

Effluence, Deposit Transport and Dredging of the Karnaphuli River – A Review

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Abstract – One of significant river of Bangladesh, Karnaphuli, has a high environmental and viable value for Chittagong and the Chittagong Hill. Numerous researches have been done on Karnaphuli river water analyzing water quality, heavy metals and deposit transport. Researches are done based on single characteristic. This article reviews the findings of maximum number of researches carried out by the various researchers considering all the characteristics of the river Karnaphuli.

Keywords – Water Quality, Heavy Metal, Pollution, Deposit Transport, Dredging.

I. INTRODUCTION

There are various researches on coastal area or estuary of Karnaphuli river. But this inscription is only on water of tidal Karnaphuli River. Throughout the work the water quality, heavy metal pollution and deposit process behavior of the tidal Karnaphuli river have been presented precisely. This study provides a better understanding about trends with respect to water quality, heavy metal pollution and velocity distribution. In this study the Karnaphuli river is reviewed in three categories: Water quality, Heavy metal pollution and hydrodynamic criteria.



Figure 1. Karnaphuli river from Google map

II. WATER QUALITY PARAMETERS AND HEAVY METAL POLLUTION

Due to excursion of Chittagong city manufacturing actions and effluents, population growth, agricultural development oil and gas are discharged in Karnaphuli river. Almost 90 percent among those 800 industries located on the both sides of Karnaphuli river bank and they don't have completed and operated their effluent treatment plant (ETP) and the owners of few industries who already claimed setting up of ETP is also not running every day [21].

Table 1 Permissible ranges of heavy metals in drinking water [12].

Heavy metal	Permissible limit				
	WHO	USEPA	ISI	CPCB	ICMR
Iron (mg/l)	0.1	-	0.3	1.0	1.0
Copper (mg/l)	1.0	1.3	0.05	1.5	1.5
Mercury (mg/l)	0.001	0.002	0.001	No relaxation	0.001
Cadmium (mg/l)	0.005	0.005	0.01	No relaxation	0.01
Arsenic (mg/l)	0.05	0.05	0.05	No relaxation	0.05
Lead (mg/l)	0.05	-	0.10	No relaxation	0.05
Zinc (mg/l)	5.0	-	5.0	15.0	0.10
Chromium (mg/l)	0.1	-	0.05	0.05	No relaxation

Various studies have been done on quality of Karnaphuli river. Farnaz et al. (2015) studied water quality assessment of Karnaphuli river showing the seasonal variations [6]. In this paper period has been divided into dry period (November-April) and wet period (May-August). Experiments were on the water quality constraints like Total Suspended Solid (TSS), Dissolved oxygen (DO), pH, Turbidity, Alkalinity, Chemical Oxygen Demand (COD), Total Dissolved Solid (TDS), and Electrical Conductivity (EC), Biological Oxygen Demand (BOD₅) etc. of the Karnaphuli river water. During the dry period of the year the absorptions of pH, Alkalinity, BOD₅, COD, CO₂, TDS, Salinity, EC etc. are higher than the BD Standards and the absorptions of turbidity and TSS are found above the permissible limit during the wet period of the year due to surface run off (Fig. 2).

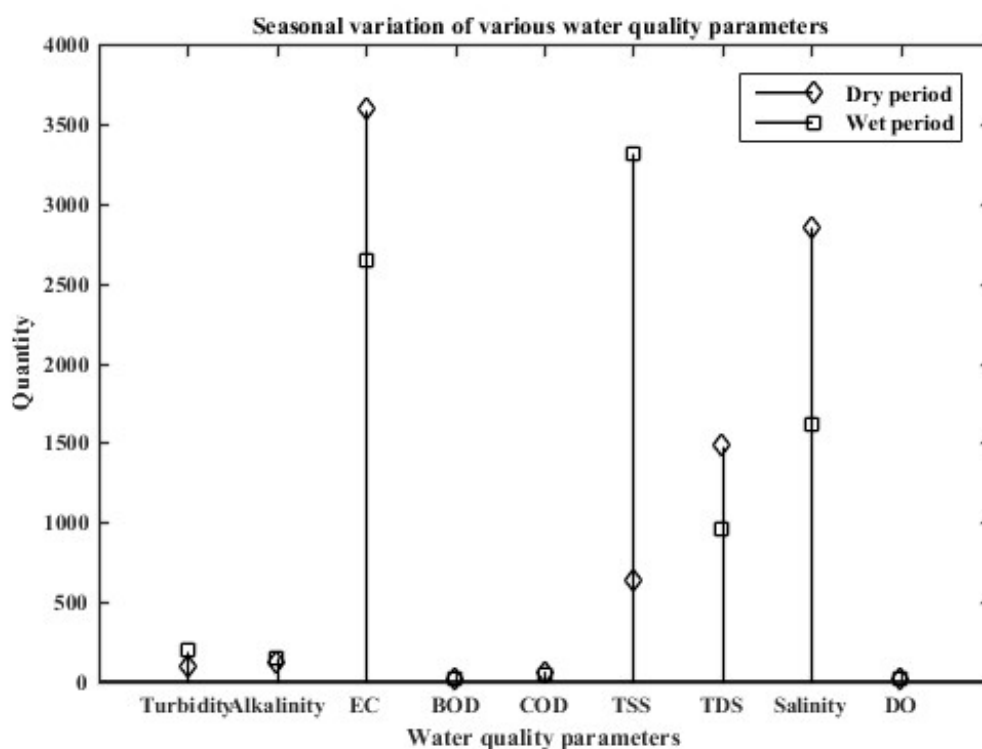


Fig 2: Seasonal variations of water quality constraints of different analyzed samples d/s to u/s (Note: Source: Farnaz et al. (2015))

Halder et al. deliberated (2017) deviation of water quality constraints from wintertime to summertime period in Chittagong, Karnaphuli river of Bangladesh [8]. Researchers have taken samples of water from Karnaphuli river, analyzed in laboratory by using different standard prescribed methods. Eight water quality constraints were investigated like as Cl^- , As, pH, Total Hardness, Fe, Turbidity, EC and TDS. All constraints were reduced from January (winter) to June (summer) except pH. The constraints' values surpassed the permitted limit recommended by WHO.

Sarwar et al (2010) designed water quality constraints: a case study of Karnaphuli river Chittagong, Bangladesh [7]. In this research paper water samples were gathered from Karnaphuli river through various points and examined. Effects of manufacturing trashes, metropolis dirt and farming overflow on the river water were examined. Samples were taken among the Kaloorghat Bridge and Patenga estuary with Chittagong port. This part owing to the occurrence of many organic fertilizers, iron, leather and pharmaceutical manufacturing is polluted. Manufacturing discharges the raw poisonous pollutant water directly into the river. The average values of were shown below (Fig. 3).

Table 2 Average values of water quality parameters:

water temperature	total suspended solids (TSS)	total dissolved solids (TDS)	total solids (TS)	turbidity	dissolved oxygen (DO)	bio-chemical oxygen demand (BOD)	chemical oxygen demand (COD)	pH	electric conductivity	total alkalinity
23° C	365.87 mg/L	8018.8	8518.33 mg/L	31.54 FTU	1.55 mg/L	6.65 mg/L	13961	247.47 mg/L	560.27 mg/L	4.8 mg/L

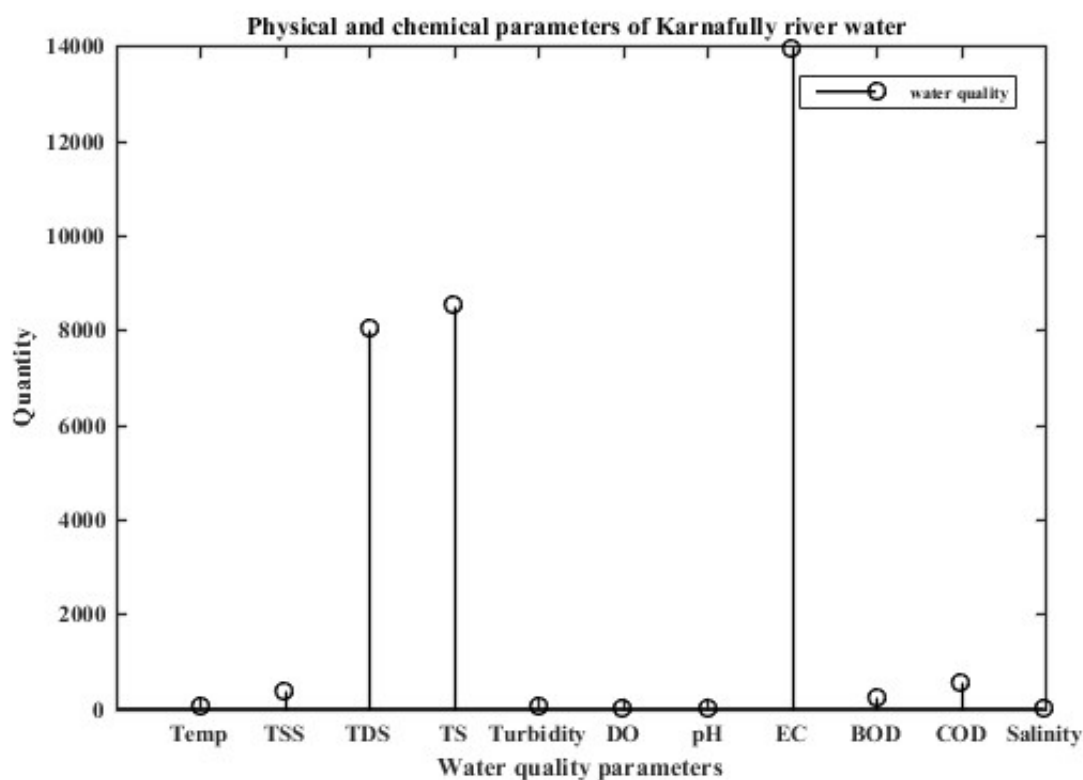


Fig 3: Physico synthetic constraints of the Karnaphuli river water (Source: Sarwar et al., 2010)

The synthetically investigation of the water samples shows the water constraints have exceeded the acceptance ranges.

Majid and Sharma (1999) contrived a writing of water quality constraints of the Karnaphuli river [9]. Rising city population is creating more loads of urban waste, and the manufacturing are propelling out their wastes directly or indirectly into Karnaphuli.

Due to fast development, there has been an upturn in the quantity of effluent being disposed to natural water bodies. Manufacturing wastes and sewage inflowing the water bodies are one of the major sources of environmental toxicity, which risks aquatic biota and deteriorates of water quality [18,19]. The quality of water is a vital concern for mankind since it is straight linked with social well-being [20].

Through the passage of heavy metals in the riverine scheme, it may endure recurrent variations due to dissolution, rainfall and absorption phenomena [25]. Consequently, it is significant to measure the absorptions of heavy metals in water and deposits of any contaminated riverine environment.

Dey et al. (2015) functioned on heavy metal contamination of Karnaphuli river, Chittagong, Bangladesh. Authors dealt with the heavy metals distribution viz. Cadmium (Pb), Chromium (Cr), Lead (Pb) and Nickel (Ni) in water of Karnaphuli River during rainy and winter seasons. Atomic Absorption Spectrometer (AAS) analysis of water sample reveals that the absorption of Lead (Pb) is very low as AAS could not detect the amount present in the water samples, while, Nickel (Ni) and Cadmium (Cd) were higher. Chromium (Cr) was detected relatively low throughout the study period. The absorption of heavy metals indicated seasonal variation and it was higher in winter season, which is not in alarming level.

Ali et al (2016) elaborated primary calculation of heavy metals in water and deposit of Karnaphuli river, Bangladesh. Researchers tested four heavy metals such as chromium (Cr), cadmium (Cd), arsenic (As), and lead (Pb) in deposits and water were examined from Karnaphuli River in Bangladesh. The increasing trend of metals were observed in water as $Cd < Pb < As < Cr$ and in deposited $Cd < As < Pb < Cr$. The ranges of heavy metals in water were the level of studied metals in water samples surpassed the safe limits of drinking water (Fig 4, 5).

The overall contamination load was upper in winter than in summer season.

Table 3 Heavy metals in water and deposit of Karnaphuli river, Bangladesh:

Heavy metal site	As	Cr	Cd	Pb
In water	13.31–53.87	46.09–112.43	2.54–18.34	5.29–27.45
Deposited	11.56–35	37.23–160	, 0.63–3.56	21.98–73.42

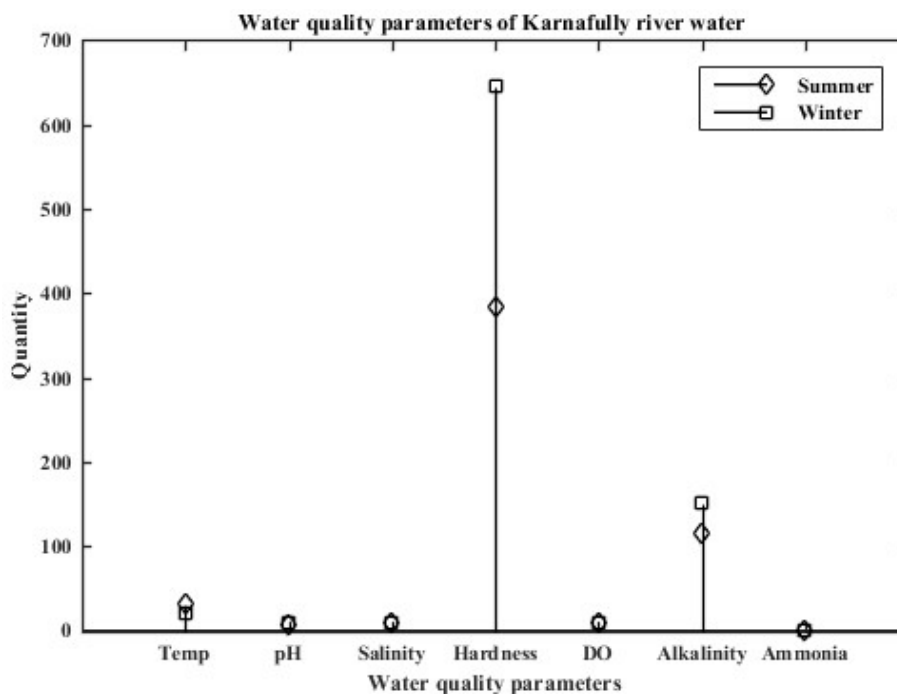


Fig 4. Water quality constraints of Karnaphuli River of Chittagong district, Bangladesh. (Note: Source: Ali et al. (2016))

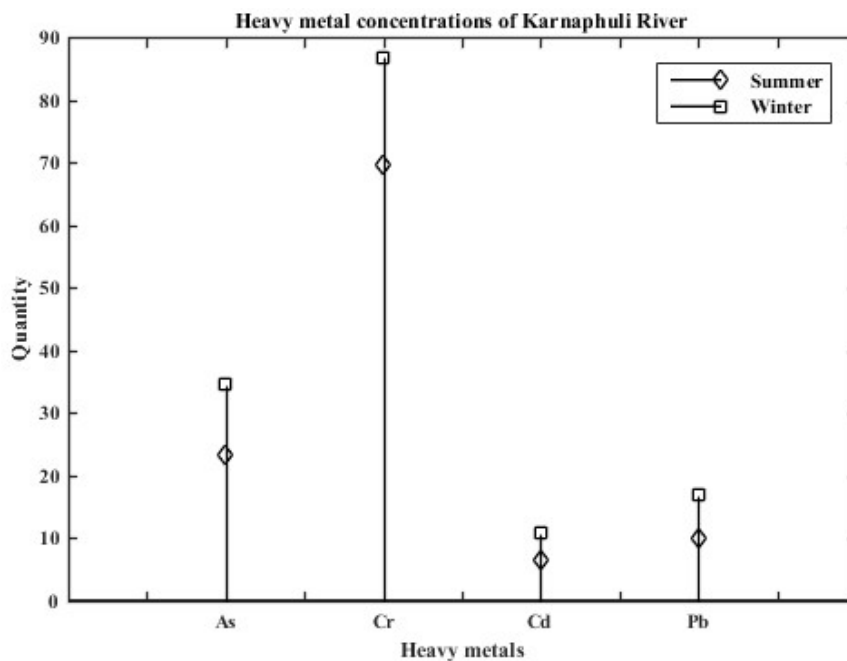


Fig 5. Heavy metal absorption ($\mu\text{g/L}$) in water sample of Karnaphuli River and extreme allowed absorption in water ($\mu\text{g/L}$).
Note: Source: Ali et al. (2016)

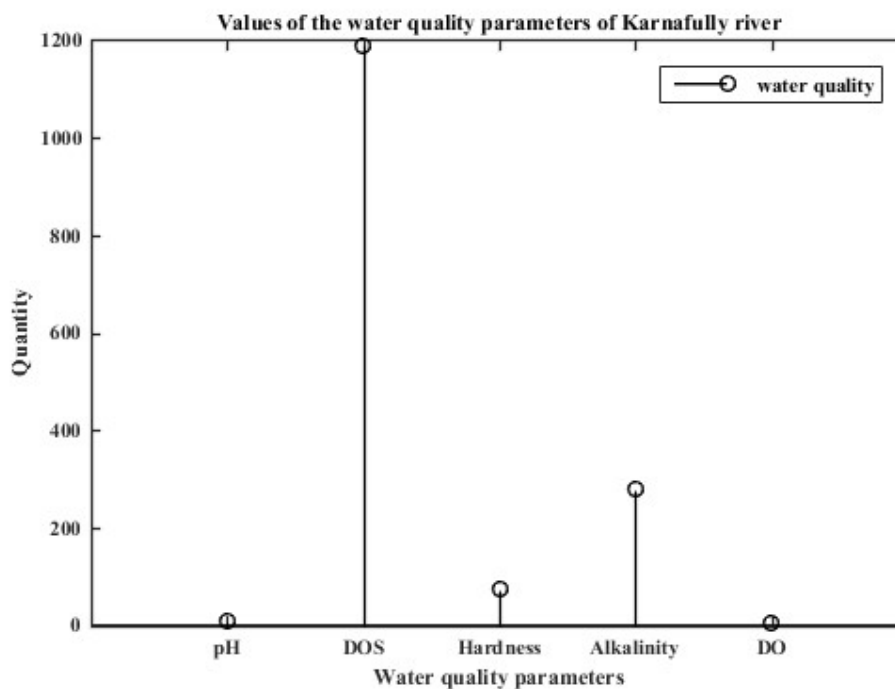


Fig 6. Values of the water quality constraints of release canals in the Kalurghat manufacturing region of Chittagong and Karnaphuli river at different collection points Note: Source: Majid et al. (2003)

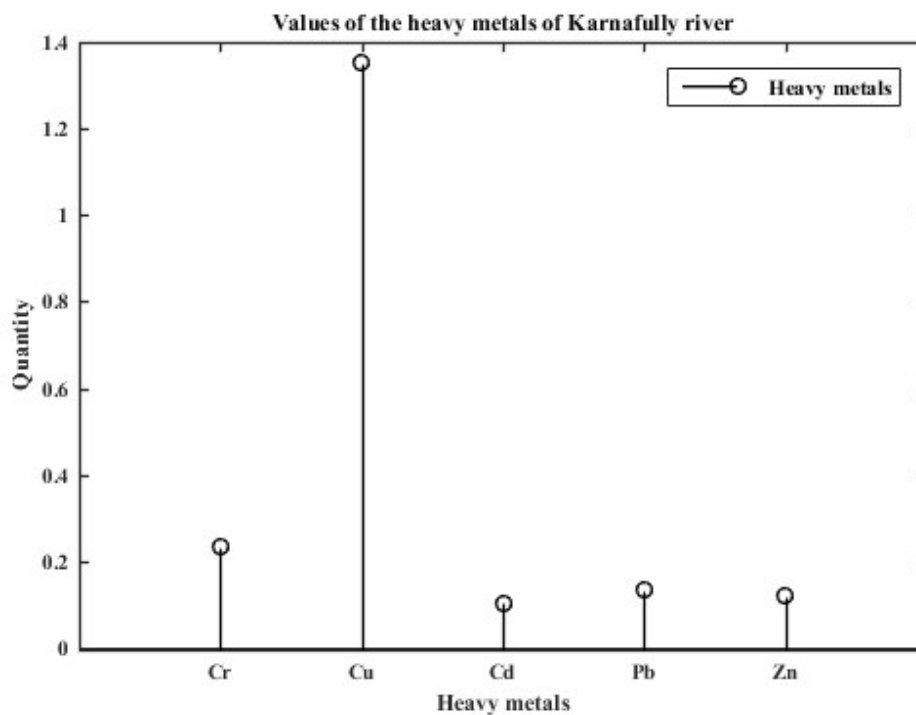


Fig 7. Trace metal status of the release channels in the Kalurghat industrial region of Chittagong and Karnaphuli river at different collection points. Note: Source: Majid et al. (2003)[15]

Majid et al. (2003) studied ecological impression calculation of the wastes from Kalurghat industrial region of Chittagong on the Karnaphuli river water [15].

In this study water samples from the Kalurghat Industrial region of Chittagong and Karnaphuli River have been examined for about two years for numerous physico-synthetical constraints such as pH, conductance, alkalinity, hardness, dissolved solids, chloride, sulphate, phosphate, nitrite, DO and trace metals such as chromium, copper, cadmium, lead and zinc to. Constraints and trace metals absorptions values are at a certain collection point depend on the industry near which it is located. There is dependability on cyclical variation. The water samples are found alkaline through having high melted solids, phosphate, chloride and nitrite contents. DO is beneath the boundary for healthy aquatic life in almost all places (Fig. 6, 7).

Islam et al. studied (2016) Assessment of industrial effluent pollution in Karnaphuli river [14]. This study has been conducted in ‘Kalurghat heavy industrial region, Chittagong’ by collecting effluent from nine manufacturing and three stationary points on Karnaphuli river. Examination displays that many manufacturers don’t have ETP, some have but these are not in operation. Physio synthetical results show that the amount of Turbidity and TSS is very high. But the heavy metal constraints are within Bangladesh standards. Thus, effluent should be treated in a proper way to dispose in the river (Fig. 8).

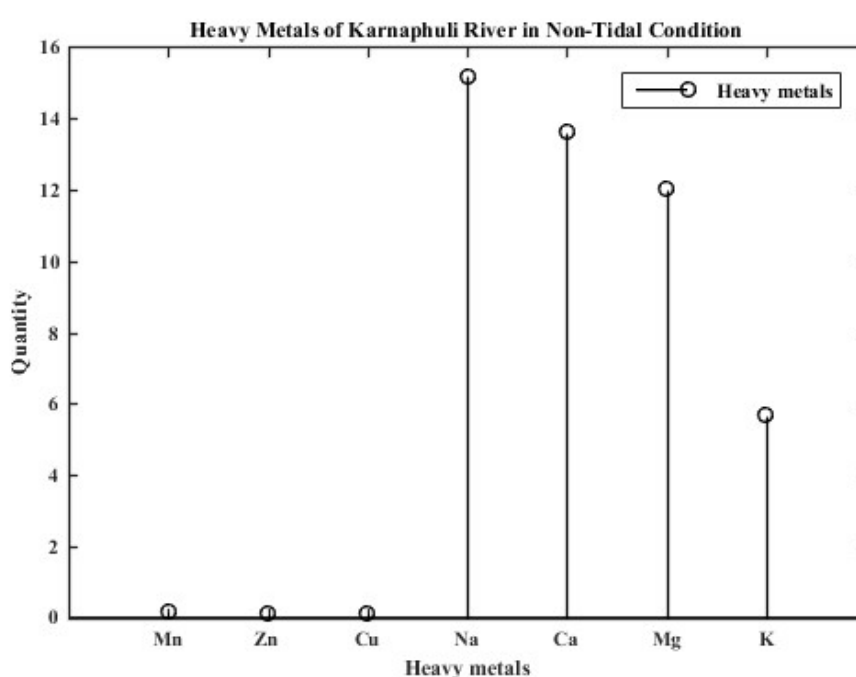


Fig 8. Assessment of heavy metals of Karnaphuli River in non-Tidal condition. Note: Source: Islam et al. (2016)

III. DEPOSIT PROCESS

To calculate the navigability and dissolving pattern it is significant to check the hydrodynamic and morphological individualities of the river deposit procedure which is replicated by its flow velocity, shear stress and deposited transport. Previously various studies were conducted at different time to evaluate the behavior of Karnaphuli river [1][2][3][4][5].

During the way this sinusoidal river passes Kaptai hydroelectric power plant, Halda-Karnaphuli confluence and several bridges [Fig:1]. The length of the river from Kaptai Dam to Halda-Karnafui confluence is about 45 km and from Halda-Karnaphuli confluence to BN Aacademy is about 30 km. Karnaphuli river is a tidal river having semi-diurnal characteristics. During overflow period the tide voyages long distance in the upstream way of Halda river and very near to Kaptai Dam in upper Karnaphuli river [15].

The Karnaphuli River is the biggest tidal river and important in the southeastern part of Bangladesh (Hossain, et al., 2005). During its course to the Bay of Bengal, the river receives a lot of canals, tributaries and small rivers, which has been played a dominant role on the hydro-morphology of the Karnaphuli River.[16]

Alam and Matin presented (2012), implementation of Delft 3D scientific model in the river Karnaphuli for two-dimensional simulation [12].

Application of 2D model to measure dissimilar hydrodynamic characteristics of the river has been studied. The model has been arranged with the recent bathymetry data collected from CPA hydrography division and the river reach between Kalurghat and Khal no-18. This 3D model used a curvilinear orthogonal grid with variable dimensions of grid cells starting from 58 m up to 166 m. Calibration and validation against the water level data for the year 2009. Results include flow (velocity) field, bed shear stress etc.

The model calculates the water stages quite well, sometimes it is little bit overvalued. Inconstant roughness values are used through the model which acted as the adjustment constraints. Roughness values used ranges between 0.025 to 0.029 (Manning's roughness).

From this simulation the susceptible regions found are mostly concave sides of each loops and places having shallower depth.

Alam and Matin presented (2013), presentation of 2D morphological model to evaluate the response of Karnaphuli river due to capital dredging. (Fig. 9, 10, 11, 12)

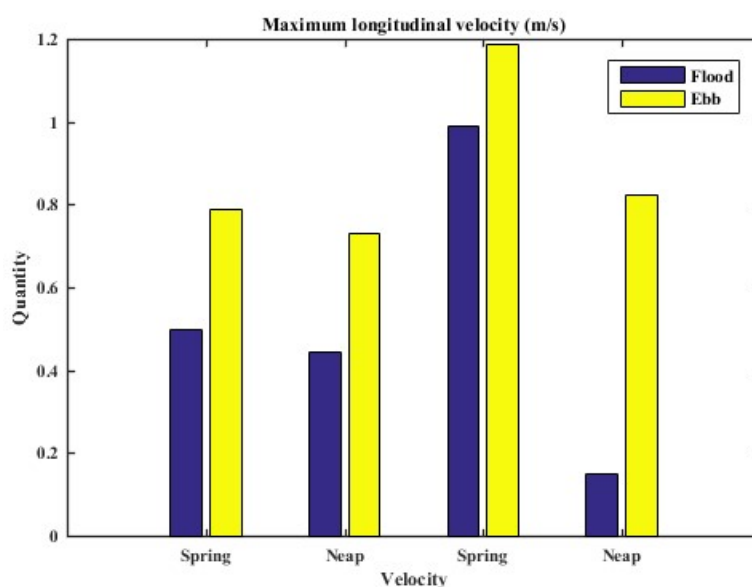


Fig 9: Extreme longitudinal velocity (m/s) constituent during dry (January) season at altered points.

Note: Source: Alam and Matin (2013)

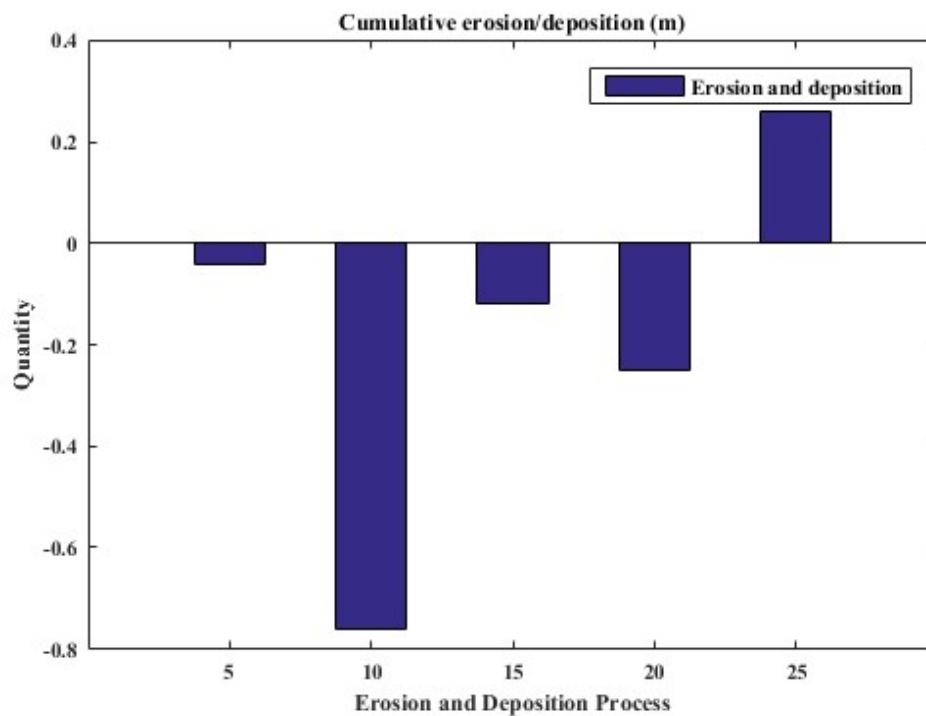


Figure 10: Collective attrition/deposition (m) through the river laterally centerline. Note: Source: Alam and Matin (2013)

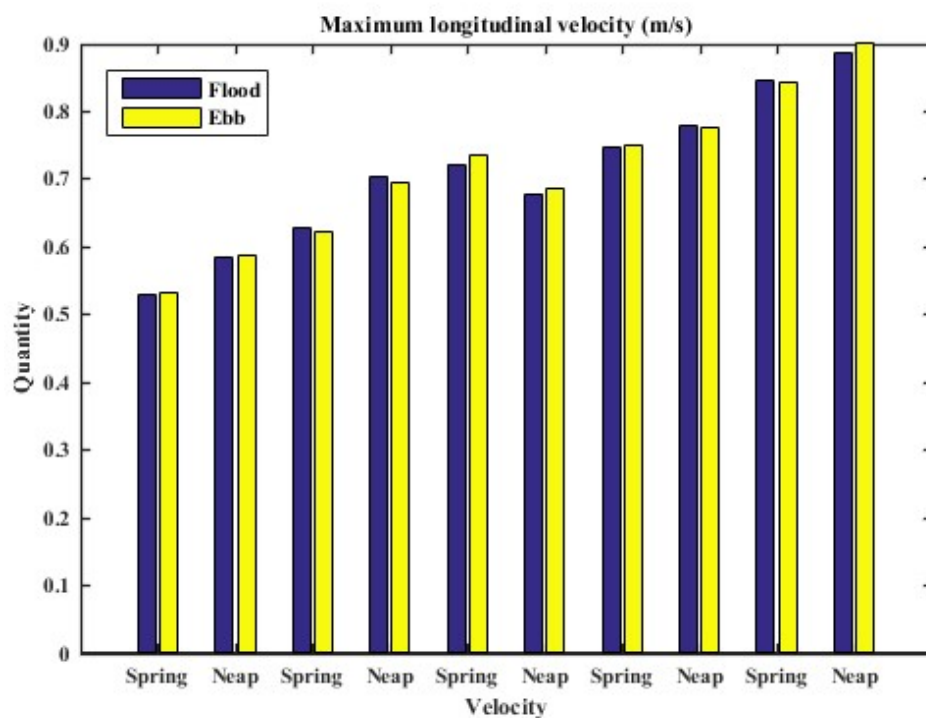


Fig 11. Exemplary outcomes presenting extreme longitudinal (m component) velocity difference (m/s) during dry season (January) [Pre= Pre-Project, Post=Post-Project condition] Note: Source: Alam and Matin (2013)

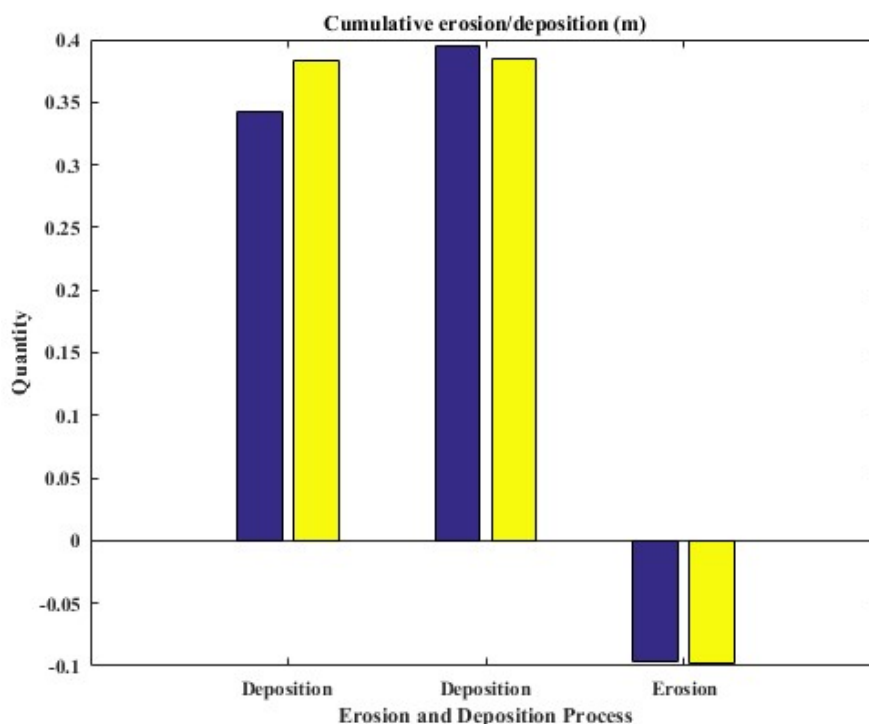


Fig 12 Exemplary outcomes presenting accumulative attrition/ deposition (mm/day) along N=15,20,25 after one year period at different distances (km) between M=67to178 [Pre=Pre-project condition, Post= Post-project condition]. Note: Source: Alam and Matin (2013)

Authors studied the same spot in their previous research paper. In this report variation of velocity, deposited transport and bed level deviations have been considered. It was used to measure the effect of Capital dredging and bank protection near Sadarghat region. Model consequence shows small rise in velocity and deposited transport due to project application. It also changes the rate of erosion/ deposition at some site of the particular reach.

It is evident that the dredged situation reasons an surge in velocity at nearly all the upstream and downstream sites near Sadarghat region (dry season and wet season). Calculation result displays rise in attrition or reduction in deposition rate in maximum of points. Particular points display minor surge in deposition. The complete magnitude of disparity is not significant at any of the sites in the experimental points.

Kabir and Ali (2017) studied hydrodynamic and morphological calculation of Karnaphuli River by CCHE2D model [17]. For exemplary setup, the river reach is designated between Kalurghat and Khal no-18.

Outcome displays minor increase in velocity. It also changes the rate of attrition and deposition at some site of the selected reach. It is expected that the outcome of the model simulation will be supportive to recommend the effect of probable future change work to be applied on this river.

Roy and Navera (2017) studied hydro morphological behavior of a non-sinuuous tidal river due to dredging of a predominant island: a case study for Karnaphuli river, Bangladesh. Authors have enclosed the pre and post dredging scenarios of horizontal and vertical velocity distribution, deposit transport (suspended and total) and deposit budget etc. along the reach focusing the seaport region. The assessment of this river has shown perceptible changes along the seaport region and upstream and downstream of the Karnaphuli river reach due to dredging (Fig 13, 14).

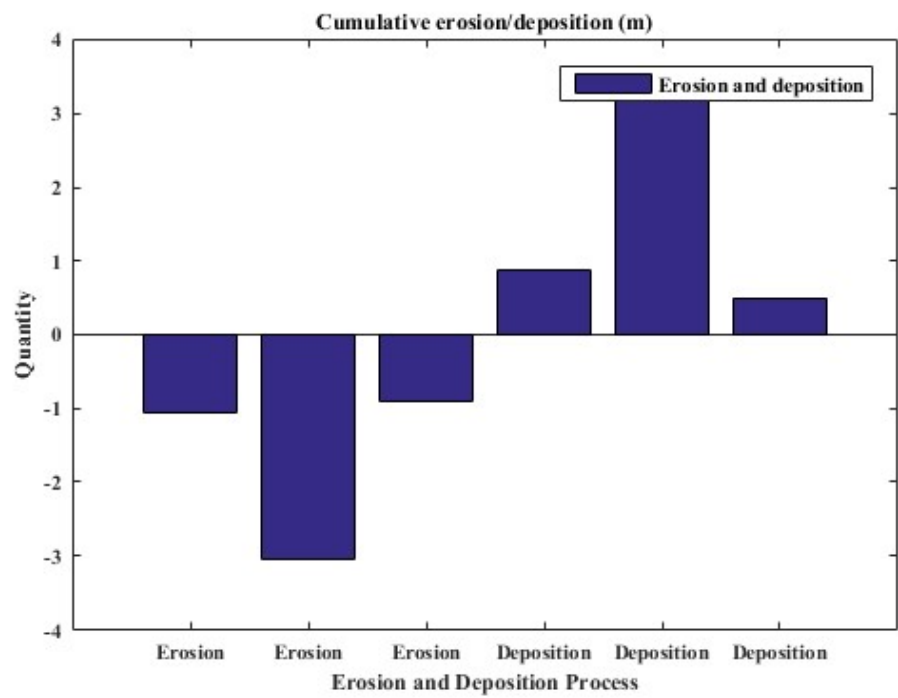


Fig 13. Morphological behavior (erosion/deposition) along Karnaphuli River
Note: Source: Roy and Navera (2017)

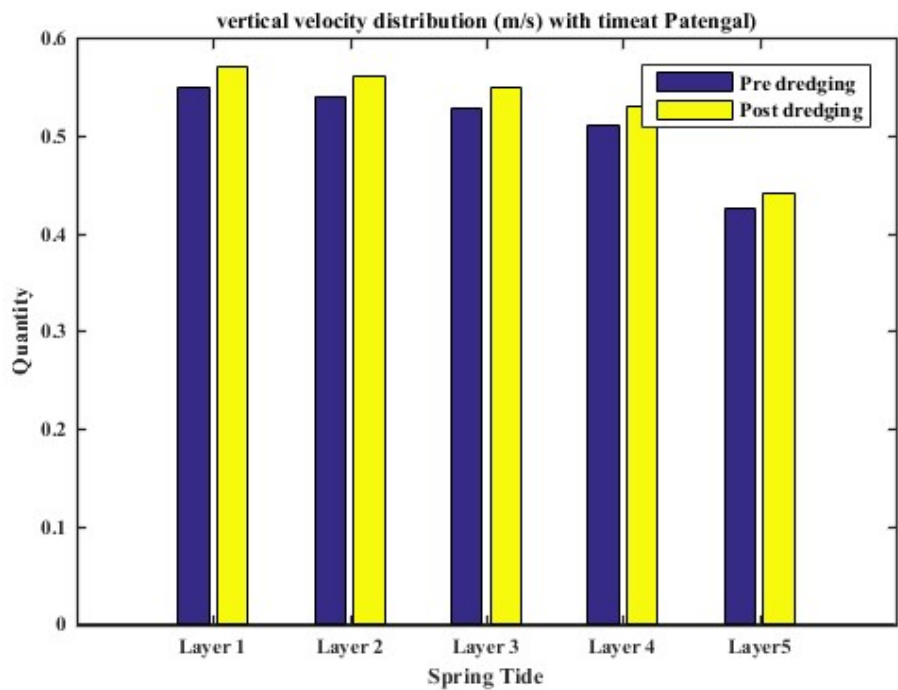


Fig 14. vertical velocity distribution (m/s) with time at Patenga (Spring Tide)
Note: Source: Roy and Navera (2017).

IV. CONCLUSION

This revised article précises the present state of water quality including heavy metal contamination in the river Karnaphuli. Several articles of water quality and heavy metal contamination indicate that the levels of various water quality constraints and heavy metals in the river

Karnaphuli water and deposited are faraway the usual absorptions. The metals go into the atmosphere through aquatic life schemes and plants and animals nearby the river. The dangers of bioaccumulation and bio strengthening of the heavy metals sort them a big danger to human well-being and welfare. Hence, it is essential that steps would be taken to diminish the metallurgical pollutant load dropped into the river. This revise anticipated that many sources of heavy metals in the water and deposit of the river should be carefully supervised; development of circumstances and manufacturing effluent and local sewage release should be maintained.

No important contrary effect on the river due to capital dredging has been observed from the velocity results.

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