

Dredging Design and Estimation of Annual Net Growth of Paturia-Daulatdia Ferry Ghat, Bangladesh

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Abstract—Bangladesh is a land of rivers where about 700 rivers including tributaries are flowing through the country that make the waterway of total length around 24,140 km. As Bangladesh is an active delta system, largest depositional basin and greatest sediments source which are mainly carried by the Ganges-Meghna-Bramaputra river system and finally waterways are clogged down frequently. Normally, at Paturia-Daulatdia Ferry ghat (Padma River) the water level remains the lowest in December to April when the navigability of the river become an acute problem. Transport fare of the ferries is the prime income source of the Government which also reduced and affected the yearly revenue. According to the problem, making an effective design of waterway for calculating the dredging cost can make the healthy revenue and estimating the other cost, like- oil cost, crew salary which are due to calculate the annual revenue. Extracted sediment selling can add up an income source for calculating yearly revenue. Only 1.45 km navigable waterway can make less dredging cost whereas existing route is 2.25 km.

Index Terms—Annual Net growth, Annual revenue, Cost estimation, DaulatdiaFerry ghat, Dredging Design, Income calculation, Paturia ferry ghat

1 INTRODUCTION

Dredging, the excavation activity usually carried out in underwater, for gathering up bottom sediments and disposing of them at a different location due to keep waterways navigable. Bangladesh Inland Water Transport Authority (BIWTA) dredges the Daultdia-Paturia route every year. Due to their immense scale, dredging projects are designed and funded based on competitive bidding processes, commonly cost shared by government. The government of Bangladesh had decided to dredge rivers to increase navigability of the rivers at a cost of \$20.48 billion (BIWTA, 11 Aug, 2015).

The Paturia Ferry Ghat is located in the district of Manikganj in Dhaka Division and the Daulatdia Ferry Ghat is in the district of Rajbari in Dhaka division (Fig 1). The area is included in the BIWTA sheet no. ARC 993/2015 A and in the scale of 1:10,000 which is sounded on 24 & 28 November & 01, 03 to 05 December, 2015 and reduction of the map is 1.65 m. Geographically, the study area lies between latitudes 23°45'/N to 23°50'/N and longitudes 89°46'/E to 89°49'/E. From

Dhaka University campus to Paturia Ferry Ghat takes two and a half hours in bus and the distance is about 79 km.

2 METHODOLOGY AND CALCULATION

2.1 Proposed Route and Design

In order to select a ferry route, numbers of criteria have to keep in mind including the cost of dredging, distance to cover

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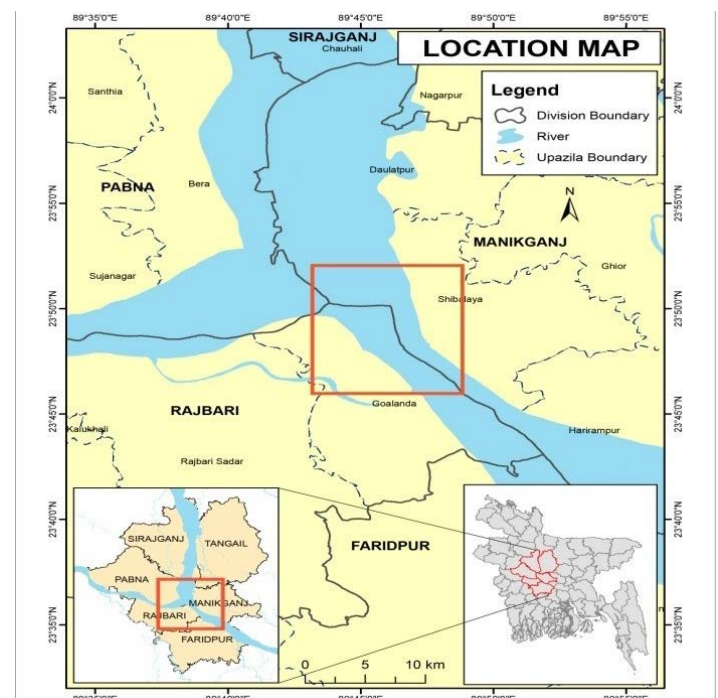


Fig 1. Location Map of Paturia-Daulatdia ferry ghat, At Padma river; Adjoining point of Ganges and Jamuna river

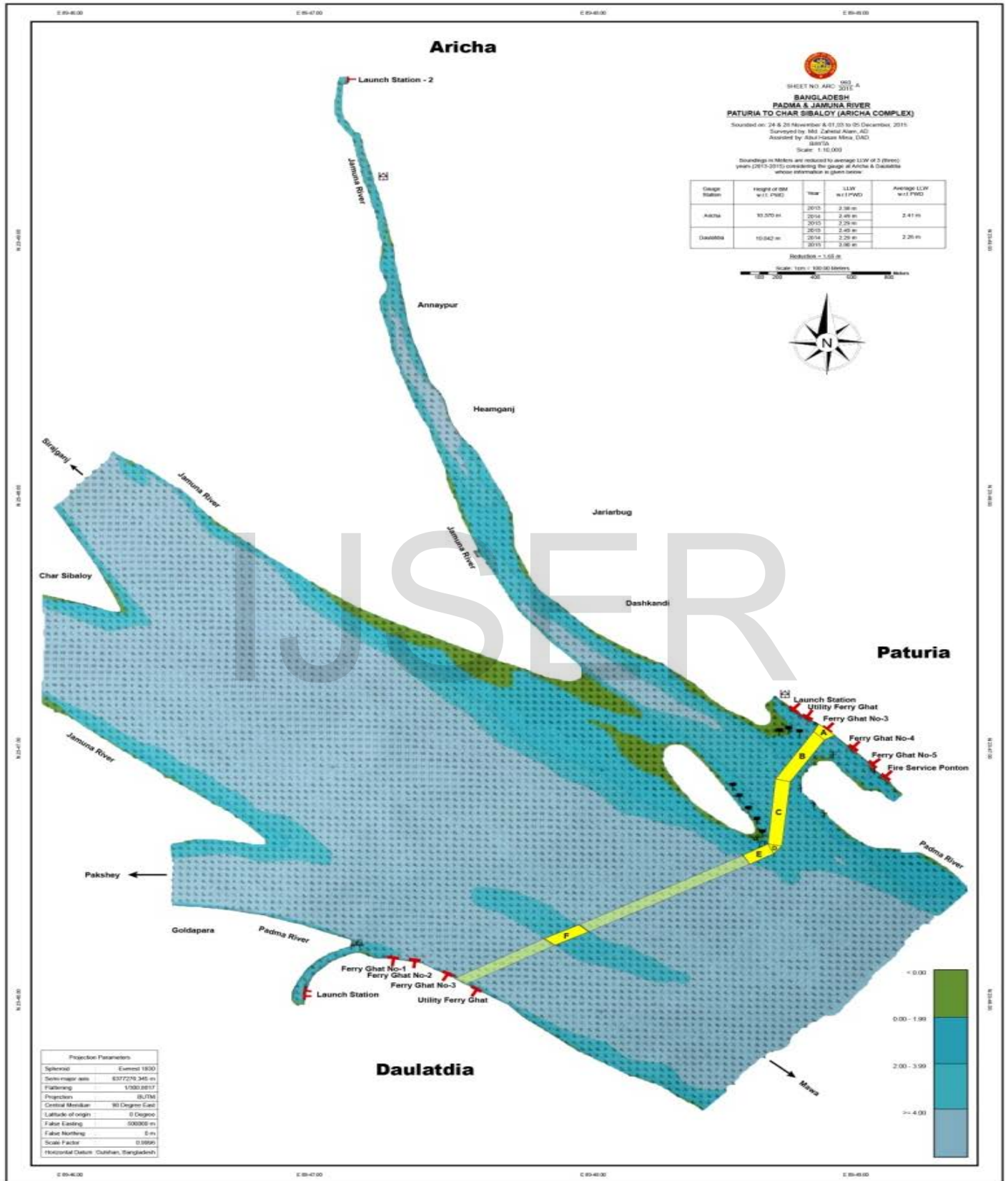


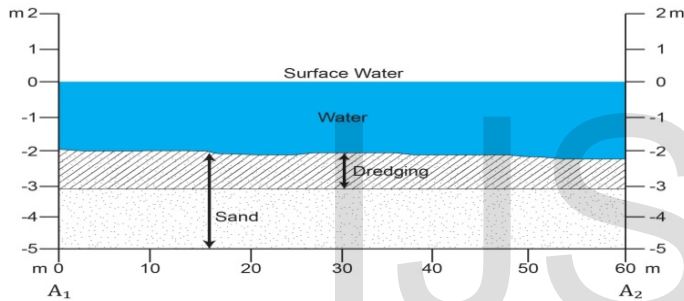
Fig 2. The Proposed Ferry Route from Paturia to Daulatdia

the route, cost of oil as to cover up the distance and duration of siltation on the water way. With the observation of Hydro-graphic Chart (Collected from BIWTA) carefully, route has selected efficiently (Fig 2) and visiting the studied areapersonally where the water depth are high, decision was made. The length of proposed ferry route is 1.45 km long whereas the wide is 73.2 m (BIWTA).

2.2 Cost estimation of dredging

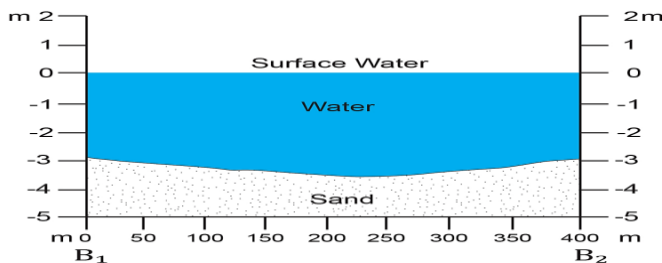
To calculate dredging cost, the route is divided into six major geometrical blocks like- Block-A, Block-B, Block-C, Block-D, Block-E, and Block-F. Average water height has calculated in every block due to the calculation of sediment height that has to be dredged. Normally 3.05 m (BIWTA) water height is required for navigating any kind of ferry that is called the Formation Level. Average water height is subtracted from the formation level for getting the height of the sediment. Thus multiplying the sediment height with the geometric area, expected sediment volume can be calculated manually. Dredging cost is calculated as \$ 2.3 per cubic meter sediment.

Block-A (Section A₁-A₂)



Average Water Height = 2.375 m
 Sediment height for dredging = 3.05- 2.375 = 0.675 m
 Area (Trapezium) of sediment= 5550 m²
 Volume of sediment= 5550× 0.675= 3746.25 m³
 Dredging cost of Sediment= 3746.25× 2.3= \$ 8,616.375

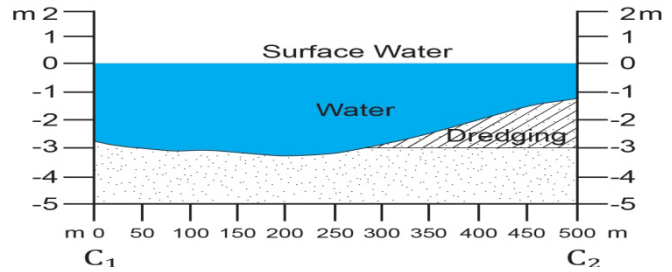
Block-B (Section B₁-B₂)



Average Water Height = 3.1 m. For navigating any water vehicle need maximum 3.05 m water height. So dredging is not necessary in Block-B as here the water height is 3.1 m

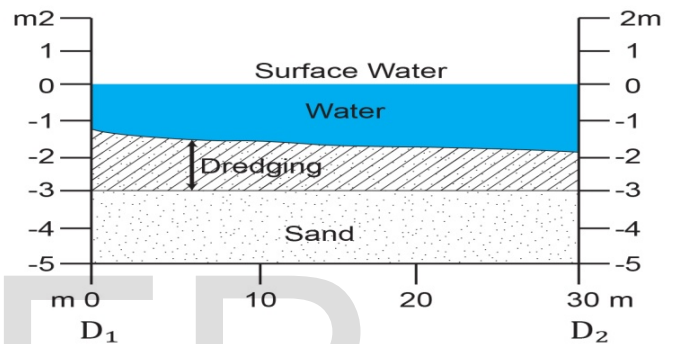
Block-C (Section C₁-C₂)

Average Water Height = 2.59 m
 Sediment height for dredging = 3.05-2.59= 0.46 m
 Area (Rectangle) of sediment = 37500 m²



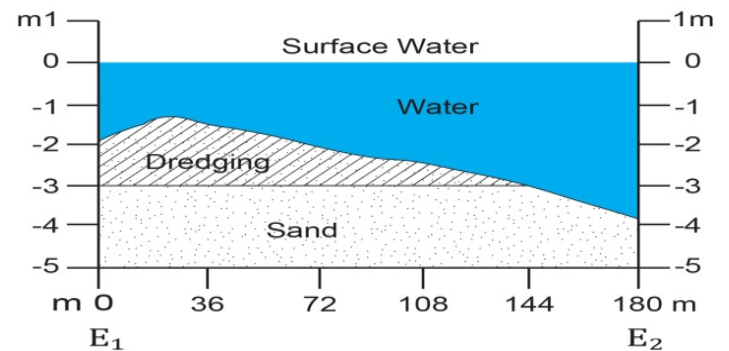
Volume of sediment = 37500× 0.46= 17250 m³
 Dredging cost of Sediment =17250×2.3 = \$ 39,675

Block-D (Section D₁-D₂)



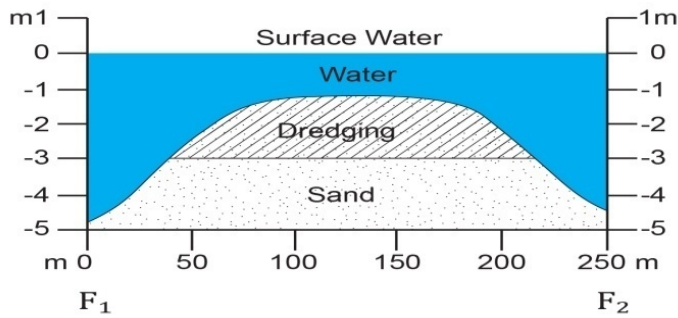
Average Water Height = 1.9 m
 Sediment height for dredging = 3.05-1.9 = 1.15 m
 Area (Triangle) of sediment = 2450 m²
 Volume of sediment = 2450×1.15 = 2817.5 m³
 Dredging cost of Sediment = 2817.5×2.3 = \$ 6,480.25

Block-E (Section E₁-E₂)



Average Water Height = 2.45 m
 Sediment height for dredging =3.05-2.45 = 0.6 m
 Area (Rectangle) of sediment = 180×75 = 13500 m²
 Volume of sediment = 13500×0.6 = 8100 m³
 Dredging cost of Sediment = 8100 × 2.3 = \$ 18,630

Block-F (Section F₁-F₂)



Average Water Height = 2.92 m
Sediment height for dredging = 3.05- 2.92 = 0.13 m
Area (Parallelogram) of sediment = 240×75= 18000 m²
Volume of sediment = 18000×0.13 = 2340 m³
Dredging cost of Sediment = 2340×2.3 = \$ 5,382

TABLE 1
CALCULATION OF OIL COST FOR TRANSPORT

Cost for per Ferry	The Cost of Oil for per Ferry = \$43.14
Cost Per Day	Number of ferries 13 (Standby 3 more) & Crosses 12 times a day. Total Cost = 43.14×13×12 = \$6,729.45
Cost per Year	Total Cost for a Year = 6,729.45×300 = \$ 2,018,835 (Based on BIWTA, as ferry route is clogged or ferry need to be repaired, 300 days are counted)

TABLE 2
CALCULATION OF SALARY OF THE CREW

	Workers	No of Workers	Salary per worker (\$)	Number of Ferry	Total Amount (\$)
Per Month	Master	1	625	13	8,125
	Chief Operator	1	500	13	6,500
	Assist. Operator	2	375	13	9,750
	Dock controller	2	250	13	6,500
	Word boy	2	187.5	13	4,875
	Total Crew salary cost = \$ 35,750				
Per Year	Total Crew Salary for a Year = 35,750×12 = \$429,000				

TABLE 3
CALCULATION OF INCOME FROM THE TRANSPORT

Income From per Ferry	Types of Vehicles	Per Vehicle (\$)	Amount (\$)
	Bus/Trucks	15	120 Average Bus/Trucks 8
	Micro Bus/Car	11.9	35.6 Average Micro Bus/Car 3
	Motorcycle	1.9	9.4 Average Motorcycle-5
	Total Income = \$165.		
Income per Day	Number of ferries 13 (Standby 3 more) & Cross 12 times a day. Total Income = 165×13×12= \$25,740		
Income per Year	Total Income for a year = 25740×300 = \$ 7,722,000		

Total Volume of Sand that could be dredged is 34253 Cubic Meters in which only 10% of it can be extracted (BIWTA). One cubic meter extracted sand will be sold at the price of \$ 6.25. Thus the Extracted Volume of Sand is 3425.3 cubic meter. So, the total income from the Extracted Sand = 3425.3×6.25 = \$21,408.13

3 RESULT

For revenue calculation, simply total cost has subtracted from total income.

$$\begin{aligned} \text{Total Revenue} &= \text{Total Income} - \text{Total Cost} \\ &= (7,722,000 + 21,408.13) - (78,783.6 + 2,018,835 + 429,000) \\ &= \$ 5,216,789.53 \end{aligned}$$

Maintenance Cost

Maintenance cost is mainly reserved for the further expenses of ferries when any types of accidental occurrences are caused. 30 % of Revenue is mainly reserved for this purpose.

Book Value

Book Value is the value at which an asset is carried on a balance sheet. It is a type of deposit money as for the security of machines. Sometimes, machines have to buy for repairing the damaged parts of ferry but with increasing price. This surplus money is sanctioned from book value. To buy a new ferry, book value is most important. 10% of Revenue is mainly reserved for book value.

Hidden Cost

Hidden Cost is mainly denoted as the unwanted cost which is invisible. Any type of problems can be confronted with this money like the transfer of ferry ghat due to the subsidence of river bank. 10% of revenue is selected for the hidden cost.

Net Growth

$$\begin{aligned}\text{Net growth} &= \text{Total Revenue} - (\text{Maintenance Cost} + \text{Book Value} + \text{Hidden Cost}) \\ &= 5,216,789.53 - (1,564,266.14 + 521,422 + 521,422) \\ &= 417,137,638 - 2,607,110.24 \\ &= \$ 2,609,679.3\end{aligned}$$

4 RECOMMENDATIONS

Some works should be carried out for the further research which are given below-

- 1) The studied area is very much vulnerable for making any type of route but more geological study is necessary to know whether the best route is feasible.
- 2) Existing dredgers can be used associated with the new instruments or new dredger to lessen the cost of dredging that is proposed.
- 3) However, properly collected of transport fare should be maintained for the annual revenue as to the abilities of government.
- 4) Nevertheless, extracted dredging sediments can also be prospected as heavy mineral industry for more revenue.

5 CONCLUSIONS

The present study represents the design of a proposed route at Daulatdia-Paturia ferry ghat. In accordance with the design, all costs- dredging cost, crew salary cost, oil cost and all income- transport fare, selling of extracted sediments are calculated. As the proposed route length is less than the existing route, the cost will be normally much less than the running project. And government doesn't get back any revenue where as the net growth is about two million dollar. So the ultimate route design is an effective waterway undoubtedly.

ACKNOWLEDGMENT

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