Quest Journals
Journal of Research in Environmental and Earth Sciences
Volume 8 ~ Issue 1 (2022) pp: 10-17
ISSN(Online) :2348-2532
www.questjournals.org

Research Paper

Impacts of Water Quality Constituents on Aquatic Biodiversity and Resident Perceptions at Turag River

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ABSTRACT: *In Bangladesh increasing industrialization and urbanization is became environmental threats. Environmental threats upturn water pollution and affect the distribution of aquatic species. The present study is conducted to found the impacts of water quality on aquatic biodiversity at the Turag River. In contrast, status of aquatic biodiversity recorded by questionnaire. The water of the river was found black in color and the odor was visible in both seasons. 100% respondents mentioned that the aquatic species were almost affected in winter season. But some fish [Shing (Stinging catfish), Taki (Spotted snakehead)], animals [Bang (Narrow-mouthed frog), Shap (Bengal Monitor)], birds [Bok (Geron)] and Plants [Kochuripana (Water Hyacinth)] were found more in summer as comparison to winter. The quality of water in Turag River was found highly deteriorated in winter. Disposal of industrial wastewater found to be the main causes for the pollution water at Turag River. It is concluded that disposal of wastewater into water body should be treated properly in terms water pollution. As a result, water will be found contamination free which will ultimately enhance species distribution and abundance for the protection sustainable environment.*

KEYWORDS: Aquatic species, biodiversity, contamination, livelihood, pollution, Water quality

Received 17 Jan, 2022; Revised 28 Jan, 2022; Accepted 31 Jan, 2022 © The author(s) 2022.
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I. INTRODUCTION

For the survival of all the animals water is very important in the world. Pure water quantity and/or water quality are one of the major problems that human livelihood is facing in the twenty-first century [1] (UNESCO, 2009). Because of climate change these serious problems are going to be more aggravated in the future, resulting in higher water temperatures, contamination of water, melting of glaciers, and an intensification of the water cycle [2] (Huntington, 2006), with potentially more floods and droughts on earth [3] (Oki and Kanai, 2006). Lack of sanitation and safe drinking water is the most severe impact of water pollution which affects more than a third of the people in the world (Islam et al., 2015). Surface water pollution has been drawing more attention for last few decades [4] (Islam et al., 2015).

Bangladesh has undeliberate industries which have not proper waste management strategies and untreated waste products have been throwing into the closest water body which polluted the aquatic environment [5] (Sarkar et al., 2017). From manmade activities industrial wastes, agricultural fields runoffs, land runoffs, municipal by products, hospital garbages and mine pollutions are the most common factors for influencing bio geochemistry of water body. Recently the government of Bangladesh giving emphasis on industrial development from the last decades for improving living standard of all people and for a constant GDP growth more than 7 %. In addition, the extended use of water for industrial purpose exerts pressure on surface water and thereby pollutes water resources as proper waste management is not imposed [6] (Islam et al.,2018).

Dhaka is densely populated city in Bangladesh. Rapid and unplanned urbanization, commercial development along with population pressure has made an environmentally polluted city in the world [7, 8] (Haigh, 2004; Karn and Harada, 2001).Urbanization is the major demographic development which is occurring very fast and with larger magnitude in the developing countries. Its transforms the existing land scape without considering the possible consequences and requirements for environmental sustainability [9] (Brookfield, 1988). Urbanization and Industrialization has created pollution and contamination problem near the river bank. Modern civilization is dependent on large-scale use of a wide range of metals and most of them are naturally present only at trace levels in the hydrosphere (biosphere). The major route by which heavy metals are dispersed in the

biosphere is associated with the disposal of industrial effluents [10] (Chow, 1968).

The Turag river is the upper tributary of the Buriganga, a major river in Bangladesh. The most pollution sources of Turag river water are various consumer goods industries (soap and detergent), garments industries, pharmaceuticals industries, lots of tanneries, 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. Most of the industries discharge their effluents directly or indirectly into the Turag River without any treatment causing pollution of the surface water. Moreover, many sewerage and municipal sewage drainage system have become a dumping ground of all kinds of solid, liquid and chemical waste that polluted the river bank [11] (Rahman et al., 2012).

Consequently, complex mixture of hazardous chemicals, both organic and inorganic are released into Turag river water resulting in different chemical and biochemical interactions in the river system and thus deteriorate the water quality. For this reason, water causestheadverse effect of surrounding land and aquatic ecosystem as well as subsequent impact on the livelihood of the local community [11] (Rahman et al., 2012). Fresh water, one of the vital elements of the earth, has a strong correlation with all kinds of lives for sustaining [12] (Sarkar et al., 2016). The strategies taken in Bangladesh for saving rivers from pollution have completely failed against recent industrial development [5] (Sarkar et al., 2017). This problem is intensified by unplanned urbanization, unlawful industrialization, unscientific land use and lack of public awareness. The Turag is an important river in Bangladesh flowing through the north side of Dhaka mega city. Rapid industrial growth has occurred on the bank city Gazipur at Tongi arena under the BangladeshMasterPlan-1959.A variety of industries like garments, textile, spinning, jute, metal industries, tobacco, pharmaceuticals, chemical, pesticides, food processing, tanneries and many more are located in this industrial zone. The rhythm, however of waste disposal and waste management system has not kept pace with this industrial growth. Therefore, the Turag has been a dumping station forth is industrial zone. A lot of works have been reported on Turag river. [13, 14, 15, 5]Zakir et al. (2006), Banu et al. (2013), Ahmed et al. (2016) and Sarkar et al.(2017) investigated the physic chemical parameters and heavy metal pollution in Turag river to give an idea about the pollution status.

Before industrial development, the Turag river was very much rich with its aquatic biodiversity. It has been served as the main earning source by supplying fish and other aquatic resources to the people living near the river. The residents of that area also used the river water for the daily consumption and household activities. But now the quality of the Turag river water has deteriorated and the biodiversity has been threatened because of the water pollution. Therefore, the present study is focused to assess the impacts of water quality constituents on aquatic biodiversity.

II. MATERIALS AND METHODS

For the selection of study area, a preliminary survey was carried out at two locations on the bank of Turag River. These locations were North side and South side of Turag River (200m East from Turag Bridge). Five (5) points were selected in both North side and South side of Turag river for data collection based on some specific criteria like generation of large amount waste from near commercial activities, situation of local market, dumping and disposal of different wastes of fish, meat and vegetable processing and industrial wastewater. Disposal of dyeing industrial waste water and municipal waste from near households were common there. Geographical coordinates of the selected study areas were 23°52'56.7"N 90°24'07.0"E for North side and 23°52'54.8"N 90°24'07.2"E for South side of Turag river. From both the sides the river suffers from infilling along its banks, which restricts the water flow. The river also suffers from acute water pollution. From visual observation, the condition of the river water was not good at both the summer and winter season, but the situation is worst during winter season. Water seems too black in most of the places with a pungent smell. A number of local boats are observed in the river catching fish or used for living purpose. The present study was conducted for 1 year (March, 2018 to February, 2019). Water samples and data collection were done in both summer and winter season within the study period. After collection of water samples, they were immediately evaluated and some portions were preserved for further analysis. A total of 100 respondents (above 30 years' age) were randomly selected comprising professional and subsistence fishermen living around the river. A questionnaire containing brief idea about biodiversity status of Turag River was used during the data collection from the respondents. In order to get a complete idea about the aquatic biodiversity, an interview schedule was prepared based on scaling of species such as A= Abundant (>80%); T=Threatened (≤50%); V=Vulnerable (≤ 20%); Ex=absent (0%). However, the questionnaire included various questions related to color, odor, taste and uses of water, status of fish, birds, shellfish, aquatic plants, reptiles, mollusk, aquatic insects and other aquatic species. Besides industrial development and its impacts on aquatic biodiversity and human health, factors affecting the level of fish production and other relevant aspects of wetland fisheries were also considered. During the data collection, both primary and secondary sources were considered. Primary data were collected from respondents by the researcher himself. Several visits were made to collect accurate information related to the objectives of the present study. Primary data were collected from the respondents through face to face interview

and focus group discussion method to have a greater accuracy of collected data through field visits by the researcher himself. Five points were selected in both North and South sides of Turag River. The collected data were summarized and processed for analysis. These data were verified to eliminate all possible errors and in consistencies. Tabular technique was applied for the analysis of data by using simple statistical tools like averages and percentages. Finally, the processed data were transferred to a master sheet, from which classified tables were prepared revealing the finding of the study. For processing and analysis purpose, MS Excel and MS word were used. The final data were presented in tables, figures and bar diagram.

III. RESULTS AND DISCUSSION

3.1. People's perception on water quality status

There are lot of industries mainly dyeing and textile, built near Turag River. These industries are releasing a huge amount of wastewater in to the river and as a result, water of the river is polluting day by day. Water quality and usage of Turag river water is shown in Tables1 and2. The obtained results conveyed that the water of the Turag River lost its natural color, odor and taste. The odor was too much pungent based on opinion of 100% respondents in winter season specially. The 100% respondents expressed that they couldn't use the water for drinking both in summer and winter seasons. In wet season around 90% respondents reported that they used this river water for bathing purpose (Table1).For washing purpose this river was used by 90 and 85% respondents in the North and South side of the river in summer, respectively (Table 1). In the summer season and 75 and 80% of the respondents reported that boating was occurred in the North and South side, respectively (Table1). In winter season 90% respondents reported that they used this river water for bathing purpose (Table 2). For washing purpose this river was used by 70 and 85% respondents in the North and South side of river, respectively (Table 2). In the winter season, 70 and 80% of the respondents reported that boating was occurred in the North and South side of river, respectively (Table 2).

Table 1. Water quality and usage based on people's perception in summer season

Content	North side of river	RP (%)	South side of river	RP (%)
Taste	Bad and rarely used	100	Bad and rarely used	100
Odor	Pungent odor	100	Pungent odor	100
Color	Slightly blackish	100	Slightly blackish	100
Washing purpose	Yes	90	Yes	92
	No	10	No	08
Drinking	No	100	No	100
Bathing	Yes	90	Yes	85
	No	10	No	15
Boating	Occurred	75	Occurred	80
	Not occurred	25	Not occurred	20

Status of Aquatic Biodiversity

Fish species

According to respondent's perception among the recorded species the status of fish species of Indian major carp group were mostly absent and vulnerable in the Turag river which was directly and indirectly contaminated by indiscriminately discharge of different solids and liquid wastes. Majority respondents reported that before industrialization most of the carp group fishes were present in the Turag river. Similar situation was also observed in Shitalakka wetland in Narayanganj city [16] (Alam et al., 2017). However, in the summer season, 15% (North side of the bridge) and 21% (South side of the bridge) people said that only Rui (Rohu) was visible as abundant (Table 3a). But in winter season Rui (Rohu) and Katla (Catla) were totally absent. In North side of the river, 5% respondents mentioned that Katla (Catla) was abundant and 95% respondents said that it was absent in summer season but in dry season 100% people said that it was totally absent from all of those points (Table 3a). Reduction and/ or decline trend of fishes in polluted wetlands by industrial effluents in different locations in Gazipur district was previously reported by [5] Sheikh et al. (2017). In the summer season there was transparent and less polluted water in the river, so many fishes were visible in the river. Reduction and/ or decline trend of fishes in polluted wetlands by industrial effluents in different locations in Gazipur district was previously reported by [5] Sheikh et al. (2017).

Table 2. Water quality and usage based on people's perception in winter season

Content	North side of river	RP (%)	South side of river	RP (%)
Taste	Bad and is not used	100	Bad and is not used	100
Odor	Pungent odor of different chemicals and oil	100	Pungent odor of different chemical and oil	100
Color	Black	100	Black	100
Bathing	Yes	90	Yes	90
	No	10	No	10
Drinking	No	100	No	100
Washing purpose	Yes	70	Yes	85
	No	30	No	15
Boating	Occurred	70	Occurred	80
	Not occurred	30	Not occurred	20

In the summer season there was transparent and less polluted water in the river, so many fishes were visible in the river. It might be happened due to lower values of dissolved oxygen in water of Turag river during the winter season which was lethal for majority of fishes. Moreover, in winter season, the values of water pH were recorded 6.2-6.4, which was also unsuitable for proper existence of carp fishes [17] (Rahman et.al. 2021). The desirable values for pH are 6.5-8 to saturation for most aquatic organisms [18] (Meade, 1998). According to [19] ADB (1994) the pH value for fishing water is6.5-8.5. Based on respondent's perception the recorded results showed that the Catfish group was affected in the Turag River which was polluted by several discharges of effluents/wastes. [20] Mohsin at el. (2013) reported that in the Padma River the lowest number of fish species was observed in the dry/winter season than the wet/summer season. Among all the catfish species Shing (Stinging catfish) and Magur (Walking Catfish) were more or less visible in those areas in summer season (Table 3a). About 70 and 60% respondents reported that Shing (Stinging catfish) was abundant in the North side and South side of the river, respectively in wet season and 60% respondents reported that Shing (Stinging catfish) was abundant in both the North side and South side of the river in winter season. Only 30 and 40% respondents reported that Shing (Stinging catfish) was threatened in the North side and South side of the river, respectively in both summer season and winter season, respectively (Table 3a). 15 and 85% of local respondents delivered that Magur (Walking Catfish) was vulnerable and absent, respectively in North side and South side of the river in summer season. On the other hand, in winter season Magur (Walking Catfish) was totally absent in all of the locations according to respondents (Table 3 a). So, it was clear enough that the deteriorated water qualities by unplanned, untreated industrial discharges were responsible for disappearing of the fishe species [5] (Seikh et al., 2017).

In summer season, among all the snakeheaded fish species only Taki (Spotted snake head) was abundant in both North and South sides of the river reported by 80 and 70% respondents, respectively (Table 3a). In winter season, Taki was abundant both in North and South sides of the river reported by 50 and 60% respondents, respectively. On the other hand, Shol (Snakehead murrel) was vulnerable reported by 30 and 35% respondents in North and South side during summer and 20 and 25% during winter season, respectively. The reduction of fish species could be due to water quality degradation. Minnow's fish group was mostly absent in the Turag river (Table 3). 100% respondents reported that Mola (Mola Carplet), Dhela (Cotio) and Bele (Scribbled goby) was totally absent in all of the locations in both seasons (Table 3a & 3 b). According to respondent's opinion the status of miscellaneous fish species before industrial development was visible in the Turag River. Both summer and wet seasons, 100% respondents reported that Potka (Green puffer fish) was totally absent from North and South sides of the river (Table 3 b). But Baim (Zig-zag eel) was mostly absent (60 and 50%) and totally absent (100%) reported by the respondents in summer and winter season, respectively (Table 3 b). This could happen due to the highly polluted water of Turag River. There are reports that shows the discharged effluents of industries in Turag river is rich in inorganic and organic chemicals like Fe, Zn, Pb, Al, Co, Mo, Cd, Ni, Cr, As, Hg and some acids and solvents as sulfuric acid, hydrochloric acid, carboxilic acids, phenol, organic acids etc.

Animal species

Anima1 species other than fish in Turag river water was shown in Table 4. In the studied areas animal species were recorded mostly visible in previous condition according to the opinion of local people living there. Some people said that Jock (Kentish Lyce), Shap (Bengal Monitor) and Guishap (Indian Rat Snake) were threatened in Turag river. About 100% respondents said that Jock (Kentish Lyce), and Guishap (Indian Rat

Snake) was totally absent from this river. However, in the summer and winter season the population of Bang (Narrow-mouthed Frog) was evaluated as abundant, threatened and vulnerable but not absent in both North and South sides of the river (Table 4). In summer, Shap (Bengal Monitor) is reported to be seen by the respondents but in winter, 90 and 80% of respondents reported that this species is absent in North and South side of the river, respectively. This might be caused due to severe negative impacts on animal species in polluted areas. The water quality in those sites were below the tolerate limits. The water in the polluted wetland contained higher amount of TSS, TDS, EC, COD, lower amount of DO, pH and some toxic heavy metals.

Table 3a. Percent respondent's perception on status of different fish species in Turag River [Based on responses (N) of 100 respondents.

	Aquatic fish	Sites	Summer season				Winter season			
			Abundant	Threatened	Vulnerable	Absent	Abundant	Threatened	Vulnerable	Absent
Indian Major Carps	LN: Rui EN: Rohu SN: *Labeo rohita*	NS SS	15 21	20 15.5	65 48.5	- 15	- -	- -	- -	100 100
	LN: Katla EN: Catla SN: *Gibelion catla*	NS SS	5 -	- -	- 20	95 80	- -	- -	- -	100 100
Cat fish	LN: Shing EN:Stinging cat fish SN:*Heteropneustes fossilis*	NS SS	70 60	30 40	- -	- -	60 60	30 40	10 -	- -
	LN: Magur EN: Walking catfish SN: *Clarius batrachus*	NS SS	- -	- -	15 15	85 85	- -	- -	- -	100 100
Snake headed fish	LN: Shol EN: Snakehead murrel SN: *Channas triatus*	NS SS	- -	- -	30 35	70 65	- -	- -	20 25	80 75
	LN: Taki EN: Spotted snakehead SN: *Channa punctate*	NS SS	80 70	20 30	- -	- -	50 60	40 20	10 20	- -
Minnows fish	LN: Mola EN: Molacarplet SN:*Amblypharyn godonmola*	NS SS	- -	- -	- -	100 100	- -	- -	- -	100 100
	LN: Dhela EN: Cotio SN: *Osteo bramacotio*	NS SS	- -	- -	- -	100 100	- -	- -	- -	100 100

LN= Local name, EN= English name, SN= Scientific name, NS= North side of river, SS= South side of river, RP= Respondent's perception, Abundant= >80%, Threatened= ≤ 50%, Vulnerable= ≤ 20%, Absent= 0%

Table 3b. Percent respondent's perception on status of different fish species in Turag River [Based on responses (N) of 100 respondents.

LN= Local name, EN= English name, SN= Scientific name, NS= North side of river, SS= South side of river,

	Aquatic fish	Sites	Summer season				Winter season			
			Abundant	Threatened	Vulnerable	Absent	Abundant	Threatened	Vulnerable	Absent
Minnows fish	LN: Bele EN: Scribbledgoby SN: *Awaous grammepomus*	NS SS	- -	- -	- -	100 100	- -	- -	- -	100 100
Miscellaneous fish	LN: Potka EN: Green pufferfish SN: *Tetradon fluviatilis*	NS SS	- -	- -	- -	100 100	- -	- -	- -	100 100
	LN: Baim EN: Zig-zag eel SN: *Mastacembekus pancalus*	NS SS	- -	10 10	30 40	60 50	- -	- -	- -	100 100

RP= Respondent's perception, Abundant= >80%, Threatened= ≤ 50%, Vulnerable= ≤ 20%, Absent= 0%

Table 4. Percent respondent's perception on status of different aquatic animals in Turag River [Based on responses (N) of 100 respondents

Aquatic animals	Sites	Summer season				Winter season			
		Abundant	Threatened	Vulnerable	Absent	Abundant	Threatened	Vulnerable	Absent
LN: Bang EN: Narrow mouthed frog SN: *Microhyla ornate*	NS SS	25 20	40 30	35 50	- -	-	20 30	30 35	50 35
LN: Jock EN: Kentish lyce SN:*Hirudo medicinalis*	NS SS	- -	- -	- -	100 100	-	- -	- -	100 100
LN: Shap EN: Bengal monitor SN: *Varanus bengalensis*	NS SS	20 30	30 40	30 15	20 15	-	- -	10 20	90 80
LN: Guishap EN: Indian rat snake SN: *Ptyas mucosa*	NS SS	- -	- -	5 7	95 93	-	- -	- -	100 100

LN= Local name, EN= English name, SN= Scientific name, NS= North side of river, SS= South side of river, RP= Respondent's perception, Abundant= >80%, Threatened= ≤ 50%, Vulnerable= ≤ 20%, Absent= 0%

Aquatic birds

According to the responses from the respondents implied that the industrially polluted water environment imposed negative impact on biodiversity of birds at studied areas. All bird species studied there were absent except Bok (Heron) (Table 5). Some Ducks were also seen which were domesticated by the native people. Besides that, 15% respondents said that Bok (Heron) was vulnerable in the North side and 20% respondents reported it is vulnerable in South side of the river during summer season. In winter season it was absent in all of the locations. Gangchil (Common Tern), Machhranga (White Breasted) and Bali hash (White winged duck) were totally absent from this river in all locations in both seasons (Table 5). In the present study it was clearly observed that the intensive industrialization enhanced deterioration of surface water quality which remarkably degraded aquatic environment and habitat for aquatic lives.

Aquatic plants

The present study report addressed that Khudipana (Duckweed), Helencha (Marsh Herb) and Kolmi (Water spinach) were absent in the Turag river in both seasons in all of the locations reported by 100% respondents. Moreover 70 and 75% respondents reported that Kochuripana (Water Hyacinth) was abundant in North and South sides of the river and 30 and 25% respondents reported that it was threatened in North and South sides during summer season (Table 6). About 70 and 60% respondents reported that Kochuripana (Water Hyacinth) was abundant in North and South sides of the river and 30 and 40% respondents reported that it was threatened in North and South sides of the river, respectively in winter season (Table 6). Poor water quality and insufficient DO of polluted wetlands induced the present threats to aquatic plants [5] (Sheikh et al., 2017).

Aquatic birds	Sites	Summer season				Winter season			
		Abundant	Threatened	Vulnerable	Absent	Abundant	Threatened	Vulnerable	Absent
LN: Bali hash EN: White winged duck SN: *Carinina scutulata*	NS SS	- -	- -	- -	100 100	- -	- -	- -	100 100

LN: Bok EN: Heron SN: *Antigone Antigon*	NS SS	- -	- -	15 20	85 80	- -	- -	- -	100 100
LN: Gangchil EN: Common tern SN: *Sterna hirundo*	NS SS	- -	- -	- -	100 100	- -	- -	- -	100 100
LN: Machranga EN: Kingfisher SN:*Halcynsmyrensin*	NS SS	- -	- -	- -	100 100	- -	- -	- -	100 100

Table 5. Percent respondent's perception on status of different aquatic birds in Turag River [Based on responses (N) of 100 respondents

LN= Local name, EN= English name, SN= Scientific name, NS= North side of river, SS= South side of river, RP= Respondent's perception, Abundant= >80%, Threatened= ≤ 50%, Vulnerable= ≤ 20%, Absent= 0%

Table 6. Percent respondent's perception on status of different aquatic plants in Turag River [Based on responses (N) of 100 respondents

Aquatic plants	Sites	Summer season				Winter season			
		Abundant	Threatened	Vulnerable	Absent	Abundant	Threatened	Vulnerable	Absent
LN: Kochuripana EN: Water hyacinth SN:*Eichhorniacrassipes*	NS SS	70 75	30 25	- -	- -	70 60	30 40	- -	- -
LN: Topapana EN: Tropical duckweed SN: *Lemna minor*	NS SS	- -	- -	- -	100 100	- -	- -	- -	100 100
LN: Khudepana EN: Duckweed SN:*Pistiastratioites*	NS SS	- -	- -	- -	100 100	- -	- -	- -	100 100
LN: Helencha EN: Marsh herb SN: *Enhydra fluctuans*	NS SS	- -	- -	- -	100 100	- -	- -	- -	100 100
LN: Kolmi EN: Water spinach SN: *Ipomoea aquatic*	NS SS	- -	- -	- -	100 100	- -	- -	- -	100 100

LN= Local name, EN= English name, SN= Scientific name, NS= North side of river, SS= South side of river, RP= Respondent's perception, Abundant= >80%, Threatened= ≤ 50%, Vulnerable= ≤ 20%, Absent= 0%

IV. CONCLUSIONS

Based on the study of water quality parameters and their impacts on biodiversity at Turag River during winter and summer seasons, the following conclusions were drawn- Physical and chemical properties of water (especially DO, pH, heavy metals) were found in higher amount than standard limits for healthy environment. In this study, different species were found highly affected during winter season as compared to summer season. Some of the species were found highly affected due to water pollution. For this reason, it is highly recommended to reduce water pollution as much as possible through public awareness and legalaction.

ACKNOWLEDGMENT

We wish to appreciate all the participants involved in this study and the Department of Environmental Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh.

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