TEMPORAL AND SPATIAL VARIATION OF WATER QUALITY PARAMETERS OF MODHUMOTI RIVER IN BANGLADESH

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ABSTRACT

Bangladesh is largely depended on groundwater (GW) sources for drinking and domestic purposes. About 90% of drinking water in Bangladesh is obtained from the groundwater sources. In addition to ground water depletion, some problems are existed in groundwater especially in southwestern coastal region of Bangladesh. To meet the water crisis, Khulna City Corporation is planned to use the water of Modhumoti River from Mollahat point. This study is aimed at determining the monthly and seasonal variation of water quality parameters of Modhumoti River and compares the results with that of Vairab, Rupsha and Mayur rivers. The water samples were collected from four locations of Modhumoti River and tested in the laboratory. The data of water quality parameters for Vairab, Rupsha and Mayur rivers were collected from Bangladesh Water Development Board and available previous studies. It is found that among the four rivers, Modhumoti contains a lower amount of chloride concentration as compared to other rivers. Water sample collection stations in Modhumoti River and its upstreams are Haridaspur (in Kumar river, upstream source of Modhumoti river), Modhupur (in Gorai-Modhumoti river, upstream source of Modhumoti river), Chapailghat (downstream of confluence of Gorai-Modhumoti at Kumar river) and Mollahat station (downstream of Chapailghat in Modhumoti river). It is found that in the upstream points the chloride concentration and salinity is lower at Haridaspur station and higher in downstream at Modhupur station. The combined flow of Modhumoti River shows higher salinity (the total of all non-carbonate salts dissolved in water) at downstream Mollarhat station than the upstream Chapailghat. The chloride concentration and salinity (the total of all non-carbonate salts dissolved in water) are greater in March and April and found to be decreased with the starting of rainy season.

Keywords: Ground water, chloride concentration, water quality, salinity.

1. INTRODUCTION

Bangladesh is one of the most vulnerable countries in the world due to ground water level depletion, intrusion of saline water, increase of river water salinity, arsenic and iron contaminated water etc, which significantly affect the human life as well as living things and overall economic and social development of the country. To get potable water is an acute problem now a day's which is increasing an alarming in southern region of Bangladesh. Khulna, the third largest city in Bangladesh, is located in the southwest of the country and has a population of 1.5 million (estimated in 2008).

Potable water is a prime requirement for daily life of human beings. Unfortunately, more than one in six people still lack is reliable access to this precious resource in developing country like Bangladesh. Most of the earth water is sea water. About 2.5% of the water is fresh water that does not contain significant levels of dissolved minerals or salt and two third of that is frozen in ice caps and glaciers. In total only 0.01% of the total water of the planet is accessible for consumption. Water supply for Citizens in Khulna has been suffering from limited access to water supply services. Out of approximately one million of population, only 17% has access to piped water supply, and the rest resorts to alternative sources, such as shared public taps and tube wells built privately. The present water supply to Khulna is mainly from ground water sources drawn from both deep and shallow tube wells. In the long term as demand increases, conjunctive use of ground water and surface water will be required, even though surface water may suffer from salinity intrusion in dry season (KWASA, 2010). Due to increasing water demand in the city the water supply system is vulnerable to supply required water to the people. Extensive abstraction of ground water from deep aquifer causes depletion of ground water level. Water in ground aquifer is not replenishing at the same rate of abstraction. In future it may not be possible to yield sufficient quantity of ground water necessary for Khulna city. The alternate option is to use surface water to reduce the pressure on ground water. The Rupsa, Vairab, Mayur, Pashur and Modhumoti are the rivers nearby to the Khulna city. Most of the rivers in southern zone contain much higher salinity as compare to the drinking

water standard. To cope with current insufficient supply and increasing demand, the Khulna Water Supply and Sewerage Authority (KWASA) plans to collect surface water from Modhumoti river and to construct a new treatment plant to make the river water potable. Therefore a comparative study of water quality for different rivers around Khulna city is necessary.

The main objectives of this study are to determine the monthly and seasonal variation of water quality parameters of Modhumoti river and to compare the water quality parameters at four spatial locations: two points at upstream of Modhumoti river (Haridaspur, Modhupur) and two stations at downstream in Modhumoti river (Chapailghat and Mollarhat). The water quality parameters of Modhumoti river will also be compared with that of previous data of Vairab, Rupsha and Mayur rivers.

2. METHODOLOGY

2.1 Study Area

The part of Modhumoti river that under investigation is under the Gopalganj district of Bangladesh (Figure 1), which is situated in Dhaka division of Bangladesh with latitude 23°20′ to 22°50′ North and 90°05′ to 89°40′ East. A baseline survey by CEGIS (2008) reported the physiography of the district. It consists of Active Ganges Floodplain 5%, Gopalganj-Khulna Beels 41%, low Ganges River Floodplain 30% and Old Meghna Floodplain 23%. Mollahat is located at 22.9417°N 89.7000°E under Bagerhat district of Bangladesh.

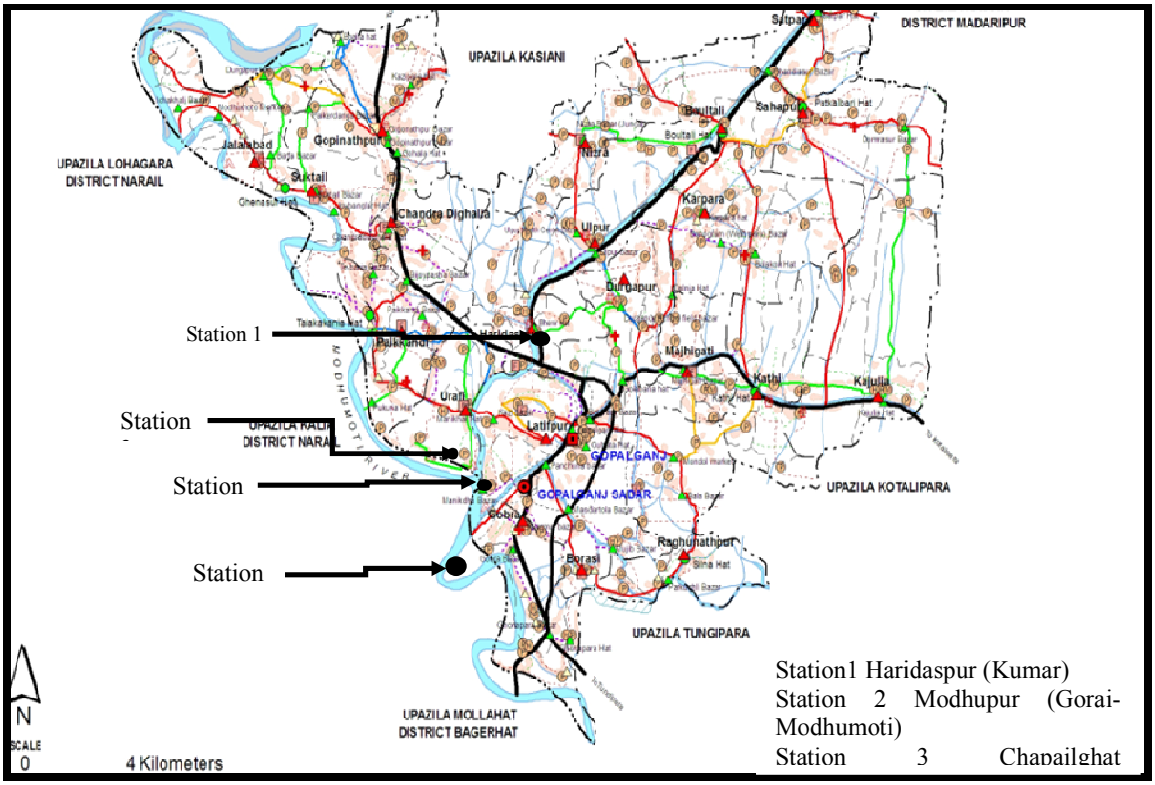

Figure 1: Samples Collection stations in Gorai Modhumoti, Kumar and Modhumoti River.

2.2 Water Samples Collection

The water samples were collected from four stations of Gorai-Modhumoti river: two stations are at upstream (Haridaspur and Modhupur) and others two are at downstream (Chapailghat and Mollahat) of Modhumoti River (Figure 2). Water samples are collected at surface from middle of the river in sterilized plastic bottle. Immediately after collecting samples, they were brought in environmental engineering laboratory within 5-6 hours. The water quality parameters namely chloride concentration, salinity, electrical conductivity, total hardness, SO_4^{2-}, TDS, pH, BOD, COD, Color and Turbidity of collected samples of Modhumoti river were

tested and compared with that of other rivers (Vairab, Rupsha, Mayur, Arial Kha) vicinity to Khulna City. The data of water quality parameters for Vairab, Rupsha and Mayur rivers were collected from Bangladesh Water Development Board and available previous studies.

Station 1: Haridaspur


(b) Station 2: Modhupur.

(c) Station 3: Chapailghat.

(d) Station 4: Mollahat.

Figure 2: Water sample collection stations

3. RESULTS

3.1 Water Quality Parameters of Modhumoti River

Monthly variation of chloride concentration for different stations is shown in Figure 3. It shows that chloride concentration is increasing from December and peak at April. Modhupur station contains higher chloride as compare to the other station. Modhupur station is on gorai-modhumoti River which is linked with Vairab River. So modhupur station contains higher chloriade as compare to the other stations. Haridaspur and Chapailghat contain higher chloride at March. All of stations contain higher chloride in summer due to lower discharge of river. For low discharge the sea water enter the downstream of river easily and contain higher chloride as compare to the upstream of the river. In April, the chloride concentration is higher in Mollahat station as compare to Chapailghat station. This is may be due to the effect of high tide and intrusion of saline water.

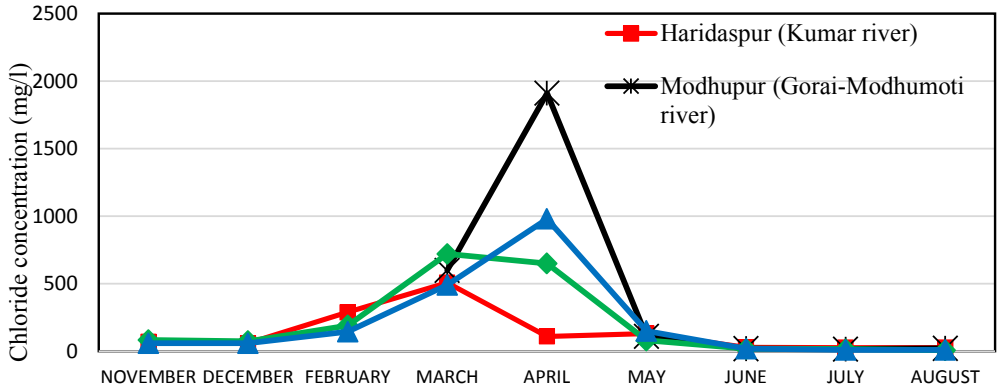

Figure 3: Variation of chloride concentration at different locations for Modhumoti rivers (duration: December 2014 to August 2015).

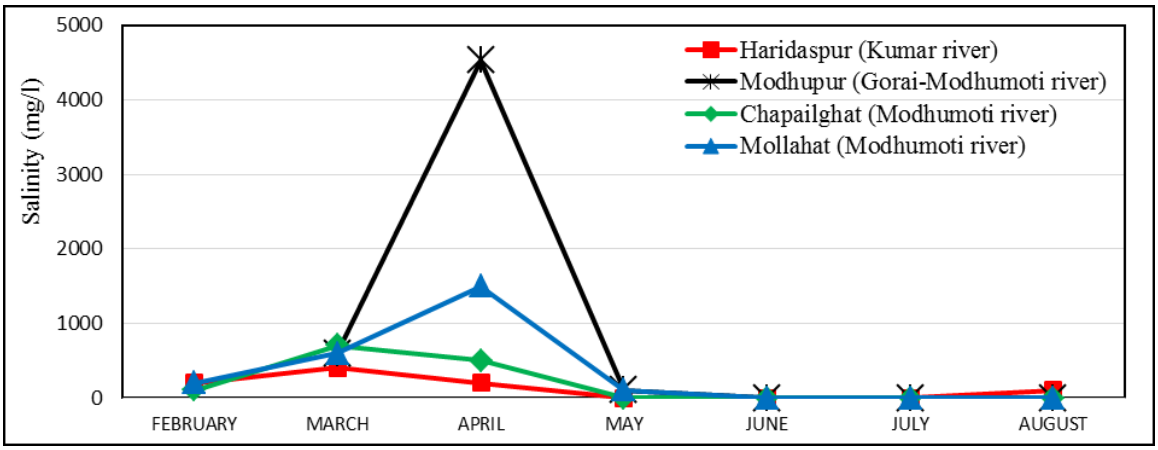

Figure 4: Variation of salinity at different locations for Modhumoti River.

Salinity is the total of all non-carbonate salts dissolved in water, usually expressed in parts per thousand (1ppt = 1000 mg/L), unlike chloride (cl^-) concentration. Salinity is a measure of the total salt concentration, comprised mostly of Na^+ and Cl^- ions. Even though there are smaller quantities of other ions in sea water (e.g., K^+, Mg^{2+}, or SO_4^{2-}), sodium and chloride ions represent about 91% of all sea water ions. So salinity is increasing with the increases of (cl^-) concentration. The temporal and spatial variation of salinity is shown in the Figure 4. Modhupur station contains higher salinity as compare to the other stations. Haridaspur and Chapailghat contain higher salinity at March. All of stations contain higher salinity in summer due to lower discharge of river. For low discharge the sea water enter the downstream of river easily and contain higher salinity as compare to the upstream of the river. In April, the chloride concentration is higher in Mollahat station as compare to Chapailghat station.

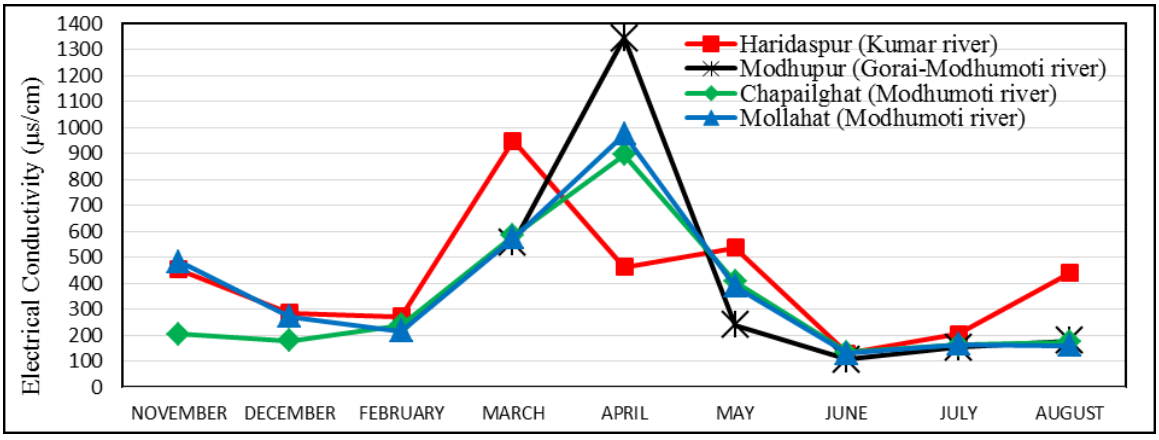

Figure 5: Variation of electrical conductivity at different locations for Modhumoti River.

Conductivity is dependent on water temperature, salinity and TDS. Water flow and water level changes can also contribute to conductivity through their impact on salinity. Water temperature can cause conductivity levels to fluctuate daily. In addition to its direct effect on conductivity, temperature also influences water density, which leads to stratification. Stratified water can have different conductivity values at different depths. Conductivity and salinity have a strong correlation. As conductivity is easier to measure, it is used in algorithms for estimating salinity and TDS, both of which affect water quality and aquatic life. since the temperature increases at march and April, electrical conductivity peak at april and Modhupur station contain higher electrical conductivity due to its higher salinity in water. Figure 5 shows the variation of electrical conductivity at different locations for Modhumoti river.

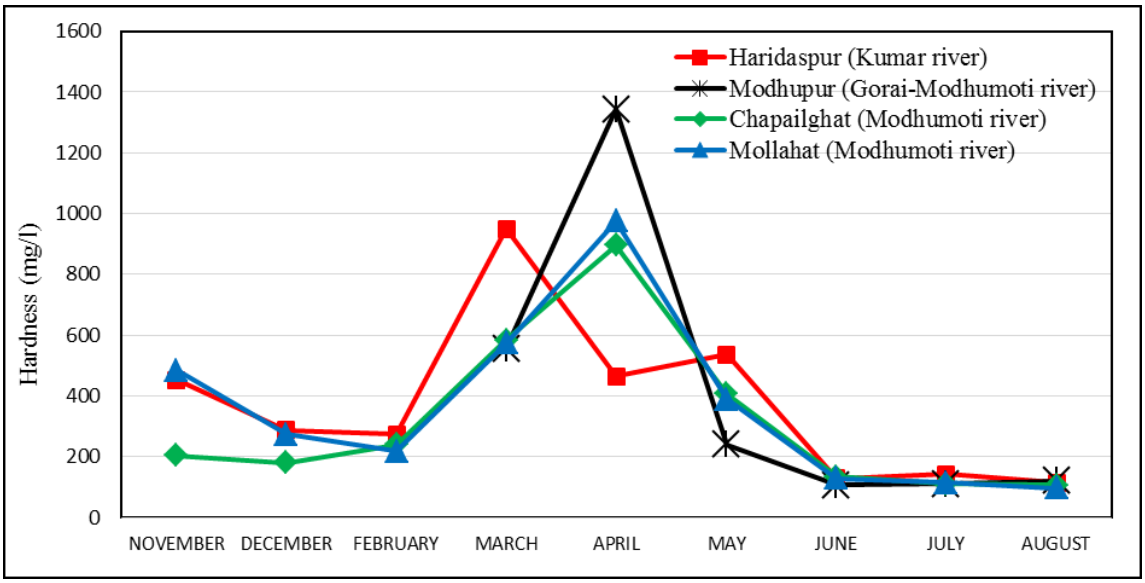

Figure 6: Variation of hardness at different locations for Modhumoti River.

Hardness parameters were analyzed and found in the range of 97.23 to 1344 mg/L. Calcium, magnesium and ferrous ions are responsible for this hardness value. The highest value is recorded at Modhupur station in April. All of stations contain higher hardness in April exception is that Haridaspur station. It contains higher hardness in March. Hardness decreases from April and contain lower amount at August. Figure 6 shows that higher hardness in summer and lower hardness in rainy season.

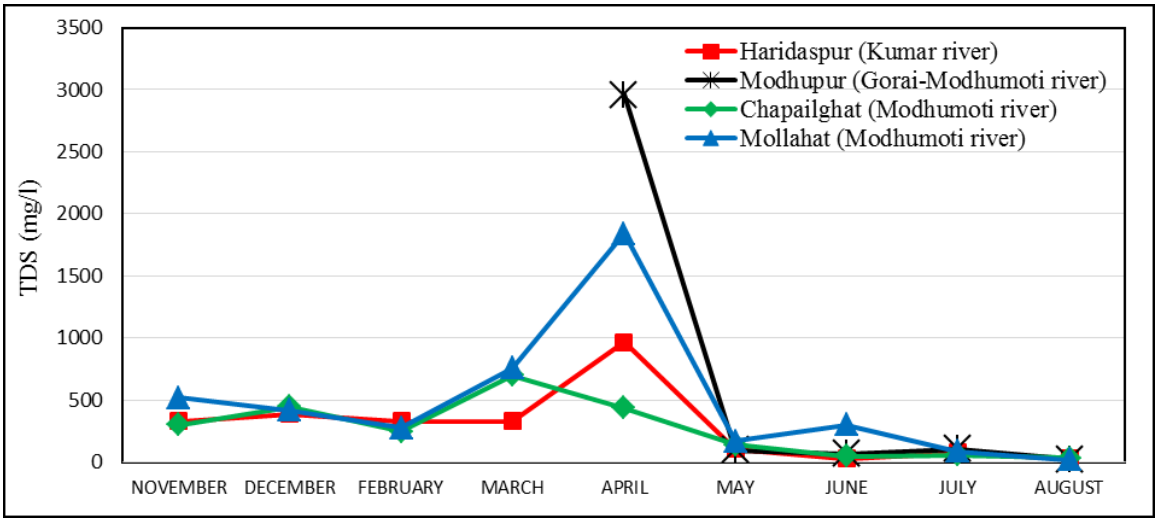

Figure 7: Variation of Total dissolve solid at different locations for Modhumoti River.

Total dissolved solids (TDS) combine the sum of all ion particles that are smaller than 2 microns (0.0002 cm). This includes all of the disassociated electrolytes that make up salinity concentrations, as well as other compounds such as dissolved organic matter. In “clean” water, TDS is approximately equal to salinity. While TDS measurements are derived from conductivity, some states, regions and agencies often set a TDS maximum instead of a conductivity limit for water quality. The relation among TDS salinity and conductivity is linear. With the increases of salinity the TDS is increasing. So Figure 7 shows higher TDS in March and April in according with electrical conductivity and salinity.

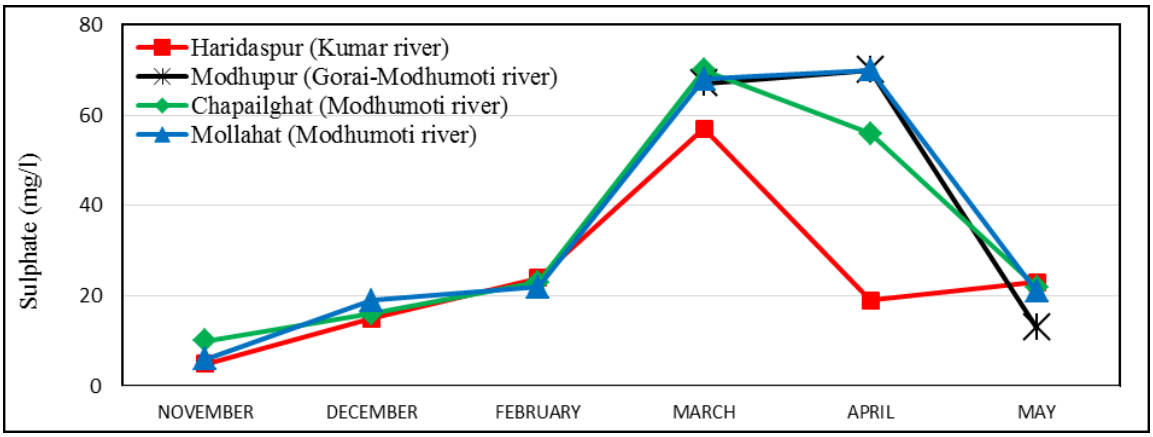

Figure 8: Variation of sulphate (SO_4^{2-}) at different locations for Modhumoti River

According to GEMS/Water, a global network of water monitoring stations, typical sulfate levels in fresh water are in the vicinity of 20 mg/liter and range from 0 to 630 mg/liter in rivers, from 2 to 250 mg/liter in lakes and from 0 to 230 mg/liter in groundwater. Higher levels of sulphate in any water source can be indicative of some form of pollution. Typical pollution sources are mine drainage and effluent return flows, which can contain sulphate concentrations of as high as 500 mg/l. In the laboratory test result, the maximum sulphate get 70mg/l at March and April. Modhupur and Mollahat contain higher sulphate as compare to the other stations (Figure 8). The river contains low sulphate at winter.

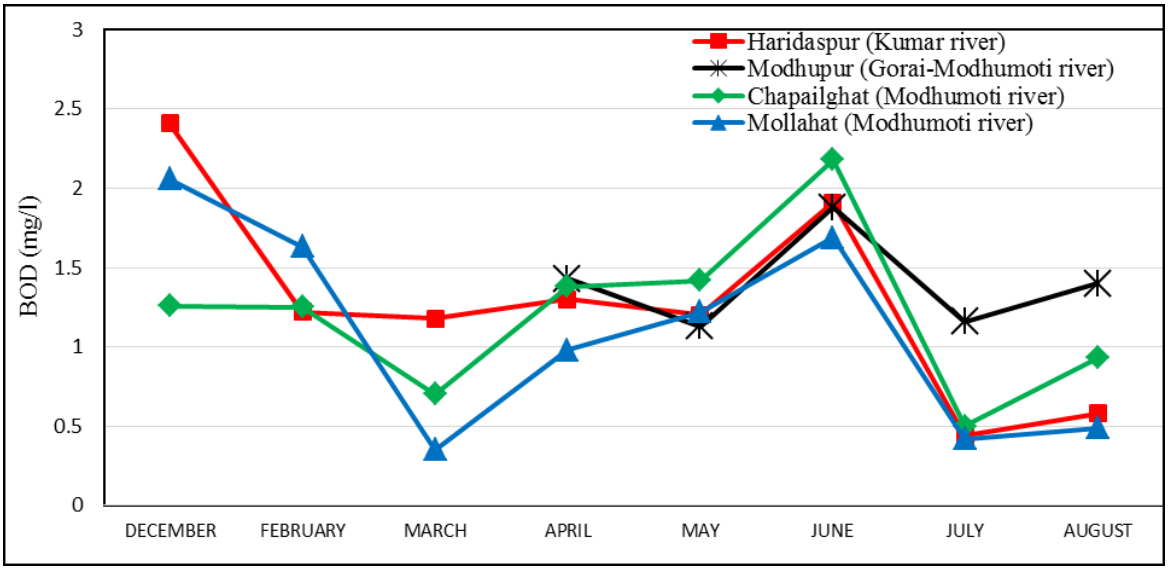

Figure 9: Variation of BOD at different locations for Modhumoti River

Figure 9 shows that the Biochemical dissolved oxygen (BOD) concentration present in Modhumoti River in the range of 0.35-2.41. For Bangladesh the standard demand is 0.2 mg/l. But the test value of BOD is very higher than standard value. Figure shows highest BOD in December at Haridaspur and lower value at Mollahat in July.

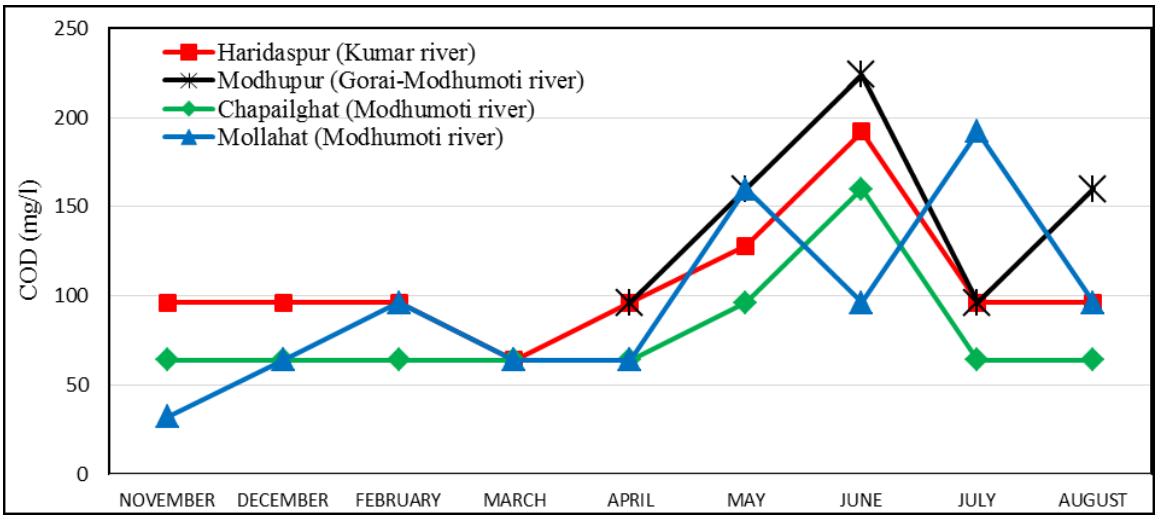

Figure 10: Variation of COD at different locations for Modhumoti River

Chemical oxygen demand (COD) also present between the range of 32 and 224 mg/L. COD term was referred as indicator to measure organic matter that exists in the water and the results obtained were agreed with findings reported by them. Since the origin of chemical oxygen demand is the organic and inorganic matter that are soluble in water. It increases rainy season due to the rivers contain higher organic matter with their flow. Figure 10 shows that highest COD at Modhupur station in the month of June and the lowest COD at Mollahat station in November.

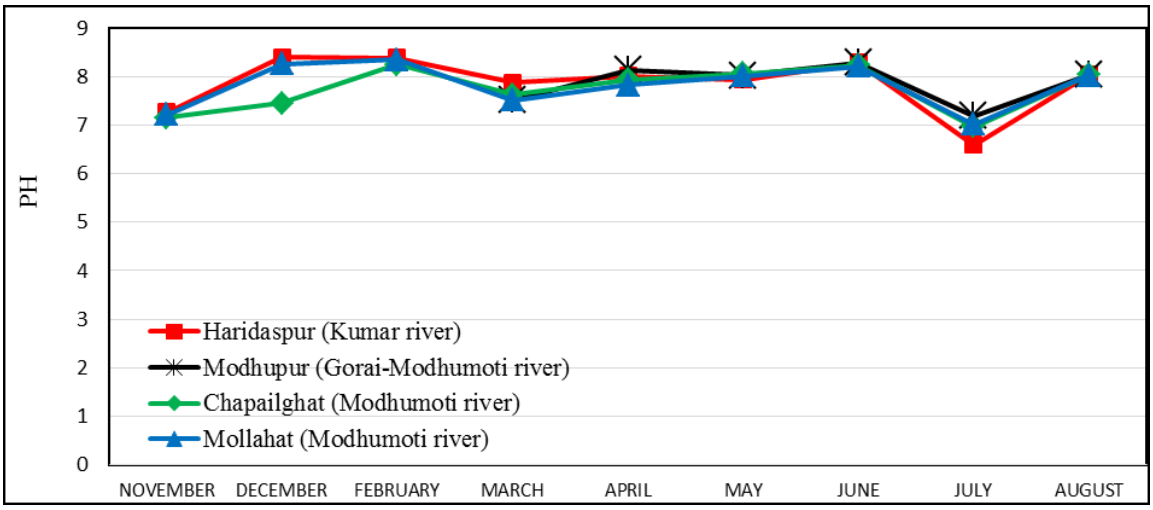

Figure 11: Variation p^H at different locations for Modhumoti River

From the analyses, pH of Modhumoti river water was found to be in basic range in maximum month. Only November and July shows the water characteristics in acidic. According to Department Of Environment 1991 Bangladesh, standard for fishing water range of pH is 6.5 to 9 and the pH value of wastewater did not comply with the standard regulated by (DOE) Bangladesh. From the Figure 11 we can see that the pH values of the four samples are within the value. Figure 11 shows that Haridaspur station contain higher pH at December and lower pH at July.

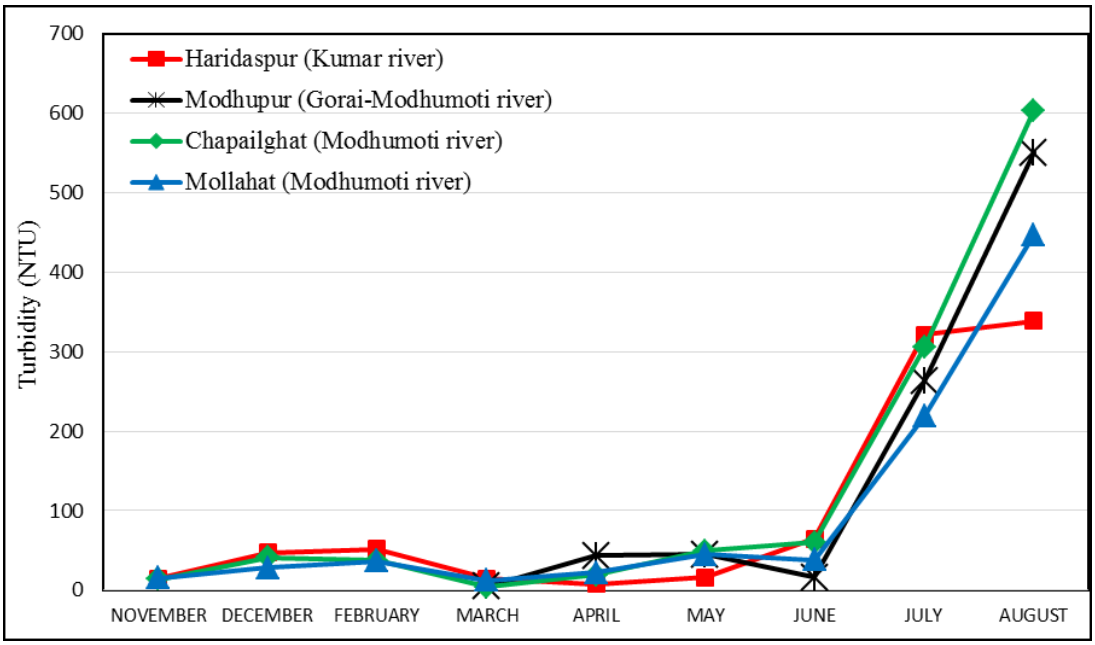

Figure 12: Variation of turbidity at different locations for Modhumoti River.

Parameter of turbidity was detected highly variation from June to August. From November to June there is small variation in turbidity which is negligible. Generally, turbidity has direct relation with presence of solid particle (Finely divided organic matter, plankton and micro-organisms) in water sample. With the starting of rainy season the amount of organic matter, and micro-organisms are increasing. Figure 12 shows higher turbidity in August. Chapailghat station contains lower turbidity in March as compare to the other station and it contain higher turbidity in August.

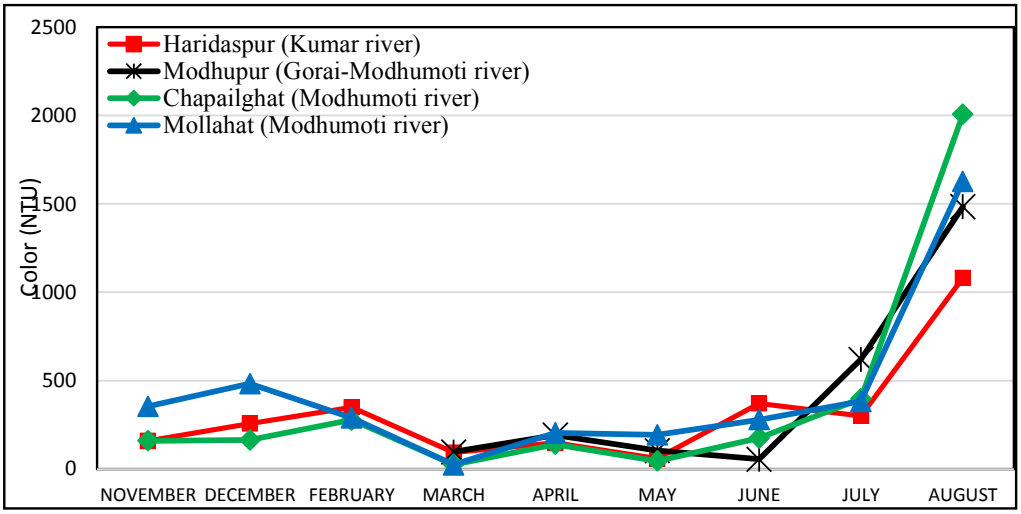

Figure 13: Variation of color at different locations for Modhumoti River.

Generally pure water is colorless. But both surface and ground water have a definite value of color. Color depends on organic and inorganic matters that are soluble in water. Figure 13 shows the color of Modhumoti River in winter and summer. There is a little flow of water in river on those seasons. But in rainy season the river has higher discharge. Sediment and other component are mixed with water. So in rainy season the figure shows highest value of color. The measurement unit for color used in the experiment was Platinum Cobalt (Pt

Co. Unit) instead of mg/L because the appearance of color in the sample was natural color. In the regulation, the regulation did not mention acceptable limit for color in Pt Co. Unit. Figure shows the great variation of color from June to August. It is increasing from June and peak at August. Chapailghat station shows highest color at August.

3.2 Variation of Water Quality Parameter of Modhumoti River with Other Adjacent Rivers

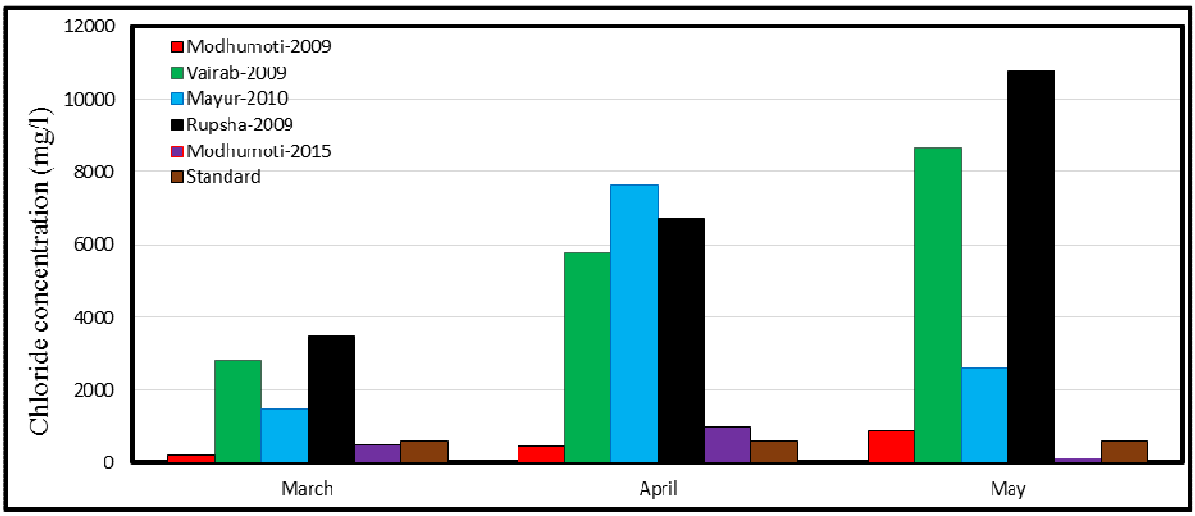

Figure 14: Spatial Variation of chloride Concentration of different river.

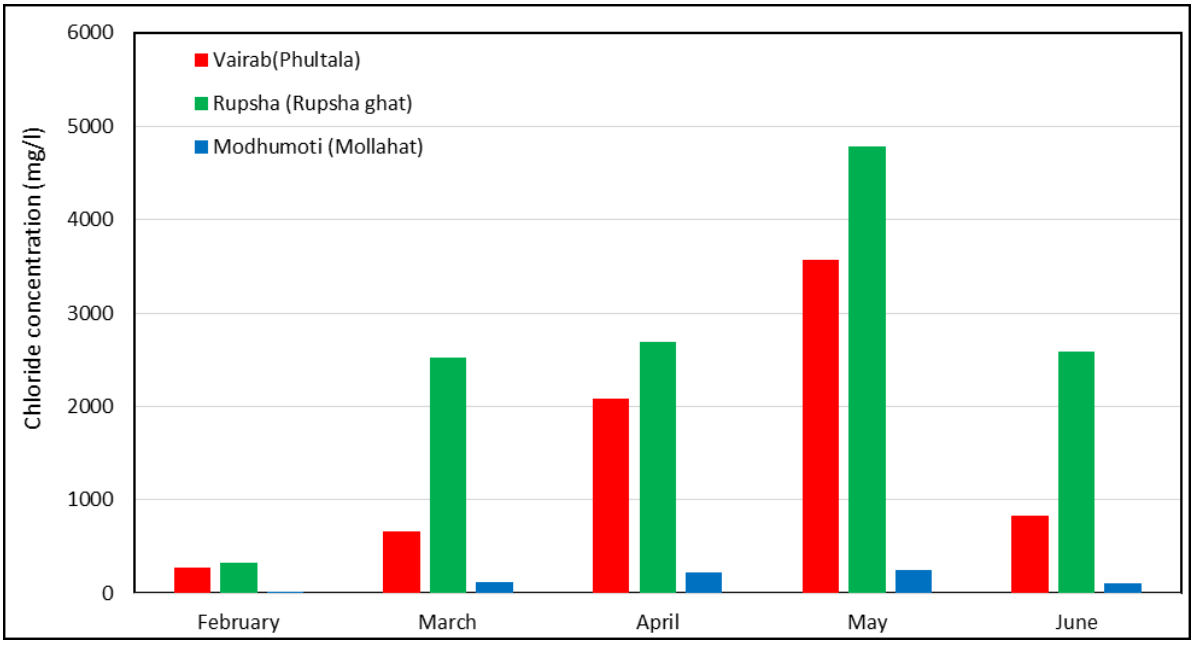

Figure 15: Variation of chloride concentration of different rivers in 2005

Figure 14 shows the spatial variation of Chloride concentration of different rivers. Among them Rupsha river contain higher chloride as compare to the other river. In Vairab chloride concentration peak at April, and Rupsha peak at May. Modhumoti contain always lower amount of chloride. But it increases at 2015 as compare to 2009.

Figure 15 shows the variation of chloride among three rivers (Vairab, Rupsha and Modhumoti) in 2005. It shows the chloride increases from February and peak in May. Among them Rupsha always contain higher amount of chloride and Modhumoti contain lower amount of chloride as compare to the other rivers. Figure 16 shows the variation of chloride concentration of different rivers in 2006. The chloride concentration increasing from February and peak in may for Rupsha and Vairab river but Modhumoti peak in June. Rupsha carries higher and Modhumoti carries lower amount of chloride concentration in every month.

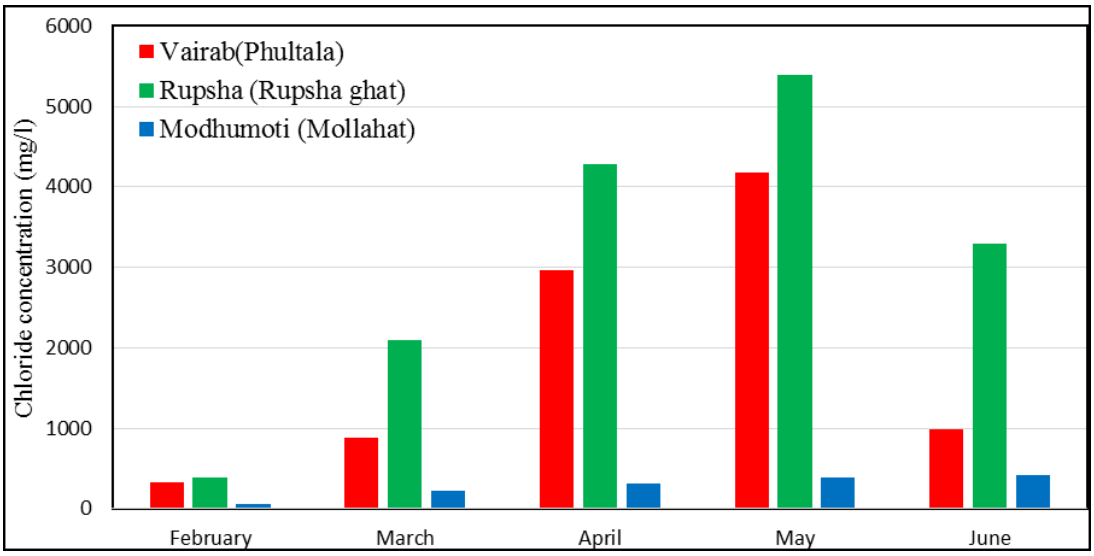

Figure 16: Variation of chloride concentration of different rivers in 2006

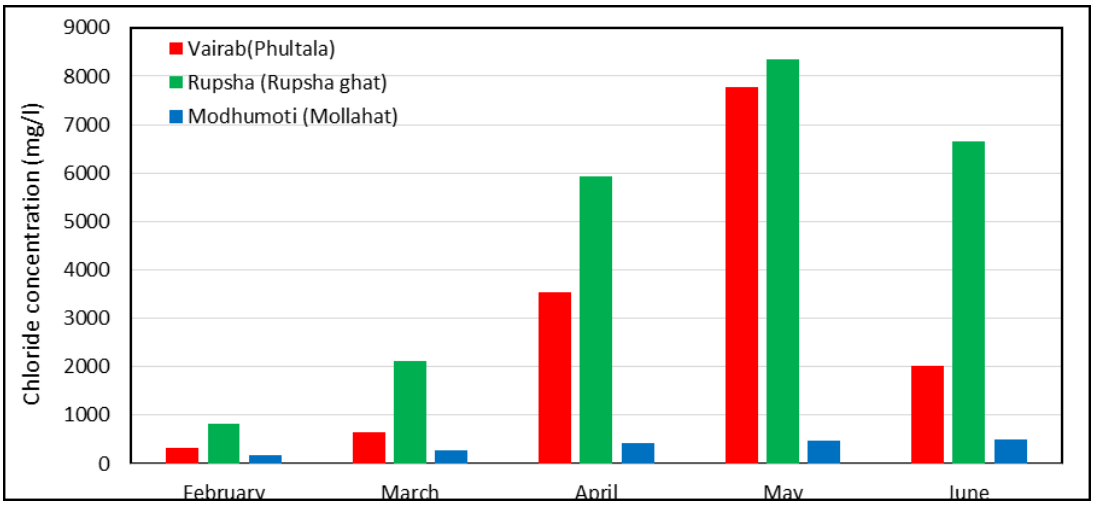

Figure 17: Variation of chloride concentration of different rivers in 2007

Variation of chloride concentration among three rivers (Vairab, Rupsha and Modhumoti) in 2007 is shown in Figure 17. Figure shows that the chloride concentration increasing from February and peak in may for Rupsha and Vairab River but Modhumoti peak in June. Rupsha carries higher and Modhumoti carries lower amount of chloride concentration in every month. Figure 18 shows the variation of chloride concentration of different rivers in 2008. Figure shows that chloride concentration is increasing from February and peak in June. Rupsha contain higher amount of chloride in every month.

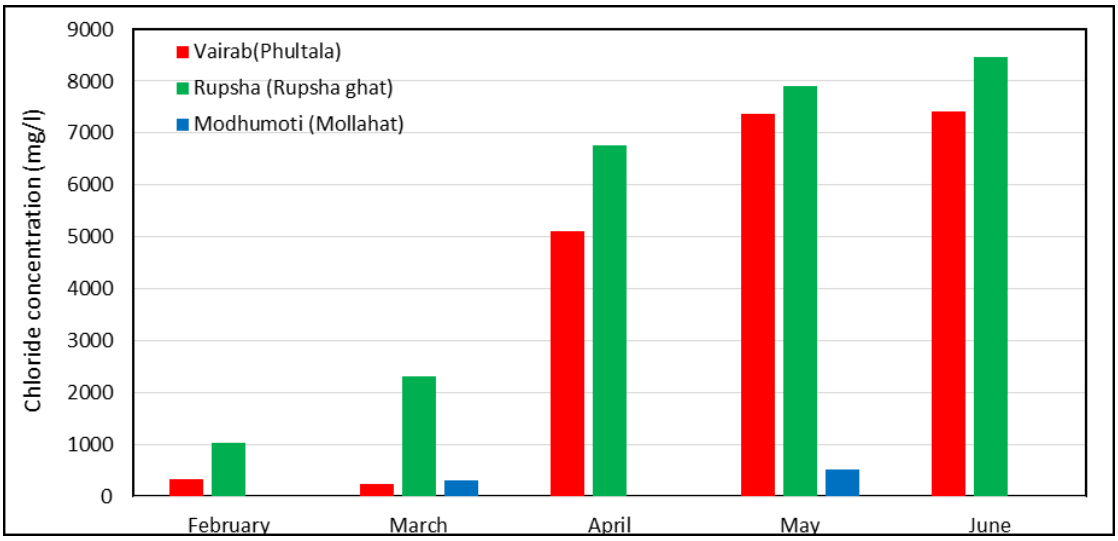

Figure 18: Variation of chloride concentration of different rivers in 2008

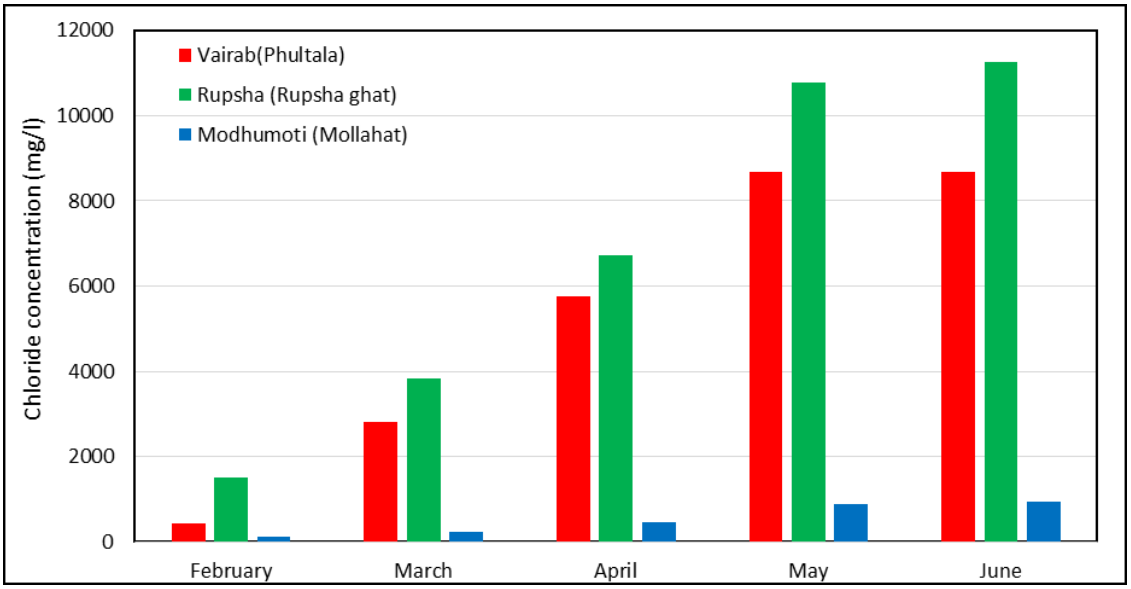

Figure 19: Variation of chloride concentration of different rivers in 2009

Figure 19 shows the variation of chloride among three rivers (Vairab, Rupsha and Modhumoti) in 2009. Figure shows that chloride concentration is increasing from February and peak in June for Rupsha and Modhumoti but Vairab peak in May. Rupsha contain higher amount of chloride and Modhumoti contain lower amount of in every month. From Figure 20, it is found that the rivers contain higher salinity in April as compare to March. Among three rivers Vairab contain higher salinity in April and Rupsha in March. Modhumoti contain lower salinity as compare to the other rivers. But the amount of saline increases at 2015 as compare to 2009.

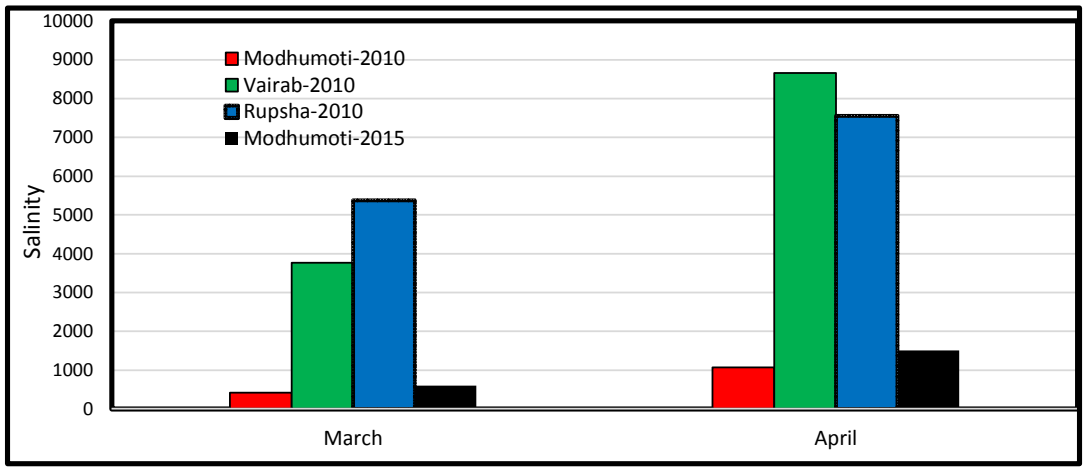

Figure 20: Variation of salinity for different rivers

4. CONCLUSIONS

There are many rivers flow through south western zone into or nearby the Khulna city and meet with Bay of Bengal in southern part of Bangladesh. Those are the Vairab, Rupsha, kobadak, pashur, Mayur, Modhumoti etc. Most of the rivers contain higher salinity which is not permissible in drinking. Water quality of the Vairab, Rupsha, Mayur River was evaluated for comparison of water quality parameters. The temporal variation of salinity of Modhumoti River was increasing from the month of February (pre-monsoon season) and reaches its peak in April and May followed by a declining trend in June. The highest level of salinity was observed in April for station 2, Modhupur with 4530 µs/cm. The spatial variation of salinity decreases gradually up to the station 4 to station 1, except that station 2. The reason for the salinity increasing from March to May is low flow in the river and low rainfall. The local runoff cannot contribute to the river discharge. The other rivers Vairab, Rupsha, Mayur also contain higher salinity in March and April. The temporal variation of salinity of other rivers was increasing from the month of February (pre-monsoon season) and reaches peak in April and May followed by a declining trend in June. From comparison it is found that Modhumoti River contains very low amount of chloride concentration and salinity as compare to the other rivers. The chloride concentration and salinity are higher in March to April and found to be decreases with the starting of rainy season.

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