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Ganges, Pollution and Culture: An Assessment of Pollution on Ganga River in Banaras City, Uttar Pradesh

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Abstract

Water is regarded as one of the most essential liquids due to its multipurpose usages like cooking, bathing, performing rituals and most importantly for drinking not only by humans but also by all the living beings on Earth. The flowing water in general and Ganges water in particular pronounced as a benefactor of purity and miracles. Ganges is one of the longest and holiest rivers across the world, but unfortunately, it is dying due to several anthropogenic activities such as dumping of garbage, ashes, corpses, idols, plastic items, garlands, human faecal and industrial effluents. The main objective of the research is to identify and analyse people's perceptions about Ganges and what kind of existential threats are being faced by the river through multiple anthropogenic activities. For the purpose of data collection, both primary and secondary database have been used in the present research, which is based on descriptive and analytical approach. Based on the various research findings, papers, reports and journals, a household survey was conducted on the selected clusters and Ghats of Banaras district of Uttar Pradesh in December 2018. After the analysis, it was concluded that Ganga is not just a river, but it is a culture from birth to death all the human activities are performed along the river banks and ghats within Banaras city. It has social, political, economic and cultural significance from the time immemorial. The river acts as the lifeline for Banaras/Varanasi. However, Ganga is well-regarded in the city, but it also carries away untreated waste materials of around 50 million people who are living in its catchment area. These waste materials are one of the major reasons for dying mother Ganga.

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Introduction

According to ancient mythology, water is pronounced as the foundation of the entire world which is the basis of all life forms and the medicine of immortality (Desai, 1988). Atharvaveda stated that may the waters carry our happiness whereby appears multiple such descriptions about the sanctity, quality, symbolism and use of water (Singh, 1994). In medicinal terms, water is considered as a healer (Murti et al., 1991). Metaphysically and metaphorically, the Indian mythologies described water as the holder of life, eternity and strength; most commonly, water is professed as a purifying medium (Eliade, 1958). To sustain the living on this planet, "we bow our heads before you, Oh holy Ganga" (Department of Tourism, 2017)! The Ganga River is regarded as the mother Ganga or Ganga Maiya which brings life in the form of holy water (Tripathi et al., 1984). The water of this river is considered as a sacred liquid, an important item for every

Hindu rituals and rites (Alley, 1994). The river has nurtured and supported the rise and fall of several Indian civilizations (Pravin and Singh, 2000). People reckon that she came down from the paradise to purify the Earth and taking dips in her water can wash away a human's all sins, but she didn't take care of human's waste i.e. pollution (Rowlatt, 2016). Water pollution in the river has amplified manifold due to several anthropogenic activities as Banaras's ghats have become the waste disposal hub for domestic sewage, industrial effluents and religious ceremonies (National Mission for Clean Ganga, 2018). According to the Hindu rituals, the ghats are regarded as the human cremation ground (Raha et al., 2003).

In the recent years, the untreated water of the artificial dyes is also draining into the river (Basak et al., 2015). The traces of heavy metals like mercury and lead can also be seen in the Banaras' Ganga water (Singh et al., 2006). These heavy metals



may cause serious diseases like cancer and tumor to the people whose life is dependent on the river (Schwartz, 1994). The accumulation of heavy metals in the river can increase the people's intake twice through the drinking water and food chain (Pandey et al., 2010). Tremendous urbanisation along the river catchment areas are also putting a huge pressure on the river water (Central Pollution Control Board, 2013). In order to cope up such problems consecutive central and state governments have come out with several programs like Ganga Action Plan (1986) and Namami Gange program (2016) (Press Trust of India, 2017). The program includes riverfront development, river-surface cleaning, biodiversity maintenance, sewage treatment infrastructure, Ganga gram, industrial effluent monitoring, public awareness and afforestation (National Mission for Clean Ganga, 2019). Despite all these instrumental steps, very little is being performed on the ground level to resolve the deteriorating river water quality in the areas of individual and community responsibilities (Upadhyay, 2009). The research will work into the various factors and way forward in saving and conserving the dying river- mother Ganges.

After the analysis, it was concluded that in giving the present shape to the research there were series of research problems. The major problem in the initial phase was the availability of authentic secondary data. In continuation, conducting the household survey was the biggest obstruction during the course of research work. The survey was conducted on the researcher's own expenditure only that to some extent has limited the field survey under the study. Inadequate financial support, besides limited availability of time to conduct the research was one of the main problems as the researchers are Ph.D. scholars. The main objective of the research is to identify and analyse people's perceptions about Ganges and what kind of existential threats are being faced by the river through multiple anthropogenic activities. The research paper is an attempt to analyse different factors which are responsible for contributing pollution in the Ganges. It also includes several important steps that have been taken to reduce the level of pollution in the river both at the individual and the government level. The study has been conducted as the authors were closely monitored and associated with the growing concern regarding the increased level of pollution in the Ganges. They have deeper knowledge and keenly interested to work in Banaras and its associated problems. In continuation, if any wrong data is collected or forwarded about the study could be easily corrected as they have immense knowledge of it. Apart from these, the more critical analysis of the study area is possible.

Conceptualizing the Sources of Pollution in Ganges

Banaras is known for the production of cotton, silk, nuts, paan and carpets for the long time (Pal, 2015). It is also known for its world class institutions like Banaras Hindu University (BHU) and Indian Institute of Technology (BHU) (Bhatnagar, 2017). Here several religious structures like Shri Kashi Vishwanath temple and Sankat Mochan Hanuman temple, Ashoka pillar, Alamgir mosque, Tomb of Lal Khan, Dhamek stupa and Choukhandi stupa can be seen (Ministry of Environment Forest and Climate Change, 2016) (Fig. 1). All these unique structures attract lakhs of pilgrims and tourists each year (Mcbride, 2014). According to Hindu mythology, cremation or death in the city eliminates the circle of rebirth and death which ultimately results in the liberation of the soul or moksha (Menon, 1988). Hence, the city has generally a large

population of aged, dying and diseased population (Ahmed, 1990). Water sources are always kept at the centre of life-supporting systems, but today different sources of pollution are threatening these sources (Ahmed, 1990). Pollution refers to the addition of harmful substances like solid, liquid and gas to our environment (Varady, 1989). It can be in any form of energy such as sound, heat or radioactivity at a faster pace than it can be diluted, stored, decomposed and recycled in our environment (Patra, 2016). The major types of pollution are water pollution, air pollution and land pollution (Sharma, 2015). Today's society is also worried about specific kinds of pollution like plastic pollution, light pollution and noise pollution (Britannica, 2019).

However, the city's infrastructures carrying capacity are not enough to tackle the rising residential and population explosion (Singh, 2007). As a result, many problems have arrived, particularly in the areas of sanitation, sewage and water supply (Nirupam, 2014). The water quality of the river is deteriorating at a very rapid pace due to throwing of unburned human dead bodies (Singh, 2002). According to an estimate, around 3.2 lakh human dead bodies are cremated every year in the city's ghats like Manikarnika ghat and Harishchandra ghat and up to 3500 tonnes of half-burnt human flesh are dumped into the river (Rowlatt, 2016).

Sewage discharge from 8 major and 70 minor drains are also one of the main water polluters in the city (Singh, 2005). Such conditions occurred as the city's existing stations can't handle 100 million liters of sewage generated every day (Alley, 2014). After seeing such a disastrous condition, the Uttar Pradesh government has come out with the proposal of 2 new Sewage Treatment Plants (STPs) at Goitha and Dinapur in Banaras (Press Trust of India, 2017). The combined carrying capacity of both the plants will be of 260 MLD (million liters daily) (The Economic Times, 2017). Both the plants will be constructed under Jawaharlal Nehru National Urban Renewal Mission (JNNURM) scheme and Japan International Co-operatives Agency (JICA) (Business Standard, 2018). The state government also proposed the contract of another STP with the carrying capacity of 50 MLD at Ramana (Dwivedi, 2017). When all these STPs will work in their full capacity, then the city will not face any sewage treatment problem till 2035 (Press Information Bureau, 2018). When the proposed treatment plants will be completed then, the city's wastewater will also be treated there before it drains into the river which was not happening earlier (Paul, 2017). In this way, the aquatic biodiversity of the river will be conserved in an effective manner (Alley, 2014). The proposed plants will also help in reviving the deteriorating river's water quality which is very important for the city economy like boating and fishing (Singh, 2014).

The Study Area

Ganges has 2 tributaries, one is Varuna and another is Assi in Varanasi (Woodward, 2015). The city derives its name from the combination of the 2 rivers (Varuna + Assi = Varanasi) i.e. Varanasi (Ramanna et al., 1998). It is located between 25° 15' N to 25° 22' N latitude and 82° 57' E to 83° 01' E longitude (Fig. 2, Census of India, 2011). It is spread over the geographical area of 1578 sq. km. with 2 tehsils (Sadar and Pindra) and 8 blocks (Baragaon, Cholapur, Chiraigaon, Kashi and so on) (Gautam, 2012-13). According to the 2011 census, it has a total population of 3.65 million, which consists of 1.92 million males and 1.75 million females (District Census Handbook-Varanasi, 2011). Here only,



the river flows from south to north over 84 world-class ghats (Fig. 3) (City Development Plan for Varanasi, 2006). It is referred as the centre of burning, temple and learning. The city has a collection of more than 4000 temples (Hindu, Buddhist and Jain temple) and around 300 mosques (Gautam, 2012-13). It is also famous as the heart of craft, handloom, art, culture and music (School of Planning and Architecture, 2006). The socio-economic landscape of ghats (landings and steps) surrounded by several temples, pavilions, plazas, streets, ponds, tanks and buildings are responsible for the river's flow (Rai, 2013).

At Banaras, the river total stretch of around 7 km (Doron, 2009). The decay of urban edge due to poor maintenance, illegal encroachment, water consumption pressure of around 3 million visitors annually and pollution in the river putting the heritage river at a greater risk (Water Resources Information System of India, 2018). The silting of banks and a shift in the river has negatively affected the river flow and the ghats economy (Patra, 2016).

Database and Research Methodology

Ganga is renowned as the holiest river not only for Hindus, but also for all human beings who have faith in nature. It is a bitter truth that it has become the most polluted river due to human-induced activities. Purposive Participatory random sampling survey was conducted at different ghats that includes Raj ghat, Dasashwamedh ghat, Manikarnika ghat and Tulsi ghat of Banaras in December 2018. Group discussions were held with the boatman on the ghats who stressed on Ganga and ghats as their source of livelihood. He said that Ganga is the only source of his livelihood as he boards and deboards passengers from one ghat to another as a ferry service in a routine manner. But these days, his livelihood is under threat as tourists are attracted by state operated large cruise. Further focused group discussions were also held with some members of Banaras Divisional Task Force who stated that they are in process of how to connect people in a spiritual manner and make them aware about the harmful effects of open defecation or throwing waste on the ghats or in the river.

Another participant (fisherman) replied that the increasing use of plastics is destroying their livelihood as people are using more and more plastic products like paper cup, glass, water bottle and polybags. After their use, they throw the plastic items on the ghats or in the river which is choking both the river and river life including fishes. Though, the government has banned single-use plastic bags across the district, but it can be easily seen with the local vendors and ration shops where people were seen carrying their products in the plastic products. Further in-depth interviews were held with the Ganga Praharis as they were other important participants who supplemented the relevant information related to the current challenges faced by them to keep the river clean. The Praharis stated that several steps have been taken by the governments (central and state) to keep the river clean like restoration of turtle sanctuary at Sarnath, use of trash skimmer, introduction of bioremediation among others. Further to explore the insight of the study area, in-depth interviews were also held with tourists and locals.

Self-assessment unit area method has been adopted for the sewage treatment plants whereby sewage pumping stations like Saraiyan and Chaukaghat were visited during the field survey. Descriptive and analytical methods have also been used to achieve the desired result. These methods were further synergised with several

techniques like ethnographic, ontological and deontological to obtain the relevant qualitative and quantitative data. Different kinds of choroschematic and chorochromatic maps have been drawn to present the data which are prepared with the help of Arc GIS 10.3 software. Working under the jurisdiction of qualitative research needs a friendly relation with study area and healthy conversation with the locals and understand the locals' perception about the pollution in the Ganges and ghats.

Different secondary sources of data have been used in the research study. It includes the Central Pollution Control Board, National Mission for Clean Ganga, Department of Landscape Architecture, Census of India, Ministry of Environment Forest and Climate Change, City Development Plan, Department of Tourism and District Census Handbook. It also includes Press Information Bureau, Press Trust of India, Ministry of Water Resources, River Development and Ganga Rejuvenation and Water Resources Information System of India. Apart from these source various literary works like articles, research papers, books, magazines, journals, newspapers have been used to achieve the desired result. Several valuable information from the internet like the government websites have been incorporated to draw the critical analysis of the study.

Findings and Discussion

It was found that the stretch of Ganga in Banaras was heavily polluted. The Ganges is an important artery of Banaras' lifeline, but she is polluted now due to several reasons like industrial effluents, mass bathing, domestic garbage, cruise and sand mining. High pollution load on the sacred river is due to the flow of domestic untreated wastewater directly to the river from 33 nallahs and rivulets across the city. The current city sewage treatment plants and sewage systems are inadequate to cater the city's water pollution problem. After reviewing the government's action plans, the Supreme Court of India, recently remarked that if the government will work with current approach then it will take >200 years to clean the river. But the current government is reiterated that the river will be fully cleaned by March 2020. Some of the factors responsible for polluting the sacred are discussed below:

a. Dominance of Upper Caste

It was observed that the National Mission for Clean Ganga and Namami Gange program didn't provide much relief to the river in terms of revival and keeping her green and clean. One of the reasons behind this is that the leadership of these programs is monopolized by Hindus who belong to the upper caste, i.e. brahmins, rajput and sadhus. All the decisions about the river health are taken up by them like when we have to clean the river or punish the people for open defecation on the ghats and in the river. Although, there are people from the lower caste who belongs to the Valmiki caste like sweeper and washerman, but they are just for the symbolic purpose and have no say in decision-making power at all. The task of cleaning the ghats and removal of garbage and waste from the river is done by lower caste community while cleaning of temples and Ganga Aarti are done by the upper caste community (Primary Survey, 2018). Such kinds of caste division in the city hinder the inclusive and sustainable development of the programme as a Pan-Banaras movement to keep the river water Aviral and Nirmal.

b. Attitude and Consciousness of the People



Despite the warning from the municipal authorities, washing of clothes by locals and washerman still continues along the river banks contributing to pollution levels. Washerman finds ghats as a convenient place as it saves both water and labour cost. It is normal to see that people are cleaning their utensils and take their cattle in the river for bathing and swimming. People openly defecate and urinate in the river as there is a huge scarcity of the public as well as private toilets in the areas surrounding ghats. People start their routine activities on the ghats like physical exercise, prayer and dip in the river around 5 am, but these toilets open at 6:30 am and close at 8:30 pm. Wherever public toilets are available, it has several issues like most of the time there is no water and to use the toilet you have to wait in the long queue. The condition of the women's toilets is worst as most of the time it is locked and if open then, there is no water supply. How we can expect that a woman can use toilet without the supply of water where men feel pride to defecate and urinate in the open which is one of the main causes of Ganga's pollution (Primary Survey, 2018).

c. Role of Rituals and Culture

Various rituals like mundanis going on the ghats of Ganga from ancient time. It refers to the shaving of boy's head, generally being performed between the ages of 1-3 years. The hairs that obtained from the mundan are dumped into the river which affects the bacteriophage activity (capability to kill harmful bacteria) of the river. It is one of the unique qualities of Ganga that makes it sacred and unique from other rivers. When human dead bodies are cremated on the ghats and at the end, only ash is left. Popular Hindu belief says that they have to flow ash into the river for the soul to rest in peace. According to one of the respondents, tonnes of ashes are being dumped into the river every day. It increases the siltation level, clogs the flow of the river and reducing the volume carrying capacity. Apart from these, the ashes promote turbidity of the river water which provides a breeding ground for unwanted things and promotes the growth of weeds in the river water (Primary Survey, 2018).

On the eve of Maha Shivratri and Makar Sankranti devotees gather at Kedar ghat and Haudeshwarnath ghat for mass bathing. The mass bathing has several negative impacts on people and the river too. Mass bathing increases AMR (anti-microbial resistance) which is the characteristics of microorganisms such as viruses, bacteria and parasites to resist antimicrobial from working against them. It is one of the main reasons that several antibiotics are not working properly against diseases like tuberculosis and so on. It is also noted that drug-resistant bacteria are also contaminating the groundwater besides the river as these pathogens have entered into our ecosystem.

d. Globalisation of Ghats Economy

Banaras' ghats economy is based on various activities and boating is one of them. The popularity of boats to travel from one ghat to another is declining at a very rapid pace due to the introduction of luxury ship or cruise. Though, boats are eco-friendly in nature and didn't cause any threat to Ganga water and marine life. On the other hand, cruise releases sulphur dioxide and nitrogen dioxide which not only pollutes but these harmful gases when inhaled by living organism causes lung problems. Further leads to decrease in the level of oxygen in the blood besides itching and irritation in various body parts. Its harmful effects can be seen in the tortoise

sanctuary of Banaras as well where they are reporting some biological changes in their bodies after the introduction of cruise. On the cruise, mostly foreign tourists travelled and they demand meat and alcohol which is the sacrilege of mother Ganga. The worst thing is that meat and alcohol are being served on the cruise. All the priests demanded the ban of such unethical meals on the cruise and for that, they did several protests, rallies and sabhas but nothing has worked as it goes against globalization of economy. The boatsman replied that, if the cruise will continue to attract and catch their customers from the ghats then, they would be finished as their whole livelihood is solely dependent on the boating. They are in the boat's profession from the generation and there is no point to change the profession at this stage of life and they don't know any other skill but boating (Primary Survey, 2018).

e. Sand Mining

Illegal sand mining has become a profitable source of income forming mafia in Banaras. The government has no control over the sand extraction rate because of its illegal mining has a very high profit return. The sand mafias have a good connection and relation with politicians, police, local administrations and their close inner circles. Hence, they freely mine sand along the banks of Ganga without a degree of fear in violating the mining law. There is a direct link between irrigation project, big infrastructure and illegal mining as the sand is used in construction of buildings, roads and embankments (Fig. 4). The construction sector boom has resulted in a rapid increase in the illegal mining. Mining results in large-scale death and migration of aquatic organisms and water level in the river has decreased by almost 50% in the last 50 years in Banaras. As documented both legal and illegal mining is completely banned along the 7 km river stretch as the tortoise sanctuary is located along the stretch from Ramnagar fort to Rajghat. In addition, all the laws on the mining prohibition are followed on government papers but in reality, illegal mining is operational even in the protected stretch within the tortoise sanctuary (Primary Survey, 2018).

f. Drain Discharge

Rivers act as a natural drain discharge point across the city stretch though drain discharge in the river has decreased after the introduction of several SPSs (Sewage Pumping Stations) (Central Pollution Control Board, 2018 (Table 1 and 2). In 4 out of 5 major drains the overall flow of water in MLD (Million Litres per Day) has been reduced by 13% between 2016 to 2018. The total organic load TPD (Tonnes per Day) carried out by 4 out of 5 drains have been increased by 14% for the same time period vis-a-vis population growth is also increasing. The overall BOD (Biological Oxygen Demand) of water discharge by 4 out of 5 drains has decreased by 10% during the same time frame low BOD is an indicator of improvement in the quality of the river water. Around 60% of the drains carried domestic sources of pollution while rest carries industrial, religious and agricultural waste. Around 80% of the drains are in flowing condition and the rest 20% is tapped stagnant due to non-maintenance.

h. Water Quality

Water quality of Ganga has been deteriorating in Banaras over the years (Table 3). The pH value of Assi ghat and Malviya bridge for most of the time is higher than the permissible limit of 6.5-8.5



from 2010-2016. The higher pH value results in more alkaline water which is mostly caused by the industrial effluents. The conductivity of the river water is lower than the permissible limit of $<2250 \mu\text{mhos/cm}$ over the given time period. One of the reasons for low conductivity is that the river water has a very low concentration of ions like sulphides, chlorides and carbonate compounds. Other reason for low conductivity is that the river water reported low temperature over the same time frame. The BOD of the river water for most of the year is $>3 \text{ mg/l}$ which indicates that the quality of the river water over the years is not suitable to take a dip and perform other rituals. The OD (Oxygen Demand) of river water for all the years is $>4 \text{ mg/l}$ and the permissible limit is $<4 \text{ mg/l}$ it is because of higher concentration of faecal coliform bacteria as most of the city's sewage are flowing into the river. The bacteria lead to the spread of several diseases like gastroenteritis and typhoid (CPCB, 2018). The spread of diseases causes out of pocket expenditure on the people and an additional financial burden on the exchequer of the district administration.

h. Faecal Coliform Bacteria

The common bacteria for the growth of coliform is *Escherichia Coli* which is generally called as E-coli. It is an indicator microorganism for several other pathogens like bacteria, virus or parasite which may be present in human and animal faecal. The occurrence of fecal coliform bacteria in the aquatic ecosystem denotes that the available water has been polluted with faecal of animal and human. When the bacteria level is high in the water, then there is a higher threat of waterborne diseases like diarrhoea, cholera, dysentery, typhoid and hepatitis A. The presence of the bacteria in the river water has abruptly increased to 21000 MPN/100 ml (Most Probable Number) in 2010 and then it falls down sharply to 13000 MPN/100 ml in 2011 (Fig. 5). The bacteria have reached to its highest level of 21000 MPN/100 ml in 2010 between 2007-2016 and then after, the decline in the presence of the bacteria has been noticed (CPCB, 2018). National Mission of Clean Ganga has played an important role in the reduction of the bacteria. Though, the permissible limit for faecal coliform bacteria in the water is $<5000 \text{ MPN/100 ml}$. It is more $>5000 \text{ MPN/100 ml}$ which is a great cause of concern for river, human and aquatic life in most of the year from 2007-2016.

i. Pressure on Wood Lots

More than 1500 kg. of woods are required for the complete burning of a single human dead body on the ghats. For this, the demand for woods particularly hardwoods are increasing at a steady rate every year, but the quantity of woods is not increasing in the same ratio. According to an estimate 5-6 million trees are cut down every year which puts a huge pressure on the forest resources besides contributing to air pollution. To stop the hardwood consumption, the district administration came out with another innovative way of burning dead bodies like gas-fired or electric in Manikarnika ghat and Harishchandra ghat. But they are dependent on unreliable sources of energy like electricity and gas and their regular supplies in the city's ghats were not ensured by the administration. Hence, these methods could not contemplate the problem of wood cutting as most of the people prefer the traditional wood method of cremation instead of electric or gas-fired one (Primary Survey, 2018). Apart from this, the popular

religious belief of Raakh, Ashthi and Bisarjan is to be done which is possible from wood burning. All these factors have led to serious impact in life of river and associated ecosystem. There has been series of initiatives and efforts undertaken to revive the river.

Initiatives Undertaken to revive Dying Mother/Ganges

The Ganges is renowned as the most sacred river on the Earth and the national river of India. She is regarded as the soul and lifeline of Indian civilizations, which was established after the decline of Indus Valley Civilization. Her basin has been inhabited since the last 5000 years and excellent irrigation systems have been used since the last 2500 years. She played an important role in our culture, history, tradition, religion, education, tourism, economy, energy, industry, agriculture, transport, livelihood and overall survival. Life without her is next to impossible in the river basin. In this context, some of the steps taken to revive the sacred river are discussed below:

a. Green Good Deeds/ Green Good Behaviour

When tourists or locals visit the ghats for an excursion, boating or any other religious activities, they bring different plastic and other products. It includes plastic bag, glass, cup, chips packet, water bottle among others, which are left out or are thrown on the ghats or in the river. These plastics and other solid products clogged the mouth of the drains and flow of the river as well. These plastic items, sometimes even results into their death when consumed by animals, birds and fishes. It was also noted that the plastic pollution is also destroying the livelihood of people like fisherman and boatman whose entire life is dependent on the water bodies. The pollution in the river results in the migration of fishes and decreases their reproduction process, and locomotive activities of boats are also restricted (Primary Survey, 2018). To address these issues, the Ministry of Environment Forest and Climate Change (MoEFCC) came out with the societal movement of Green Good Deeds/Green Good Behaviour. The ministry has appealed to all people that "*if you can't reuse plastic, then you can refuse it*". We have to do green good deeds every day means some green work for our mother Ganga. Through this movement, people are becoming more sensitive towards Ganga and avoid the use of plastic items. Nowadays, people have started using Khadi bags instead of plastic to carry their products and that change in their attitude will definitely help in achieving the greater goal of green and clean Ganga.

b. Tortoise Sanctuary

Natural cleaning of river water requires four carnivorous species of the tortoise that were introduced way back in the river under Ganga Action Plan, 1984 (GAP). Four tortoise species named as Sundari, Pacheda, Kathawa and Dhond which feed on half-burnt and full burnt corpses that are thrown in the river, contributing in reducing the pollution level and keep the water clean. To protect these tortoises, around 7 km stretch along the Ganga from Ramnagar fort to Malviya bridge was notified as tortoise sanctuary in Banaras under GAP in 1989. Till December 2018, >45000 turtles have been released into the river. The release of these turtles is very important as they keep check and balance on the river water pollution level and play a very important role in the river food chain (Primary Survey, 2018).

c. Bioremediation



Bioremediation is a waste management technique that uses naturally occurring living organisms like fungi, bacteria or plants to breakdown harmful substances into non-toxic or less toxic substances in in-situ or ex-situ. The rising pollution level and deteriorating water quality have led the Central government to come out with bacterial remediation technique. The technique is relatively cheap and needs very less time duration to say around 5-7 months for commissioning and showing good results. On the other hand, STPs take 3-4 years for commissioning and their cost of installation is also very high as compared to the technique. The technique reduces the level of BOD and COD (Chemical Oxygen Demand) by 89% and 84% respectively. Under the technique, the microbes eat up hazardous substances floating on the river surface and reside on the river bed like organic matter and oil. These microbes play an instrumental role in the proper treatment of sewage without release of any foul smell. The technique reduces toxic chemicals and heavy metals like mercury, zinc, copper, cadmium and lead apart from the removal of stink from the sewage. Here, all sewage should be captured and diverted to STPs for complete treatment and restricted to flow through the channel of stormwater. In the first phase, Nagwa/Assi drain and Rajghat drain has been selected for the application of bioremediation technique in Banaras as both the drains are in flowing condition and contributing to the domestic sources of pollution. In the second phase, Ramnagar drain and Varuna drain will be selected for the technique as both the drains are also in flowing conditions and belongs to the mixed (domestic, industrial and agricultural) category of pollution. In the final stage, Shivala drain will be renovated which is non-functional and stagnant condition now and it belongs to the domestic sources of pollution (Table 1 and 2). When all these drains function in their full capacity, then the city will not face any kind of drainage problems, especially during monsoon seasons as the city faces acute drainage problems during that season and in the rest months of the year, it is manageable.

d. Control over Rise in Temperature

Anthropogenic activities like industrial effluents, mass bathing and domestic sewage are increasing the temperature of the river water as these harmful pollutants are dumped in the river without any proper treatment. The rise in the temperature levels of the river water disturbs the entire food chain of life on land and life below water along the banks and ghats of the river. The temperature of the river water is generally under control over the last 6 years that from 2010-2016 (Fig. 6). The lowest mean temperature was 22.5 °C which was recorded in 2014 while the maximum mean temperature was 26 °C in 2016. Though, the permissible limit of annual average temperature for the river water is 25.6 °C and in this regard, the water temperature of all the years (2010-2016) are under control except for 2016 (26 °C). Namami Gange program played an important role in controlling the river water temperature as lakhs of trees have been planted along the river banks. In addition to these thousands of tortoises have been released into the river to consume the dead bodies and control the river temperature. Further, trash skimmer collects all kinds of solid waste like old clothes, plastics, coconuts and several other puja materials that pilgrims used to throw in the river while performing the religious activities. In this way, the skimmer cleans the surface of the river and controls temperature as the solid waste contributes to rise in the river temperature.

e. Ganga Gram Yojana

Villages located on the river's surrounding contributes to the pollution load in the river. It can be in terms of open defecation, solid wastes and contaminated water from the households entered into the river through village nallahs and drains. Hence, rural pollution load in the river is required to be tackled through the development of Ganga Grams. The vision of the yojana is to develop an ideal village that depicts itself as an inclusive and harmonious package of historic, sanitized, economic and cultural units on the banks of the river. Villages from 3 blocks namely Chiraigaon, Cholapur and Kashi Vidyapeeth have been adopted under the scheme. Promoting Ganga as a brand in its organic farm produce, handicrafts and tourism which empower the locals and boost the village's economy. Under the yojana, around 54 villages out of total 823 villages are selected from Varanasi district of Uttar Pradesh (Table 4). These 54 villages are selected from 3 blocks viz. Chiraigaon (34), Cholapur (6) and Kashi Vidyapeeth (14) (Fig. 7) (National Mission for Clean Ganga, 2017). In the selected villages, open drains which are flowing into the river will be diverted and the alternative provisions for sewage treatment will be prepared. Each village household will have bio-toilets and will be developed under the Seechewal model. The model refers to storage of sewage water in a canal or pond and allows its use for irrigation purposes after the complete treatment in eco-friendly way. Further, the yojana includes development of Ganga ghats where various modern facilities like free Wi-Fi access and CCTV cameras will be installed. A separate site within the ghats has been developed for pilgrims to throw religious materials like garlands, sarees, agarbatti, plastic items etc. and from there, solid wastes are picked up by the local urban bodies. The local urban bodies have tie-up with some local agencies that convert these puja materials into some reusable products like agarbatti of different types so that we can utilize these products again. It is a small step in the movement of conversion of "Waste into Wealth" and open new avenues for employment as well. Each village sarpanch has given the responsibility to make entire villagers aware about the bad practices of throwing even a single piece of paper in the river while performing the religious practices (Primary Survey, 2018). The village sarpanch is also reporting some positive change in the attitude of villagers now, they are becoming more and more conscious during the river's ghats visit. Further, they also convey the messages of keeping the river clean to other visitors as well.

f. Ganga Greenery Scheme/ Ganga Hariteema Yojana

Ganga Greenery Scheme/ Ganga Hariteema Yojana has been launched in 27 districts of Uttar Pradesh which are situated on the banks of Ganga and Banaras is one of them. The yojana aims at increasing green cover and controls land erosion in the catchment areas of the river which was caused by sand mining and human encroachment on the river banks. Under the yojana, tree plantation was carried out in and around 1 km area from the river banks. Locals and devotees are also encouraged for tree plantation even on their private lands under the slogan "One Person One Tree". The yojana experiences a positive response from the people as those who want to contribute in keeping the river clean can contribute under the yojana. On the eve of International Environment Day that falls on 5 June 2018 a huge rally was organised to aware people about yojana. The yojana is followed by



several sections of the society like students, teachers, pilgrims etc. Several schools enthusiastically have participated in the campaign of "One Person One Tree" by organizing rallies from their schools to the ghats or riverbanks. At the beginning of the rally, there were only students and teachers, then locals joined when it reaches the city streets/roads as well. Such kind of rallies have developed a sense of belongingness to the river and inspire people to plant a single tree wherever it is possible either in their home, office, the riverbank etc. Mass conservation educational programs, several TV shows and radio programs are also going on to mobilise the reach of the yojana to the maximum number of people (Primary Survey, 2018).

g. Ganga Prahari: Guardians of the Ganga

Ganga Praharis are trained and self-motivated volunteers from the local communities like teachers, students or locals. The community consists of people who are living on the river banks, doing fishing or involved in dumping waste in the river. Their involvement is very important for the inclusive development of the program as they are the sons of the soil and have much more knowledge than any other outsourcing agency. The program provides technical support like establishment of incubation centre, generation of revenue from the waste picked up from the river. It helps Praharis to channelise their knowledge and vision to clean Ganga in the right direction. They on the spot conserve, clean and stop the further deterioration and degradation of the river if anyone flowing waste, spreading filth. They inspire them not to indulge in such kinds of bad practice after all we all worshipped her as a mother. They are also working for biodiversity conservation and Ganga rejuvenation with the aim to safeguard the river purity via. Aviral Dhara and Nirmal Dhara. The program also deals with the restoration of turtles in the river as some species of turtles feed on dead bodies and keep the river clean. The aim of the initiative can be achieved by creating awareness about the harmful effects of open defecation and urination. It will be possible by inculcating a sense of belongingness among locals and tourists towards the river, benefits of keeping the river clean and vibrant. Linking local's livelihood with the river like making of organic incense sticks, prasad and sell them on the ghats as these ghats have good market potential for such items (Primary Survey, 2018).

h. Namami Gange Project (Clean Ganga Fund), 2016

Namami Gange focuses on the pollution reduction through treatment, interception and diversion of the wastewater directly flowing into the river from the open drains. It includes in-situ treatment, innovative technologies, bioremediation and installation of STPs (Sewage Treatment Plants, Fig. 8).

To tap the drain of polluted water in the river from Banaras, 5 SPSs (Sewage Pumping Stations) have been constructed on the ghats of Banaras (Fig. 9). These are Harishchandra ghat SPS, Mansarovar ghat SPS, Dr. R.P. ghat SPS, Jalasena ghat SPS and Trilochan ghat SPS. These 5 SPSs are connected to Koniya MPS (Multi Pumping Station) and from there waste-water diverted to the Dinapur 80 MLD STP for the treatment. Then, after the treatment from Dinapur STP, these waters are discharged into the river. To treat around 300 MLD wastewater of the city, 80 MLD STP of Dinapur was not adequate that's why a new 140 MLD STP will be established in Dinapur. The sewage from Varuna River and Assi River is also polluting Ganga River. To tap the sewage from Varuna

River 3 interceptor sewers like Phulwariya SPS, Chaukaghat SPS and Saraiyan SPS have been constructed and connected to Dinapur STP.

For Assi River sewage, Assi interceptor has been established. On the other hand, the whole city's pollution burden was on the Old Trunk Sewage and to reduce its burden a new Relieving Trunk Sewage is also constructed. In Banaras, Ganga is also getting polluted from Ramnagar sewage and for that 4 major sewers of Ramnagar have been intercepted. The waste-water of all these sewers first diverted to Ramnagar STP with 10 MLD capacity and after proper treatment discharged them into the river. The project not only limited to the sewage, but also ensured that not even a single trash from the city to be dumped into the river. Apart from these, several under construction STPs of the city are as follows Goitha STP with 120 MLD, Dinapur STP with 140 MLD and Ramana STP with 50 MLD. Ramana STP will become India's 1st hybrid annuity-based PPP (Public-Private Partnership) model. Under the project special trash skimmers technology has also been deployed to remove oil or floating waste materials from the river surface to keep the river clean.

Though efforts have been made since a long time, there still remains gap in terms of planning and implementation of initiatives, leading to less positive outcome. After reviewing the initiatives and policies undertaken by the government and other agencies, we have come up with certain recommendations for conserving the holy river by reducing the increasing pollution level.

Suggestions/Recommendations for Controlling Pollution

- a. Heavy penalty to be imposed on all the industries that are discharging their harmful effluents without complete treatment in the river.
- b. All kinds of plastic products should be fully banned within the radius of 5 km from the ghats and riverbed not only on paper but on the ground.
- c. All SPSs and STPs to be monitored and regularly checked and under construction STPs must be completed at the soonest.
- d. More turtle breeding centres to be opened in different parts of the city as there is a need for more turtles to remove the Ganga's wastes in the shortest possible time.
- e. No litter policy to be adopted and a heavy fine to be imposed on all who are indulged in polluting the river whether local or tourist.
- f. To make the entire stretch of Ganga and its ghats open defecation and urination free, there is an urgent need to construct more and more toilets with proper water supply along the ghats and riverside.
- g. Mass bathing should be strictly regulated on the ghats and banks of the river through several awareness programs for regulated and controlled bathing should be promoted.
- h. Working condition CCTV cameras to be installed in all potential public areas like markets, riverside, ghats and temples to keep eyes on the polluting sources.
- i. During religious ceremonies, special occasions and festivals, additional arrangements and preparations should be made for cleanliness drive. Students, teachers and locals can be asked to serve as volunteers during such time.
- j. Involve private company or institute to sponsor one ghat and in return their name can be in the ghat like maintained and cleaned by ABC company or institute.



- k. Declare Ganga as an endangered river to sensitise people.
- l. Recently, Uttarakhand High Court has declared Ganga as the first living entity of India, which considers her as a human being with all the right given under the constitution of India to a person.
- m. Prepare an inclusive and sustainable working committee which may include environments, geographers, conservationist, ecologists, governments, NGOs, pressure groups and civil society groups.
- n. The success of any project is incomplete without mass participation. Invite them to join as a volunteer just for half or 1 hour in a day on a routine basis.
- o. The ghats and banks of the river require adequate funds and a strong government will power to make the existing programs and projects a great success.
- p. Adoption of latest technology like trash skimmer to keep the river water Aviral and Nirmal must be feasible, accessible and sustainable.

Conclusion

As we all know Ganga is not only a river, but also a medium to meet the soul with the ultimate divine. One of the great Mughal emperors, Akbar called Ganga as the water of immortality. Historically, culturally, religiously and traditionally, we have always shown a great love, affection and respect towards Ganga. But from the industrial and green revolution, we haven't worshipped her as a mother, instead started misusing her as a commodity. Nowadays, with the increasing urbanisation, commercialisation and industrialisation, we have literally started abusing and polluting her for our greed. Though, the Constitution of India provides us the right to use clean water which is a fundamental right under the right to life (Article 21). At the same time, we forget that there is also a fundamental duty of every citizen to protect, preserve and improve the natural resources of the country like lakes, forest, wildlife and rivers and to have compassion for all living creatures. To keep the river clean is not only the task of government, it involves participation from all the sections of the society whether students, teachers, devotees, corporates, NGOs, sadhus, pilgrims, tourists and locals. Participation of each one plays an important role in keeping the river clean at micro and macro level. There is an urgent need to change our bad habits by following Green Good Deeds campaign. Hence, let's pledge from the land of Moksha that we all will definitely keep Ganga Aviral and Nirmal in the next couple of years.

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Table -1: Drains Discharge into Ganga River Monitored during Monsoon, 2016

Catchment	Name of the Drain	Flow (MLD)	Organic Load (TPD)	BOD mg/L	Pollution Sources	Present Status
Varanasi	Nagwa/ Assi Drain	147.00	14.04	126	Domestic	Flow
	Ramnagar Drain	31.84	1.39	162	Domestic+Agriculture+Industrial	Flow
	Varuna Drain	501.26	17.04	67	Domestic+Agriculture+Industrial	Flow
	Shivala Drain	-	-	-	Domestic	Standing
	Rajghat Drain	246	19.31	182	Domestic	Flow
Total		926.10	51.78	537		

Source Central Pollution Control Board, 2016

Table – 2: Drain Discharged into Ganga River Monitored during Monsoon, 2018

Catchment	Priority Drain	Flow (MLD)	Organic load (TPD)	BOD mg/L	Pollution Sources	Present Status
Varanasi	Nagwa/Assi Drain	198	22.57	114	Domestic	Flow
	Ramnagar Drain	11.29	1.77	157	Domestic+Agriculture+Industrial	Flow
	Varuna Drain	571.30	31.59	55	Domestic+Agriculture+Industrial	Flow
	Shivala Drain	-	-	-	Domestic	Tapped
	Rajghat Drain	25.57	3.96	155	Domestic	Flow
Total		806.16	59.89	481		

Source Central Pollution Control Board, 2018



Table - 3 Water Quality of Ganga River: Banaras

Year	Station	pH		Conductivity (µmhos/cm)		BOD (mg/l)		DO (mg/l)	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Water Quality Criteria		6.5-8.5		<2250 µmhos/cm		<3 mg/l		<4 mg/l	
2010	Assi Ghat	7.3	7.7	256	358	3.4	4.2	7.4	8.7
2010	Malviya Bridge	7.8	8.8	282	385	4.2	10.8	6.8	7.7
Total		15.1	16.5	538	741	7.6	15.0	14.2	16.4
2011	Assi Ghat	7.5	7.8	224	266	3.7	4.2	7.5	7.8
2011	Malviya Bridge	7.9	8.1	240	290	5.2	9.6	7.0	7.2
Total		15.4	15.9	464	556	8.9	13.8	14.5	15.0
2012	Assi Ghat	7.7	8.5	230	278	2.8	3.5	7.3	8.6
2012	Malviya Bridge	7.5	8.5	240	310	5.1	8.5	7.1	7.6
Total		15.2	17.0	470	588	7.9	12.0	14.4	16.2
2013	Assi Ghat	7.6	8.4	268	370	2.9	3.2	6.9	8.8
2013	Malviya Bridge	7.7	8.4	306	392	3.3	5.1	6.4	8.3
Total		15.3	16.8	574	762	6.2	8.3	13.3	17.1
2014	Assi Ghat	7.2	8.0	272	378	2.3	3.8	8.2	8.7
2014	Malviya Bridge	8.0	8.4	282	392	2.4	3.3	7.3	9.2
Total		15.2	16.4	554	770	4.7	7.1	15.5	17.9
2015	Assi Ghat	7.3	8.3	280	382	2.8	3.5	8.3	8.8
2015	Malviya Bridge	7.9	8.5	302	391	3.1	4.3	6.8	9.6
Total		15.2	16.8	582	773	5.9	7.8	15.1	18.4
2016	Assi Ghat	7.4	8.5	320	496	2.8	3.5	7.4	9.8
2016	Malviya Bridge	7.3	8.6	338	544	4.2	6.8	6.4	8.6
Total		14.7	17.1	658	1040	7.0	10.3	13.8	18.4

Source Central Pollution Control Board, 2018 (Prepared by Author)

Table – 4: Number of Blocks and Villages Selected under Ganga Gram Yojana: Banaras

Block	Village	Block	Village	Block	Village
Chiraiagaon	Amauli, Amauli(Ramala), Bhartharakala, Panditpur, Bhokalpur, Chitawna, Chitawni, Chandpur, Bakani, Dawariya, Dharadhar, Gangapur, Govarahan, Rampur, Kamoli, Kukuda, Dhobahi, Luthakala, Luthakhurde, Misrapura, Awadhipur, Muridpur, Jigana, Mustfabad, Kurav, Paranapur, Ramchandipur, Sarai Mohana, Sarsol, Sighwar, Siristi, Rajapur, Tatepur, Vamanpura	Cholapur	Arazi, Chandrawati, Dhaka, Kaithi, Nakhava, Gaura Uparavar	Kashi Vidyapeeth	Molanapur, Veravar, Bhagwanpur, Chhintupur, Domari, Madhopur, Mundadev, Nopurakala, Ramana, Saray Dagari, Shirgoverdhanpur, Sujabad, Tarapur, Tikari

Source National Mission for Clean Ganga, 2017 (Computed by Author)

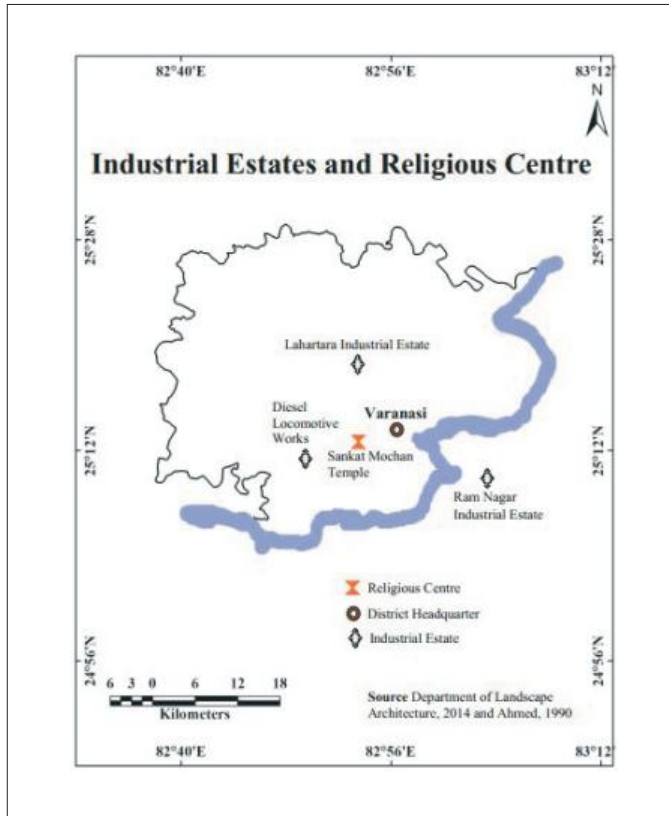


Fig. 1: Location of Industrial Estates and Religious Centers

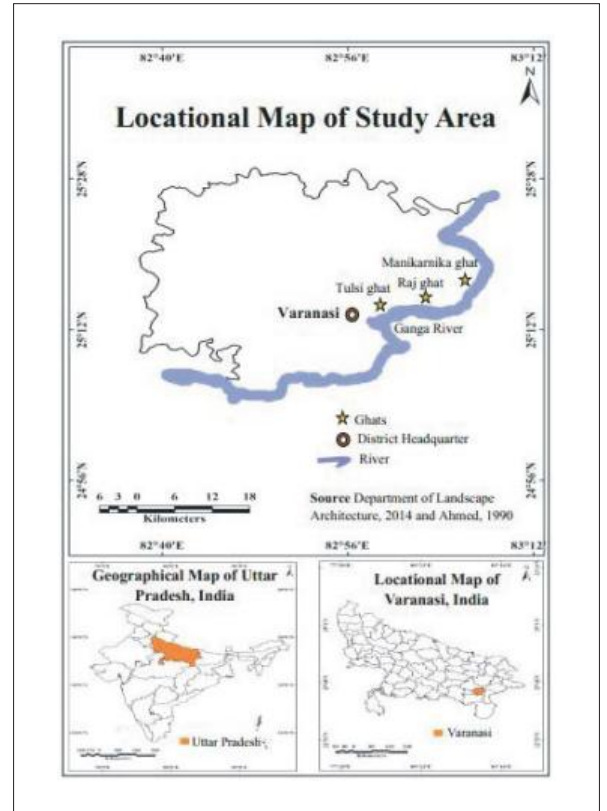


Fig. 2: Location Map of Varanasi

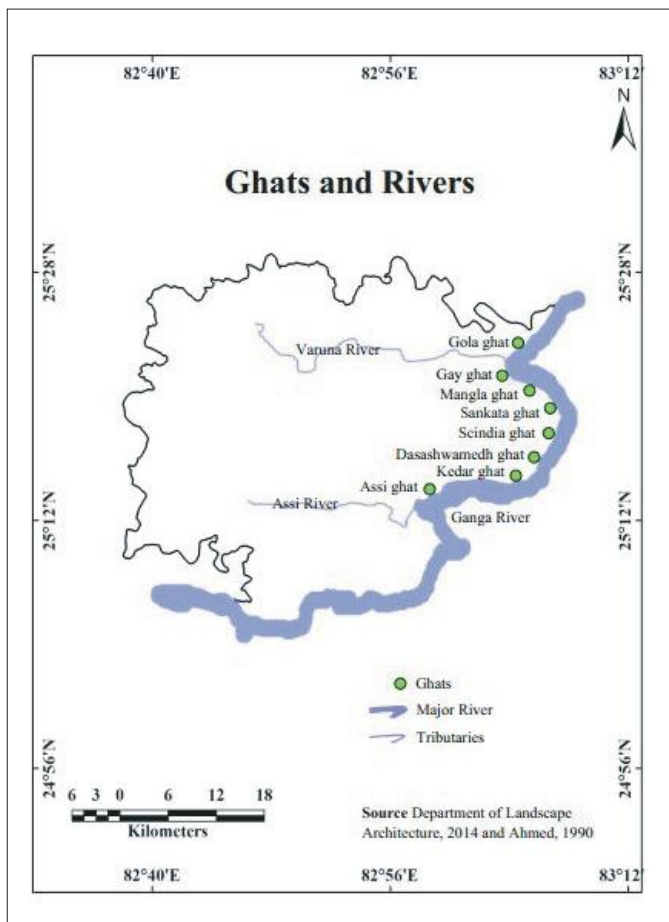


Fig. 3: Location of Ghats along the Ganga R in Varanasi

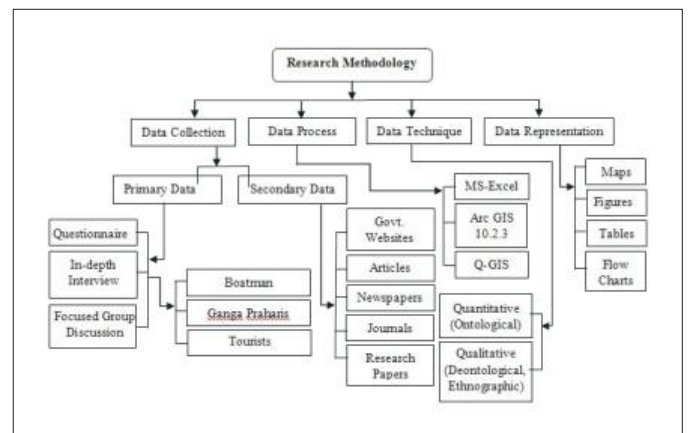


Fig. 4: Flowchart of Research Methodology

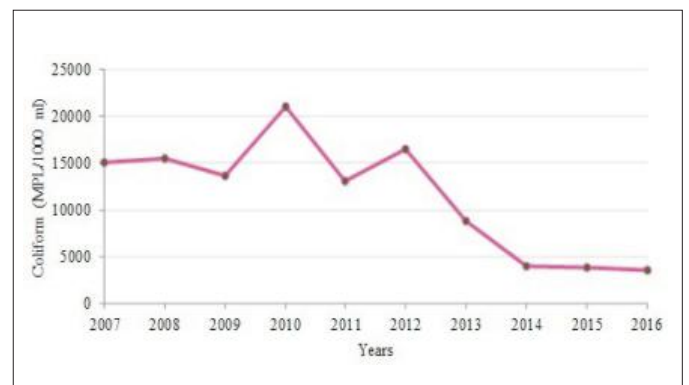


Fig. 5: Presence of Fecal Coliform Bacteria in Ganges (2007 - 16)[compiled from CPCB, 2018]

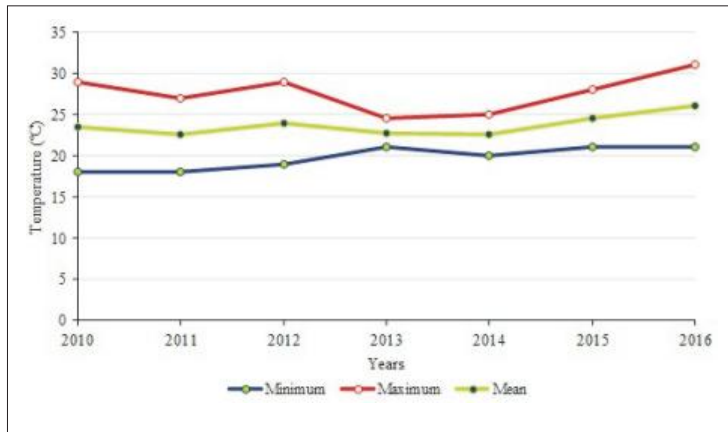


Fig. 6: Trend of Ganges Water Temperature, 2010-2016 (adopted and compiled from CPCB, 2018)

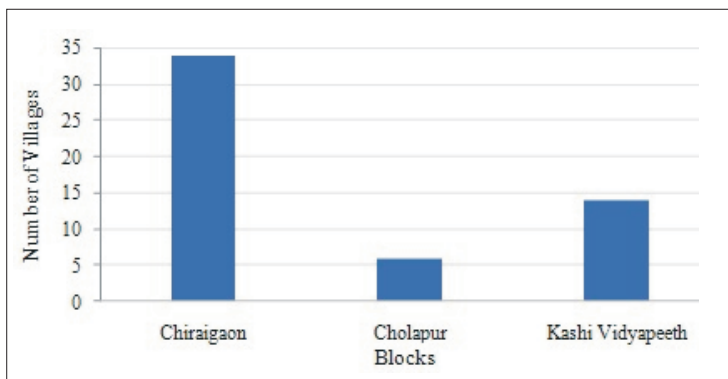


Fig. 7: Villages Covered under Ganga Gram Yojana, Banaras (adopted and compiled from NMCG, 2017)

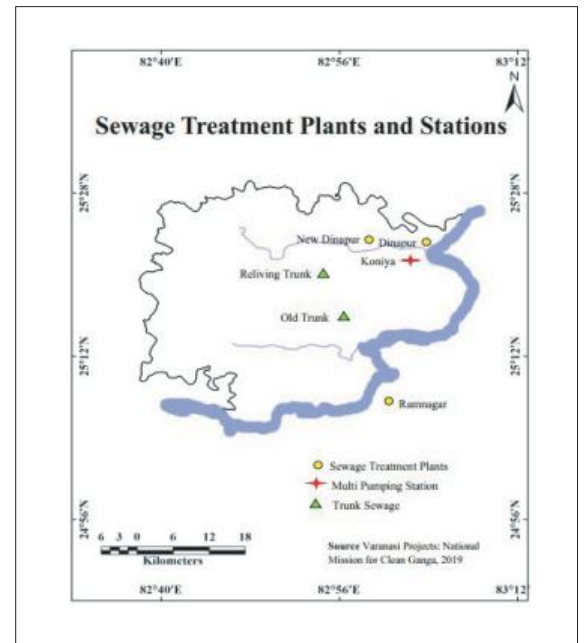


Fig. 8: Sewage Treatment Plants and Stations

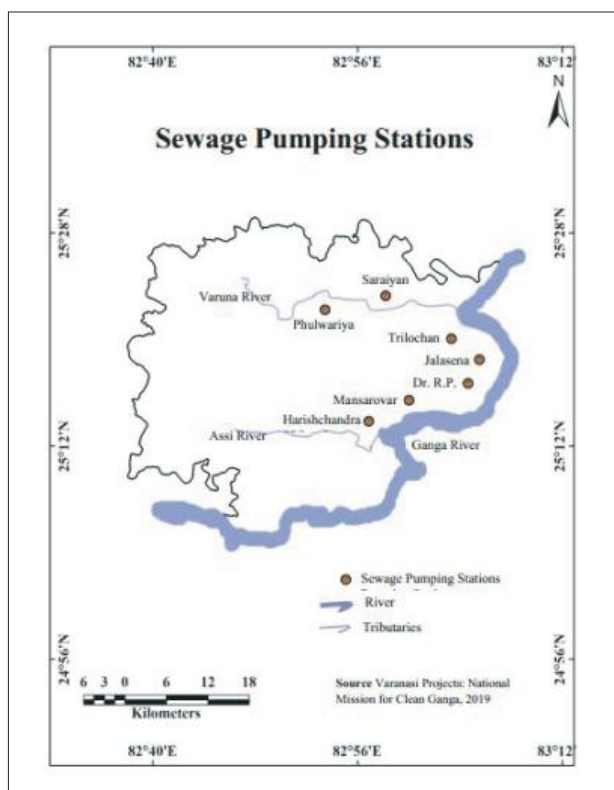


Fig. 9 Location of Sewage Pumping Stations



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