

Chapter 8

Rejuvenation of Rivers in India: A Case Study on Efforts for Rejuvenation of River Ganga



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Abstract Ganga, our national river, which is considered sacred by the Hindus, is facing the worst level of pollution. Its water which was once used for drinking has deteriorated to such an extent that it has become unfit even for bathing at most of the stretches of river. Its water quality deteriorates as it progresses from upstream to downstream. Anthropogenic activities like disposal of untreated sewage and industrial effluents, bathing, washing clothes, the bathing of animals, construction of dams, religious activities, waste generated due to tourism, disposal of half-burnt dead bodies, etc. are the main reason behind the pollution of River Ganga. Self-cleansing capacity of River Ganga is badly influenced by the pollution caused due to increase in population density, unplanned industrialization, and urbanization.

The government has been continuously working on various ways to improve the quality of River Ganga for more than three decades but didn't get the expected results. A number of initiatives have been undertaken to clean the River Ganga which are the Ganga Action Plan, Namami Gange Programme, etc. Namami Gange aims at Ganga rejuvenation by focusing on all the present efforts and preparing an effective action plan for the future. Academic institutes like the Indian Institute of Technology and non-governmental organizations like the India Water Portal, Centre for Science and Environment, Energy and Resources Institute (TERI), Tarun Bharat Sangh, Save Ganga Movement, and Ganga Mahasabha are also involved in efforts for rejuvenation of River Ganga. All the initiatives taken by the government can only be successful with active community involvement in mission mode for rejuvenating Ganga.

Keywords Pollution · Anthropogenic activities · Water quality · Self-cleansing capacity · Namami Gange programme · Ganga action plan

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8.1 Introduction

Our country, endowed with many river systems and its fertile alluvial flood plains, formed the basis for the origin of the Indus Valley civilization at a riverbank. Most of our daily requirements of water get fulfilled by surface water. These rivers have served us for generations as our economy, culture, and festivals have been centered on our rivers. Their overexploitation and pollution have led to their deterioration. Their deterioration has caused devastating impacts on wildlife, flora, and fauna as well as on our economy. Generation of massive wastewater from households, industries, and agricultural farms (Kumar et al. 2020) as well as surface runoff from surrounding catchment areas deposits organic and inorganic matter in the river. These deposits lead to further deterioration of water quality which causes the extinction of river biota (Kumar et al. 2020) and causes health impacts on humans. River rejuvenation is defined to be an effort that can restore the poor health of rivers that are polluted and overexploited (Shekhar 2016). Many rivers in India are perennial and peninsular. We are mainly dependent on rivers for irrigation and drinking purpose.

In India, the River Ganga is considered the most sacred and important river as our cultural ethos has been centered on it (Chaudhary and Walker 2019). It was declared to be the national river in 2008 by the Indian government (Ganga River Basin Environment Management Interim Report 2013). Forty-four percent of the Indian population living in approximately 30 cities, 70 towns, and several thousands of villages beside the river (Nandi et al. 2016; Kumar et al. 2020) depends on the River Ganga (Chaudhary et al. 2017; Chaudhary and Walker 2019). It covers a large catchment area (Xun et al. 2017) and crosses five states, viz., Uttarakhand, Uttar Pradesh (UP), Bihar, Jharkhand, and West Bengal (Chaudhary and Walker 2019). It is regarded as a living Goddess and worshipped as Ganga Maa by Hindus (Xun et al. 2017). The banks of River Ganga are used for cremation by Hindus as they believe that Ganga Maa provides “moksha” to the soul of dead bodies burnt on its bank (Naskar 2014; Chaudhary and Walker 2019). The river water is renowned for its use as antimicrobial and medicinal properties (Nautiyal 2009; Chaudhary and Walker 2019) due to bacteria like *Escherichia*, *Pseudomonas*, and *Enterobacter* and bacteriophages in the river water (Dwivedi et al. 2020; Kumar et al. 2020) which provides self-cleaning property to River Ganga (Kumar et al. 2020).

The Ganga covers approximately 8,61,404 km² (Chaudhary and Walker 2019; Das et al. 2020), which constitutes 26% of the geographic area of India (IAAD 2017). It has the largest river basin in India (Goyal and Ojha 2010; Goyal and Ojha 2012; Kumar et al. 2020), the 15th largest in Asia, and 29th in the world (Chaudhary and Walker 2019). Various major historic and sacred cities like Haridwar, Kanpur, Allahabad, Varanasi, and Kolkata are located along the bank of River Ganga (Joshi et al. 2009; Chaudhary and Walker 2019; Kumar et al. 2020).

8.1.1 Need of Rejuvenation

Rivers are dynamic and have an ecosystem that results from the interaction between biotic and abiotic constituents (Shekhar 2016; Shekhar and Prasad 2009). Hydrological variables like changes in environmental flow determine the ecological function of rivers (Shekhar 2016). This environmental flow when impeded by anthropogenic or natural factors can impact directly on river health. The natural flow gets disturbed during the construction of dams, and diverted water is used for various purposes like domestic, industrial, or agricultural use (Poonia et al. 2021; Goyal et al. 2018; Shekhar 2016). Activities like sand mining, deforestation in the catchment area, and construction activities around the river have also adversely impacted the river health (Shekhar 2016). Agricultural farming, overgrazing by animals, and arbitrary deforestation result in increased surface runoff leading to soil erosion (Sinha et al. 2013). The increased surface runoff leads to siltation of rivers which causes a reduction in flow and converts these perennial rivers into seasonal (Sinha et al. 2013). The situation has worsened due to the pollution of rivers.

8.1.2 Factors Responsible for Deterioration of River Ganga

Various problems that influence the water quality of rivers are indiscriminate urbanization, industrialization, excessive use of chemicals in agriculture, deforestation, excessive use of water for agricultural and industrial use (IAAD 2017; Kumar et al. 2020), inadequate and mostly inefficient sewage treatment plants (Xun et al. 2017; Reymond et al. 2020), insufficient funding for development of water quality infrastructure, and inefficient administrative execution (IAAD 2017; Kumar et al. 2020). Approximately one billion liters of untreated wastewater discharged every day into the River Ganga from numerous drainage discharges deteriorates its water quality (Chaudhary and Walker 2019). This deteriorated water quality causes a reduction in the flow of rivers and over-dependence on groundwater and thus disturbs the hydrological cycle (Khan et al. 2017; Kumar et al. 2020). It also causes floods in the river basin (Chaudhary and Walker 2019). The River Ganga is considered to be the most polluted river in the world despite being a lifeline for almost 50 million people (Chaudhary and Walker 2019). Sources of pollution in Ganga include both inorganic and organic pollutants consisting of urban sewage, industrial wastes, runoff from farmlands, and religious wastes (Chaudhary and Walker 2019). Among all the sources of pollution, urban sewage and industrial wastes are the most significant cause of degradation of the water quality of River Ganga (Dwivedi et al. 2018; Chaudhary and Walker 2019). Approximately three-fourths of pollution in the river is caused by the dumping of unprocessed municipal waste from expanding urban residential areas in the river basin (Das 2011; Chaudhary and Walker 2019). The high load of municipal waste in River Ganga is

due to the location of 29 large cities which has populations greater than one million. Almost 8250 million liter per day (MLD) of municipal wastewater comes from cities in the Ganga basin; however, treatment plants have the capacity to treat 3500 MLD, and around 2550 MLD of the untreated waste is dumped into the Ganga (Chaudhary and Walker 2019).

8.1.3 Status of Pollution in River Ganga

As indicated in Fig. 8.1, the most polluted stretch of River Ganga is the middle stretch as most of the industrial cities like Kanpur and historic cities like Allahabad and Varanasi, which attract tourists for pilgrimage, are situated in this region. Also, the flow of the river reduces drastically here as the river reaches the plain surface. This sudden reduction in flow and inputs of industrial and municipal waste from densely populated cities located in this stretch, solid wastes in the form of plastics, wastes dumped by tourists, burning of dead bodies, atmospheric depositions through rainfall (Pandey et al. 2014; Yadav and Pandey 2017), etc. also make the River Ganga the most polluted in this part. Recently there have been lot of development activities for expanding Varanasi without following proper technical standards while construction of roads. There is requirement of more sewage treatment plants to treat

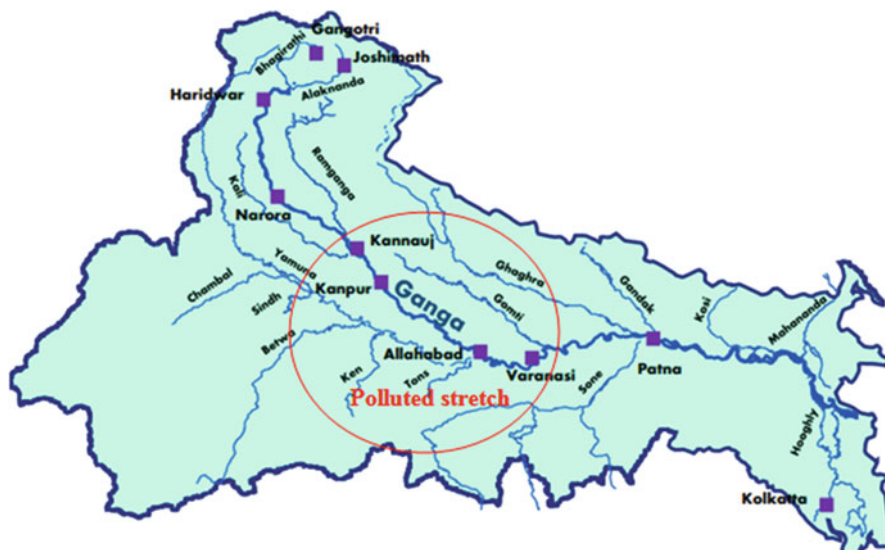


Fig. 8.1 River Ganga, its major tributaries, and its most polluted stretch

waste water, better garbage collection system, and drainage system (Pandey and Singh 2017).

8.1.4 Problems Due to Deterioration of Water

Various parameters indicating water quality, viz., pH, electrical conductivity, biological oxygen demand, chemical oxygen demand, and dissolved oxygen, show deterioration when untreated wastewater gets discharged in the river (Chaudhary and Walker 2019). The Central Pollution Control Board (CPCB) found that microbial counts were more than acceptable limits in drinking (50 MPN/100 mL) and bathing water (500 MPN/100 mL) (CPCB (Central Pollution Control Board) 2009; Chaudhary and Walker 2019). These have made water quality deteriorate to such an extent that it is unsuitable for drinking purposes, and at most of the stretches, it is even not worthy for bathing. The aesthetic appearance of the rivers degrades that discourages tourism.

8.2 Methodology for River Rejuvenation

The methodology adopted for river rejuvenation has the following steps (Das 2018):

1. The first step involves identification of the natural course of a river and understanding the factors which affect the flow like geology, geomorphology, geohydrology, pedology, and structure of the terrain.
2. Identification of factors responsible for river deterioration.
3. Preparation of proposal of rejuvenation of the river.
4. Preparation of action plan by using modern technologies like GIS, GPS, remote sensing, and mobile applications.
5. Implementation of the action plan and bringing community awareness among the local and government officials in a proper schedule.
6. For proper monitoring, young leaders from each village and relevant government officials get trained.
7. Assessment of impact by gathering the dynamic parameters like geohydrological, land use, and agricultural data periodically through mobile applications for better and sustainable management of water reserves.

The most popular river rejuvenation methodology used is Managed Aquifer Recharge (MAR) (Das 2018). There is potential to utilize the surplus water in rivers during the monsoon by artificially recharging so that base flows in the rivers can be sustained and reestablish environmental flows in rivers (Das 2018).

8.3 Rejuvenation Strategies for River Ganga

Excessive consumption of water in various productive activities leads to competitive demand reduced flow of rivers (CPCB 2017; Kumar et al. 2020). Various leaders in Indian governments in the last three decades took the initiative to clean the River Ganga (Xun et al. 2017). Then the Prime Minister, Mr. Rajiv Gandhi, introduced the Ganga Action Plan I (GAP-I) in 1985 for 5 years (budget of US\$33 million) with help from various voluntary native and global organizations (Hamner et al. 2006; Kumar et al. 2020) to resolve water pollution of River Ganga. The GAP-I had the objective of expansion of sewage treatment plants (STPs) in urban as well as remote places and the creation of many electric crematoriums (Birol and Das 2010; Kumar et al. 2020). GAP-I helped in the decline of direct release of sewage waste in Ganga, although the water quality of the river was still unsuitable for bathing (Tare et al. 2003; Kumar et al. 2020). The government continued it till 2000 as the problems were not resolved. GAP Phase II started in the year 1993 to include tributaries of River Ganga and 25 towns that have population greater than 100,000 exempted under GAP Phase I (Xun et al. 2017; Kumar et al. 2020). GAP-II couldn't achieve the objectives mainly because of improper administrative preparation and less participation of the community (Kumar et al. 2020). Both GAP-I and GAP-II created better sewage treatment facility, but it did not result in visible improvement in water quality (Xun et al. 2017).

Prime Minister Narendra Modi merged the National Ganga River Basin Authority (NGRBA) into the Ministry of Water Resources (MoWR) and formed the Ministry of Water Resources, River Development and Ganga Rejuvenation, creating a platform named “Namami Gange” (National Mission for Clean Ganga) in 2014 to work in mission mode to rejuvenate Ganga (Xun et al. 2017; Vyas and Nath 2021). In 2015, the Union Cabinet permitted a budget of approximately US\$3 billion for the first 5 years (Xun et al. 2017). The objective of Namami Gange was to integrate earlier and present efforts for the rejuvenation of Ganga and its tributaries (Kumar et al. 2020; Vyas and Nath 2021).

8.4 Efforts Made by NGOs and Community

Tarun Bharat Sangh (TBS) is an NGO that has gained popularity by constructing more than 10,000 rainwater harvesting structures (RWHS) on 7 rivers—Arvari, Sabi, Ruparel, Jahajwali, Sarsa, Bhagani, and Maheshwara rivers – in different geographical regions of Rajasthan, including Alwar, Jaipur, Jodhpur, Jaisalmer, Karauli, Pali, Sawai Madhopur, and Tonk districts (Sinha et al. 2013). These efforts have successfully resolved the water crisis for 8600 sq. km covering several thousands of villages. Since 2007, it has started working enthusiastically on *Nirmal Aviral Ganga*. TBS in tandem with communities made them self-reliant in water resource management by encouraging local people participation (Sinha et al. 2013).

Their initiatives like organizing several camps at different places generated awareness about the significance of the River Ganga and encouraged youth to actively volunteer in Ganga rejuvenation. This has gained momentum, and several people at different locations are working to restore the health of the Ganga River. TBS under the guidance of Dr. G. D. Agrawal launched a national movement for maintaining an unaltered flow of the river Bhagirathi in Uttarakhand (Sinha et al. 2013). This movement resulted in making River Ganga a national river by the Government of India, and NGBRA was formed in February 2009 as co-coordinating authority for the Ganga (Sinha et al. 2013).

Various programs like Ganga Utsav, Ganga Amantran, Great Ganga Run, Ganga Quest, and Cleanliness Drive are being organized by the government in which community participation and youth involvement are encouraged. Ganga Utsav was organized on 4 November 2019 to celebrate the declaration of Ganga as a national river. Multiple activities engaging students and youth like river cinemas, quizzes, storytelling, games on ecological learnings, group discussions, etc. were conducted to create awareness among students and youth. Social outreach programs through adventure sports like Ganga Amantran connected with lakhs of people in 34-day long river rafting expedition covering over 2500 km of River Ganga from Devprayag to Gangasagar. Marathon (Great Ganga Run) to create awareness about the River Ganga was organized in New Delhi on 15 September 2019. Almost 20,000 people participated in the marathon. Cleanliness Drive is organized regularly in association with the local organization, NGOs, and community volunteers at several places along Ganga. For the rejuvenation of River Ganga, people from local communities like Ganga Praharis and task force like Ganga Mitra work together to achieve the objective of restoring the “Nirmal and Aviral Dhara.”

8.5 Significance of River Rejuvenation and Its Positive Impacts

There have been several socioeconomic, cultural, and environmental impacts of rejuvenating rivers in India. The augmentation of water in rivers led to increased water levels and renewal of flow in rivers (Sinha et al. 2013). These were deliberate changes associated with water availability. There were also unintended changes in quality of life as socioeconomic factors are associated with water abundance in the region (Sinha et al. 2013). It also resolved several environmental issues and created aesthetic green spaces with the return of flora and fauna when rivers became cleaner and abundant with water. It caused an increase in the biodiversity of land in the aquatic and terrestrial environment.

The revival of several rivers has solved the water crisis problem in several villages in Rajasthan, directly enriching the lives socially, culturally, and economically. It has saved several hours spent in search of water and to fetch it daily from

far-off places. It has also increased the food security and well-being of people as the villagers had easy access to clean water nearby their villages.

Various indirect positive impacts of river rejuvenation on the social, economic, and environmental aspects have been identified, for example, there is drastic reduction in hard work for collection of drinking water by women and children. This resulted in increase in quality time for family, reduction in distress migration caused due to water crisis, and increase in the percentage of turnout in schools (Sinha et al. 2013). Significant societal changes were observed like changes in approach toward girl education and societal issues like dowry with better education (Sinha et al. 2013).

8.6 Conclusion and Recommendations

Overexploitation and anthropogenic activities have resulted in the deterioration of the water quality of rivers. There have been several attempts by the government and NGOs to rejuvenate River Ganga for the last few decades. Ganga rejuvenated itself during lockdown when industrial waste (Kumar et al. 2020; Dutta et al. 2020) and agricultural runoff were not discharged (Dutta et al. 2020). It indicates that industrial pollution needs to be controlled as industrial waste is the major source of pollution in River Ganga. The tendency of humans to disturb the natural ecosystem is dangerous and it needs to be curbed. All the initiatives can only be successful if community participation makes it a mass movement and citizens are involved in mission mode. Even after achieving the target, we should work together involving children to spread awareness so that they become torchbearers and ensure that River Ganga does not get recontaminated. It is only possible with collective effort and cultural shifts in our behavior.

To minimize the waste effluent which is discharged in rivers, we should strictly follow zero liquid discharge. We must treat and reuse the wastewater until it gets fully utilized. For achieving this goal, the following measures are recommended:

1. Chemicals from laboratories should not be discharged directly into the drain, and proper guidelines must be followed for its disposal.
2. Industries should strictly recycle and reuse their wastes until it gets consumed completely.
3. Effluent from sewage treatment plants should undergo tertiary treatment before discharging into water bodies.
4. Organic farming should be encouraged, and pesticides and insecticides should be avoided so that chemicals do not enter water bodies through runoff.
5. Desiltation of rivers should be done periodically at places where siltation is common.
6. The practice of burning dead bodies near the banks of the River Ganga should be completely banned.

7. Open defecation is a common practice on the river banks which should be restricted through community awareness.
8. Disposal of solid wastes should be restricted in River Ganga.

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