



(RESEARCH ARTICLE)



## Water quality assessment, reasons of river water pollution, impact on human health and remediation of polluted river water

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### Abstract

Bangladesh is a land of rivers. The pride of Bangladesh is her rivers with one of the largest networks in the world. The Rivers of Bangladesh play an important role in the wealth of our country. The prosperity of agriculture and fisheries are depending on the rivers. But our resourceful rivers become polluted day by day due to over growth of population and uncontrolled industrialization and urbanization, which is deploying harmful impacts both on human health as well as aquatics ecosystem and environment. Improper management of industrial and sewage effluents are major causes of river water pollution. The microorganisms within the water are prime sources to cause different water borne diseases like Diarrhea, Cholera, Scabies, Asthma etc. To find out the remedies to this problem, urgent emphasis should be given on preventive measures and to take appropriate steps to improve the existing pollution of the rivers. A lots of water treatment systems like physical chemical treatments, microbial remediation, wetland remediation etc. are being practiced throughout the world to restore the health of the rivers. So, our government should take necessary steps to prevent river water as soon as possible.

**Keywords:** Water pollution; Water quality parameter; Water borne diseases; Chemical and physical remediation; Wetland remediation

### 1. Introduction

Water is called as life without pollution but death when it is polluted. Water pollution is the release of substances into bodies of water that makes water unsafe for human use and disrupts aquatic ecosystems. Water pollution is the contamination of water bodies, usually as a result of human activities. River water plays a vital role in our life but now-a-days they are drowning in chemicals, waste, plastic and other pollutants. Water quality is a big issue that mankind is facing in recent year. As per WHO reports 80% of our diseases are water borne [1].

Bangladesh is riverine country. There are many rivers in Bangladesh. The number of rivers in Bangladesh is often 700. Often 310 and it also has 58 trans-boundary rivers. It has total Length of 24140 Kilometers. The Rivers contain water body huge amount, most of them used for agricultural land for irrigation to produce food products. A protected environment is needed to our comfortable and safe life. At present now, Environmental degradation, river bank erosion is a common factor in Bangladesh, and it is increasing day by day. Water is the most important part of our life because we use water in our everyday life and it is needed for human being or all plants, animals and aquatic life etc. It is a natural renewable source any cultural or civilization depends on the availability of water [2].

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**Figure 1** Main rivers of Bangladesh

River water has a great impact in the environment but it is polluted in many ways. These include deforestation, agricultural activities, and industrial and urban development. Rapid human population increase and uncontrolled human activities have led to pollution of the river [3]. Polluted water is very harmful for the living beings and as well as for the environment. It is not only affecting the life of present generation but it also affect the life of upcoming generations because its effect remains for long. If water is polluted in a area, then the all living creatures and people are faced to drink polluted water because they have no other option. It affects their bodies, skin, lungs, brain, liver and kidneys, caused cancers, birth defects and other diseases. Water borne diseases like Blackfoot, Flurosis, Cholera, Jaundice, Diarrhoea, Tuberculosis etc. can be caused by drinking polluted water [4]. To solve the problem, we have to take several measures like we can restrict the ways of polluting the river water through enforcing laws. Though The Environment Conservation Law (1995) is established in Bangladesh, it has been failed to be proved as fruitful in reducing pollution. According to this, some effluent treatment plan (ETP) can serve the purpose of making the waste material reusable and safely disposable by recycling it through multiple physical, chemical and biological processes. So by creating awareness among people, taking preventive measures, and installing water treatment plan this river pollution can be addressed [5]. River water pollution is a burning issue now-a -days. This paper is representing an overall picture of Water quality assessment, reasons of river water pollution, their negative effects and remediation.

## 2. Water Quality Assessment

Water occupies 71% of the earth's surface and it is a key component of the environment. It is one of the most demanded of all urban and rural amenities and it is indispensable for man's activities. Water is a resource that has many uses, including recreation, transportation, hydroelectric power and domestic, industrial and commercial uses. Although more than three quarters of the Earth's surface is made up of water, only 2.8 percent of the Earth's water is available for human consumption. Rivers play a major role in assimilation or carrying off of municipal and industrial wastewater and runoff from agricultural land, the former constitutes of constant polluting non- point sources whereas the later is a seasonal phenomenon. With the rapid development in agriculture, mining, urbanization, and industrialization activities, the river water contamination with hazardous wastes and wastewater is becoming a common phenomenon [6]. To assess the level of pollution status of the river a number of physiochemical parameters are measured. They are (a) pH (b) Electric conductivity (c) Temperature (d) Total dissolved solid (TDS) (e) Total Solids (TS) (f) Total Alkalinity (g) Dissolved oxygen (DO) (h) Chemical oxygen demand (COD), (i) Biochemical oxygen demand (BOD), (j) Total Hardness and different dissolved metals and substances.

Different Water Quality Parameters and Their Recommended Levels

**Table 1** Different Water Quality Parameters and Their Recommended Levels [7]

Water quality parameters	Bangladesh Standards (mg/L)	WHO Guide Line	Water quality parameters	Bangladesh Standards (mg/L)	WHO Guide Line
p H		6.5-8.5	Chloride	150-600	
Electric conductivity	-us/cm		Chlorine	0.2	
Temperature	20-30C		Na	200	
TDS	1000		K	12	
Iodine	200-500		Color	15 Hazen	
Total Alkalinity			Iron	03-1.0	
DO	6		Lead	0.05	
COD	4		Ni	0.1	0.02
BOD	0.2		Phosphate	6	
Total Hardness	200-500		Zinc	5	
Mercury	0.001	0.001	Al	0.2	
Turbidity	10 NTU		Ammonia	0.5	
As	0.05	0.01	Silver	0.02	
Cd	0.005	0.003	Chloroform	0.09	0.2
Ca	75		Coli Form	0 CFU (N/100ml)0.01	

### 2.1. Reasons of river water pollution

Generally, the pollutants come from three prominent sources

- discharge of sewage into the river,
- discharge of industrial effluents into the river without any pretreatment and
- Surface run off from agricultural land, where chemical fertilizers, pesticides, insecticides and manures are used.



**Figure 2** Discharges of waste into the river

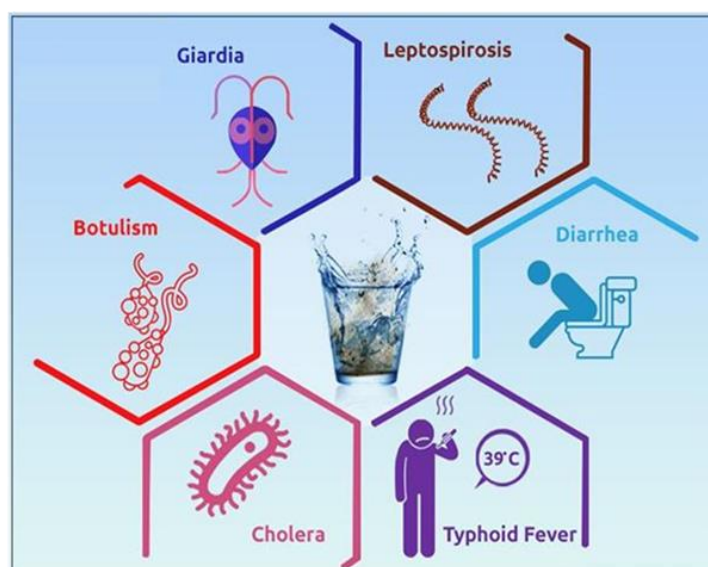
For this reason, the river water become unsafe for drinking and bathing. About 1500 substances have been listed as pollutants in freshwater ecosystems and a generalized list of pollutants includes acids and alkalies, anions (e.g. sulphide, sulphite, cyanide), detergents, domestic sewage and farm manure, food processing water, gases chlorine, ammonia), heat, metals (cadmium, zinc, Lead), nutrients (phosphates, nitrates), oil and oil dispersants, organic toxic wastes (formaldehydes, phenols) pathogens, pesticides, polychlorinated biphenyls and radionuclides, in addition to oxidizable materials, domestic sewage contains detergents, nutrients, metals, pathogens and a variety of other compounds [8]. In Bangladesh the river which is situated close to city become more polluted. For an example research has been done for four central rivers of Bangladesh, where it has been shown that the river which situated very close to the capital Dhaka found more polluted due to large number of urban waste goes directly to the river [9].

## 2.2. Negative effects of River water pollution

River water pollution does a lot of harms not only for human health but also for the environment as well as other living being. Some of the negative effects are described as follows.

### 2.2.1. Effects on Human health

Some of the chemicals and heavy metals such as Fluoride, Arsenic, Lead, Cadmium, Mercury, petrochemicals, chlorinated solvents, pesticides and nitrates which are present in water can cause harm to human health. Fluoride in water is essential for protection against dental carries and weakening of the bones. Concentration below 0.5 mg/l can cause dental carries and mottling of teeth but exposure to higher levels above 0.5 mg/l for 5-6 years may lead to adverse effect on human health leading to a condition called fluorosis. Arsenic is a very toxic chemical that reaches the water naturally or from wastewater of tanneries, ceramic industry, and chemical factories and from insecticides such as lead arsenate, effluents from fertilizers factories and from fumes coming out from burning of coal and petroleum. Arsenic is highly dangerous for human health by causing respiratory cancer, arsenic skin lesion. Long exposure leads to bladder and lungs cancer. Lead is contaminated in the drinking water source from pipes, fitting, solder, household plumbing systems and it affects the blood, central nervous system and the kidneys. Child and pregnant women are mostly prone to lead exposure. Mercury is used in industries such as smelters, manufactures of batteries, thermometers, pesticides, fungicides etc and it causes human disable and also cause death [10].



**Figure 3** Water borne disease in human

In developing countries, different enteric diseases are occurred due to water borne diseases among which Cholera is contributing to the highest share of total cases measuring 3-5 million cases and 100,000 - 130,000 deaths annually all together. In fact, Bangladesh is a red zone for cholera. In the year 2004, Bangladesh Demographic and Health Survey (BDHS) also published that 5.1% under five children deaths and 1.2% neonatal deaths were related to diarrhoea [11].

If we drink water which is contaminated with various microbiological organisms causes these enteric diseases, for example, Diarrhoea, Cholera, Dysentery, Typhoid, Hepatitis B and A, Polio, Ascariasis, Cryptosporidiosis etc. They can also cause skin diseases like: scabies, dermatitis, respiratory diseases like: asthma, lung cancer, urinary tract infection,

meningitis, septicemia etc. The water mixed with pesticides also causes nausea, vomiting, blurred vision, breathing difficulty, and coma [12].

### *2.2.2. Effects on Aquatic Plants and Organisms*

In polluted water, decomposer use up the dissolved oxygen which is obligatory for the aquatic plant and lives. So, reduced DO level caused the hamper of the eggs and larva to survive, reduction in growth as well as death of the adult and juvenile aquatic lives. Moreover, impaired physico-chemical properties of water, like attenuated BOD, COD level, salinity of water, increased TDS and CO<sub>2</sub> facilitates the growth of pathogenic bacteria leaving the water inappropriate for aquatic fish, lives and environment hampering the biodiversity consequently [13].

### *2.2.3. Effects on Agriculture and Soil*

River water usually used for agricultural purpose in most cases. So, when the river water gets polluted, and therefore used for irrigation activities, it pollutes the soil as a consequence. Farmers themselves often opine that, if they would not have to use the contaminated water, the soil would not be damaged [14]

### *2.2.4. Effects on Animals*

By drinking the polluted water, cattle are also suffered from sore mouth, skin conditions. This can be happened even if they are washed using this polluted water. In addition, these pollutants through the water enter the food web and become deleterious to the birds, fish, and mammals [15].

## **2.3. Impacts on Economy**

This pollution of river hinders the development of river based tourism and recreational activities which could be a potential source of income and a strength for the economy [15].

## **3. Remediation**

Water pollution causes a severe threat to ecological safety in the world. Therefore it is urgent to develop remediation technologies to prevent the deterioration of surface water quality and maintain a healthy aquatic ecosystem [16]. Some remediation are describes as follows.

### **3.1. Physical and Chemical Remediation**

#### *3.1.1. Aeration*

Aeration can restore and enhance the growth and the vitality of micro-organisms to improve the water quality. This technology is very simple and effective method which began to be utilized since the early river restoration. In practical applications, many factors should be taken into account, such as channel conditions, source characteristics, water quality improvement requirements, etc. and the fixed aeration, mobile aeration and water aeration are selected limberly when it can be achieved to deal with the sudden pollution for improving water quality over a short period. Since the 1960s, the mobile oxygenation platform was used as well as the fixed aeration station in the river aeration, which was the common method and was applied in some countries [17]. Currently, the utility of river aeration technology has relatively been mature in foreign countries, and the research and practical applications showed that the artificial aeration can improve water quality effectively. For example the aeration equipment was used in the treatment of the Homewood Canal of U.S. in 1989, which increased the dissolved oxygen in bottom water and by which the biomass of river became enriched. The river aeration was used to improve the river water quality effectively in Germany in 1994. The river aeration technology was used to eliminate the phenomenon of black-odor of water thoroughly in Busan, South Korea. In order to improve the environment, eight aeration equipment's were placed in Qing River with each power of 11.025 KW during Beijing Asian Games as early as 1990, which made the level of dissolved oxygen rose from 0 to 6mg/L, and the removal rate of BOD 5 also reached 60%. This process almost eliminated all odors in the river [18].

#### *3.1.2. Water transfer/ Diversion*

The clean water could dilute polluted rivers and thus results in the black and stink of water body eliminate quickly, the self-purification capacity of water body improved. The water diversion to flush out pollutants was used in Fuzhou, Zhongshan and other cities in China, while the calculation of diversion scale was the key technology based on the effluent water quality. For example, Hong Lijian analyzed the effect of flushing out pollutants of diversion scale about Fuzhou River, which was applied to engineering design. It is feasible to control river pollution through water diversion [19].

### 3.1.3. Removal of Algae by Chemical Agent

The commonly used chemical agents for algae removal were copper sulphate, bleaching powder, alum, poly aluminum and ferrous sulfate, etc. It could remove the algae effectively and reduce or even eliminate the smell of water to put the copper sulfate and change the value of water PH; the calcium hypochlorite can kill the green algae, cyanobacteria and diatoms causing the water bloom effectively [20].

### 3.1.4. Dredging river sediment

This method involves removal of polluted sediment by dredging machine & thus improve river water environment. It is cost intensive mechanical process [21].

### 3.1.5. Hydraulic Structures

The construction of hydraulic structures like irrigation weirs or irrigation infrastructure on the river can improve water quality and make the river water suitable for irrigation [22]. The installation of irrigation weirs on the river reduces water flow velocity but increases hydraulic retention time, which facilitate sedimentation, aeration, sunlight irradiation and anaerobic reactions, resulting in improving water quality. The protection of riverbanks using appropriate materials can enhance the riparian biodiversity and ecosystem restoration process [23].

### 3.1.6. Riverbank Filtration

Riverbank filtrate includes both groundwater and river water that has percolated through the riverbank or riverbed to an extraction well. One of the primary objectives of this study was to assess the pollutants removal capabilities of RBF independent of any groundwater dilution. RBF systems can significantly reduce the concentrations of many surface-water pollutants [24].

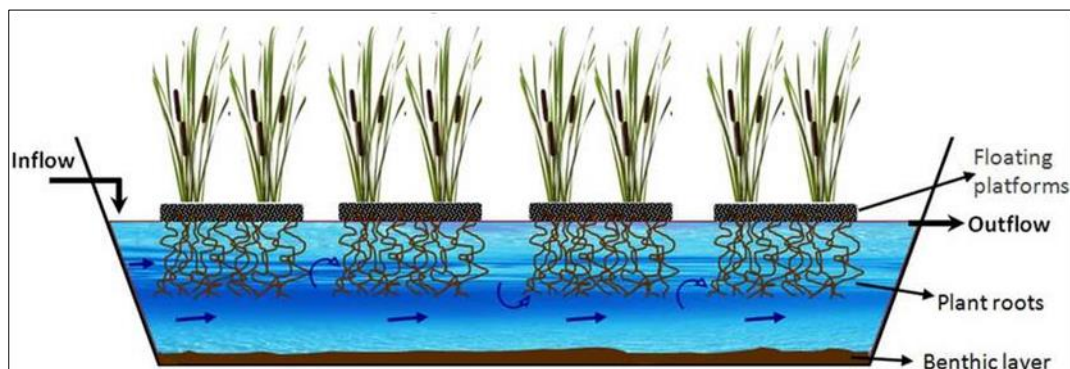
**Table 2** Efficiency, advantages and disadvantages of different treatment methods of river water [25]

Treatment Techniques	Process Description	Advantages	Disadvantages
Artificial aeration	Air flow into river- water increases microbial diversity and degrades organic compounds in water.	Effectively improve water quality, simple and easy to apply, sustainable and widely applicable.	Cost intensive during operation and maintenance phase.
Water transfer/diversion	Mixing of clean water with polluted river water and dilution of pollution.	Improve river water quality, water supply, river pollution control, promote self-purification process.	Potential destruction of ecosystem, cost and labour intensive.
Mechanical algae removal	Removal of algae by mechanical process.	Improve river water and sediment quality.	Cost intensive during operation and maintenance phase.
Dredging river sediment	Removal of polluted sediment by dredging machine.	Improve sediment and river water environment.	Potential increase of pollution, cost intensive mechanical process.
Building hydraulic structure	Irrigation weirs or infrastructure built on the river	Improve river water quality for irrigation purposes.	Potential destruction of ecosystem, health, cost intensive
Riverbank Filtration	Flow through riverbed and groundwater aquifer to the pumping wells.	Remove organic and inorganic contaminants through natural filtration process	Slow process.

## 3.2. Floating Treatment Wetlands (FTW)

Floating treatment wetlands (FTW), an innovative approach, offers a practical solution for treatment of polluted river water. It is composed of vegetative plants on a floating mat through which the roots grow and hang within the water

column. It depicts properties of both pond and conventional wetlands as it is an inventive combination of these technologies. It can be installed in any pond or river without digging, earth moving or additional land acquisition and does not reduce the storage volume of the water body. The ability of FTW to withstand water fluctuation and inundation makes it perfect for its application in pond and river systems. In addition to that, installation of FTW in water bodies also provides habitat for wildlife such as fish, invertebrates and birds.



**Figure 4** Floating treatment Wetland

In FTW, organic matter, nitrogen and phosphorus are removed by plant–bacteria interactions through decomposition, assimilation, denitrification, sorption, entrapment in roots and finally sedimentation. The roots of plants absorb nutrients directly from the surrounding water and provide support for the attached microbial community. Biofilm on roots and endophytes within the aerial tissue of plants boosts up the decontamination process of wastewater. Bacteria degrade complex organic pollutants, assimilate nitrogen and phosphorus and reduce concentrations of nitrate, phosphate and heavy metals in polluted water by their metabolic and non-metabolic processes. Rhizospheric and endophytic bacteria also promote plant growth and surge the resistance to biotic and abiotic stresses [26].

### 3.3. Microbial remediation

In our communities drinking water usually sourced from rivers, springs and underground source. Some form of treatment is carried out to ensure the water is ok to drink. In many developing countries, one source of water can serve many uses such as drinking, washing, swimming, bathing, etc. In the same vein, sewage can be channeled into water bodies. Sewage can be defined as used water draining out of homes and industries that contain a wide range of debris, chemicals, and microorganisms. Such water is regarded as potential health hazard to consumers or the users of other sort. A major kind of hazard is the presence of pathogenic organisms in such water. This is why water is usually treated in three phases [27]. The first is to separate large matter in the water source and the second stage focuses on removing more toxic substances and other matter and the tertiary phase involves total purification of water commonly by chemical disinfection. More recently, membrane bioreactors are being used and have been found to be very efficient in removing contaminants [28]. A very recent advancement in the biological treatment of wastewater is the use of membranes in bioreactors, where the membrane can serve three major purposes. Firstly, membranes can be used as a surface for the attachment for growth of organisms and to permit oxygen to permeate into the biofilm. An example of this is the hollow-fiber gas-permeable membranes in wastewater treatment. Such membrane is produced from microporous, hydrophobic polypropylene and allows almost 100% oxygen transfer while ensuring high biomass density within the space. The second way membranes can be used as selective barriers. Such membranes permit organic compounds in wastewater to permeate but do not transport ions into the bioreactor. Thus, it allows for the selection of biodegradable organic compounds. An example of a material used for such membrane is silicone rubber. Finally, membranes can be for biomass separation. This third category requires that the membrane be used instead of a clarifier after activated sludge treatment. When such membranes are used, the effluent produced is of high quality and less sludge. In addition, automated processing can be easily employed. The disadvantage however is the financial enormity of the investment for initial start-up as well as maintenance [29, 30].

## 4. Conclusion

Water is indispensable part of our lives as well as other animals and environment. It plays very significant role for all living organisms. Rivers are the main source of water, which is used for various purposes like agricultural use, industrial activities and also used as inland transportation. But polluted water causes great harm for human and other living beings. When human drinks polluted water, it has serious effects on their health. Water pollution can also cause various

diseases, death of aquatic animal's, destruction of ecosystems, disruption of food chains and so on. Water pollution is a worldwide issue. The best things we can do to prevent water pollution is to educate ourselves in order to protect the water resources. It is recommended that there should be proper waste disposal system and waste water should be treated before entering into the river. To control the pollution different types of educational and awareness programs, seminars, workshops should be organized. More studies should be conducted on different water treatment systems and installed and practiced like other developed countries to bring positive changes for the aquatic environment.

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## Compliance with ethical standards

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The author declares that there is no conflict of interest regarding the publication of this paper.

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