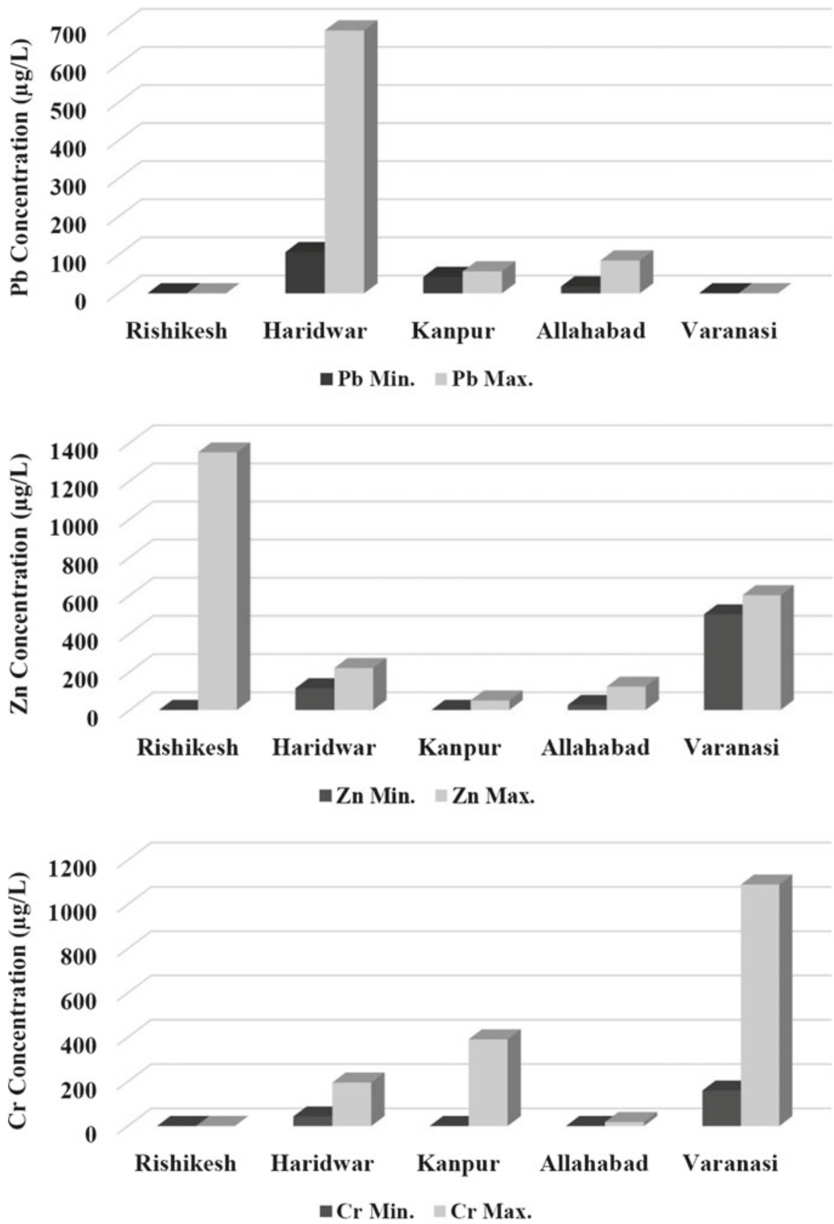

Fig. 3 The concentration of heavy metals Pb, Zn and Cr in Rishikesh, Haridwar, Kanpur, Allahabad and Varanasi

Most of the region's large-scale and small-scale enterprises lack appropriate facilities for treating garbage. Consequently, both treated and untreated garbage produced are either directly introduced or combined with the municipal effluent from these enterprises indirectly into the network of rivers. Total coliform MPN results show the bacterial river water pollution. The physicochemical characteristics of the sewage produced in Kanpur City, which are the primary causes of water degradation of the Ganga's purity.

B. Agricultural Field Runoff

The Ganga River originates in Gomukh and travels downstream through five Indian states: Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal.

The Ganga River obtains water from the river basin's extremely productive agricultural regions along its 2525 km journey. According to a study by Trivedi and Trivedi (2012), these agricultural fields utilize a significant amount of pesticides, herbicides, insecticides, and rodenticides to safeguard their crops.

These agrochemicals, which are primarily fertilizers, are carried to river water by surface runoff during rainfall, resulting in serious water contamination issues.

C. Discarding of Bio-medical and Solid Wastes

A significant amount of solid garbage is produced in small towns and urban agglomerations along the Ganga River's banks. A variety of hazardous and poisonous substances make up biomedical wastes. These wastes, including solid and biomedical wastes, are often disposed of at landfills near riverbanks. Large amounts of hazardous chemical leachates from these locations are either directly or indirectly added to river water. These wastes are occasionally dumped into rivers in an open manner, seriously degrading their quality.

D. Washing of Clothes and Animal Cleaning

The Ganga River gets a significant amount of organic and inorganic waste from numerous anthropogenic activities, including clothing washing and animal bathing, as it flows through urban areas and small towns. It has been noted that washing garments releases a significant amount of carbonate, phosphate, and alkaline minerals into the river system. The pH of the river water in the washing ghats close to Kanpur, Allahabad, and Varanasi has risen from 8.5 to 9.5 as a result of these operations. In a similar vein, most bathing ghats are used to bathe pets like cows, dogs, buffalo, etc. because there isn't enough water or transportation infrastructure. As a result, these occurrences also contribute to the Ganga's declining water quality.

E. Temple Waste Materials

The Ganga River has its own spiritual values and is very important to Hinduism.

The Hindu society worships and reveres the Ganga, which is considered sacred and comprehensive. As a result, it is known as "Mother Ganga." Every day, about a thousand tons of flowers and garlands are added to the river. After being thrown into the river, these flowers continue to break down, creating an environment that is conducive to the growth of bacteria and lowering the river's dissolved oxygen (DO) concentration. A lot of plastic bags that were used to transport the worship supplies are just thrown into the river. The water becomes physically contaminated as a result.

F. Use of Lift Canals for the Extraction of Water

Several dams, barrages, and canal systems have been constructed on the Ganga River to divert water for **domestic, industrial, agricultural, and hydropower purposes**. The **Tehri Dam** on the Bhagirathi River in Uttarakhand is primarily used for electricity generation. At **Haridwar**, a large volume of water is diverted into the **Upper Ganga Canal**, while additional barrages at **Bijnor** and **Narora** further redirect river flow into the **Madhya Ganga** and **Lower Ganga Canal** systems, respectively. Numerous lift canals also supply water to the extensive agricultural lands of the Gangetic plains.

The extensive withdrawal of river water has significantly altered the natural flow pattern of the Ganga. Reduced river discharge lowers its ability to dilute pollutants and decreases its natural self-purification capacity, thereby contributing to the deterioration of water quality.

G. Deforestation in Himalayan Region and Development of Reservoirs

In the Himalayan region, numerous multipurpose dams and reservoirs are built on the Ganga and its tributaries, mostly for the purpose of producing electricity. Many woods are being destroyed in this area as a result of the development of these hydropower projects.

-The Ganga River receives the silts and sediments produced by the erosion through runoff, which causes the riverbed in this area to become heavily silted. As a result, the river's ability to hold water is diminished.

H. Cleaning Efforts from Government of India

Things ought to have been worse if the government hadn't intervened. In this regard, writers personally value the government's occasional efforts. Highlighting the government's significant initiatives is crucial. Here, a few of these programs are worth highlighting.

NamamiGange Programme (NGP)

On July 10, 2014, the Indian government's Union Finance Minister announced an integrated Ganga development project called "NamamiGange," which translates to "Obeisance to the Ganga River." This scheme will cost Rs. 20,000 crores over the next five years, and as part of it, the Indian government has issued stringent orders to shut down roughly 48 industrial facilities that are located close to the Ganga River. The Central Government is providing 100% support for a number of initiatives and activities under this strategy. Drawing lessons from the limited success of earlier **Ganga Action Plans (GAPs)**, the government has introduced measures to ensure the operation and maintenance of river-cleaning infrastructure for at least **10 years**. For highly polluted areas, a **Special Purpose Vehicle (SPV)** and **Public–Private Partnership (PPP)** model has been proposed to improve project implementation and management.

The **Namami Gange Programme** primarily focuses on reducing pollution through the diversion, interception, and treatment of wastewater from drains. Key initiatives include the installation and upgrading of **Effluent Treatment Plants (ETPs)** and **Sewage Treatment Plants (STPs)**, rehabilitation of existing treatment facilities, adoption of **bio-remediation techniques**, and implementation of innovative pollution-control measures. The program also emphasizes immediate actions to capture and treat pollutants at discharge points and prevent the entry of untreated sewage into the Ganga River.

Ganga Manthan (GM)

Another strategy, Ganga Manthan, was unveiled on July 7, 2014. In order to restore the water quality, a number of issues were explored, including how to clean the Ganga. The purpose of the National Conference was to gather input from interested parties and create a plan of action for cleaning the Ganga. The National Mission for Clean Ganga at Vigyan Bhawan in New Delhi was part of this initiative.

National Mission for Clean Ganga (NMCG)

The National Mission for Clean Ganga (NMCG) was registered as a society on 12 August 2011 under the Societies Registration Act, 1860. Initially, it functioned as the implementation arm of the National Ganga River Basin Authority (NGRBA), which had been established under the Environment (Protection) Act, 1986 to oversee conservation and management of the Ganga River.

In October 2016, the NGRBA was replaced by the National Ganga Council (NGC), also known as the National Council for Rejuvenation, Protection, and Management of River Ganga. The new framework introduced a five-tier institutional structure at the national, state, and district levels to prevent pollution, protect the river ecosystem, and ensure adequate river flow.

The five levels of governance are:

- National Ganga Council (NGC) chaired by the Prime Minister of India.
- Empowered Task Force (ETF) led by the Union Minister of Water Resources, River Development, and Ganga Rejuvenation.
- State Ganga Committees in the concerned states.
- District Ganga Committees in districts located along the Ganga and its tributaries.
- National Mission for Clean Ganga (NMCG) as the primary implementing agency.

This multi-level governance structure was designed to strengthen coordination and improve the effectiveness of Ganga conservation and rejuvenation efforts.

National Ganga River Basin Authority (NGRBA)

The National Ganga River Basin Authority (NGRBA) was established to reduce pollution and improve the water quality of the Ganga River. The authority was empowered to plan, coordinate, monitor, and implement conservation measures through four major sectors:

- Solid Waste Management
- Wastewater Management
- Riverfront Development and Management
- Industrial Pollution Control

Formed on 20 February 2009 in New Delhi, the NGRBA aimed to conserve the Ganga using a river basin management approach, which encourages integrated planning, inter-sectoral coordination, and effective pollution reduction. The initiative also focused on maintaining water quality, ensuring environmental sustainability, and preserving adequate river flow.

The authority was responsible for developing and monitoring programs to achieve these objectives while promoting sustainable management of the Ganga basin. The Ministry of Water Resources, River Development and Ganga Rejuvenation served as the nodal ministry for the program.

The NGRBA was chaired by the **Prime Minister of India** and included Union Ministers as well as the Chief Ministers of the Ganga basin states—**Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal**. Through coordinated efforts between the central and state governments, the authority sought to restore and protect the ecological health of the Ganga River.

The National Ganga River Basin Authority (NGRBA) was responsible for preparing a comprehensive River Basin Management Plan for the Ganga River. Its key objectives included preventing pollution, conserving water quality, reducing contamination, and restoring the river's ecological health across the Ganga basin states.

To ensure the long-term sustainability of the river, the authority emphasized maintaining minimum ecological flows, which are essential for preserving aquatic ecosystems and supporting the river's natural functions. The NGRBA implemented and financed various programs focused on:

- Improving sewage collection and treatment infrastructure
- Watershed management and conservation
- Public awareness and community participation
- Protection and management of floodplain areas

These measures were designed to enhance water quality, reduce pollution, and promote sustainable management of the Ganga River basin.

Ganga River Basin Management Plan (GRBMP)

A comprehensive River Basin Management Plan for the Ganga is being prepared by a partnership of seven Indian Institutes of Technology (IITs): Kanpur, Delhi, Madras, Bombay, Kharagpur, Guwahati, and Roorkee. The Ganga River basin management plan aims to improve the environment and restore the health of the river ecology. There are four ways to make a river healthy: "AviralDhara" (Continuous Flow), "Nirmal Dhara," "Ecological Entity," and "Geologic Entity."

The following is the GRBMP's vision:

1. The water should flow smoothly and continuously.
2. The river ought to be connected both longitudinally and laterally.
3. The river should have enough room for all of its purposes.
4. The garbage burden shouldn't be carried by the river.

Other Initiatives

Additionally, IIT Roorkee students are closely collaborating with MoWR, India, and NIH, Roorkee to identify all the tributaries and drains that could deteriorate the Ganga's quality between a reach that covers Uttarkashi and Narora.

Other locations are likewise making such efforts. River cleaning should be an exercise in the same way that government is of and for the people.

V. Summary

A common concern is that the **reduced flow of the Ganga River** has weakened its natural ability to dilute pollutants and cleanse itself. Therefore, effective conservation of the river requires the active involvement of all stakeholders, including government agencies, industries, communities, and citizens. Preventive measures, supported by sound policies and long-term planning, are essential for sustainable river management.

Studies of river sediments have revealed the presence of **heavy metals**, indicating that pollution persists not only in the water but also in the riverbed. Consequently, even if pollutant discharges are completely eliminated, restoring the river to its original high-quality condition would take considerable time due to ongoing interactions between contaminated sediments and flowing water.

Riverbank filtration has emerged as a promising technique for providing safe drinking water to communities that rely on the Ganga. Overall, current initiatives by the Government of India represent positive steps toward river restoration, and with continued cooperation from all stakeholders, the goal of a cleaner and healthier Ganga can be achieved.

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