



# Hydro-morphology monitoring, water resources development and challenges for Turag River at Dhaka in Bangladesh

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The Hydro-morphological regime of Dhaka city lies on several connected rivers and channels with extensive inundates flood plain in both side of the river areas. The current study exposed the Hydro-morphological condition and challenges of water resources development for Turag River. The Hydro-morphological data that was used in this study were collected from Bangladesh Water Development Board (BWDB). Arc GIS 10.1 software has been used for map preparation. Tidal flow is dominated at downstream of Turag River and water level varies 1m to 2m with discharge of 124 and 1136 cusec in dry and monsoon period respectively. Morphologically Turag is irregular meandering tide dominated river with sinuosity ration is 1.5. Cross-section of Turag River with different ID 1 to 10, 11 and 12 at different year has been analyzed to investigate the change of thalweg shifting. Major bed level shift has been observed between 2005 and 2014 at cross-section ID-6. For protecting Dhaka city from flood, improve drainage system and environment a 12.5 km embank has been constructed. But the challenges for Turag River to maintain its natural hydro-morphology and water resources development are the population, pollution, industrialization, encroachment and so on. The mighty Turag River is dying and the ecology of this river is now in critical situation. So a sustainable river management is necessary to save the river.

## INTRODUCTION

River is one of the important sources of water (Islam et al., 2015) and recognized civilization is grow in the vicinity of river (Balasankar and Nagarajan, 2000, Ahmed et al., 2016). Turag River plays a very significant role as main drainage channel of Dhaka city (Salam and Alam 2014). Hydro-morphological monitoring system is important aspect in water resources planning, development and management. For example, it helps for quantification of water resources, water quality assessment and morphological behaviors of river etc. According to Mowla (2010) in 1947, about 50% of present Dhaka city was low laying flood plain and water bodies. Dhaka integrated flood control project has been constructed along this river which includes flood protection embankment and water pumping stations, and this has made western part of Dhaka city mostly flood free. The city is facing severe environmental consequences resulting from rapid expansion of urbanization, river water pollution and encroachment of river. In the river vicinity, the encroachment is now standing in a common practice (Chowdhury et al., 2015). Thus water management in Dhaka city has multifaceted challenges due to the poor quality of surface water, inadequate management of solid and liquid water, water logging by storm water and depletion of ground water table. Water is most valuable element but poorly managed in the developing country (Fakayode,

2005). The focal point of study is to identify availability of hydro-morphological information of the Turag River. The study also takes account the availability of major water /flood management intervention on Turag River.

## MATERIALS AND METHODS

### Study area

The geographical setting of Dhaka city is very incredible with the six surrounding rivers. There are Turag, Tongi khal in the Northern side; Shitalakhya and Balu in the Eastern side; Turag River in the Western side; Buriganga and Dhaleswari in the Southern and South-Western side. The overall flows of six rivers are from North, North-West to South, Southeast side. The study area is concentrated to Turag River (Figure 1) which is located to the North of Dhaka city. Total length of Turag River around 63 km is originated from the adjacent district Gazipur. The landscape of Dhaka, the capital of Bangladesh is characterized by flat, alluvial and low floodplains of the river system. The Low and flat topography of Dhaka city varies within 2-6 meter above MSL.

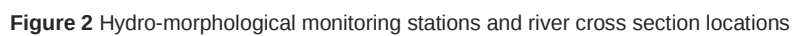
### Data and Software

#### Hydro-morphological data collection

The paper is based on the secondary data collected from Bangladesh Water Development Board (BWDB) under Ministry of Water Resources (MoWR). BWDB monitors hydrological parameters at two locations along Turag River. Major hydrological parameters that used in this study are water level, discharge and water quality. Figure 2 shows locations of

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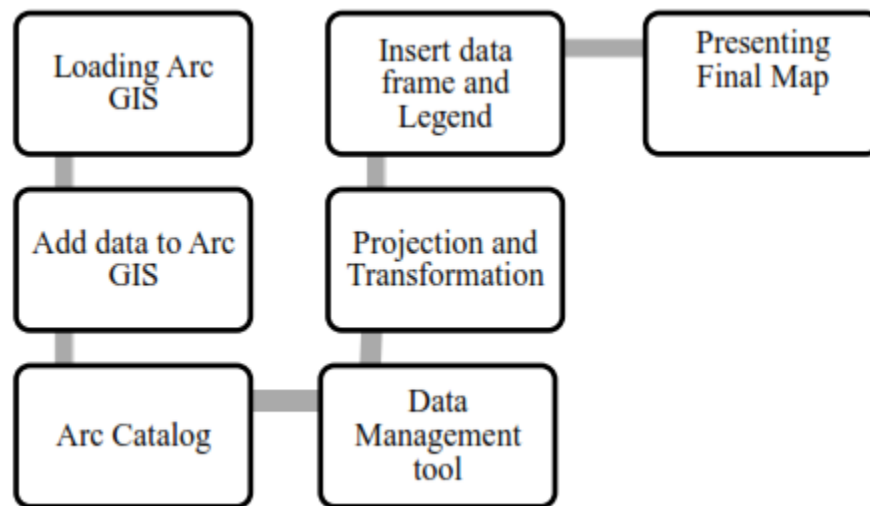


**Table 1** List of Hydrological Motoring stations around Dhaka

| Stations ID | Stations name | River Name | Remarks                              | Data availability                         |
|-------------|---------------|------------|--------------------------------------|-------------------------------------------|
| SW301       | Khaliakhor    | Turag      | WL                                   | 1953                                      |
| SW302       | Mirpur        | Turag      | WL, Discharge, Surface Water Quality | 1949 and surface water quality since 2001 |

**Table 2** Sinuosity calculation

| Sinuosity Index                                                             | Description                                                                                               | Reference                                |
|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|------------------------------------------|
| <i>Sinuosity Index</i> =<br>Where,<br>Stream Length= 63<br>Valley length=42 | SI <1.05: almost straight<br>1.05 ≤ SI <1.25: winding<br>1.25 ≤ SI <1.50: twisty<br>1.50 ≤ SI: meandering | (Yeasmin and Nazrul, 2011; Schumm, 1977) |

**Figure 3** Overview of Methodology**Table 3** Major Hydro morphological features of Turag River

| Physical description  | Nature         | Meandering , gradient 2cm/km                |
|-----------------------|----------------|---------------------------------------------|
|                       | Bank level     | Left 2.67 m to 5.92 m, right 4.210 to 368 m |
|                       | Bed level      | -0.748 to -12541 m,                         |
|                       | Catchment area | 1024 sq km                                  |
| Discharge/ River Flow | Seasonal       |                                             |
|                       | Dry period     | 124 cusec,                                  |
|                       | Monsoon period | 1136 cu sec                                 |
|                       | Tidal effect   | D/S Tidal upstream, non-tidal               |

the Hydro-morphological monitoring stations and Table 1 shows the stations ID-name and data availability. There are two hydrological data collection gauging stations, one is located at the source and another is located near the downstream end. Stations at Mirpur measures water level, Discharge, and Surface Water Quality while stations at Kailiakhor measures only water level. BWDB has historical records of these hydrological parameters at SW 301 no. station since 1949 and SW 302 no. stations since 1953.

#### Data Analysis and Software used

The Sinuosity of Turag River has been calculate using the equation at table 2. In where the Stream length is 63 km and the valley length is 42 km. A version of Arc GIS 10.1 being used to processing the data and the final map preparations. Now a day GIS is extra-ordinary useful tool to input, store, analyze and output of geographically referenced data

(Siddik et al., 2013; Chowdhury et al., 2016). Watershed of the Turag river are delineated by the physically from the outlet point and are done by the SWAT software. Microsoft excel was used to prepare and analysis of the graph. Secondary information has also been taken form relevant literature. An overview of methodology is representing in Figure 3.

## RESULT AND DISCUSSION

### Hydro-Morphology of Turag River

#### Hydrology of Turag River

The Turag River originated from the Bangshi River (lower) at Khaliakhor upazilla under Gazipur district. Major Hydro-morphological features of Turag River were presented in Table 3. Turag River is divided into two parts at the point of Birulia Union of Savar upazilla under Dhaka district. The river is flowing over Khailaikhar, Ashulia,

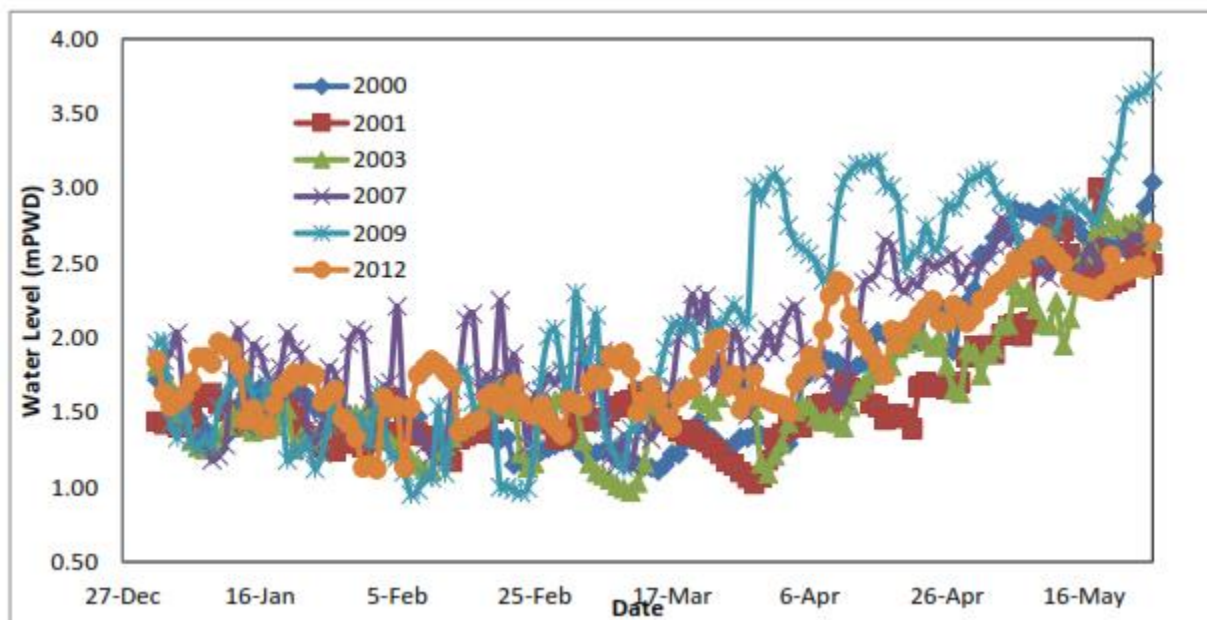


Figure 4 Hydrograph for month January –May of different year of Turag River at Mirpur Station

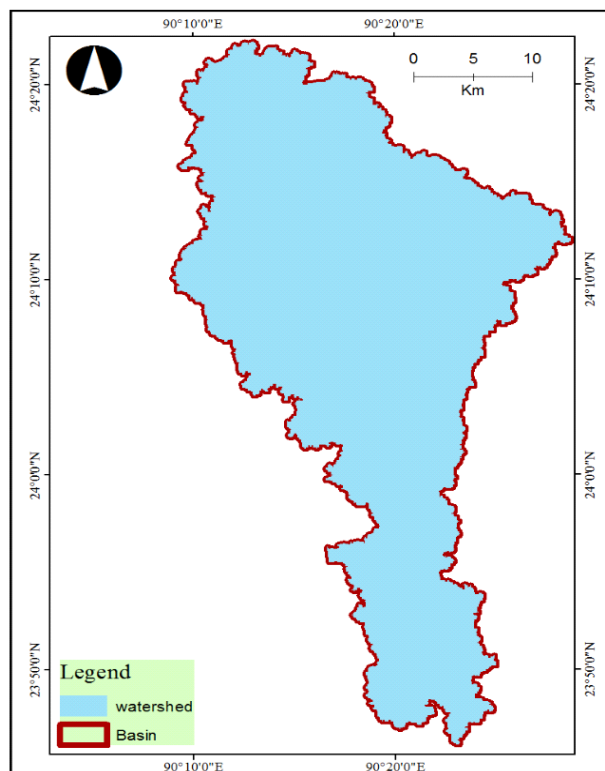
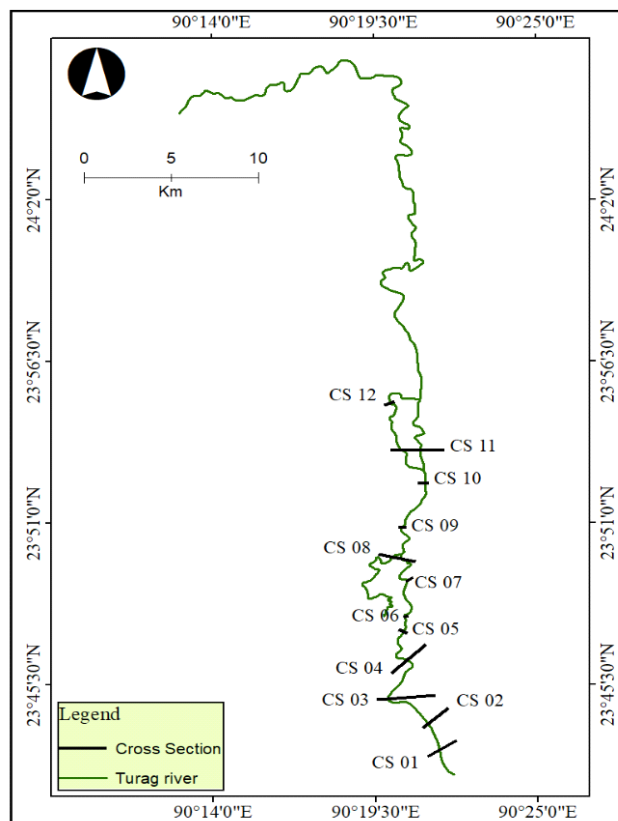


Figure 5 Delineated watershed of Turag River

Table 4 Morphological Cross section across the Turag River

| Sl. | Cross section Id           | Availability years                   |
|-----|----------------------------|--------------------------------------|
| 1   | RMTUR 1,2,3,4,5,6,7,8,9,10 | 1974,77,93,94,2000,05,09,10,11,12,13 |
| 2   | RMTUR 11                   | 1974,77,93,94,2000,09,10,11,12,13    |
| 3   | RMTUR 12                   | 1974,77,93,94,2001,09,10,11,12,13    |

\*RMTUR (River Morphology of Turag River)



**Figure 6** Cross-section Location of Turag River

Savar, Mirpur, Keraniganj, and finally falls into Buriganga River at Hazaribag in Dhaka District. Another part falls into Buriganga River of Kaundia Union of Savar Upazila in Dhaka district. Three tributaries Gollar Khal, Salda and Labundha were met at Boalia union of Khaliakhar upazilla under Gazipur district and at Mirzapur of Tangail sadar. One distributary Tongi khal originated from Turag at Burulia union of Savar upazilla and Dhaka district. Tidal effect is dominant at the downstream. At monsoon period water flow increases and inundates the flood plain both side of the river. Low flow or dry season flow is very important for Turag River as it becomes polluted from the nearby industries. Figure 4 shows the water level hydrograph for January to May period of several years. Water level varies from around 1 m to 2 m from January to April. All the years shows similar pattern and during dry period tidal flow is dominant. Watershed is drainage region of a river. River watershed defined by upstream outlet. Figure 5 exposed the watershed of Turag River, in where the longest path, reach, watershed and basin boundary are shown. The catchment of Turag River is semi-funnel shape (Uddin, 2005).

#### **Morphology of Turag River**

Morphological Cross sections across the Turag River within availability years is uncovered at Table 4. Figure 6 successfully reveals the location of cross-sectional area. Cross-section of River (Cross section ID-6) for the year 2005, 2010 and 2014 has been superimposed to investigate (Figure 7) the change of Thalweg shifting as well as river bed change. It has been observed from the superimposed graph that flood plain area becoming higher and higher every year which indicates intervention of river flood plain. Significant bed level shift has been observed between 2005 and 2014 (Figure 7). The Turag River is non-beaded irregular meandering river. The sinuosity of the river is 1.50, which indicated the

river carry a meandering property rather than straight. Sinuosity is 1.5 or greater of a river refers meandering property of river (Yeasmin and Nazrul, 2011).

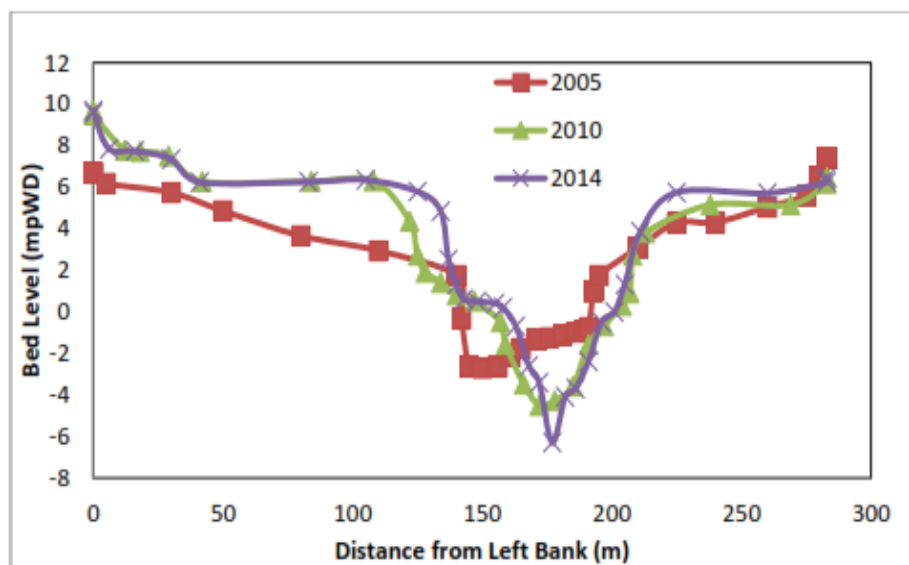
#### **Major Water Resource Development Activities**

In 1988, a vast area of Bangladesh, including the Dhaka City, was hit by a catastrophic flood. In view of the adverse effects of the flood on the Dhaka City, a flood control plan for the Greater Dhaka Metropolitan area has been taken. A feasibility study on the Dhaka Integrated Flood Protection (DIFPP) Project under FAP-8B was taken up in January, 1991 & completed in September 1991. The project has 3 components (i) Flood Protection (ii) Drainage & (iii) Improvement of environment. These 3 components were implemented by three agencies namely Bangladesh Water Development Board, Dhaka WASA, and Dhaka City Corporation. A 12.5 km fully flood protected embankment at western part of the Dhaka City along the Tura River is constructed by BWDB. In figure 8 the blue color is indicator of the flood protection embankment where the green is indicator of the hydrological gauge station of the embankment area.

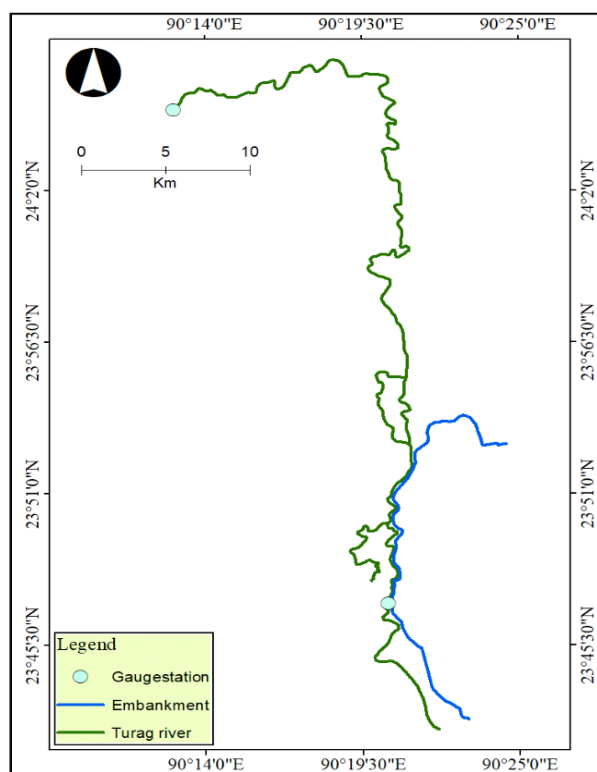
#### **Major Challenges**

##### **Population**

Dhaka is the highest population growth city in the world. At 2011, highest number of population among different city was found in Dhaka city 47424418 (Chowdhury et al., 2015). The increase of population has direct and indirect impact on the Turag River. For instance, poor people living near Turag River are polluting river water by discharging waste. Similarly, people are encroaching river for constructing houses and other infrastructures that intervene the natural flow of Turag River.



**Figure 7** Supper imposed River Cross sections of Turag River at cross section ID 6



**Figure 8** Dhaka City flood protected embankment and Hydrological gauge station

### **River water pollution**

River water pollution is very common for the rivers around Dhaka city. Water quality is decreasing day by day. Pollution sources may be Point source, non-point source. Major point sources are industrial waste as well as municipal waste directly dumping into the rivers, and on-point source surface runoff. The pollution level of Turag River at Tongi Railway Bridge is significantly higher than Ijtema field and Ashulia (Rahman et al., 2012). In Turag River at Konabari, BSCIC area the values of pH, DO, BOD, COD, and TDS ranged from of 6.25 to 9.65,

0.55 to 2.98 mg/L, 65-142 mg/L, 192-445 mg/L and 1155-2085 mg/L respectively (Sayed et al., 2015). There have higher concentration of Pb and Fe exceeding acceptable limits of domestic water supplies and aquaculture standard of Turag River at Konabari industrial area (Islam et al., 2012).

### **Urbanization and Industrialization**

Dhaka is one of the first growing cities in the world. Major effects of Urbanization reduce the width of river and canals, encroachments of

canals and rivers and loss of water storage area due to landfilling. Trade activities on the bank of Turag River are increasing by encroaching of river (Mahmud 2014). The order of encroached rivers was Turag > Buriganga > Sitallakhya > Balu (Chowdhury et al., 2015). Therefore, due to urbanization and industrialization existence of river is under threat.

### Urban Flood Management

Urban Flood management is one of the important issues for Dhaka city. The City is vulnerable to flood both river flood especially eastern part. Dhaka City was affected severely by flood 1988, 1998 and 2004. Among these, the 1988 and 1998 floods were catastrophic. In the 1988 flood, it was estimated that about 85 percent of the city was inundated at depths ranging from 0.3 to over 4.5 meters, and about 60 percent of city dwellers were affected (Huq and Alam 2003). Dhaka Integrated Flood Protection Project's constructed embankment along the Turag and Buriganga River. That protect western part of Dhaka safe from river flood. But heavy rainfall causes flooding many parts of the city due to drainage congestion. Dhaka West surrounded by embankments, flood walls, raised roads to give protection against riverine flood (JICA, 1991). But due to the various flood protection structure the natural flow of the river has been changed.

### CONCLUSION

Hydro-morphologically Dhaka city is blessed of nature for its four major peripheral river of Buriganga, Turag, Balu, Sitallakhya. Turag River is irregular meander type and Thalweg shifting river with its high monsoon period discharge. The Turag River inundates the flood plain both side of the river and dominant by monsoon period water flow. Pollution of surface water and river encroachment in Turag River are the first and second eye sore causing the city unloving. The river is now stand to face the rapid ecological calamities. Due to the surface water pollution and hydro-morphological changes causing not only the ecological but also the environmental and economic damage. Sustainable development, proper close monitoring of the river surface water quality, some mandatory role and regulation with proper institutional body can reduce the impact on ecological, environmental and economic.

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