Article

Pollution of Ganga River Due to Urbanization of Varanasi

Adverse Conditions Faced by the Slum Population

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Shikhar Kumar, Pallavi Jha, Klaus Baier, Ramakar Jha and Rafig Azzam

Abstract

One of the most important and holiest rivers in the world, the Ganga has now become highly polluted because of the pollution from many cities present along its banks. Nearly all kinds of wastes coming out of Varanasi, viz. sewage inflow, industrial waste, animal carcasses, unclaimed human dead bodies, and nearly all other kind of biodegradable as well as non-biodegradable wastes is being dumped in the Ganga river. Faecal Coliform Counts of more than 4 million/100 ml have been recorded at downstream end of the city near the Varuna Confluence. Many studies have shown that there is a significant relativity between water-borne diseases and the use of the river water for potable uses like bathing, laundry, washing of utensils etc. The present study aims to bring the increasingly worsening situation into limelight and to present few possible solutions to bring the River Ganga to its former glory.

Keywords

Water pollution, river Ganga, urbanization, Varanasi, slums

Introduction

All over the world, rivers are now under severe threat. Even though non-existence of life without freshwater is a recognizable and acceptable fact everywhere on the planet, the pure rivers and freshwater sources are being abused. Rivers which are lifeline to any city or society are being treated as sewage drains and are used to throw away all kinds of wastes so that the river can take it away downstream (Varenya). The 'World Watch Reader' reports: 'The Nile, the Ganges, Amu Dar'ya and Syr Dar'ya, the Yellow River and the Colorado are each now so dammed, diverted, or overtapped that, for parts of the year, little or none of their freshwater reached the sea. Their collective diminution portends not only worsening water shortages and potential conflicts over scarce supplies, but mounting the ecological damage'. As a result, increasing number of water-borne diseases is spreading among the people who live along the banks of such polluted rivers. As per WHO estimates, 1.1 billion people lack access to an

improved drinking water supply; many more drink water that is grossly contaminated (Marale et al., 2012).

The River Ganges, 'Ganga Maa' for the Hindus, is the holiest river in India, ever since its origin. Belonging to the seven sacred rivers of the country, it is still regarded as the most important river in the Hindu religion. On its 2,510 km course, Ganga flows through the Indian states of Uttar Pradesh, Bihar and West Bengal. In central Bangladesh, it is joined by the Brahmaputra river and the combined waters called the Padma River then empty into the Bay of Bengal forming a delta about 354 km wide. The Gangetic plain is one of the most fertile and densely populated regions in the world (Gits4u.com).

Varanasi is one of the oldest cities in Asia situated on the left bank of the River Ganga along the seven kilometre-long river face extending from Rivers Assi in the south to Varuna in the north. According to Hindu mythology, Varanasi city, also known as Kashi, is described as a column of light and as the Headquarters of Lord Shiva. Needless to say, that both the River Ganga and Varanasi city are very important and symbolic to Hindu religion.

The present work is done with the aim of presenting the rapidly going down quality of water of the Ganga river, the cause of which is dumping of raw sewage, solid wastes, dead animal carcasses etc. from the city directly into the river without second thoughts. Rapidly growing population and growth of the city with the lack of sanitation system to deal with the growth of the city has brought the situation of the city and Ganga river to such a bad point.

Pollution of Ganga

For many people in Varanasi, the River Ganga is the medium of life. Few areas along the ghats of the river have very high population density which also includes areas with slums where the inhabitants are dependent on the river for both their religious as well as potable water needs. About 60,000 people are at the ghats of Ganga everyday for their holy dip. Most of these people either do not care or do not believe that the water of the River Ganga is polluted.

The situation in Varanasi was not like this before. The city was given its due importance during the British period in India. The city got its first underground gravity sewage system during that time which was constructed for a maximum population of 200,000 people (Mishra, 2005). The sewage then flowed into the river but the locations of outlet sewage pipes into the river were selected so as to not affect the water quality near the ghats in the city. It has now been more than 60 years and the population of the city has increased from a meagre 200,000 to more than 3.6 million (Directorate of Census Operations, Uttar Pradesh, 2011). Due to rapid growth of population, construction of settlements along and on the low-level lands along the rivers Assi and Varuna has caused severe detrimental effects on those rivers. Assi river is now nothing more than a drain through which only the sewage from the city flows and enters into the river Ganga. Many plans for cleansing of River Ganga, cleaning of the city, development of the city etc. were and are made but due to political pressures, they are sometimes suspended, discarded or are changed because of which they are unable to achieve their objectives. In the year 1986, the Government of India passed Ganga Action Plan (GAP), the objective of which was to reduce or remove the pollution of the River Ganga by putting up more treatment plants and better sewage system so as to avoid dumping of untreated raw sewage directly into the river. Even after the completion of Phase I of the GAP in the year 1993, the river water quality did not show considerable

change (Hamner et al., 2006; Pandey et al., 2005). In fact, the faecal coliform level was higher than ever. Raw sewage was still flowing into the river freely from various types of point sources. Even today, a stroll along the ghats or a boat ride along the river will show many drains, ditches, sewer pipes and other outlets which are continuously putting more raw sewage and other chemical waste water coming from the small scale industries in the city. In the last 50 years, Varanasi has undergone very haphazard and unplanned growth. Solid waste disposal is also a big problem in the city since there is absence of any good system for it. Because of this, a lot of solid waste is either thrown in the river or it flows down in the sewage lines and/or open drains and gets dumped in the river via around 30 such point sources located along the ghats in the city.

Study Area

Varanasi, one of the oldest cities of the world, famous for being the holiest city in India, is characterized by numerous temples, narrow streets and most important of all, the River Ganga. The River Ganga is the life line of the Gangetic plain in northern India. So much so that Ganga basin is the most populated river basin in the world, with over 400 million people and a population density of about 390 inhabitants per square kilometre. The city was founded between the rivers Varuna and Assi on the western side of the meandering Ganga. Name of the city is the amalgamation of Varuna and Assi forming Varanasi. Much like most of the cities and villages in the Gangetic plain, Varanasi depends on the River Ganga and its tributaries and the groundwater of the region for its water needs. The potable water sources for the people in Varanasi are the groundwater and the water from River Ganga. Geomorphologically, the city is a part of central Ganga plain of the Indian subcontinent as shown in Figure 1. The average elevation of the city area is about 76 m above mean sea level. The whole area has largely a very even topography with low relief kilometre scale undulations. The climate of this region is tropical with a marked monsoonal effect. Around 80 per cent of the annual rainfall in the region is received in the months of July and August. Summer temperatures can go upto 47°C and in winter, the temperature drops to 4°C with an average annual temperature of 24°C. Geologically, the city is underlain by Quaternary alluvial sediments of Pleistocene to recent times. In the study area, unconsolidated sediments form a sequence of clay, silt and sands of various grades. The origin of these sediments is from alluvial deposits.

The four locations from where the water samples were collected are shown in Figure 1. The sample points are along the River Ganga starting at Tulsi ghat and then moving downstream till the Varuna River Confluence point. The sample collection and analysis of four time periods is included in this work starting from May 2004 till May 2009.

Methodology

Quality data of Ganga river water collected from various ghats of the city was collected from the website of 'Sankat Mochan Foundation, Varanasi'. Dissolved Oxygen (DO in mg/l) and Faecal Coliform Count (FCC/100ml) were given the most importance in this study. Quality data collected from three major ghats (viz. Tulsi Ghat, Rajendra Prasad Ghat and Panchganga Ghat) and from the Varuna River confluence are included in this work. From all the various data periods available, quality results from four time

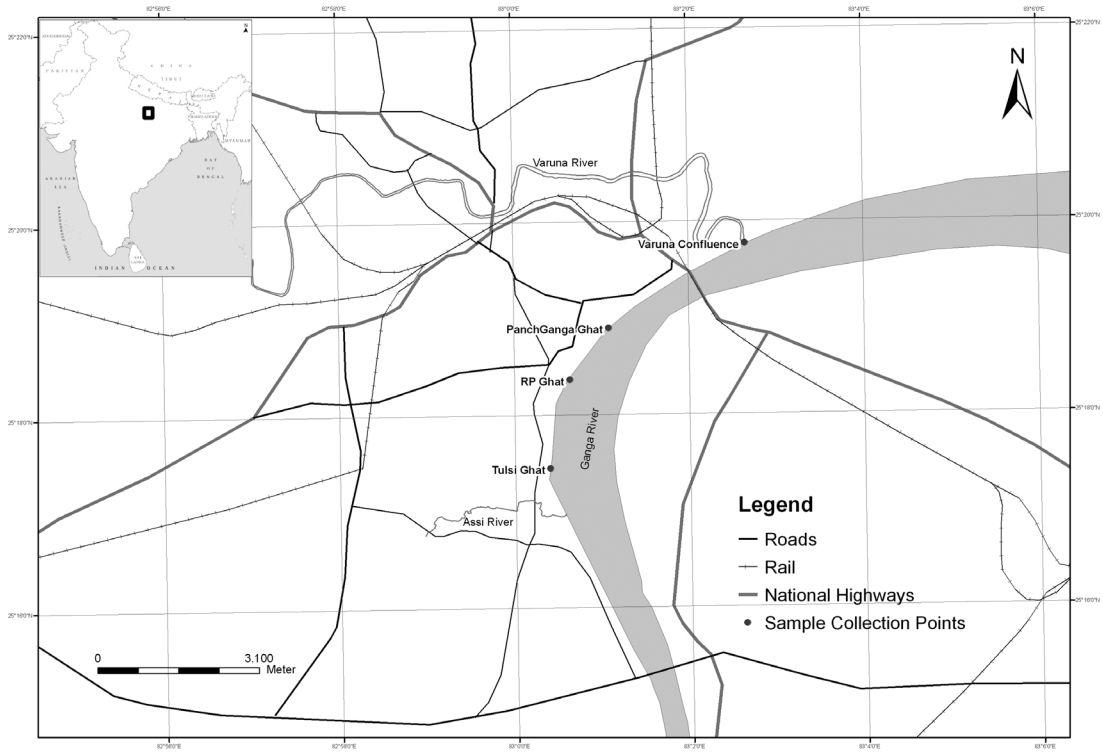

Figure 1. Map of the Study Area

Source: Made by the authors using various maps in ArcGIS software.

periods were selected. The selection of the time periods was made with the objective of selecting the same months of different years so that an actual trend can be seen independent of different weather conditions. Various published research articles related to Ganga river quality and water-borne diseases were collected and the studies conducted in those articles were incorporated in the present study. Other articles like media reports and unpublished government reports which talk about water quality status and their relation to water-borne diseases were also collected. The data collection thus made was used in GIS environment to analyse the visible trends.

Results

The present study is done by using the data collected from the Sankat Mochan Foundation database which is given in Table 1. All the data available on the website was not used in this study because not all data collection was done regularly, at fixed time intervals or at fixed sample collection points. The database

used in this study was selected on the basis of its uniformity of time of collection of data and fixed sample collection points which were nearly equidistant from each other along the river Ganga, starting from the near to the start of the city in the South till near to the end of the city in the North. The sample locations, starting from southernmost point and moving downstream with the river are viz. Tulsi Ghat, Rajendra Prasad (RP) Ghat, Panchganga Ghat and the Varuna Confluence. The collected samples from these locations were analyzed for micro-biological characteristics by the Sankat Mochan Foundation. The present study is focussing on Dissolved Oxygen and Faecal Coliform Count data for various samples collected during the four time periods being studied in this work.

Table 1. Dissolved Oxygen and Faecal Coliform Count Data for the Collected Samples in Different Time Periods

	May 2004		Jan 2006		May 2007		May 2009	
Location	DO (mg/l)	FCC/ 100ml	DO (mg/l)	FCC/ 100ml	DO (mg/l)	FCC/ 100ml	DO (mg/l)	FCC/ 100ml
Tulsi ghat	5,8	210000	7,2	41000	6,8	68000	7	49000
RP ghat	6,8	65000	7,4	63000	5,8	81000	7,2	69000
Panchganga ghat	7,2	35000	7,6	27000	7,2	29000	7,3	24000
Varuna confluence	2	2000000	3,4	3400000	3,4	4400000	1,7	4300000

Source: Sankat Mochan Foundation website.

In the Figure 2, it can be clearly seen that Dissolved Oxygen values of samples collected at all the ghats except for samples collected at Varuna Confluence is high and >5 mg/l, whereas at Varuna Confluence, in no time period of the current study, does the Dissolved Oxygen value went over 3.4 mg/l. Faecal Coliform Count at all locations is high but at the Varuna river Confluence, the count is extremely high in all time periods (Figure 3). In all the cases, the FCC value ranges in millions at Varuna Confluence whereas in all other locations it ranges in the thousands.

Interpretation

The extremely high values of Faecal Coliform and much lower dissolved oxygen make perfect sense in the present state of things at Varanasi. Around 30 point sources put more than 200 MLD of untreated sewage in the river in addition with solid waste, animal carcasses etc. By the time the water reaches nearly the end of the city, its quality is degraded to very low levels as shown by the data and the figures. In Figure 1, it can be seen that Varuna Confluence is the northernmost point of collection of sample and it is the point where the river is actually leaving the city after consuming all the dumped materials being thrown into it. It is therefore not surprising to see very high Faecal Coliform content and low Dissolved oxygen in the samples collected at that point. Also, we should also include the fact that the water from Varuna River which is entering into the Ganga River is also not very clean since it is also bringing some

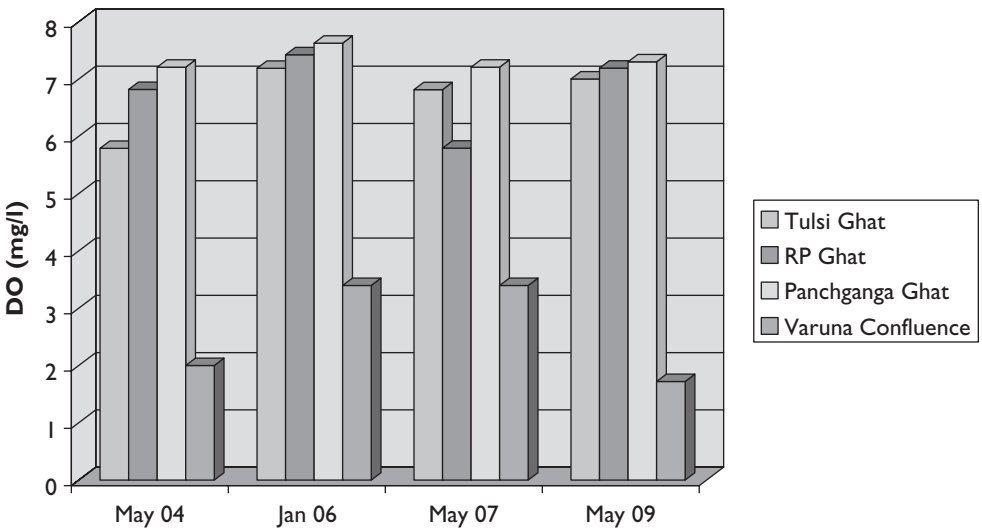

Figure 2. Graph Depicting Time Varied Values of Dissolved Oxygen in the Study Area

Source: Data from Table 1 being used.

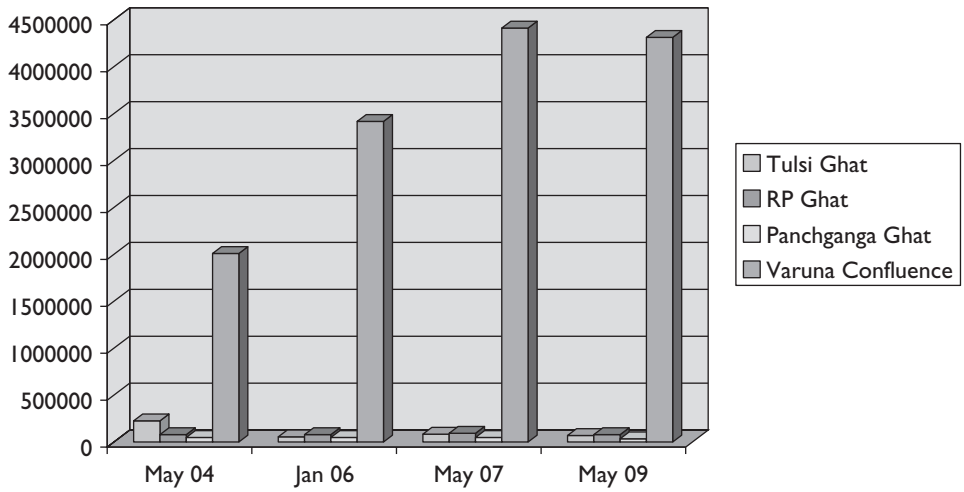

Figure 3. Graph Depicting Time Varied Values of Total Coliform Count in the Study Area

Source: Data from Table 1 being used.

waste water being thrown into the river while it flows through the northern borders of the city. So, the quality of water of Varuna River can also be responsible for further degradation of the water quality of the Ganga River at the Confluence region.

It is also very clear that with time, the quality of water in the river has gone down considerably. The major reason for this is rapid and haphazard growth of the urban area of the city and big growth in total population as well as population density in the central parts of the city. The water supply and sanitation facilities of the city are unable to cope up with the very high rate of unregulated growth which has made correction of situation very difficult. All the plans working for better water supply facilities, waste disposal system, cleaning up of the river etc. are either too weak or are not planned according to the unique conditions present in the city.

In Figure 4, land use data of areas around the city and along the ghats of the river can be clearly seen. It is very evident that most of the poor population which lives in the slums of the city are living in very close quarters of the ghats. Also, because that area is closer to the river and is very close to the centre of the city, population density in those slum areas is also very high (Figure 5). Because of the holy nature of the river Ganga and also because it is the closest source of water to these areas, many people living in these areas use the river water for potable purposes. They are also at times forced to use the river water

Figure 4. Land Use Classification in and Around the Study Area

Source: Made by the authors using satellite imageries procured from USGS website and data collected in field surveys conducted in Varanasi in May–June 2011.

very close to a drain pipe coming from the city and polluting the river. The water nearby such point sources is obviously more polluted and more dangerous but because of lack of any better option, people living in these areas are forced to utilize such water.

The water which is supplied to the people of the city by the municipal authorities is also of very bad quality. The supplied water comes both from the River Ganga as well as many bore wells owned by the government around the city. About 11 MLD, nearly 50 per cent of the total water supplied comes from the River Ganga. Total Coliform (MPN/100ml) level in the water is exceeding the desirable and sometimes the maximum permissible limits (Planning Commission, Government of India). Such water can be used for drinking after conventional treatment. But unfortunately, because of very old water distribution system and sewage pipe lines and lack of maintenance, most of the water supplied in most parts of the city is polluted with the sewage materials leaking from sewer lines. Water is supplied in the morning and in the evening times throughout the city, and whenever the water supply starts, a lot of very dirty, smelly water comes for the first few minutes. After that the water looks clean enough to be used. But even then it contains small quantities of the sewage materials, which is continuously being leaked into the distribution supply system.

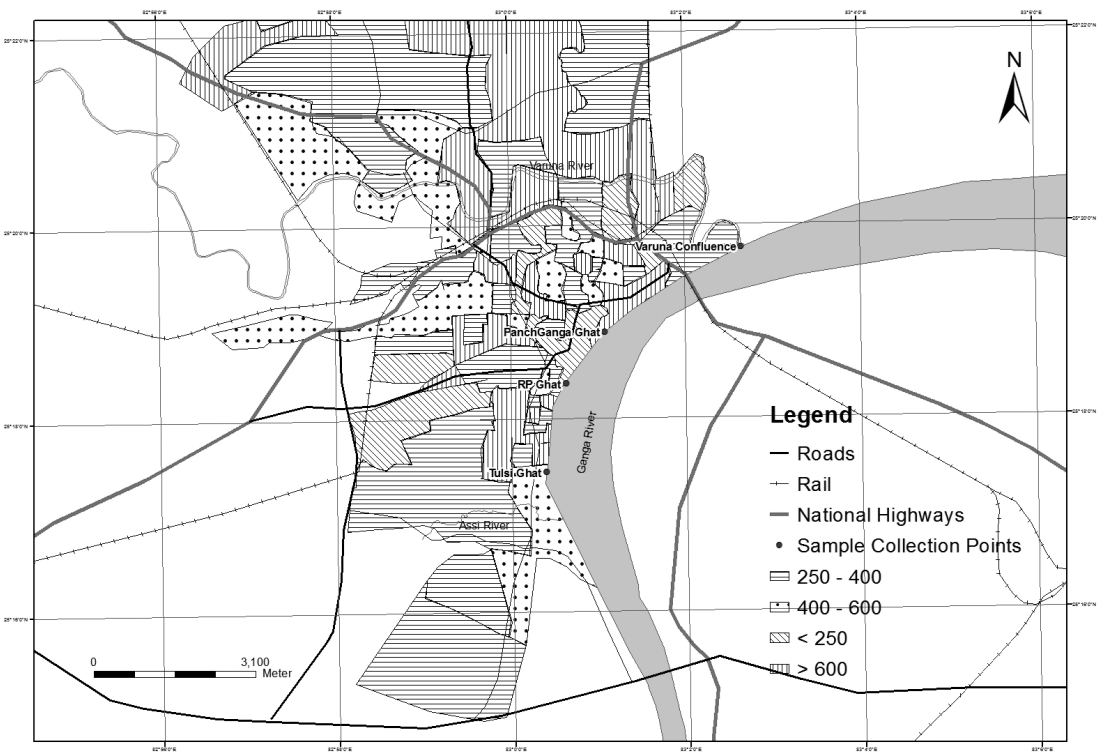

Figure 5. Population Density in and around the Study Area (Unit: number of people/ha)

Source: Made by the authors using data collected from Varanasi Nagar Nigam and data collected in field surveys conducted in Varanasi in May–June 2011.

Very recent surveys and talks done by the author in different parts of the city prove this fact. Because of this, water-borne diseases are way too common in many parts of the city. People who cannot afford costly water purifying systems are forced to drink the supplied water directly which causes severe health problems.

Conclusion

Water quality of Ganga river in Varanasi is unacceptable for potable or for farming purposes and it is getting worse. Discharge of nearly all liquid and solid wastes in the river by various point sources is contaminating the river to a very high extent and soon a condition may arise from where return or repair may not be possible. Presence of only 100 MLD worth of sewage treatment plants for better part of the decade even though the actual sewage production in the city is more than 300 MLD for a long time now, is unacceptable. The water supply and sanitation system of the city requires a major overhaul, before the situation becomes even worse. Continuously worsening quality of water of the Ganga river shows that the various government plans to cleanse the river has failed and is still failing to do their job. Untill the objective of cleaning the Ganga is achieved, people should be educated and informed about the situation of the river quality so that the use of its water for daily purposes is stopped. Alternate clean water resources for people living in the slums are to be provided.

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Shikhar Kumar (corresponding author), PhD Student, RWTH Aachen University, Department of Engineering Geology & Hydrogeology, Lochnerstr, Aachen, Germany.
E-mails: shikhar5070@gmail.com; kumar@lih.rwth-aachen.de

Pallavi Jha, Department of Civil Engineering, National Institute of Technology Rourkela, Orissa, India.

Klaus Baier, Dr.rer.nat., Scientist, RWTH Aachen University, Department of Engineering Geology & Hydrogeology, Lochnerstr, Aachen, Germany.

Ramakar Jha, PhD (Civil Engineering), Professor, Department of Civil Engineering, National Institute of Technology, Rourkela, Orissa, India.

Rafig Azzam, Professor Dr.rer.nat., Dr.h.c., RWTH Aachen University, Department of Engineering Geology & Hydrogeology, Lochnerstr, Aachen, Germany.