GSC Advanced Research and Reviews

eISSN: 2582-4597 CODEN (USA): GARRC2

Cross Ref DOI: 10.30574/gscarr

Journal homepage: https://gsconlinepress.com/journals/gscarr/

(RESEARCH ARTICLE)

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Investigation of the water samples of six central rivers of Bangladesh

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GSC Advanced Research and Reviews, 2022, 10(03), 062–070

Publication history: Received on 04 February 2022; revised on 12 March 2022; accepted on 14 March 2022

Article DOI: https://doi.org/10.30574/gscarr.2022.10.3.0072

Abstract

Six central rivers of Bangladesh were selected for this investigation. The name of the rivers are Meghna, Shitalakshya, Dhaleshwari, Padma, Buriganga and Turag. The Electrical Conductivity (EC), pH, Total Dissolved Solid (TDS), Salinity, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Turbidity of the six river waters were evaluated. The EC values of the water of the Meghna, Shitalakshya, Dhaleshwari, Padma, Buriganga and Turag rivers were found to be 202.8, 225.8, 362, 264.4, 586 and 609 µS/cm respectively. The EC values were found higher for the Turag River water than that of the other five river waters. Similarly, the pH values of 6.8, 6.8, 6.6, 6.5, 6.4 and 6.5 were found for the river waters of the Meghna, Shitalakshya, Dhaleshwari, Padma, Buriganga and Turag respectively. The pH values were found lower for the Turag river water than that of the other five river waters. The TDS and salinity of the Turag river water were found 305 ppm and 1.2% respectively. On the other hand, the TDS and salinity of the Meghna river water was found 101.4 and 0.4% which is lower compared to the other five rivers. From this research, this is clear that the quality of the Meghna river water is much better than the river waters of the Shitalakshya, Dhaleshwari, Padma, Buriganga and Turag. The quality of the Turag river water was found inferior. The Turag is one of the most important rivers of Dhaka city, the capital of Bangladesh, and a large number of unban waste goes directly to the river Turag. As a result, the water of Turag river became deteriorated. This investigation proved that the Meghna river water quality is still much better and suitable for many applications.

Keywords: River Pollution; Electrical Conductivity; TDS; Salinity; Environmental Pollution

1. Introduction

Water is the most important that profoundly influence life. But nowadays it is becoming threat to us. Water resources are mostly polluted by industrial waste. The pollution of rivers is more severe and critical near urban stretches due to huge amounts of pollution load discharged by urban activities. Unplanned urbanization and industrialization occurring in these countries like Bangladesh, India, Nepal and Sri Lanka, etc. may be largely responsible for this grave situation. Rapid industrialization and indescriminate use of chemical furtilizer and pesticides in agriculture are causing heavy and varied pollution in aquatic environment leading to deterioration of water quality and depletion of aquatic biota [1-3]. Rivers in underdeveloped and developing countries are widely used as waste disposal sites for domestic and industrial waste. The waste contains various types of contaminants that contribute to the poor quality of river water [4].

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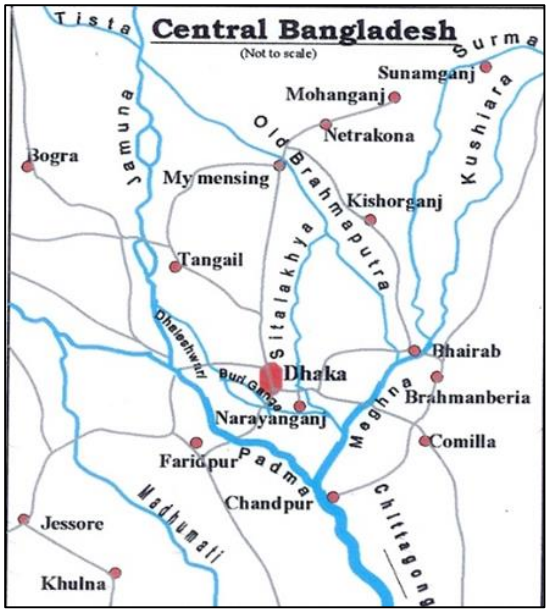

Figure 1 Map of the rivers of Bangladesh

Bangladesh is a land of river. In our country, there has not been much research on human health impacts due to water pollution where we probe to understand it better. The adverse impacts of these pollutions are also destroying the aquatic ecosystem and hampering environmentally and economically as well. So addssing this issue has become obvious to restore the river, most specifically Meghna, Shitalakshya, Dhaleshwari, Padma, Buriganga, Turag etc. [5]. More than 230 rivers flowing across Bangladesh. Dhaka City, the capital of Bangladesh, is one of the most overcrowded cities in the world with a population of more than 16 million. Dhaka is located on the bank of the Buriganga river and is surrounded by the rivers Turag, Dhaleshwari, Balu, and Shitalakkhya. Most of the industries and factories are situated on the banks of these five rivers or close to the river system. There are more than seven thousand industries located near these rivers. The rivers around Dhaka city are increasingly being polluted as a result of a huge volume of toxic wastes from industries and sewage lines. In this investigation, six central rivers of Bangladesh were selected for investigation. The name of the rivers are as follows: Meghna, Shitalakshya, Dhaleshwari, Padma, Buriganga and Turag. The combined water of these rivers gradually flows into the Bay of Bengal by the name Meghna river [6-10]. A brief description of the six central rivers of Bangladesh is given below:

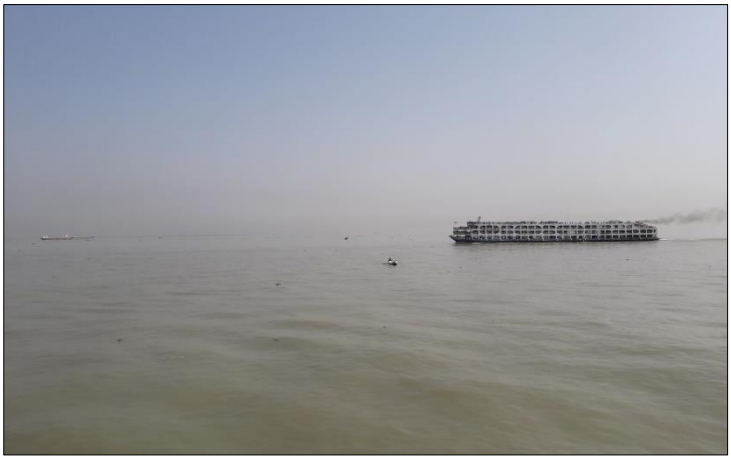

Figure 2 The Meghna River

The Meghna River is one of the most important rivers in Bangladesh. The water quality of Meghna has become a matter of concern due to pollution. Meghna River near Narsingdi Sadar is used as a river Ghat to move in various directions from Narsingdi District by cluster of wood made engine boats a waiting for passengers. The launch terminal is just steps away from this Ghat. There are a lot of textile mills and textile-related industries nearby. Moreover, dying industries and jute industries are also occupying in the catchment area. Therefore, the sources of pollution are various. The present

study was conducted to assess the surface water quality of upstream of the Meghna River using physic-chemical parameters. Water quality was evaluated by laboratory analysis considering water quality parameters. The study indicates that some parameters exceed the permissible limit for drinking purpose, it may cause potential threat to the human, but the water of this river is not immediate threat to human or ecosystem [11-12].

Figure 3 The Shitalakshya River

The Shitalakshya is one of the Distributary Rivers of Brahmaputra in Bangladesh. It was famous for the muslin industry in the past. Initially, it flows to the southwest direction. Later, it changes its path to the east of Narayanganj and then it comes to at one place with Dhaleswari near Kalagachhiya. Banar River is its upper course's portion [13]. Different type of industrial bodies are installed on both the side of the river especially in the Narayanganj part of the river. There are lots of industries especially dyeing and textile have been established in this area. More than 80% industries have no effluent treatment plant (ETP) or directly and indirectly dumping their wastes into the Shitalakshya River. The wastes, effluents and agrochemicals contain heavy metals, toxic substances, germs and nitrogen containing toxic substances which contaminate the natural system of Shitalakshya River and it actually acts as a sink. So, the Shitalakshya river needs attention to save it from gradual degradation process [14].

The Dhaleshwari River is a distributary which is 160 kilometers long, of the Jamuna River in central Bangladesh. The Bangshi river is an important tributary of the Dhaleshwari River. It originates from the foot of the Madhapur tract. The river flows through the eastern part of Mymensingh district and travels southwards to fall into the Dhaleshwari after entering Dhaka district near the junction of Savar and Kaliakair upazilas. This river is heavily polluted by the industrial effluent discharged by the Dhaka Export Processing Zone (DEPZ) [15]. It is located at Savar in which about 86 industries already exist. These industries generate a large amount of effluent every day and discharge into the adjacent irrigation channels and wetlands which finally pass into the adjacent river. People living near the rivers, having no alternative, are forced to use polluted river water. Some also use the water because they are unaware of health risks. This causes spread of water borne and skin diseases [16].

The Padma river coming from India enters Bangladesh in Chapai Nawabganj. It flows through several districts and finally meets Meghna River in Chandpur. It has been found higher coliform and Vibrio cholera counts in river water during summer season. Zn, Cu, Pb, Cd, Mn and Cr concentration in popular fish species from Padma River was analysed and found that continuous consumption of fishes from Padma River may cause serious health injuries. River flowing beside the Rajshahi city receives pollutant loads through drains and canals from city. Acute deforestation is occurring in this area. Open waste dumping, sewerage line, industrial effluents and domestic water continuously affect the river water quality. Besides, inorganic fertilizers, pesticides, insecticides washed out from agricultural field comes to river water [17].

The Buriganga river is one of the largest rivers in Bangladesh and flows through west and south of Dhaka. It is considered the lifeline of Dhaka city because it is a source of water used by the city residents for bathing, drinking, irrigation and industrial purposes. This river is a tide-dominated river passing through west and south of Dhaka. In ancient times one of the courses of the Ganges used to touch the Bay of Bengal through Dhaleshwari. This course gradually shifted and eventually lost its connection with the main channel of the Ganges and was changed the named as the Buriganga. The water quality of this river has become a matter of concern due to anthropogenic intervention of vital pollutants such as industrial effluents, urban sewage and solid wastes in this area. Buriganga River is at risk to the contamination from untreated municipal wastes, industrial discharges, runoff from organic and inorganic fertilizers, pesticides, insecticides, and oil emission around the river [18-20].

The Turag is an important river. Turag River of Bangladesh is a tide-influenced River flowing through west-north and north of Dhaka City. Turag river is an upper tributary of the Buriganga River and originates from the Bangshi River that flows through Gazipur and joins with the Buriganga River at Mirpur, Dhaka. The catchment area of the Turag is located in the southern part of Modhupur, which covers 999.74 km2. The Turag represents an important feature of the Dhaka City lifestyle because of the abundance of fish. Unfortunately, the uncontrolled dumping of industrial waste from the industries located along the banks of the river has greatly increased the river water pollution to a significantly dangerous level. The majority of the industries have made little effort to follow environmental law, and the water has become visibly discolored and polluted [21-22].

Figure 4 The Turag River

The major pollution sources of Turag River water are various consumer goods industries (soap and detergent), garments industries, pharmaceuticals industries, dyeing industries, aluminum industries, battery manufacturing, match industries, ink manufacturing industries, textile, paint, iron industries, pulp and paper factories, chemical factories, frozen food factories and steel workshop etc. The Turag River has been declared as ecologically critical areas (ECA) by the Department of Environment. Study on Turag River water quality was carried out in different time by Department of Environment. But the various industries besides the Turag River are continuously discharging their effluents and waste water into the Turag River and seriously polluting the river water. As a result, the values of different physiochemical parameters are continuously changing at an alarming rate in this river water [10, 21-22].

2. Material and methods

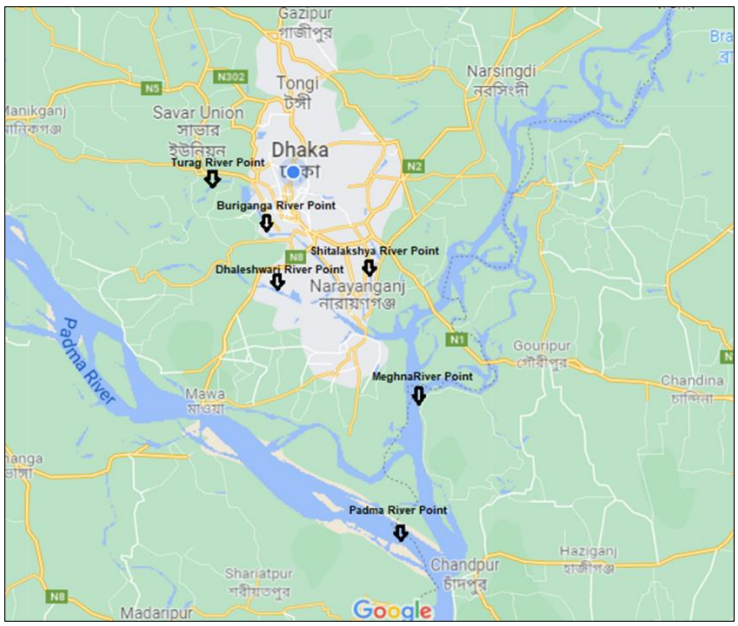

Figure 5 Sample collection points of the six rivers are indicated in the figure by black marked lines

Six points of the Six central rivers of Bangladesh were selected in this investigation. The points of the rivers are shown in above Figure 5.

River water samples were collected in the dried plastic bottles. The Hydrogen ion concentration (pH) was determined by a digital pH meter (Model edge® HI2002 digital pH meter, Hanna Instruments, USA). The electrical conductivity (EC), total dissolved solid (TDS), and salinity of the river water samples were analyzed by combined digital EC meter (Model HI2003-01, edge® Dedicated Conductivity-TDS-Salinity Meter, Hanna Instruments, USA). The DO and BOD were measured by Dissolved Oxygen and BOD meter (Hanna HI 98193). The testing of the water samples was carried out at 28 °C. The river water samples were collected on 3rd December 2021.

3. Results and discussion

Six points of six rivers of Bangladesh were selected for this investigation. The name of the rivers is Meghna, Shitalakshya, Dhaleshwari, Padma, Buriganga and Turag. Six samples of each point of the rivers were examined. The values presented here are the mean of that six samples. The Electrical Conductivity (EC), pH, Total Dissolved Solid (TDS),Salinity (%NaCl), DO, BOD and turbidity of the river waters were evaluated. The results with discussion are reported as follows.

3.1. The Electrical Conductivity (EC)

The EC measures the concentration of ions in water. The concentration of ions depends on the environment, movement and sources of water. The soluble ions in the surface water originate primarily by the dissolution of rock materials. Conductivity of an electrolyte solution is a measure of its ability to conduct electricity. The SI unit of conductivity is Siemens per meter (S/m). Conductivity measurements play a vital role in many industrial and environmental applications. The EC measurment is a rapid, easy, and reliable way of measuring the ionic content in water. Electrolytic conductivity of water is a function of temperature. Generally, conductivity is directly linked with the total dissolved solids in water samples. The EC value of high quality deionized water is about 0.5 µS/cm at 25°C, for drinking water 200 to 800 µS/cm. Sea water has a high value of EC, around 50,000 µS/cm [23-25].

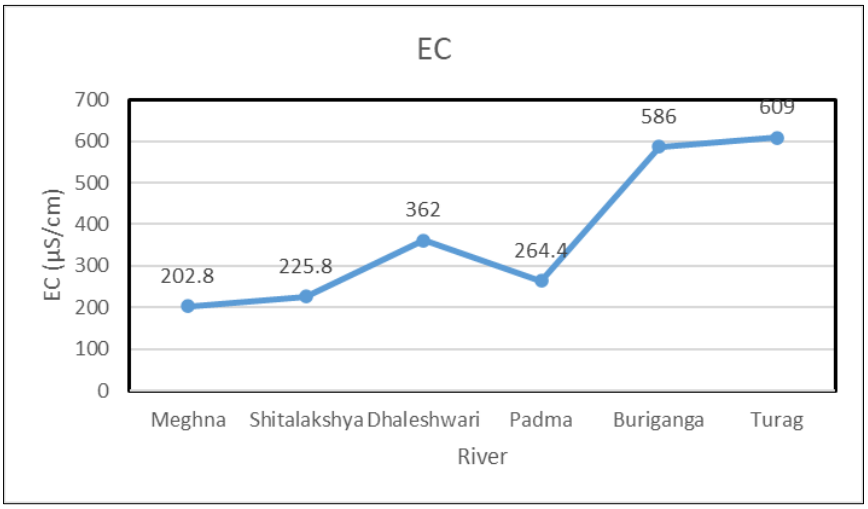

Figure 6 The EC values of the water samples of six central rivers of Bangladesh

The EC values of water samples of the Turag, Buriganga, Padma, Dhaleshwari, Shitalakshya and Meghna rivers were found to be 609.0, 586.0, 264.4, 362,225.8 and 202.8 µS/cm respectively. The EC values of the water of Turag river (609.0 µS/cm) was found higher than other five river water samples. The lowest EC value was reported for the Meghna river water (202.8 µS/cm). The EC values of the Six river waters are reported in Figure 6 . A significant reduction of EC values was noticed comparing to the water of Meghna with Turag river water.

From this investigation, this is clearly indicated that the Meghna river water quality is much better than that of the river Turag. Actually, Turag river is flowing on the bank of the Dhaka city, capital of Bangladesh. A lot of urban and industrial wastes are going to the Turag river and the river water became polluted. The Turag river ranks among the most polluted rivers in Bangladesh. The distance between Meghna river (Chandpur point) and Turag river (Birulia bridge point) is about 66.68 nautical miles or 123.5 kilometers. In this investigation, Birulia bridge point of Turag river and near Chandpur launch terminal point of Megha river were selected.

3.2. The pH Values of the River Water Samples

Basically the pH value is a good indicator of whether water is hard or soft. The pH of pure water is 7. In general, water with a pH lower than 7 is considered as acidic, and with a pH greater than 7 is considered as basic. It indicated that the Meghna river water quality is near to neutral.

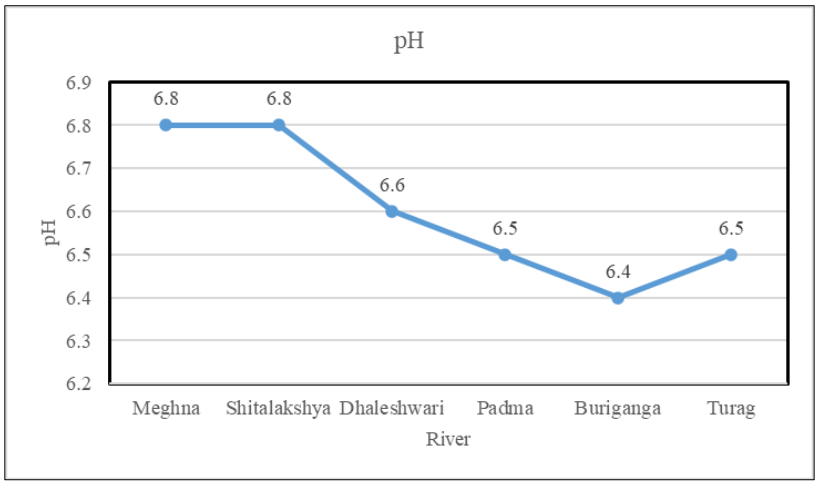

Figure 7 The pH values of the Six central river waters of Bangladesh

The normal range for pH in surface water systems is in the range of 6.5 to 8.5. The higher values of pH represent that there is high chloride, bicarbonate, carbonate in the water samples that means the water is alkaline [26-28]. The pH values of the waters of the the Turag, Buriganga, Padma, Dhaleshwari, Shitalakshya and Meghna rivers were found to be 6.5, 6.4, 6.5, 6.6, 6.8 and 6.8 respectively. Figure **7** showed the pH values of six river water samples. From this investigation, it is clearly evidenced.

3.3. Total Dissolve Solids (TDS)

The TDS is defined as all inorganic and organic substances contained in water that can pass through a 2-micron filter. In general, TDS is the sum of the cations and anions in water. Ions and ionic compounds making up TDS usually include carbonate, bicarbonate, chloride, fluoride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, and potassium, but any ion that is present will contribute to the total. The organic ions include pollutants, herbicides, and hydrocarbons.

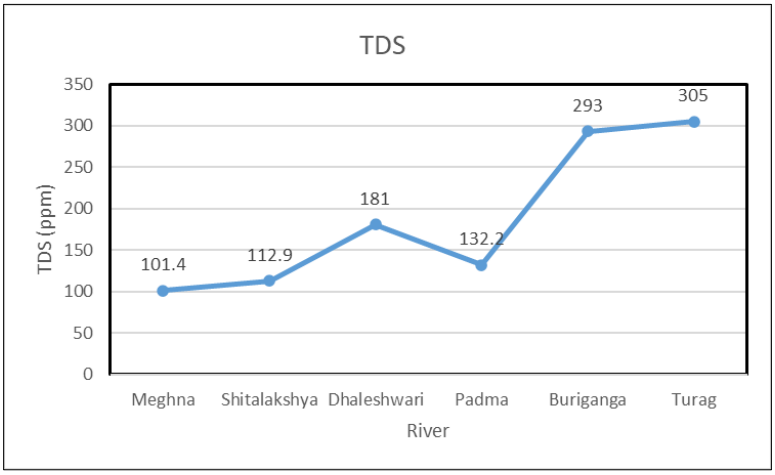

Figure 8 The TDS values of the water samples of six central rivers of Bangladesh

The TDS is measured by milligrams per liter (mg/l). The TDS of ocean water is around 35,000 mg/l, fresh water is normally less than 100 mg/l, and the rain water is less than 10 mg/l [25-27]. The TDS values of the water of the rivers of Turag, Buriganga, Padma, Dhaleshwari, Shitalakshya and Meghna rivers were found to be 305, 293,132.2, 181,112.9 and 101.4 ppm respectively. Figure 8 represented the TDS values of water samples of six central rivers of Bangladesh.

From this investigation, this is clearly evidenced that the Turag river water contains highest TDS values than that of the other five rivers of Bangladesh.

3.4. Salinity of the River Water Samples``

Salinity is simply a measure of the amount of salts dissolved in water. An estuary usually exhibits a gradual change in salinity throughout its length, as fresh water entering the estuary from tributaries mixes with seawater moving in from the ocean. Salinity is usually expressed in parts per thousand (ppt) or percent (%). Generally, the fresh water from rivers has a salinity of 0.05% or less and for ocean water this is more than 3% [25-28].

The salinity values of the water samples of the rivers the Turag, Buriganga, Padma, Dhaleshwari, Shitalakshya and Meghna rivers were found to be 1.2%, 1.10%, 0.50%, 0.70,0.40 and 0.40% respectively. Figure 9 showed the salinity values of the water samples of the six central rivers of Bangladesh.

From this investigation, this is clearly evidenced that the Turag river water contains highest salinity values (1.2%) than that of the other five rivers of Bangladesh. The lowest salinity values (0.40%) were reported by the water samples of the river Meghna. Therefore, this is clear that the Meghna river water quality is much better compared to the Turag river water. In fact, Turag river is situated in the capital city Dhaka. As a result, a lot of urban and industrial wastes are dischanges to the river Turag and thereby the river water became polluted. This is well known in Bangladesh that the Turag river ranks among the most polluted rivers in Bangladesh. This investigation also proved that. On the other hand, Meghna river water quality is much better than five other river waters specially the Turag river.

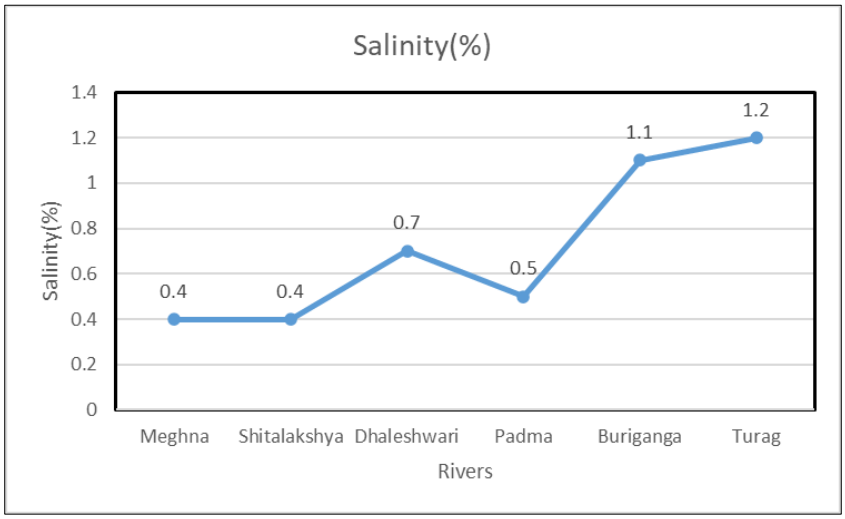

Figure 9 The salinity values of the water samples of six central rivers of Bangladesh

3.5. DO, BOD and Turbidity

Table 1 DO, BOD and Turbidity values of the rivers

River	DO (%)	BOD (Mg/L)	Turbidity (NTU)
Meghna	34.5	2.75	0
Shitalakshya	29.5	2.66	0.42
Dhaleswari	31.7	2.87	1.17
Padma	33.9	3.05	3.74
Buriganga	27.8	2.47	0.02
Turag	25.7	2.32	19.16

The DO values of the waters of the rivers Turag, Buriganga, Padma, Dhaleshwari, Shitalakshya and Meghna rivers were found to be 25.7,27.8,33.9,31.7,29.5 and 34.5 respectively. Table showed the DO values of six river water samples. The BOD values of the waters of the rivers Turag, Buriganga, Padma, Dhaleshwari, Shitalakshya and Meghna rivers were found to be 2.32, 2.47,3.05,2.87,2.66 and 2.75 respectively. The Turbidity values of the waters of the rivers Turag, Buriganga, Padma, Dhaleshwari, Shitalakshya and Meghna rivers were found to be 19.16, 0.02, 3.74, 1.17,0.42 and 0 respectively. From this investigation, it is clearly evidenced that the Meghna river water quality is good in compare to the other five rivers.

4. Conclusion

From the observed parameters it has been shown that the Megha river water quality is much better than that of the river Turag. The Turag river is flowing by the side of the capital city of Bangladesh, Dhaka. A lot of urban and industrial wastes are going to that river and the river water became very much polluted. This river is known as one of the most polluted rivers in Bangladesh. The quality of the river waters of Meghna, Shitalakshya and Padma were found better. The Meghna river water quality is good for marine environment. When moves from Turag to the downstream, the quality of the river waters is getting better. Finally, the values of EC, pH, TDS, salinity, DO, BOD and Turbidity of the river water of Turag is alarming. The quality of the water of the five rivers is comparatively better than that of the river Turag.

Compliance with ethical standards

Acknowledgments

The research work was supported by the Annual Development Project (ADP) of Bangladesh. The title of the project is: "Strengthening of existing gamma source of Bangladesh Atomic Energy Commission". Special thanks to The Ministry of Science and Technology and The Ministry of Planning, Government of the People's Republic of Bangladesh. Heartiest thanks to Shahariar Rahaman Romel, Ervin Zayan, Anjuman Lucky, Mehrab Hossain Alif, Kazi Mahmudul Haque and Jurana Jahan Deepti for their cooperation in this research work.

Disclosure of conflict of interest

All authors state that there is no conflict of interest.

References

[1] Khandakar m. Nahiun, Bijoy Sarker, Kamrun N. Keya, Fatin I. Mahir, Shahirin Shahida and Ruhul A. Khan. A review on the Method of Industrial waste water treatment. Academic Research Publishing Group. 2021; 7: 20-31.

[2] Bijoy Sarker, Kamrun N. Keya, Fatin I., Khandakar M. Nahiun, Shahirin Shahida and Ruhul A. Khan. Surface and Ground Water Pollution: Causes and Effects of Urbanization and Industrialization in South Asia. 2021; 7: 32-41.

[3] SP Gorde and MV Jadhav. Assessment of water quality Parameters: A Review. Open access. 2013; 3: 2029-2035.

[4] Aisien FA, Aisien ET and Shaka F. The effects of rubber factory effluent on Ikpoba river. Nigeria. Journal of Biomedical Engineering. 2003; 2(1):32-35.

[5] Jyoti Das, Nanda Karmaker and Ruhul A. Khan. Reasons and consequences of river water pollution and their remediation: In context of Bangladesh. GSC Advance Research and Reviews. 2021;07(1): 023-034.

[6] Kamal MM., Hansen AM, and Badruzzaman AB. M. Assessment of pollution of the river Buriganga, Bangladesh, using a water quality model. Water Science and Technology.1999; 40(2):129-136.

[7] Mowla QA. and Mozumder MAK. Deteriorating Buriganga river: It's impact on Dhaka's urban life. PSC Journal. 2015; 2(2): 01-10.

[8] MN Uddin, MS Alam MN Mobin and MA Miah. An assessment of the river water quality parameters: A case of Jamuna river; Environmental Science and Natural Resources. 2014; 7(1): 249-256.

[9] Begum Tahmina, Dey Sujan, Roy Karabi, Mostofa Kamal Abu Hena, Khan Ruhul Amin and Sultana Sharmin, (2018). Assessment of surface water quality of theTurag river in Bangladesh Research Journal of Chemistry and Environment. 2018; 22 (2): 49-56

[10] MN Mobin, MS Islam, MY Mia and B Bakali (2014). Analysis of physicochemical properties of the Turag river water, Tongi, Gazipur in Bangladesh. Journal of Environmental Science and Natural Resources. 2014; 7(1): 27-33.

[11] MD. Simul Bhuyan, Muhammad Abu Bakar, Aysha Akhtar, M. Belal Hossain and Md. Shafiqul Islam. Analysis of water quality of the Meghna River using multivariate analysis and RPI. Journal of the Asiatic Society of Bangladesh. 2017; 43 (1): 23-35.

[12] Romana Rima, Abdullah Al Ryhan , Ruhul Amin Khan , Sony Ahmed ,Rafiq Islam , Sharif Hossain Munshi and Sabbir Azam. Assessment of Water Quality Parameters of Meghna River Kishoreganj. Bangladesh. Asian Journal of Environment and Ecology. 2020; 12(2): 29-37.

[13] Husna Israt Pia, Marufa Akhter, Supria Sarker, Masud Hassan , Sadique Rayhan ABM , Md Mazharul Islam and Md Arafat Hassan. Contamination Level (Water Quality) Assessment and Agro-ecological Risk Management of Shitalakshya River of Dhaka, Bangladesh 4. Hydrology: Current Research.2018; 9(1): 01-04.

[14] Mallika Saha, AHM Shafiullah Habib, Md. Anichur Rahman and Shova Saha. Some Physicochemical aspects of the Shitalakshya river at two points in Narayangonj. Jagannath University Journal of Life and Earth Sciences. 2019; 5(1):66-76.

[15] Sharmin Yousuf Rikta, Md. Shiblur Rahaman , Jakia Jerin Mehjabin , Md. Khabir Uddin, Mohammad Mahbub Kabir and Shafi Mohammad Tareq. Evaluation of water quality parameters and Humic substance status of Bangshi, Dhaleshwari and Padma Rivers in Bangladesh.International Journal of Environmental Sciences. 2016; 6: 1129-1139.

[16] Sarmin Akter , Kamrujjaman , Rashed-Ul-Islam 3 and Badhan Saha. An Investigation into Chemical Parameters of Water of Dhaleswari - A River alongside Tannery Village of Bangladesh. International Journal of Sciences. 2019; 8: 159-164.

[17] Md. Jamal Uddin and Yeon-Koo Jeong. Urban river pollution in Bangladesh during last 40 years: potential public health and ecological risk, present policy, and future prospects toward smart water management. Heliyon.2021;7: 1-23.

[18] Shaikh Sayed Ahammed, Sadia Tasfina, K. Ayaz Rabbani, Md. Adbul Khaleque. An Investigation Into The Water Quality Of Buriganga - A River Running Through Dhaka. International Journal of Scientific and Technology Research.2016; 5: 36-41.

[19] Md. Abdullah Salman, Shamim Ahmed, Mehedi Hasan Peas , Nusrat Khan. Water Quality Assessment of the Buriganga River, Dhaka, Bangladesh. International Journal of Emerging Technology and Advanced Engineering. 2018; 8:17-23.

[20] Fatema K, M Begum, MAl Zahid and ME. Hossain. Water quality assessment of the river Buriganga, Bangladesh. Journal of Biodiversity Conservation and Bioresource Management.2018; 4: 47-54.

[21] Parvin Aktar, Mst Sabrina Moonajilin. Assessment of Water Quality Status of Turag River Due to Industrial Effluent. International Journal of Engineering and Information Systems (IJEAIS). 2017; 1 (6): 105 - 118.

[22] Amena Ferdousi, M. Mostafizur Rahman, Mohammad Abdur Rob and Muhammad Mahfuz Hasan. Researches in Effluence and Environmental flow of Turag River – a review. AIUB Journal of Science and Engineering. 2020;19(1):25-32.

[23] Khan MAI; Hossain AM, Huda ME, Islam MS, Elahi SF. Physico-chemical and biological aspects of monsoon waters of Ashulia for economic and aesthetic applications: Preliminary studies. Bangladesh Journal of Scientific and Industrial Research. 2007; 377-396.

[24] Bhuyan MS, and Bakar MA. Seasonal variation of heavy metals in water and sediments in the Halda River, Chittagong, Bangladesh; Environmental Science and Pollution Research. 2017; 24(35): 27587-27600.

[25] Davis ML. and Cornwell DA. Introduction to Environmental Engineering, third edition. McGraw Hill Book Company. 1998; 289-297

[26] Peavy HS.; Rowe DR and Technology, G. Environmental Engineering McGraw Hill Publishing Company Ltd.1985; 11-46.

[27] Dara SS. (2007). A Textbook of Environmental Chemistry and Pollution Control. 7th ed. S. Chand and Company Ltd., Ram Nagar, New Delhi, India. 2007; 44-75.

[28] Alam MJB, Muyen Z, Islam MR, Islam S. and Mamun M. (2007). Water quality parameters along river. International Journal of Environmental Science and Technology. 2007; 4(1): 159-167.