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River Ecosystem Restoration: In Perspective to Turag River

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Turag River is an important lifeline for Dhaka city flowing through Gazipur, from north meeting Buriganga at the south. One of the importance of its existence is waterway transportation, carrying goods and a large number of construction materials like brick and sand. The paper upholds serious issues behind the river pollution. Due to the massive disposal of industrial wastes and garbage dumping, the river is suffocating in the presence of hazardous chemicals, dye and sewage water. On the other hand, businessmen with the influence of political parties are encroaching the river banks for sand trading, Brickfields, housing projects. To restore the current condition of Turag in its natural form, resourceful techniques are explored and analyzed. This study depicts such suitable techniques which are implementable with less financial resources in the context of Bangladesh. Among various methods, environmental flow management and riparian ecosystem restoration are two unique and widely used processes for the restoration of water quality, lost habitats and degraded ecosystem.

Keywords: Environmental flow, Riparian ecosystem, River pollution, River restoration.

Field of Research: Environmental Engineering

1. Introduction

Bangladesh has abundant inland water bodies crisscrossing its low lying flatlands. According to Matin and Kamal (2010), Bangladesh comprises some of the biggest rivers in the world which are extremely vulnerable owing to its geographical characteristics. Presently, these rivers are facing many threats due to natural and anthropogenic activities which might cause the extinction in near future. Brookfield (1988) highlights the rapid urbanization process as one of the causes that change current terrain and landscape without thinking of likely consequences and requirements to sustain the environment and ecology. Industrialization near the side of rivers has created a massive pollution problem. Ahmed and Bodrud-Doza (2014) featured the Turag River as an important environmental feature of Dhaka city. It is an upper tributary of Buriganga River which is 40 miles in length and 15 miles in width to the maximum.

Rabbani and Sarker (2017) pointed out the roots of anthropogenic river water pollution in their study that encompasses numerous industries producing consumer items like soap and detergents, garments industries, pharmaceuticals industries,

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tanneries, dyeing industries, aluminum industries, battery manufacturing industries, match industries, ink manufacturing industries, textile, paint, iron industries, pulp and paper factories, chemical factories, frozen food factories and steel workshop factories. Rahman et al. (2012) disclosed, how untreated effluents coming from industries, directly or indirectly into the river, triggering pollution to the surface water. Additionally, the authors observed that sewerages and municipal sewage drainage system dump all kinds of solid, liquid and chemical wastes in the river bank. As a result complex mixture of hazardous chemicals is forming in the river water and deteriorating the water quality. Surrounding lands, the aquatic ecosystem as well as the livelihood of the local community get seriously affected because of polluted river water. This study report on Turag River is segmented into two major points, while the one part represents pollution scenario of the River Turag comprising pollution parameters, the rate of encroachment and critical ecological issues based on the secondary information; the other part deals with the techniques that may revive the river to its former glory.

According to the Department of Environment (2010), The Turag River has been declared an ecologically critical area. People residing near the river are generally dependent on the river system for food, transportation, and aesthetics as well as for daily necessities like water supply and household cleaning purposes. However, due to the presence of high physic-chemical properties, this river is considered as one of the most critically endangered water body of Bangladesh. Rahman et al. (2012) discovered the presence of high level of pH, COD, BOD, free CO_2 which are not suitable for any organisms including human for consumption as well as for other uses. The report is structured in a systematic way comprising six different sections. The Introduction provides general ideas of river pollution in Bangladesh, whereas the second section is the review of different kinds of literature and articles on the Turag River focusing on the pollution parameters. The methodology discusses different approaches available to revive the Turag River in the third section of this report. The fourth section deals with recommended measures to bring back the river to a healthy state. Limitations of the research, as well as analysis and conclusion, are provided in section five and section six respectively.

2. Current Status of Turag River

The water of the Turag River is so polluted that it is hindering the preservation of ecology in the capital city. Alam (2016) discussed in his report about millions of gallons of raw wastewaters that coming from manufacturing houses on a regular basis are being discarded in the rivers around Dhaka city through almost 185 outlets. He mentioned, nearly thirteen openings discharge untreated industrial wastewaters in the Turag and the Balu between Tongi Kamarpara and Isapur. Alam (2016) further observed, during the Bishwa Ijtema which is a big religious gathering for Muslim pilgrims coming from all over the world stay by the riverside for several days. As proper accommodations and adequate sanitation systems are lacking greatly, human wastes and garbage generated at the site are being disposed into the river shown in figure 1. As a result, river water gets polluted and the ecosystem is negatively impacted.

Figure 1: Garbage and Waste Dump into the Water Near Abdullahpur and Tongi

2.1 Pollution Parameters

Banu et al (2013) pointed out recent findings on potential polluted site which includes Buriganga Third Bridge area at Basila and the Tongi Bridge area, shown in figure 2. These contaminated water is pitch black colored and has strong odors. Therefore, the water cannot be used for any purposes. Hossain (2011) found zero level of Dissolved Oxygen (DO) at both of these sites for almost round the year except during the monsoons when the river is full. According to the Environmental Quality Standard (EQS) complied in Bangladesh, DO level required for drinking, recreation, fish and livestock, industry and irrigation are 6 mg/l, 4-5 mg/l, 4-6 mg/l and 5 mg/l respectively. The Biological Oxygen Demand (BOD) level tolerance is 0.2 mg/l, 3 mg/l, 6 mg/l and 10 for drinking, recreation, fish and for irrigation respectively. But according to a study carried out by Hossain (2011), the BOD level of the water at these two points is close to zero, which is not safe to use. Similarly, other parameters of water quality like TDS, TSS, TS, Turbidity, Conductivity, COD, pH, Cadmium, Copper, Zinc, and Lead have gradually obtained such statistics that have already exceeded the limits of appropriateness.

Figure 2: Chemical Waste and Garbage Disposal has Stagnated the Water and Turned Blackish

2.2 Critical Ecological Issues

Hossain (2011) explained, due to the excessive presence of pollutants in river water, the agricultural lands situated at Washburn and Shalmasi of Keraniganj, Basila, and Katasur of Mohammadpur have become contaminated and sterile. Therefore, these

lands are left with no use around the year. Though some of these lands are now used for housing projects and brickfields but eventually, such uses of these lands causes illegal occupation near river banks and also escalates the pollution on the river.

Ahmed and Bodrud-Doza (2014) unveiled, the presence of municipal wastes and nutrients from induced fertilizers from agricultural lands along the river bank ultimately made the river prone to eutrophication and resulted into the degradation of water quality as well as the aquatic environment. Pollution is being injected into the food chain as well as birds, fish and mammals are found dead due to pollutants. Hossain (2011) stated that density of pollutants increases unexpectedly at the arrival of the lean period as the water level of the river decreases a lot at this time but the rate of pollutant released into the river remains unchanged. At this period, pollution becomes so intense that hardly any hydro-organisms can live through it and eventually, fishes of different species are found floating dead in the river water. Dead fishes and other hydro-organisms further pollute the water.

2.3 River Bank Encroachment

Mahmud (2014) stated that river land grabbing and encroachment are the major problems at the Turag River site. Alluvial rivers like Turag, Buriganga, and Shitalakhya are good sources of fine grade sand. To compete with the recent development of Dhaka city, sand traders have invaded the river banks, shown in figure 3, to extrude sand from the river bed neglecting all the rules and regulations issued by the High Court of Bangladesh. As a result, some areas of the river have been dried up and the river channel has changed.

Figure 3: Encroachment of River by Sand Traders and Brickfield Owners

According to some articles published in United News of Bangladesh (2017), Encroachments on the River Turag has not only been unpleasant to eyes but also added the problem of reduced navigability. Sand lifting not only affects its immediate riverbanks but increases the erosion risk elsewhere, that potentially impacting thousands of other people by relocating them from their homes and destroying their livelihoods. Erosion at Turag River, became serious in recent times at different places in Bhakurta union of Savar Upazila, due to illegal sand lifters extracted sand from the river for housing projects in the area. The Turag contracted day by day as the invaders took south bank of the river and filled with sand and stones from the river for different housing projects. Salman (2016) explained local view about the current situation of the river. According to locals, the river used to be 1,500ft wide,

however, it has turned into a canal because of continuous encroachment. It has been observed during a visit that river land is being occupied near Birulia Bridge, Dhour Bridge, Protyasha Bridge, Kamarpara Bridge and 20 other places along the Tongi-Ashulia Link Road.

3. Methods and Methodology

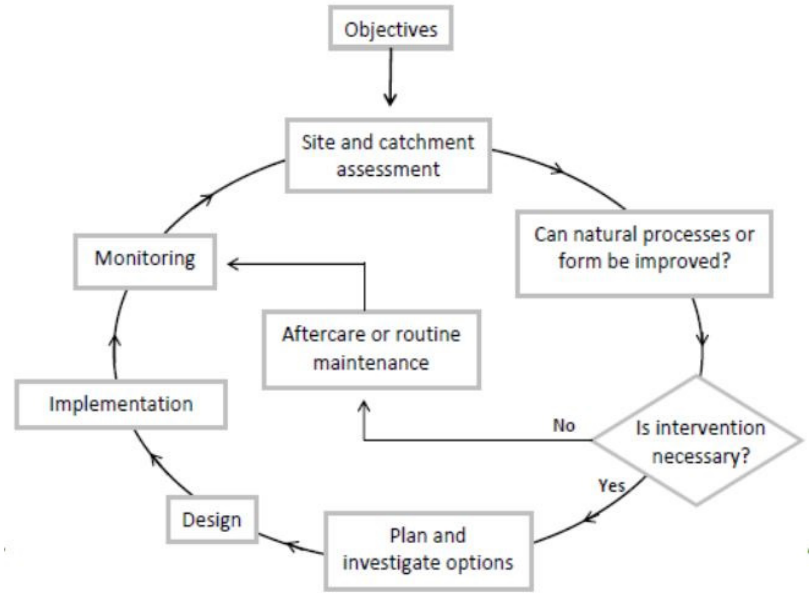
There are several types of research about Turag River which features its pollution sources, determining pollution loads, level of contamination and analysis of Physicochemical Properties of river water. Most of the previous studies have been limited to identifying water quality parameters. However, there is hardly any research found suggesting restoration of river ecosystem in the context of Bangladesh. In this paper, various articles and journals have been utilized to identify potentially polluted sites near Turag River. The study further details numerous techniques practiced around the world for the river restoration and sustainable river management. The concept of restoration was developed to manage the degraded ecosystem of water bodies like rivers and lakes and turn them into healthy and stable condition. European countries and countries in the United Kingdom have shown a great deal of expertise in the field of river management and ecosystem restoration. Functional perspectives of river restoration aim to regain the full suite of biogeochemical, ecological, and hydro-geomorphic processes that make up a healthy river. Some of the popular techniques implemented in various projects in the UK and Europe are given in the following table 1.

Table 1: River Restoration Techniques (Be, Know, Do: Manual of River Restoration Techniques, 2013; European Commission, 2016)

River restoration techniques	No. of UK projects (NRRI)	No. of EU projects (Wiki)
River narrowing to increase velocity(by adding structure)	404	21
Lakes, Ponds, wetlands restored or established	324	61
Obstructing structure replaced/removed	293	57
Bank re-profiling/hard bank removal	292	50
Riparian/floodplain vegetation (planting/ management)	283	52
Remaindering or restoring sinuosity	206	69
Daylight/culvert removal	156	07
River floodplain reconnection	129	15
Long section habitat enhancement (pool/ riffle sequences)	154	53
Backwaters and pools established/reconnected	137	09

There is a sequence of activities to plan, design, implement and subsequently manage the restoration works. This sequence is defined in figure 4 that shows how the river restoration processes can be managed in a systematic way.

Figure 4: Management Cycle of River Restoration Method (Be, Know, Do: Manual of River Restoration Techniques, 2013)



The restoration techniques for Turag River is primarily focused on two objectives which are water quality adjustment and habitat improvement. Most of the methods described in table 1 does not comply with the social-economic status of Bangladesh. Some of the projects are very costly like Bank retrofitting, restoring sinuosity. On the contrary, some techniques are not necessary such as river narrowing, removal of obstruction/culvert, backwaters, and pool establishments etc.

4. Ecosystem Restoration Measures

Rivers are an integral part of Bangladesh's culture, commerce, and transportation. Therefore, more effort is required to protect them from the environmental neglect which could threaten their well-being. The most suitable techniques that can be implemented in Turag River region for its ecosystem restoration are enhancing the Environmental Flow and Riparian Ecosystem development and modifying geomorphology to improve habitat. Mitigation of water pollution requires strong laws from authority for the industries to establish effluent treatment plant (ETP) and Sewage Treatment Plant (STP) for clean disposal of sewage waste.

4.1 Environmental Flow for Ecosystem Restoration

Moore (2004) illustrated environmental flow that is fundamental to secure the ecological activities, the health of the river and also make it more navigable. Environmental flows are the flow regimes needed to maintain important aquatic ecosystem services. Hirji and Davis (2009) established a hypothesis that environmental flow system as a core element of good practice in water resources planning and management. Moore (2004) revealed a global survey in his research which took place in 2003 with the subject of perceptions of environmental flow. Out of the 272 respondents during the survey, 88% agreed that the concept of enhancing environmental flow for sustainable water resources management and durability for

future generation need. Many countries have come forward in adopting and implementing the environmental flow concept and policies after the Brisbane Declaration on Environmental Flow in 2007.

The flow system of the river influences the quality of water, biotic interactions, water heads (energy head and cycle) and habitat of rivers. There are four components of the environmental flow management that are necessary to restore the important aspect of the river ecosystem. Such as;

- Water quality,
- Restoring sediment deposition,
- Habitat for fish and wildlife,
- Restoring the livelihoods of river-based communities.

The environmental components to restore the riverine ecosystem are as follows:

- Extreme Low Flow: Occurs during the drought period, water level drop below normal, exotic species decrease with the increase of native species, increase aquatic vegetation.
- Low Flow/ Base Flow: The natural flow that is observed the most time of the year, suitable for both aquatic and terrestrial habitat depending on the river flow, adds moisture to the soil beneficiary for plants, enhance aesthetics and influence recreational activities.
- High Flow Pulses: The rising water flows after precipitation but does not flow over the river banks. Water temperature decrease with increase in DO, floating vegetation washed out, a significant amount of sediment deposit, causes scouring of river line.
- Small Floods: Rare floods occurring at irregular intervals (every 2 to 10 years). During such events migration to floodplains, wetlands or other habitats but provide resources to many species as well as riparian plants. Supports habitat for native waterfowl and livestock but decrease non-native species. Small floods highly benefit irrigation and fishery.
- Large Floods: During large floods, the channel flow path and channel bed changes due to the mass overflow of water bringing a great amount of sediment and plant matter. Large flood also helps to move plant seeds over a large area allowing the seedling to be in soil moisture for a long period of time. It also benefits the fishery and irrigation.

Figure 5: (A) Typical Low Flow Period of Turag River in December to February (Left); (B) During High Flow Pulse after Few Days of Rain in the Month of August 2015, the Watercolor has Drastically Changed from Blackish (Right)

The above flow components are again quantified with some variables which determine the flow characteristics and time. Magnitude, Timing, Duration, Frequency, Rate of change. The environmental components associated with environmental flow management are easily applicable to Turag River as the flow pattern, the catchment area is still in good condition. Naturally, due to the pollution, waste dumping, and illegal land encroachment the water flow is very low which can be seen in figure 5.

4.2 Riparian Ecosystem Restoration along Turag River

Griggs (2009) described The Riparian ecosystem restoration as a unique and very innovative process to manage degrading river system. The Riparian ecosystem concept mainly focuses on vegetation on the river bank which will act as habitat for many species, enhance the quality of soil and provide a refreshing environment for recreation. Riparian zones provide significant value to the river ecosystem through various phenomena including shelter for aquatic organisms, water temperature regulation, reducing sedimentation and erosion etc. The study of Griggs (2009) also shows that the presence of Riparian zones reduces the pollution from surface runoff and plays an important role in enriching water quality. The embankment of the Turag River provides the suitable location to develop the Riparian Ecosystem. Around 40 miles long, the Turag River embankment can create a green belt of trees and vegetation on the northern side of Dhaka. Bangladesh having subtropical monsoon climate with a variety of high temperature, humidity, and rainfall; it supports all sorts of vegetation. The concept of agroforestry can be applied to developing a riparian ecosystem.

The figures 6 (A) and 6 (B) shows the flow path of the Turag River around Dhaka. Close observation shows that the river lining has spaces on both sides where tree plantation can be practiced in order to develop a riparian ecosystem. If such long ecosystem is established, it will be beneficiary for both the river health quality as well as for the newly developed residential areas, Uttara Residential Model Town and Purbachal New Town.

Figure 6: Satellite Image for Turag River Flow Path. (a) North-West of Dhaka Near the Uttara Residential Model Town (Left), (b) North-East of Dhaka Near the Purbachal New Town (Right)

The functional aspects of the Riparian ecosystem are as follows:

- **Green Belt of Vegetation**: Improve the air quality, soil interactions, provide shades to the water hence regulating temperature for aquatic organisms.
- **Habitat Regeneration**: Enrich the diversity of bird and fish species through shelter, food, and reproduction.
- **Water Quality**: The quality of water will change due to the infiltration of water from the river, absorbing nitrate compounds. Sedimentation through surface runoff and erosion will reduce providing less turbid water. Bio-filtration of surface runoff will diminish pollutants entering the river system.

The aesthetic and recreational aspects of the Riparian ecosystem are as follows:

- **Recreation Purpose**: Developing a park within the Riparian project will encourage hundreds of visitors for activities like jogging, exercise, swimming, fishing, boating etc.
- **Floral Garden and Children Park**: The natural environment of the Riparian zone will support multi-variety of flowers farming for both beautification and business purpose. With the never-ending development and a shortage of land, such riparian zones can provide much needed safe and healthy playground.
- **Contribution to the Climate**: Establishing long and wide riparian ecosystem with the various tree, herb and shrub species will obviously act as a key element against climate change.

Figure 7: A Conceptual Diagram of the Riparian Ecosystem (Be, Know, Do: Aquatic Ecosystems, 2017)

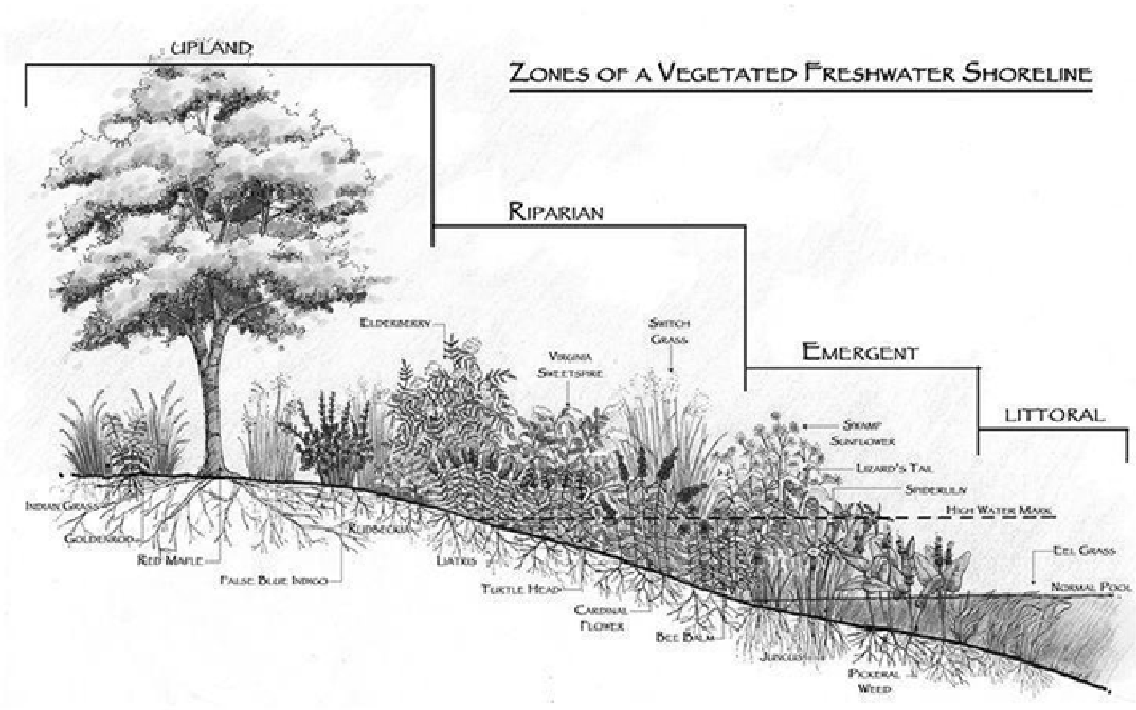
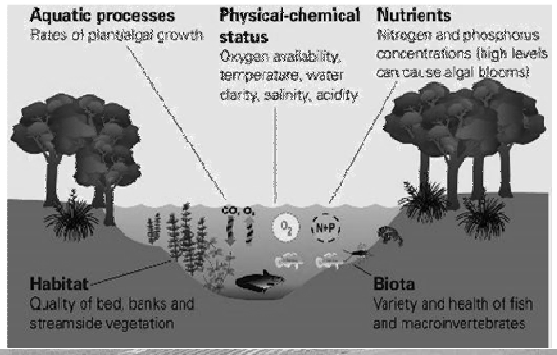


Figure 8: (a) The Biological Process That Takes Place in the Riparian Ecosystem; (b) Lake Erie, 4th Largest Lake in North America is preserved with Riparian Tree Cultivation



4.3 Long-term Restoration

Hazardous industrial wastes in the water have massively hindered the aquatic habitat of the Turag River. If proper measurements are taken with the help of adequate law the current dumping of solid waste materials and industrial chemicals can be controlled. Some suggestions are presented which could prove effective for the long-term restoration process. The propositions include:

- Setting up boundaries along the channel alignment (figure 9)
- Erecting tall fencing to prohibit dumping of any solid wastages and garbage
- Sealing the river bank permanently with pavement slabs
- Dredging of critically narrow and shallow river bed near the Estama Field
- Proper action against land encroachers
- Seal all the pipelines coming from cities/town sewerage and industries
- Implement existing law and regulations
- Removal of illegal residential and industrial buildings from the bank of the river
- Establish an effluent treatment plant (ETP)

Figure 9: Newly Established Embankment with Concrete Slabs and Long Clean Pavement from Abdullahpur to Kotbari Bazar

5. Limitation of the Study

Turag River is a very long water body with some branches near Buriganga and Tongi area. The sections, width, accessibility changes with distance along the river. The water quality also varies depending on the presence of industries near the river, dumping sites, illegal infrastructures, and encroachment. Water samples could not be taken for testing due to lack of laboratory facility hence previous data from DoE and other journal papers are used.

6. Conclusion

In order to debate against the current state of Turag, suitable new techniques have been presented that can be implemented considering the socio-economic prospect of Bangladesh to build a more sustainable ecosystem. The problems of the Turag River have been covered such as pollution, land illegal encroachment and a possible threat to the nearby residents. Finally, the report briefed about Environmental Flow

Management and Riparian Ecosystem, both are equally important and beneficiary for the survival of Turag River. Both the techniques are suitable for Bangladesh and have a great extent of advantages to the residents nearby the Turag River. Developing a riparian ecosystem with the natural flow of the river will build a safe environment for the diverse species of organisms, enhance the air quality and also provide an aesthetically beautiful place to visit. Although the absence of a laboratory facility has limited the research to produce fresh results on Turag river pollution which has been covered by secondary data sources. Furthermore, the outcome of the proposed ecosystem restoration techniques cannot be presented at the moment as they have not been practiced yet in Bangladesh.

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