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Zoology

A REVIEW ON POLLUTION STATUS OF RIVER BHAGIRATHI-HOOGHLY IN THE STRETCH OF WEST BENGAL, INDIA

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ABSTRACT Ganges (river Ganga) is one of the important river systems in the world and the largest river basin of India covering an area about 1,086,000 km2. About one third urban population of the country (37%) live in different towns besides the river. In its entire stretch, river Ganga flows through several states of India namely Uttarakhand, Uttarprdesh, Bihar, Jharkhand and West Bengal. In its lower stretch the Ganga flows through the state West Bengal by the name "Bhagirathi-Hooghly" and finally meets the Bay of Bengal. Recently this river system is facing the adverse effects of rapid urbanisation and industrialization especially due to the massive discharge of domestic and industrial effluents directly into the river in addition to various agrochemicals through surface water runoff.Although a number of research works and Government projects have been initiated to assess the pollution load and to improve the water quality of the river but the success rate is quite low. River Ganga is still considered as the sixth most-polluted river in the world. The present work is an attempt to gather all data related to the limnological characteristics of the river and to point out the major sources of pollution (point and non-point sources) in Bhagirathi-Hooghly river stretch of West Bengal.

KEYWORDS : Water quality, Pollution, River Bhagirathi-Hooghly, West Bengal.

INTRODUCTION

Our planet is also known as "Blue planet" as the water covers almost 70% of earth's surface. But about 97% of total surface water of the world is stored in different oceans and seas. About 2.4% of water is stored as glacier or ice (more than 85% of earth's fresh water is placed in Antarctic ice sheet followed by Arctic), 1.6% is stored underground (as aquifers) and only 0.6% is stored as surface water (e.g., different river systems, lakes, dams and ponds). Furthermore only 0.001% water is found in clouds, vapour and rainfall (Kurunthachalam, 2013). So from the above mentioned information it is observed that only a small percentage of water is available in ponds, lakes, reservoirs and rivers for the mankind. So we need special attention to conserve this valuable resource.

The Himalaya, the mountain range, situated at the north of Indian subcontinent is often called "The water tower of India" as it is the main source of most large rivers. These rivers have perennial flow all over the year as these are snow-fed. These are the Indus, the Ganga and the Brahmaputra. These rivers draining water from the eastern Himalaya and considered as "Freshwater biodiversity hotspot" as they play a crucial role to support essential lifeline of the people on the floodplain and the downstream nation. The Ganga is considered as most sacred or holy river in India and it covers almost one-fourth (26.3%) of total geographical area of this country and is the biggest river basin in of the country (CPCB, 2013). The word "Ganga" is synonymous to pure and holy water in India and people considered the river as "Maa Ganga" (mother Ganga) (Agarwal, 2015).

The entire stretch of river Ganga is divided into 3 portions – upper, middle and lower. The upper stretch ranges from its origin- Gamukh to Haridwar (294 km); the middle stretch ranges from Haridwar to Varanasi (1082 km) and the lower stretch starts from Varanasi and ended in Bay of Bengal in West Bengal (1134 km) (GAP annual report, 2015 (*www.gangaaction.org*).The main objectives of this paper are to review the past and present limnological characteristics of river water and also to review the major sources of pollution (point and non-point sources) of river Ganga (Bhagirathi-Hooghly) in the stretch of West Bengal *i.e.,* in lower stretch of river Ganga.

The Ganga River:

1A 1B

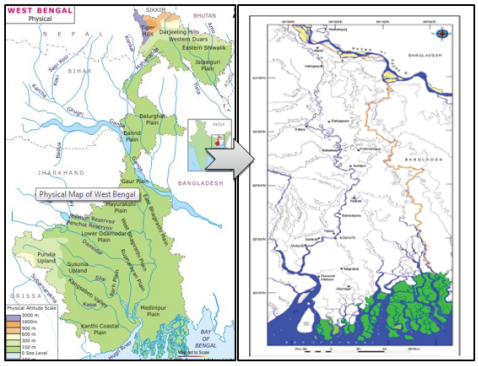
Map No.: (1A) Maps showing position of river Ganga in India and **(1B)** Different stretches of River Ganga. [*Source: www.mapsofindia.com&www.gangaaction.org*]

The Ganga basin is the largest river basin in India covering an area about 1,086,000 km^2falls in four countries which are India, Bangladesh, Nepal and China and (Agarwal, 2015). In India it covers the entire states of Uttar Pradesh, Uttarakhand, Delhi, some portions of Hariana and Punjab, Himachal Pradesh, Madhya paradesh, Rajasthan, Bihar and West Bengal (CPCB, 2013).The total catchment area of Ganga river basin extends between 22º30´ to 31º 30´ north latitudes and 73º 30´ to 89º 00´ east longitudes.Gamukh ice-cave of Gangotri glacier (approximately 4100 meters above the sea level) is supposed to be the origin of river Ganga. The main stream originates from Gamukh by the name of Bhagirathi and its flows about 205 km from its source through the state of Uttarakhand. In its stretches many other small streams join with the main stream, namely, Alakananda, Mandakini, dhuli Ganga, Pindar and Bhilangana. At Devprayag the Alakananda meets with Bhagirathi and the joint flow is named as river Ganga and then its flows further downward to meet Bay of Bengal in the state of West Bengal.The total length of the river is approximately 2525 km (CPCB, 2013; NMCG, Govt of India; Agarwal, 2015). A large number of tributaries join with the main course of river Ganga during its 2525 km journey. Among them the principle tributaries are Yamuna, Gandak, Mahananda, Tons, Ramganga, Kosi, Punpun, Ghaghra, Kiul, Sone, Burhi-Gandak etc (Trivedi, 2010). Betwa and Chambal are the two sub-tributaries of river Yamuna (Jain et. al., 2007).In its entire stretch river Ganga flows through several states of India namely Uttarakhand, Uttarprdesh, Bihar,Jharkhand and West Bengal. In the state West Bengal, the mighty dam "Farakka" regulates the water flow of the river Ganga between two countries – India and Bangladesh. From Farakka barrage the river Ganga splits into 2 streams – river Bhagirathi (Hooghly) on the right and river Padma on the left. In West Bengal river Bhagirathi (Hooghly) flows 520 km downstream and finally meets Bay of Bengal. On the other hand river Padma enters into Bangladesh, after that it joins with river Brahmaputra and Meghna and then finally meets with Bay of Bengal.

The Bhagirathi-Hooghly river:

The river basin of Ganga is one of the most densely populated and overcrowded river basins in the world (Agarwal, 2015). About one third urban population of the country (37%) live in different towns besides the Ganga river and 45% of total irrigated regions of India is situated in the Ganga basin (Kurunthachalam, 2013). RiverBhagirathi (Hooghly) is the most significant river in West Bengal (State of Environment Report West Bengal, 2016). River Bhagirathi originates from the Ganga at Mithipur village of Murshidabad district of West Bengal, which is about 40 km to the south-east of Farakka barrage. It then flows further southward for about 500 km downstream and lastly joins the Bay of Bengal at Gangasagar. Geomorphological study

reveals that 280 km downward stretch of river Bhagirathi after Nabadwip town is mostly tidal. The tidal stretch of this river is further named as "river Hooghly"(Rudra, 2016; State of Environment Report West Bengal, 2016).



2A 2B

Map No.: (2A) Map of State West Bengal [*Source: www.mapsofindia.com*]

(2B) The Bhagirathi-Hugli river system [*Source: Rudra 2012*].

Water quality of river Bhagirathi-Hooghly:

Water quality of river means the physical, chemical, biological and aesthetic characteristics of water which determine its quality for use and also its ability to sustain the integrity of aquatic ecosystem thrives therein (State of Environment Report West Bengal, 2016). The West Bengal Pollution Control Board (WBPCB) and Central Pollution Control Board (CPCB), under the National Water Monitoring Programme (NWMP) regularly monitors the water quality of all major river systems throughout the stateto understand the level of pollutionand to assess the fitness of water.

Water quality of Bhagirathi-Hooghly river was extensively studied by WBPCB in 2004 and 2007 on some selected points like Berhampur, Garden Reach and Diamond Harbour (WBPCB, 2009 and Bandyopadhyay *et. al.,* 2014). Chakraborty and Gupta (2003) further studied the water quality of Hooghly river between Palta and Dhankheti khal on the basis of 6 limnological parameters. Central Pollution Control Board (CPCB, 2013) also studied the different water quality parameters of river Bhagirathi-Hooghly and reported satisfactory amount of average DO value at all sampling stations for the period of 2006-2011. They further reported that high average BOD levels at several points like – Howrah-Shivpur, Dakhineswar, Palta, Serampur, Uluberia, Garden reach and Diamond harbour. BOD values of those aforementioned points show an increasing trend. A fluctuating trend is observed for the faecal coliform value at all sampling stations. Finally they conclude that, the river water of Bhagirathi-Hooghly is polluted in respect to different limnological parameters, pollution (both organic and inorganic) and Coliform level through entire stretch of West Bengal. West Bengal Pollution Control Board (WBPCB), 2016 thoroughly checked the different limnological parameters of the river Bhagirathi-Hooghly at several sampling stations. According to their survey report, the DO values at all sampling sites are always above the minimum standards in both pre and post-monsoon months. This indicates that the river water is suitable to sustain the aquatic life. The BOD is found above the level of consideration (*i.e.,* 3.0 mg/l) at Berhampur, Palta and Garden reach during both pre and post-monsoon months; Dakshineswar during pre-monsoon months; Tribeni, Haroa-Shivpur and Diamond harbour during post-monsoon months. The total and faecal coliform level is found quite high in both pre and post-monsoon seasons and it is considered that the river water is unable to use for drinking and recreational purpose. The study further revealed that the micro-pollutant levels (trace metal, pesticides, heavy metals etc.) were quite high in the river water of Bhagirathi-Hooghly. The bathing standard for running water has been standardised by CPCB, India. According to CPCB, the DO level of standard bathing water should be equal or above 5 mg/l, BOD value should not exceed 3 mg/l and the faecal coliform numbers should be less than 500/100 ml of water. But the data provided in the table no. 1 showed that not a single sampling station of the river meets the bathing standard as the TCC and FCC values are very high in almost all the stations.An extensive study was made by CSIR-NEERI (2014) in the three stretches of river Ganga on the basis of different physico-chemical parameters, Microbiological Parameters and heavy metals. Nath *et.al.,* (2017) also studied nine limnological parameters of Hooghly river at four different sampling stations from September-2015 to March-2016 and recorded low DO levels, high alkalinity and turbidity from all the stations.

Table No. 1: Water quality of the Bhagirathi-Hooghly river at different sampling stations (State of environment report West Bengal, 2016).

Stations	DO (mg/l)		BOD (mg/l)		TCC (MPN/100ml)		FCC (MPN/100ml)	
	Apr. 2015	Oct. 2015	Apr. 2015	Oct. 2015	Apr. 2015	Oct. 2015	Apr. 2015	Oct. 2015
Berhampur	7.2	7.3	5.5	6.2	110000	110000	80000	80000
Nabadwip	7.1	6.5	1.25	3.0	110000	110000	70000	80000
Tribeni	7.1	6.0	1.88	4.3	140000	110000	70000	80000
Palta	6.0	5.7	3.58	4.65	220000	110000	140000	80000
Serampore	6.5	5.6	2.68	1.15	140000	80000	110000	70000
Dakshineswar	6.3	5.1	5.0	2.85	500000	400000	80000	250000
Haroa-Shivpur	5.4	4.9	2.1	5.5	80000	280000	220000	140000
Garden Reach	5.3	5.4	3.1	3.4	170000	240000	110000	130000
Uluberia	5.0	3.7	1.45	2.7	30000	13000	11000	8000
Diamond Harbour	6.6	5.2	1.2	4.2	22000	70000	11000	30000
Patikhali	7.1	6.0	1.4	2.45	5000	30000	2300	13000

Pollution scenario of river Bhagirathi-Hooghly:

On the basis of nature of source, pollution source can be categorized into point sources and non-point sources. Point sources refer to the single or identifiable sources of pollution where as non-point sources refer to the diffused sources of pollution that do not come from single discrete source (Mali *et. al.,* 2015).In India, almost 70% of available surface water is polluted by various means, out of which 84-92% is due to municipal and domestic sewage disposal and rest 8-16% is due to industrial effluents (Leland, 1991 and Mali *et. al.,* 2015). Water pollution in our country as well as in the state West Bengal can be categorised in several ways –

1. Water borne diseases through bacterial pollution is wide spread in the state which in turn various illness even death of many people round the year (Neely, 2011).
2. Industrial pollution has an extensive fatal impact on people, wildlife and environment. Massive amount of industrial effluents discharged every year into the fresh water bodies. Near about 31000 million m^3 of effluents discharged every year in to the fresh waters of India (Report of MOEF, 2010).
3. More than 50% of untreated sewage of urban municipal areas and 90% untreated sewage of rural municipal areas discharged into different freshwater ecosystems (Status of Sewage Treatment in India, 2005).
4. Fecal pollution in our country is a vast problem especially in rural areas. About 200000 tones fecal load is generated every day (Sharma, 1997).
5. Pollution from different chemical fertilizers, pesticides and insecticides is an up-growing problem of our country. Extensive use of these chemicals brings the degradation of surface water quality by causing nitrate contamination (Gupta, 2012).

Pollution due to industrial effluents:

Literature survey reveals two main sources of river pollution in West Bengal. These are – industrial waste water and urban or municipal waste water. And the major industries are as follows –

1. Chemical industries (includes fertilizer, petro-chemical , pesticides and pharmaceuticals)
2. Dairy, Food & Beverage industries
3. Distillery
4. Paper and pulp industries
5. Sugar mills
6. Textile, Bleaching & Dyeing industries
7. Tannery

8. Other industries (Cement, Ordinance, Electronics & Electrical, Electroplating, Paint, Slaughter house, Metallurgical, Packaging & printing, Thermal, automobile etc.)

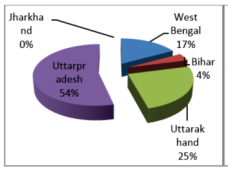


Fig. No. 1: State-wise wastewater generation (on % basis). [*Source: CPCB, 2013*]

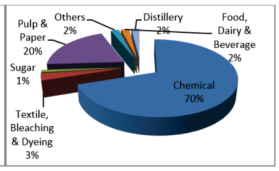


Fig. No. 2: Sector-wise wastewater generation (on % basis) in West Bengal.[*Source: CPCB, 2013*]

CPCB (2013) has identified 22 Grossly Polluting Industries (GPI) through the entire stretch of Bhagirathi-Hooghly river in West Bengal which emits a total of 87 MLD (Millions of litres per day) waste water into the river bed. CPCB (2013) and Agarwal (2015) defined the Grossly Polluting Industries (GPI) as – (a) The industries which discharges their effluents directly into the lake and river water. (b) The industries either involved in use and production of different hazardous chemical substances or emit chemical effluents with BOD load of minimum 100 kg per day or both. In West Bengalthistype of industries are located beside the two banks of the river Bhagirathi-Hooghly.According to Rudra (2016), the river water of Bhagirathi-Hooghlyis used as convenient drainage for untreated waste water mostly in urban and industrial areas.

After the report of CPCB (2013) it is found that, in West Bengal chemical industries discharge almost 70% of total wastewater followed by Pulp & paper mills which is 20% (Fig No.2). According to the report of Rai (2013), numerous industries are located on the two banks of river Ganga from Uttarakhand to West Bengal. These are mainly textile mills, chemical and fertilizer plants, paper mills, petro-chemicals and hospital wastes. These industries drain their untreated solid and liquid wastes to the river water directly and 20% responsible for Ganga river-water pollution.

Dutta *et al.,* (2005) thoroughly assessed the hazardous impact of lead (mainly generated from various chemical and metal plants, battery industries, and paint manufacturing industries) on water quality of river Ganga in West Bengal.Sarkar *et al.,* (2007) also investigated the levels of different heavy metals (Fe, Mn, Zn, Cu, Hg and Pd) at three ecologically distinct zones along the lower stretches of river Hooghly in West Bengal and reported high levels of Pb and Hg in the discharges of pulp and paper manufacturing industries and automobile factories. They further pointed out that the degradation of water quality in the lower stretch of the river is mainly due to massive inorganic and organic load of untreated effluents from the twin cities Kolkata and Howrah which are situated on West and East bank of the river. Effect of fly ash on water quality of Bhagirathi River from different thermal power stations in West Bengal was studied by Dhara et. al., (2015).Study and assessment of pollutional impacts of different heavy metal from various industries on the river bank of Bhagirathi-Hooghly is done by various authors (Ghosh *et. al.,* 1983; Bhattacharya *et.al.,* 2008; Kar *et. al.,* 2008; Paul and Sinha, 2013; Paul, 2017).

Pollution due to domestic and municipal sewage:

According to CPCB report on Status of water supply, wastewater generation and treatment in Class-I and Class-II cities of India (2013),Class-I cities of West Bengal solely generates 1311.3 MLD *i.e.,* 50% of total wastewater (2601.3 MLD) generated by Class-I cities of other states on Ganga river basin and in the state West Bengal, Kolkata generates 47% (618.4 MLD) *i.e.,* almost half of total Class-I city-wastewater followed by Haora, which produces 136.2 MLD wastewater *i.e.,* 10% (CPCB,2009 and 2013).On the other hand Ranaghat which is the only class-II city of West Bengal generates 06 MLD of wastewater. So it is found that sewage generation from different class–I cities of Ganga river basin is maximum in West Bengal followed by Uttarpradesh, Bihar and Uttarakhand.

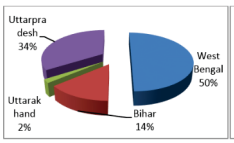


Fig. No. 3: Percentage wise sewage generation from Class-I cities of different states on Ganga river basin[*Source: CPCB, 2013*].

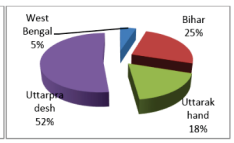


Fig. No. 4: Percentage wise sewage generation from Class-II cities of different states on Ganga river basin[*Source: CPCB, 2013*].

CPCB has identified 54 main canals or drainage from different towns and municipal areas all over the state along the Bhagirathi-Hooghly river stretch out of which 34 canals are located on the left bank of the river and emit 1179 MLD of wastewater to river water directly and 20 canals are situated on right bank and emit 600 MLD of wastewater per day. The canals in the left bank of the river can be classified to 10 different zones and they jointly produce a BOD load of 74624 kg/day.On the other hand the canals of left bank can be classified in 6 zones and they produce a BOD load of22514 kg/day (CPCB, 2013).

WBPCB has further pointed out 20 different canals throughout the Bhagirathi-Hooghly river stretch which emits 1650 million litres of unprocessed waste into the river water per day carrying a BOD load of 89 tons (Rudra, 2016). State of Environment Report West Bengal (2016) has pointed out 12 major East bank canals of Bhagirathi-Hooghly river which discharge 1017.66 MLD wastewater causing a BOD load of 70.23 tons/day and 8 major West bank canals which discharge 472.26 MLD wastewater causing a BOD load of 18.82 tons/day.Rai (2013) also pointed out the amount of sewage waste discharges from different major cities on the bank of river Ganga throughout the India as well as in West Bengal.

Pollution due to agricultural wastes:

The data regarding to various non-point sources especially of different chemical wastes from agricultural areas are very much scanty (Rudra, 2016).River water of Ganga is extensively used in the process of agriculture, fisheries, animal husbandry, forests, etc. (Helmer *et. al.,* 1997).Agricultural runoff contains a number of toxic chemicals and pesticides which can pollute the surface water sources (Chakraborty D. and Gupta T.K., 2003 and Kumar et. al., 2015). Such non-point source like agricultural run-off contains residues of fertilisers and pesticides which may harm aquatic flora and fauna (Helmer *et. al.,* 1997).In India, 6 million tons of fertilizers and about 9000 tons of pesticides are applied to various agricultural fields in Ganga river basin per year (Ghose *et al.,* 2009 and Rai, 2013) and recently the amount is to be 21000 tons (NGRBA, 2011). Among the pesticides, insecticides are used widely in our country than herbicides and fungicides. Organochlorine insecticides were dominant till 1990s, after that the usage of organophosphates increased (Samanta, 2013).

The adverse effects of different agricultural pesticides, fertilisers and heavy metal to the Ganga river water and biodiversity were extensively studied by various authors and organisations (Singh *et. al.,* 1987; Beg *et. al.,* 1989; ISGE, 1990; Ray, 1992; Agnihotri *et.al.,* 1994 and 1996; Nayak *et. al.,* 1995; Rehana *et. al.,* 1996; Sinha *et. al.,* 2001 and Sigh *et.al.,* 2012). In West Bengal, the adverse effects of some hazardous pesticides like DDT, DDE and Endosulphan to aquatic organisms in lower Ganga stretch (river Hooghly) is thoroughly studied by Joshi (1986) and Halder *et.al.,* (1989). Further Kole*et.al.,* (2005), Aktar *et.al.,* (2009), Ghose *et. al.,* (2009) and Samanta (2006 and 2013) have studied the Ganga river water pollution in the stretch of West Bengal due to agricultural runoff and they also studied the effects of different pesticides on aquatic organisms especially on fishes.Effects and bioaccumulation patterns of different heavy metals, on aquatic flora and fauna of Hooghly estuary is studied by Bhattacharya *et. al.,* (1994), Mitra *et.al.,* (1996) and Samanta (2013). Moreover Environmental impact assessment of lower Ganga system is conducted by Ghosh*et.al.,* (2000).

According to Rudra (2016), massive deforestation in the catchment areas of the rivers for extension of agricultural lands and human settlements causes decay of the rivers due to increasing sediment load. Further intensive agricultural practices along the banks of the river, river islands and sand mining in the lower stretches of the river Ganga has altered the physico-chemical properties of water and sediments and it also altered the habitat distribution of several species. It also changes the species assemblages throughout the river stretches (WII-GACMC, 2017).

Pollution due to religious factors:

The Ganga river basin is one of the densely populated areas of the world. It holds more than 300 million people including India, Bangladesh and Nepal (Gopal, 2000) and its average density is almost 520 persons per square kilometre (Das and Tamminga, 2012). In India, the Ganga isconsidered as the most sacred river from ancient time (Agarwal, 2015).Ganga river basin is full of culture, heritage and religious values (Welcomme, 1985). Festivals play an important role to the life of every Indian. During the festive times people come to river

Ganga for bathing purpose. They also dump their "Asthiya" (The remnant of the dead bodies in the form of ashes) to the river water from their religious views and they also throw some materials like flowers, leaves, food particles and remnants of puja materials to the river water (Rai, 2013).

During mass bathing period at Gangasagar, West Bengal the water of river Bhagirathi-Hooghly becomes polluted and the water quality degraded. Sharma*et.al.,*(2014) and Sinha *et.al. ,* (2018) have extensively studied different limnological and biological parameters of water samples of river Bhagirathi-Hooghly and recorded low DO, high BOD, COD, turbidity and bacterial load during mass-bathing seasonat Gangasagar than the non-bathing seasons.

Idol immersion after festivals is one of the common rituals in West Bengal as well as in India. It has been estimated that nearly 1600 idols are immersed in the Bhagirathi-Hooghly river from Kolkata (Babughat) alone (Basu, 2015). Recently Lead (Pb), a heavy metal, is used as a component of chemical paints which is used to paint the idols. This heavy metal is a potential water polluting agent creating major problems of bio-accumulation and bio-magnification along the food chain (Goswami and Mazumdar, 2016).After immersion of idols, the colours and the chemicals get dissolved into the river water leading to deterioration of physico-chemical properties of water(Goswami *et.al.,* 2012). Further it is observed thatduring and after the immersion process turbidity of the river water gets higher (Nayana and Malode, 2011). So it is obvious from the aforementioned studies that the limnological properties of river water are highly deteriorated during the immersion process of idols after festivals. At that timethe Pb concentration in river water is significantly increased manifolds compared to the acceptable limits of BIS, WHO, ICMR and ISO 10500:1991 standards (ICMR, 1975).

CONCLUSION

River Ganga has declared as the "National River of India" on November 4th 2018 (Sanghi & Kaushal, 2014). But now river Ganga has been enlisted in world's top ten most endangered river list (Wong *et. al.,* 2007) and is considered as the sixth most-polluted river in the world (Flynn, 2016) due to inclusion of enormous amount of pollution load from various sources. We have seen that surface water pollution in India becomes serious cause of concern in recent times. Surface water source such as river is deteriorating rapidly due to increase rate of pollution from different industrial, domestic and agricultural sources. According to Agarwal (2015), the level of chemical contaminants like pesticides, insecticides and industrial effluents is very high and above the considerable limit at several points along the stretch of river Ganga. Ganga Action Plan (GAP) has been initiated by Government of India in 2 phases - Phase-I from 1985 and phase-II from 1991, but have little success (Das & Tamminga, 2012). GAP Phase-II was later merged with National River Conservation Plan (NRCP) in late 1996 (MoEF, 2003 and Basu Roy, 2017). Later National Ganga River Basin Authority (NGRBA) was formed to reduce the pollution level and conservation of river Ganga. Recently "Namami Gange" (meaning obeisance to the river Ganga) project was launched in the budget programme on July, 2014 by Government of India. Although several studies, research-works, pilot-projects have been carried out on aforesaid purpose, but success in reducing the pollution level from river Ganga yet has not been achieved.

So we need some proper planning and advancements to reduce the pollution load and to conserve the water quality and unique diversity of the sacred river Ganga. We need to build partnerships with local people who possess a symbiotic relation with river Ganga and establish a bridge between science and sacred.

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