SIMULATION OF FLOW AND SALINITY IN RUPSHA-PASSUR RIVER SYSTEM

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ABSTRACT

Surface water salinity in the Gorai River and in its associated river network has been increasing due to low flow from the Ganges River and siltation of Gorai River mouth upholding it as a great concern for the entire south western region of Bangladesh. Rupsha-Passur river system,the major river system associating the Gorai river flows through Khulna, Chalna, Batiaghata, Rampal, Dacope and Mongla upazilla. Being tidal in nature saline water intrudes into the river system from the Bay of Bengal during stronger spring tide but at following neap tide, salinity is not totally flushed out due to low flow availability at upstream. Thus analysis on the dry period flow and salinity characteristics of the Rupsha-Passur river system is momentous. The study has been carried out on a hydrodynamic and salinity modeling in HEC-RAS to assess the variables that governed the flow and amount of salt in the river system. From the results of hydrodynamic and salinity model it has been observed that the maximum flow occurs during the month of August in both the Rupsha and Passur river. The discharges in Khulna, Bhatiaghata, Rampal, Dacope and Mongla Upazillas have been obtained as 2405 m³/s in 23rd August, 3145 m3/s in 27th August, 3689.65 m³/s in 22nd August, 5824 m³/s in29th August and 7688 m³/s in 19th August for the year 2014 respectively. The maximum salinity concentration of these Upazillas are 7703.96 ppm in 28th May, 3630 ppm in 28th June, 3396 ppm in 30th June, 3630 ppm in 19th May and 13049 ppm in 6th June respectively. Analyses results reveal that the peak value of surface water salinity reaches its maximum in late March or early April. On many occasions the maximum salinity of Chalna exceeded the concentration at Mongla although Mongla is 17 km downstream of Chalna which occurred due to high saline water mixing from the Sibsa River. The study is expected to support long term assessment that may affect the sundarbans as a result of changes in the flow from upstream due to the water abstraction activity for domestic and irrigation water supply.

Keywords: *Hydrodynamic modeling, Salinity, Rupsha-Passur, HEC-RAS*

1. INTRODUCTION

Water is a critical resource for life and essential for economic success and sound ecosystems in an environmentally friendly society. Of the world's water about 97.5 % exists as saline water in the oceans and seas. Only 2.5 % exists as fresh water and 99 % of this is trapped in glaciers and ice caps. Water is required for domestic consumption, sanitary use, industrial use, hydroelectric power generation, agriculture, irrigation and protection of the ecology and ecosystems. Bangladesh is a low-lying, riverine country located in South Asia with a largely marshy jungle coastline of 710 km (441 mi) on the northern littoral of the Bay of Bengal, formed by a delta plain at the confluence of the Ganges (Padma), Brahmaputra (Jamuna), Meghna Rivers and their tributaries (BWDB,2012). The flow of the Ganges in Bangladesh reduced significantly due to withdrawal of water in the upstream at the Farakka Barrage. India commissioned the Farakka Barrage in West Bengal in 1975 to divert 40,000 cusec water of the Ganges River into the Bhagirathi-Hooghly Rivers for flushing silt and improve navigability of Kolkata Port connected to the Bay of Bengal on the south (BWDB, 2012). The reduction of dry season flow in the Ganges has led to various water quality related, ecological, hydrological and hydraulic problems in south-western zone of Bangladesh. The main impact of reduced low flow values has been the drop in hydraulic head of the Ganges River system and the consequent increase in salinity in the rivers of the south-western part of the country (Rahman and Ahsan, 2001). The coastal areas of Bangladesh have already been facing salinity problem which is expected to be exacerbated by climate change and sea level rise, as sea level rise is causing unusual increase in the height of tidal water. In dry season, when the flows of upstream water reduce drastically, the saline water goes up to 240 kilometres inside the country and reaches to Magura district. Presently around 31 Upazilla of Jessore, Satkhira, Khulna, Narail, Bagerhat and Gopalganj districts are facing severe salinity problem. Agricultural activities as well as cropping intensities in those Upazilla have been changing; as a result farmers cannot grow multiple crops in a year (Shamsuddoha and Chowdhury, 2007). Most of the lands remain fallow in the dry season (January–May) because of soil salinity and the lack of good-quality irrigation water (Mondal, 1997). In general, soil salinity is believed to be mainly responsible for low land use as well as cropping intensity in the area (Rahman and Ahsan, 2001). Salinity levels increased in the Sundarbans when intake-mouths of the Mathabhanga, Kobadak and other rivers that used to bring fresh water from the Ganges to the south were silted up and thus lost their connection with the Ganges. Therefore the increased salinity and alkalinity have damaged vegetation, agricultural cropping pattern and changed the landscapes in the Sundarbans region. A salinity level of 10 ppt (parts per thousand) in the water inundating the shores of the canals and the rivers of the Sundarbans area have led to the "top dying;" a disease of the prevalent native Sundari trees (Hoque et al., 2006). World Bank study predicted a 1 m sea level rise at the end of the century which might affect 17.5% of total land mass of the country (World Bank, 2000).

Saltwater intrusion is the movement of saline water into freshwater aquifers, which can lead to contamination of drinking water sources and other consequences. The huge freshwater outflow from the Ganges, the Jamuna and the Meghna induce a large zone of brackish water in the coastal region of Bangladesh. The general ocean currents in the Bay show a clockwise circulation of water in the dry season and anti-clockwise circulation in the wet season (Rahman, 2006). Bangladesh is likely to be one of the most vulnerable countries in the world to salinity problem. In monsoon, soil gets enough water and soil salinity decreases as rain water dilutes the concentration of salt in the soil. In post-monsoon, soil salinity starts to increase because of lower rainfall and higher evaporation of moisture from soil surface. Increasing soil salinity continues up to pre-monsoon when soil becomes water stressed (Uddin, 2012). Climate change is an important issue now-a-days. The anticipated sea level rise would produce salinity impacts in three fronts: surface water, groundwater and soil. Increased soil salinity due to climate change would significantly reduce food grain production (Uddin, 2011). IWM, 2013 carried out a study of salinity zoning map for coastal zone of Bangladesh. A comprehensive assessment on salinity and storm surge was carried out through extensive and continuous salinity measurement and field investigation under this study with the following specific objectives:

(a) To set up the flow model of Rupsha-Passur River and calibration and validation of the flow model.

(b) To set up water quality model and perform water quality simulation of Rupsha-Passur river with HEC-RAS.

(c) To develop different flow scenarios and examine the impact of flow availability on salinity for the developed hypothetical flow scenarios.

1.1 Study area

The Rupsha River is a river in southwestern Bangladesh. It forms from the confluence of Bhairab and Atrai river and flows into the Passur river being affected by tide throughout the entire reach. Figure 1 shows the Rupsha-Passur river system focusing the study area. The river Rupsha flows by the side of Khulna and connects to the Bay of Bengal through Passur River at Mongla. Near Chalna the Rupsha River changes its name to Passur River and flows to the Bay of Bengal. The average width of this river is about 486 meter and the maximum and minimum width is about 650 meter and 322 meter respectively. It is a meandering and perennial river. Passur River is a significant river in the Sundarbans area as an extension of Rupsha River. The river Rupsha flows further south and rename as Passur near Chalna and falls into the Bay of Bengal. The maximum flow of the Gorai-Madhumati ultimately passes through the Rupsha-Passur river system. The Passur is placed after the Meghna in size in the Deltaic region. The river is joined by Mongla canal at about 32 km south from Chalna. Flowing further south the river meets the Shibsa at about 32 km north from its mouth and debouches into the sea keeping its original name Passur (BWDB, 2012).The river is very deep and navigable throughout the year and large marine ships can easily enter Mongla Sea Port through it. The Passur is an important river route through which Khulna-Barisal steamboats and other vessels ply. The total length of Passur is about 104 km. The maximum and minimum width of this river is about 2112 meter and 690 meter respectively. The average width of the river is about 1164 meter. Passur River is a meandering and perennial river and highly affected by tides (BWDB, 2012).

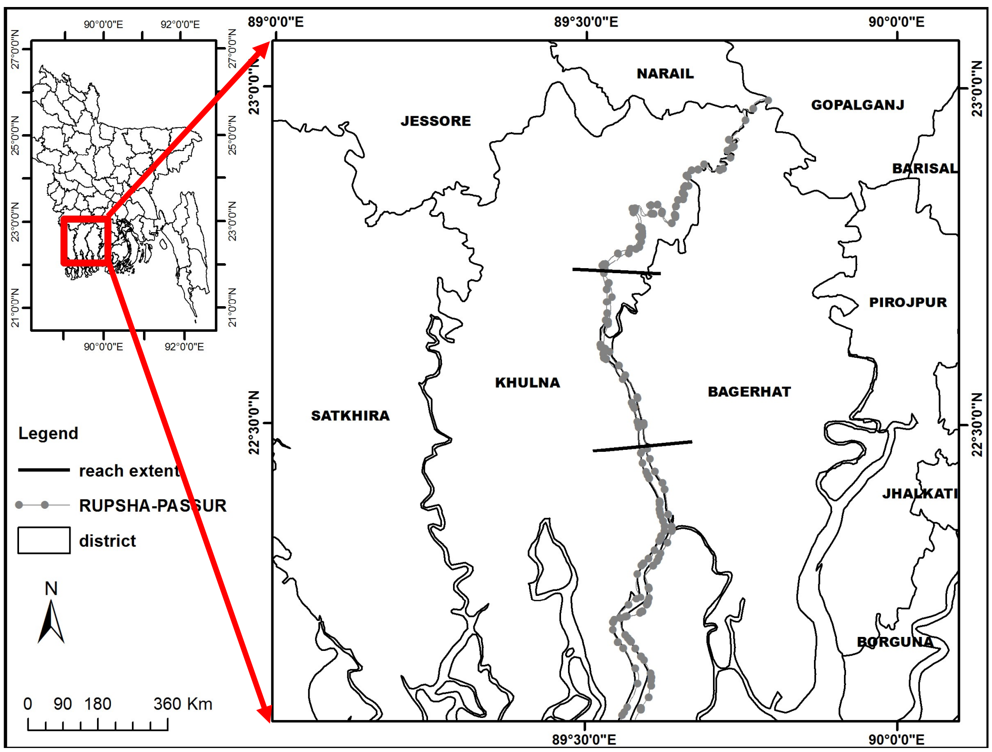


Figure 1: Location of the study area of Rupsha-Passur river.

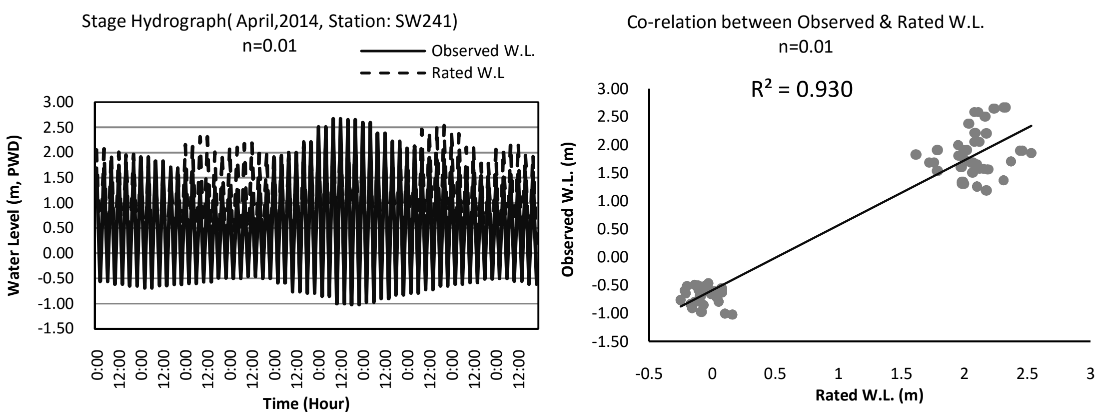
2. METHODOLOGY

2.1. Data Collection and Model Setup

For the development of hydrodynamic and salinity model of Rupsha-Passur River data on bathymetry, discharge, stage hydrograph and salinity concentration at different stations have been collected from relevant sources. The selected reach of the river is about 70 km long having 14 cross sections (8 of Rupsha & 6 of Passur River) starting near Khulna and ending at Mongla. At Kamarkhali Transit flow is divided into two parts, one part enters into Nabaganga River and the other into Madhumati River. It has been assumed that 70% of discharge of Kamarkhali Transit (SW101) enters into Nabaganga river which later flows through the Rupsha-Passur river. Stage hydrograph at the downstream of the river system near Mongla (SW 244) is going to be used as the downstream boundary and stage hydrograph at Chalna (SW 243) was used for calibration and validation. As Rupsha-Passur river is a tidal river so there is two high tides and two low tides within a day period. Salinity data at Khulna (SW 241) and Mongla (SW244) have been collected for the year 2014 to be used as upstream and downstream boundaries and data at Chalna (SW 243) is going to be used for calibration of salinity model of Rupsha-Passur river system.

2.2. Calibration and Validation of Hydrodynamic and Salinity Model

The water level data for the month of April 2014 at Khulna(SW241) and Chalna(SW243) along the Rupsha-Passur river system have been used for calibration using the Manning's roughness coefficient, 'n' as calibration parameter. After several trials, manning's roughness co-efficient, n=0.01 provides with the good match between the observed and simulated water level values and optimum value of the coefficient of determination. Figure 2 shows the comparison and correlation between observed and simulated water levels during the month of April for the manning's roughness, n= 0.01 at Khulna. The best value of R^2=0.9302 has been found for n=0.01 as shown in figure. Validation results at locations Khulna and Chalna compliment the calibration results. Calibration of salinity model has been done for different dispersion co-efficient for the month January, February and March near Chalna (SW 243). The best value of R^2 has been found for D=15 m^2/s. Validation results obtained from the model support the calibration outputs.



(a) (b)

Figure 2: (a) Calibration Hydrograph for manning's n= 0.010 (b) Regression analysis for manning's n= 0.01 near Khulna (SW 241)

3. ANALYSIS AND RESULTS

3.1. Analysis on Discharge, Water Level and Velocity for different flow scenarios

Rupsha-Passur river system flows through the Khulna and Mongla district of Bangladesh. The discharge and water level have been assessed at these two locations along the reach of Rupsha-Passur River system. Flow scenarios with 15%, 40% increase and 15%, 40% decrease have been obtained at the upstream boundary condition. Figure 3 shows the different flow scenarios that are to be used as upstream boundary condition to predict the hydrodynamic condition and water quality. Using the variable flow scenarios hydrodynamic assessment has been made at specified location along the Rupsha-Passur River system. Table 1 shows the discharge, velocity and water level variation with different flow scenarios at Khulna.

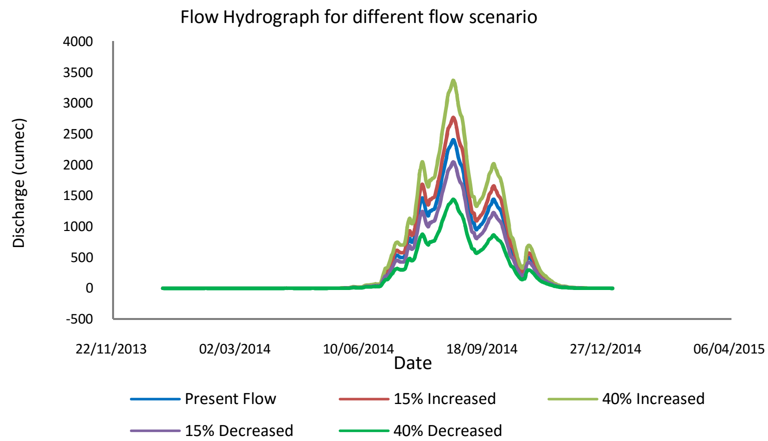


Figure 3: Flow hydrographs for different flow scenarios

From the Table 1, some important points have been found:

(1) The flow is high for the month July, August and September. During the month June and October, the flow is moderate but after this month the flow decreases drastically. The flow is very low for the month January, February, March, April and May. So, it can be said that during the pre-monsoon and post-monsoon period the river gets a little amount of flow at this region and it affects the climatic condition of this region.
(2) The velocity found to be maximum on 31 August. If the discharge is increased by 15% & 40% during monsoon period the velocity is also increased by 11% and 28% respectively
(3) If the velocity is decreased by 15% and 40% during the monsoon period the velocity is also decreased by 8% and 25% respectively.
(4) During the pre-monsoon and post-monsoon period the velocity variation is very negligible for different flow scenarios.
(5) In this region the river is affected by tides. So the water level variation is very little due to the change of discharge. During high tides the water level increases and during low tides the water level decreases.

Table1: Velocity, Discharge and Water Level for different flow scenarios at Khulna

Location Khulna	Parameter	Jan 1	Jan 31	Feb 28	Mar 31	April 30	May 31	June 30	July 31	Aug 31	Sep 30	Oct 31	Nov 30	Dec 31
Present Flow	Velocity (m/s)	0.20	0.16	0.19	0.17	0.17	0.15	0.27	0.68	0.79	0.64	0.26	0.16	0.14
	Discharge (m^3/s)	497	386	455	420	431	381	687	1805	2319	1707	676	417	366
	Water level (m)	1.78	1.54	1.83	1.64	2.05	1.88	2.34	2.35	2.53	2.39	2.26	2.15	1.81
15% Increased	Velocity (m/s)	0.20	0.16	0.19	0.15	0.18	0.15	0.28	0.75	0.93	0.71	0.27	0.16	0.16
	Discharge (m^3/s)	497	386	455	376	456	381	721	2006	2601	1893	715	418	399
	Water level (m)	2.02	1.53	1.83	1.79	2.27	1.88	2.35	2.36	2.53	2.40	2.26	2.15	1.99
40% Increased	Velocity (m/s)	0.20	0.17	0.19	0.17	0.18	0.15	0.30	0.87	1.09	0.82	0.30	0.16	0.16
	Discharge (m^3/s)	497	411	455	420	458	383	776	2340	3071	2200	782.5	420	399
	Water level (m)	2.02	1.55	1.83	1.64	2.29	1.88	2.35	2.36	2.55	2.40	2.26	2.15	1.99
15% Decreased	Velocity (m/s)	0.20	0.16	0.19	0.17	0.17	0.15	0.25	0.61	0.74	0.58	0.24	0.16	0.14
	Discharge (m^3/s)	497	385	455	412	430	380	654	1603	2037	1524	636	416	365
	Water level (m)	2.02	1.53	1.83	1.61	2.05	1.88	2.34	2.35	2.52	2.39	2.26	2.15	1.80
40% Decreased	Velocity (m/s)	0.18	0.16	0.19	0.15	0.16	0.15	0.23	0.48	0.57	0.46	0.22	0.16	0.14
	Discharge (m^3/s)	439	384	454	378	402	379	599	1267	1562	1216	569	414	365
	Water level (m)	1.78	1.53	1.83	1.80	1.77	1.88	2.34	2.35	2.52	2.39	2.26	2.15	1.80

Table 2 shows the discharge, velocity and water level variation with different flow scenarios at Mongla.

From the table 2, it can be seen that:
(1) In this region discharge is increased round the year because the river is affected by tides. During high tides, sea water flows into the upstream and during low tide it again falls into the sea.
(2) The river is affected by tides. So the water level variation is very little due to the change of discharge. During high tides the water level increases and during low tides the water level decreases.
(3) During the monsoon period the velocity is increased by 3% and 8% for the increased flow of 15% and 40% respectively. For the 15% and 40% decreased discharge the velocity of flow is decreased by 2.5% and 8% respectively.
(4) The variation of velocity in Baghaerhat district is less than that of in Khulna district for different flow scenarios.

Table 2: Velocity, Discharge and Water Level for different flow scenarios at Mongla

Location Mongla	Parameter	Jan 1	Jan 31	Feb 28	Mar 31	April 30	May 31	June 30	July 31	Aug 31	Sep 30	Oct 31	Nov 30	Dec 31
Present Flow	Velocity (m/s)	0.91	0.71	0.87	0.79	0.73	0.61	0.82	1.00	0.96	1.01	0.68	0.65	0.60
	Discharge(m^3/s)	3476	2805	3311	3040	3106	2715	3564	4482	4752	4490	3179	2942	2631
	Water level (m)	2.02	1.63	1.94	1.73	2.15	1.97	2.45	2.45	2.62	2.50	2.35	2.25	1.90
15% Increased	Velocity (m/s)	0.91	0.71	0.87	0.79	0.73	0.61	0.83	1.03	1.01	1.05	0.69	0.65	0.60
	Discharge(m^3/s)	3477	2805	3311	3040	3106	2716	3594	4654	5003	4651	3215	2943	2631
	Water level (m)	2.02	1.63	1.94	1.73	2.15	1.97	2.45	2.46	2.62	2.50	2.35	2.25	1.90
40% Increased	Velocity (m/s)	0.91	0.71	0.87	0.79	0.73	0.64	0.84	1.09	1.09	1.10	0.70	0.65	0.65
	Discharge(m^3/s)	3477	2805	3311	3040	3106	2846	3643	4950	5415	4917	3277	2944	2874
	Water level (m)	2.02	1.63	1.94	1.73	2.15	2.07	2.45	2.46	2.62	2.50	2.35	2.25	2.08
15% Decreased	Velocity (m/s)	0.91	0.71	0.87	0.79	0.73	0.61	0.82	0.96	0.92	0.98	0.68	0.65	0.60
	Discharge(m^3/s)	3476	2805	3311	3040	3106	2714	3534	4305	4498	4332	3142	2940	2631
	Water level (m)	2.02	1.63	1.94	1.73	2.15	1.97	2.45	2.45	2.61	2.50	2.35	2.25	1.90
40% Decreased	Velocity (m/s)	0.83	0.71	0.87	0.78	0.73	0.61	0.80	0.90	0.83	0.93	0.66	0.65	0.60
	Discharge(m^3/s)	3199	2805	3296	3002	3105	2713	3484	3997	4056	4068	3080	2939	2631
	Water level (m)	1.90	1.63	1.93	1.72	2.15	1.97	2.45	2.45	2.62	2.50	2.35	2.25	1.90

3.2 Comparative Analysis of Hydrodynamic Parameters

3.2.1 Discharge:

In the figure 4 it has been seen that discharge is generally high during the monsoon period. But in Mongla discharge is greater than that of in Khulna district. This is because Mongla is situated at the downstream of the reach which is very near to the sea. So during the high tide, sea water flows into the upstream. So the discharge is increased in this region. During the pre-monsoon and post-monsoon period the discharge is very low.

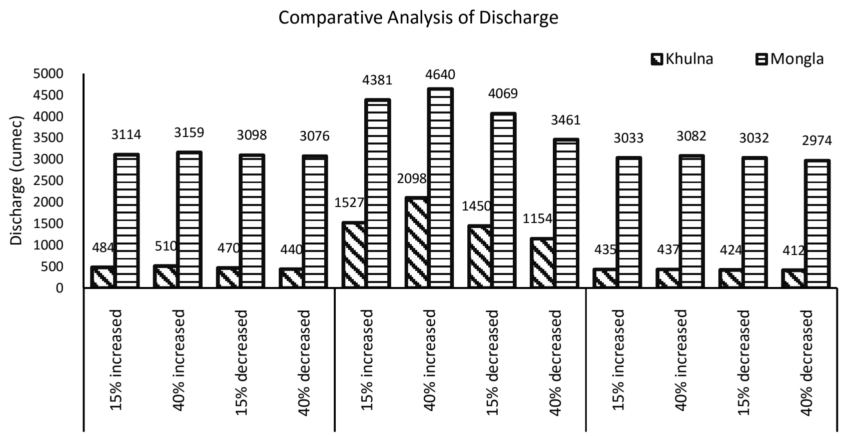
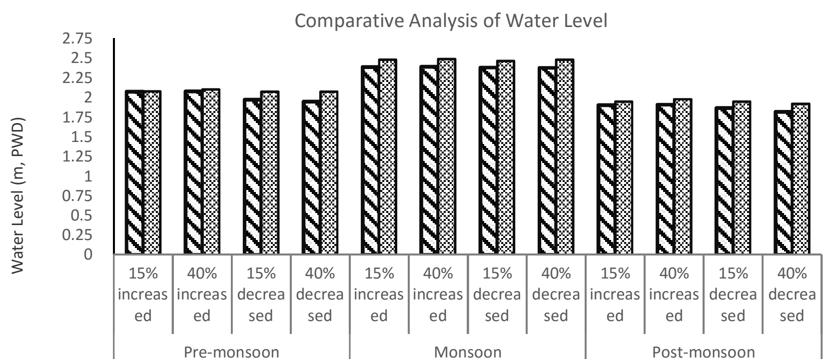


Figure 4: Comparative analysis of discharge between Khulna and Mongla.

3.2.2 Water Level:

In the figure 5, water level has been taken into account during high tide only. So there is little variation with water level in Khulna and Mongla. Water level is high during monsoon period but in pre-monsoon and post-monsoon period water level is lower than monsoon period. During this time water level difference in Khulna and Mongla is very little. Because during these period upstream flow is very little and sea water flow into the upstream during high tide has a great effect.



	15% increased	40% increased	15% decreased	40% decreased	15% increased	40% increased	15% decreased	40% decreased	15% increased	40% increased	15% decreased	40% decreased
	Pre-monsoon				Monsoon				Post-monsoon			
Khulna	2.073	2.08	1.97	1.948	2.388	2.393	2.38	2.379	1.904	1.908	1.866	1.818
Mongla	2.08	2.101	2.075	2.073	2.48	2.49	2.465	2.481	1.95	1.98	1.948	1.922

Figure 5: Comparative analysis of water level between Khulna and Mongla

3.2.3 Velocity:

From figure 6 it can be said that velocity is increased during monsoon period as there is greater amount of availability of discharge during this season. During monsoon for the 15% increased flow the velocity in Mongla will be greater than that of in Khulna by 43%. For the 40% increased flow the velocity in Mongla will be greater than in Khulna by 30%. During the pre-monsoon period the velocity in Mongla will be about 4 times than the velocity in Khulna for the 15% and 40% increased flow. During the post-monsoon period the velocity in Mongla also will be about 4 times than the velocity in Khulna for the 15% and 40% increased flow. During the pre-monsoon and post-monsoon period the difference of velocity between Khulna and Mongla is very high because during the period in Khulna region the upstream flow is very low but in Mongla region sea water intrusion occurs during high tides it falls into the sea during low tide.

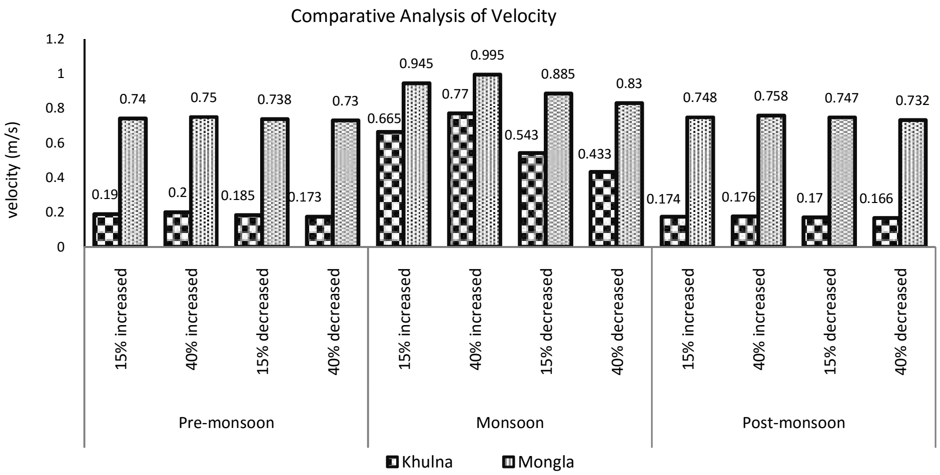


Figure 6: Comparative analysis of velocity between Khulna and Mongla

3.3 Local flow field under different scenarios

To assess the local flow field under different flow scenarios, velocity distributions at different locations along the reach of Rupsha-Passur river system have been represented for the maximum and minimum flow day of observed flow for the year 2014. The velocity distribution for maximum and minimum flow near Khulna and Mongla has been shown in figure 7 and figure 8 respectively. The maximum velocity near Khulna is about 0.8 m/s and minimum velocity tends to zero m/s. On the other hand the maximum velocity near Mongla is about 2 m/s and minimum velocity is about 0.8 m/s. The velocity decreases towards the banks of the rivers.

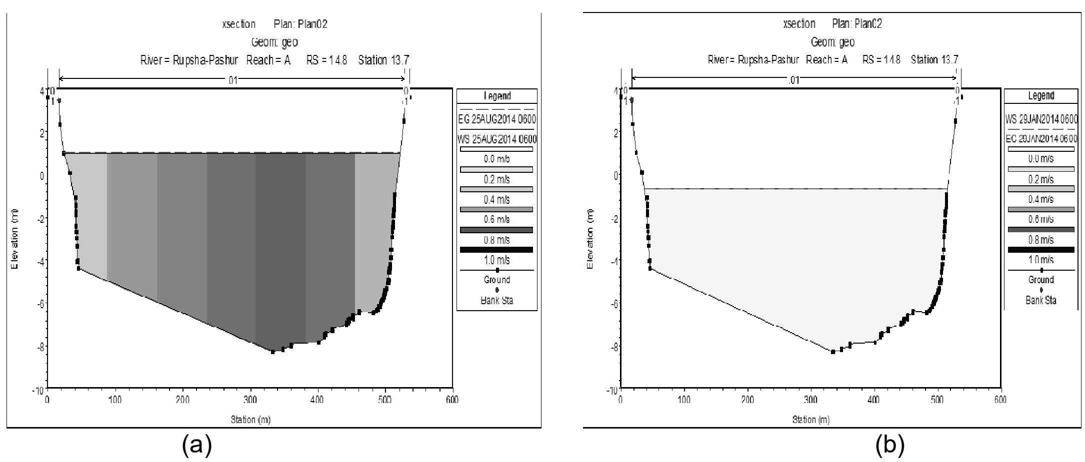


Figure 7: Maximum and minimum velocity distributions for the observed flow of 2014 near Khulna (a) the maximum velocity (b) the minimum velocity

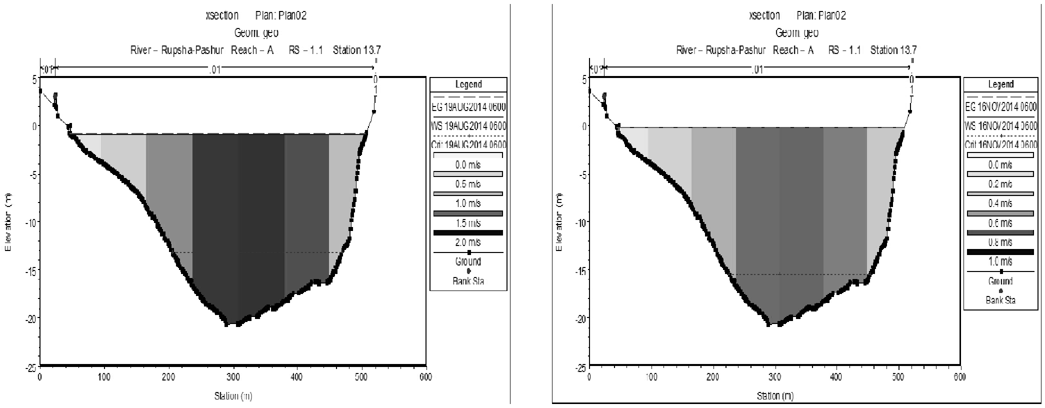


Figure 8: Maximum and minimum velocity distributions for the observed flow in 2014 (a) the maximum velocity (b) the minimum velocity

3.4 Water Quality Analysis

Water quality analysis has been performed for different flow scenarios to examine the effect of salinity at different locations during different seasons. Water quality analysis has been performed to examine the effect of salinity in Khulna and Mongla during different seasons. In Mongla during the pre-monsoon period the salinity is about 13 ppt for the present flow. During the monsoon period the salinity is about 3.5 ppt for the present flow and during post-monsoon period the salinity is about 7 ppt. In Khulna during the pre-monsoon period the salinity is about 3 ppt for the present flow. During the post monsoon and monsoon period salinity variation is not remarkable. Figure 9 shows the variation of salinity over the months for the year of 2014.

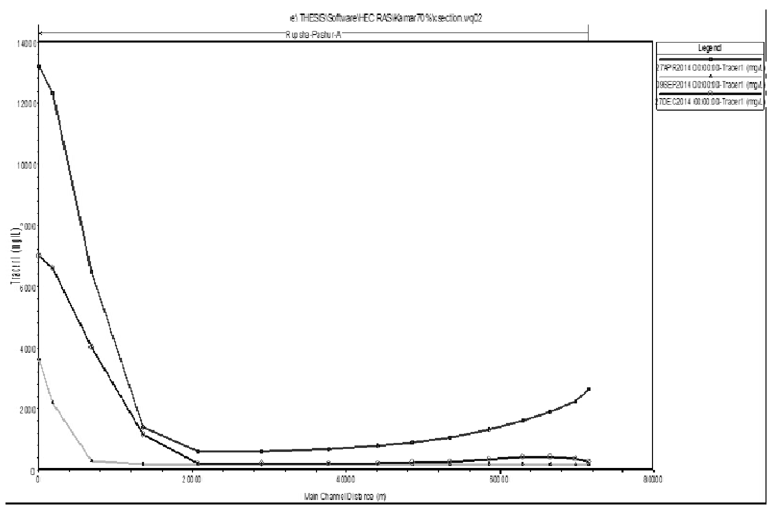


Figure 9: Salinity simulation for the present flow 2014

3.4.1. Analysis on Discharge, Water Level and Velocity for different flow scenarios

From the table 3 it has been seen that:

(1) During April, May, June, July the salinity concentration is very high in Khulna district. But the salinity concentration is moderate for the month January, February, March and low for the month August, September, October, November and December.

(2) The maximum salinity concentration has been observed in 30 June. During this time if the flow is increased by 15% and 40% then the salinity will be decreased by 10% and 24%

respectively but if the flow is decreased by 15% and 40% the salinity will be increased by 40% and 45% respectively. So it will be very alarming at this region if the current flow is decreased.
(3) The minimum salinity concentration is observed in 31 August.
(4) During the pre-monsoon season the salinity concentration becomes greater than 10 ppt which is very harmful for agriculture and environment at this region. And if the present flow is somehow decreased this scenario will be worsened.

Table-3: Salinity Concentration for different flow scenarios at Khulna

Location Khulna	Parameter	Jan 1	Jan 31	Feb 28	Mar 31	April 30	May 31	June 30	July 31	Aug 31	Sep 30	Oct 31	Nov 30	Dec 31
Present Flow	Salinity (ppt)	2.65	2.49	2.83	3.89	5.25	7.32	13.09	6.47	0.85	0.94	1.04	1.08	1.47
15% Increased	Salinity (ppt)	2.65	2.46	2.81	3.84	5.20	7.26	11.75	6.41	0.85	0.94	1.03	1.07	1.45
40% Increased	Salinity (ppt)	2.65	2.46	2.79	3.81	5.15	6.81	10.03	6.40	0.84	0.94	1.03	1.06	1.45
15% Decreased	Salinity (ppt)	2.75	2.49	2.86	4.05	5.39	7.52	18.49	6.68	0.92	0.95	1.05	1.07	1.49
40% Decreased	Salinity (ppt)	2.80	2.55	2.87	4.06	5.48	7.88	19.02	6.95	1.06	0.97	1.05	1.08	1.55

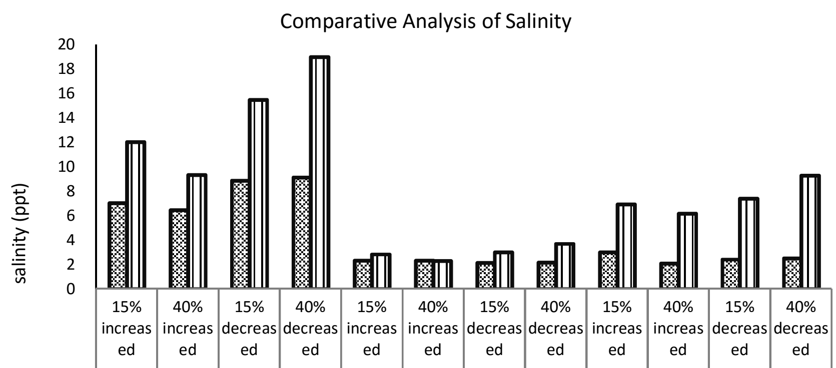
From the table 4, it has been observed that:
(1) The maximum salinity concentration has been observed in 30 June. During this time if the flow is increased by 15% and 40% then the salinity will be decreased by 0.5% and 35% respectively but if the flow is decreased by 15% and 40% the salinity will be increased by 4% and 18% respectively. So it will be very alarming at this region if the current flow is decreased.
(2) During the pre-monsoon and post-monsoon period salinity concentration in this region is greater than that of in Khulna district. This is because Mongla is at downstream of the reach with respect to Khulna district. So during high tide, sea water intrusion is very high in Mongla.
(3) The minimum concentration of salinity has been observed in 31 August. This is because during this time the river gets maximum flow. So this increased flow retards the sea water intrusion.

Table-4: Salinity Concentration for different flow scenarios at Mongla

Location Mongla	Parameter	Jan 1	Jan 31	Feb 28	Mar 31	April 30	May 31	June 30	July 31	Aug 31	Sep 30	Oct 31	Nov 30	Dec 31
Present Flow	Salinity (ppt)	8.16	5.10	5.5	12.6	14.50	12.1	16.3	8.03	1.03	1.13	1.24	8.54	7.95
15% Increased	Salinity (ppt)	8.15	4.93	5.4	7.49	12.49	11.8	16.3	7.93	1.02	1.13	1.2	8.19	7.77
40% Increased	Salinity (ppt)	8.14	4.92	4.8	7.11	8.21	11.4	10.5	5.82	0.99	1.12	1.23	5.58	7.21
15% Decreased	Salinity (ppt)	8.16	5.37	5.9	13.3	18.28	13.2	16.9	8.47	1.08	1.14	1.25	8.68	8.75
40% Decreased	Salinity (ppt)	9.53	6.29	6.9	15.5	21.38	16.4	22.5	10.3	1.44	1.34	1.65	10.80	12.8

3.4.2 Comparative Analysis of Salinity between Khulna and Mongla

In the figure 10 it can be seen that for the extreme scenario (15% & 40% decreased flow) the salinity in Mongla is above 15 ppt and in Khulna above 8 ppt during the pre-monsoon season. But if flow is increased by 40% the salinity is about 7 ppt in Mongla and 6 ppt in Khulna during the pre-monsoon season. But during the monsoon period the salinity is about 3 ppt both in Khulna and Mongla. During the post-monsoon period the salinity again increases in Mongla and it becomes above 6 ppt. But in Khulna the salinity remains below 2 ppt. For 15% decreased flow the salinity in Mongla is greater than that of in Khulna by 45% during the pre-monsoon season. For 40% decreased flow the salinity in Mongla is greater than that of in Khulna by 49% during the pre-monsoon season.



	Pre-monsoon				Monsoon				Post-monsoon			
	15% increased	40% increased	15% decreased	40% decreased	15% increased	40% increased	15% decreased	40% decreased	15% increased	40% increased	15% decreased	40% decreased
Khulna	7.0137	6.4512	8.8637	9.11	2.3112	2.305	2.136	2.171	2.991	2.084	2.4025	2.5112
Mongla	12.012	9.3195	15.436	18.957	2.832	2.2905	2.9865	3.6872	6.8976	6.144	7.3824	9.2764

Figure-10: Comparative analysis of salinity concentration between Khulna and Mongla

5. CONCLUSIONS AND RECOMMENDATIONS

In this study, an attempt was performed to analyze the trend of variables of Rupsha-Passur River and assess its present flow and salinity condition. From the study, the following conclusions and recommendations can be drawn:

From hydrodynamic and water quality analysis, it was seen that these rivers get very little flow during the pre-monsoon and post-monsoon period. As a result during these periods the salinity remains very high due to increased intrusion of saline water. To prevent the intrusion of saline water the discharge must be increased during pre-monsoon and post-monsoon periods. The maximum salinity occurs in March, April, May and June, during the dry period. During this period the water cannot be used for irrigation and drinking purposes. The salinity intrusion zone has been increased during this time. This study is limited to the impact of Rupsha-Passur river discharge only. For better result, its branch channels and other sources of fresh water should be considered. Sea level rise should be taken into account to perform this study so that the salinity scenarios can be understood more accurately.

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