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Impact on Aquatic Environment for Water Pollution in the Vahirab River

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----------**ABSTRACT**----------

Water is a valued natural resource for the existence of all living organisms. Vahirab river is the prominent & important rivers for vital source of water from Jessore to Khulna. The prime reason of deterioration and pollution of the river water quality by effluents discharged from industries, municipal sewage, household wastes, clinical wastes and oils. The purpose of this study is to investigate the impact of this wastewater on the river and thus to provide an updated report on the state of water quality of river Vahirab. The water sample were collected from different areas in the river Vahirab and analyzed for physico-chemical parameters and fresh water elements in the month of July, 2013 to November, 2013. The values of temperature, turbidity, pH, chloride, hardness, DO, BOD, COD, Fe, As, Pb, Cd and Cr in the river water were measured. During study period the temperature, turbidity, pH, hardness, chloride, DO, BOD and COD were found to be 28^0C to 31.5^0C, 37 to 947 NTU, 7.2 to 8.01, 92 to 140 ppm, 9 to 34 ppm, 122 to 5.51 mg/L, 0.22 to 5.79 mg/L and 3.80 to 10.80 mg/L respectively. The concentration of Fe, Pb, As, Cd and Cr were found to be 0.10 to 2.60 ppm, 0.004 to 0.025 ppm, 0.001 to 0.004 ppm, 0.00015 to 0.0094 ppm and 0.001 to 0.006 ppm respectively. From the results of investigation, it was observed that the values of pH, Cl^- , hardness, As, Pb, Cd and Cr were within standard limit but the values of temperature, turbidity, DO, BOD, COD and Fe were not within acceptable limit as recommended by WHO and BDS guidelines. The results obtained from this investigation will help the people of the research area to be conscious for using the water in the Vahirab river.

Keywords *- Vahirab river, pollution, physico-chemical parameters, water elements.*

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I. INTRODUCTION

Water pollution affects marine ecosystems, wildlife health, and human well-being. Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater). Water pollution occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds. Water pollution affects plants and organisms living in these bodies of water. In almost all cases the effect is damaging not only to individual species and populations, but also to the natural biological communities. It is a well known fact that clean water is absolutely essential for healthy living. Adequate supply of fresh and clean drinking water is a basic need for all human beings on the earth, yet it has observed that millions of people worldwide are deprived of this. The development of industry and agriculture created a number of environmental problems including air and water pollution with their serious effects on human health [3].

Rapid industrialization and urbanization have resulted in elevated emission of toxic heavy metals entering the biosphere [4-5]. An estimate of Witt [6] based on WHO reports suggests that 80% of all human illness in the developing countries is associated with polluted water. It has been suggested that it is the leading worldwide cause of deaths [7-8] and that it accounts for the deaths of more than 14,000 people daily [8]. An estimated 1,000 Indian children die of diarrhea every day (a special report on India 2008). The contribution of geology is to help isolate environmental aspects that may influence the incidence of disease. Bangladesh is

facing enormous challenges in meeting the rising freshwater demand due to limited water supply from the available Ground water and Surface water sources as they are affected by the salinity and other water quality problems [9-10]. At present, the principle cause of salinity intrusion in Khulna region is the drop of hydraulic head during the dry period (November to May) into both Surface Water and Ground water of the area [11]. In case of fishery, increased salinity affects spawning ground leading to substantial reductions in the inland open water fishery [12].

Various factors like water temperature, turbidity, nutrient, hardness, alkalinity, dissolved oxygen (DO) play important role for the growth of plants and animals in the water. On the other hand the biological oxygen demand BOD) and the chemical oxygen demand (COD) indicate the level of pollution of a given water body. Each factor has a specific role in aquatic eco-system. The river plays an important role for fisheries. The rivers also support thousands of people for their bath and other domestic purpose. The surface water is essential for keeping the environment balance of total region, particularly in the estuaries to the south and at the mouth of the rivers. Surface water monitoring is essential for aquatic resources management and flood forecasting [13]. Bangladesh has extensive water bodies that have a high potential for fisheries production [14]. The productivity depends on physico-chemical characteristics of the water body [15]. The population of natural fish species has declined considerably due to increased fishing pressure and various anthropogenic activities leading to siltation, aquatic pollution and loss of natural habitat for spawning and growth [16-17]. These factors not only destroyed the breeding grounds but also caused havoc to the availability of brood fish including fry and fingerlings [17]. As a result, recently the fish is considered as one of the most endangered species in Bangladesh [18]. Rivers and surrounding land drained by catchments are very important for wildlife habitats. The quality of aquatic environment generally depends on four kinds of factors, such as physical, chemical, biological and meteorological factors [19]. Water Quality is controlled and determined by the combinations of all kinds of factors in various ways and intensities [20]. Just by assessing the physical, chemical and biological characteristics of water one can conclude about its quality [21]. In the present study, the values of pH, Cl^- , hardness, As, Pb, Cd and Cr as well as the values of temperature, turbidity, DO, BOD, COD and Fe were evaluated that will help the people of the research area to be conscious for using the water in the Vahirab river also monitoring this.

II. EXPERIMENTAL

The study area of Vahirab river channel from Noapara, Jessore to Labonchara, Khulna is located in the southwest of Bangladesh and the longitude of the study area $89^0$23’41.6” to $89^0$34’58.9” East and latitude of the study area $23^0$02’12.6” to $22^0$46’42.0” North. Khulna City area is bounded by the river of Vahirab on the northeast, Rupsha on the southeast. The Atharobanki river meets with Rupsha and Atai river meets with Vahirab river on the central east [22]. These rivers are virtually the distributaries of Ganges River, which carry sediment from upstream. The Rupsha-Vahirab river are the active tidal river with strong current.

I.1) Preparation and preservation of Sample

Sample bottles were rinsed properly with the samples to avoid dilution and interferences. And tightly sealed and there no air bubbles in the sample bottles after sampling that tagged with specific sample code. All the collected samples were placed into a plastic box and transported to the chemistry laboratory immediately for further analysis. The preservation procedure varies depending of the test to be performed. The sample for DO and BOD, after collection should not be allowed to remain in contact with the air or be agitated because either condition causes a change in its gaseous content. The DO sample should be fixed on the spot by some prescribed reagents (such as, Manganese Sulphate $MnSO_4.4H_2O$ and Alkali Iodide Azide) as soon as the samples has been collected [23]. Water samples were quickly brought into the laboratory and initially 500ml were filtered with Whatman-44, Ash less, 125mm diameter filter paper and then acidified by concentrated HNO_3 acid (4ml/Liter) to prevent adsorption of metal ions on the sides of the bottles. Finally bottles covered with cap and stored at refrigerator.

I.2) Data collection and GIS Analysis

Latitude and longitude position of each location from where samples were collected was confirmed by GPS (Model: Xplora GPS 200) reading which is given in Table 1:

Table 1: Location, Latitude, Longitude & sample ID of the sampling points

Sl. No.	Location	Latitude	Longitude	Sample ID
1	Shankar pasha Ferry ghat, Noapara, Jessore	$23^0$02’12.6”N	$89^0$23’41.6”E	Z-1
2	Akij Leather, Noapara, Jessore	$23^0$01’02.9”N	$89^0$24’43.0”E	Z-2
3	Kali bari ghat, Khulna	$22^0$49’06.5”N	$89^0$34’18.5”E	Z-3
4	Labonchara, Rupsha Bridge, Khulna	$22^0$46’42.0”N	$89^0$34’58.9”E	Z-4

I.3) Physical Parameter

The temperature was taken by a mercury thermometer graduated 0^0C to 100^0C. Water sample was taken in a clean beaker and bulb of the thermometer was dipped into the water for one minute. The value was noted and it was the water temperature. The turbidity was measured by HACH portable spectrophotometer

I.4) Chemical Parameter

The pH of water was determined by using a glass electrode pH meter (TOA pH meter HM-12P). The instrument was standardized at pH 4.7 & 10 with standard buffer solution (HACH singled pH buffer solution packs). After successful calibration electrode was rinsed thoroughly by using distilled water. The electrode was placed into the sample and read button was then pressed. When the reading was stable the pH was recorded. Total Hardness of water sample was measured by the standard method of APHA, 2005 [24]. Chloride is measured by Mohr's methods with using Silver nitrate, Potassium chromate and Sodium chloride. Dissolved Oxygen is measured by Winker titration methods with using titrating reagents. Biochemical Oxygen Demand is measured by DO probe -5 days incubation methods and Chemical oxygen demand (COD) Chemical oxygen demand is measured by Permanganate Titration methods at 100^0C.

I.5) Fresh Water Elements

Atomic absorption spectrometry is a latest, modern and generally accepted method for the analysis of many fresh water elements. In a typical AAS method, sample is aspirated into a flame, where ions within the liquid are reduced to the atomic state. The elements in the atomic state can then quantitatively absorb light at the wavelengths characteristic of their resonance frequencies, e.g. 217.0 and 283.3 nm for lead. Alternatively the ions may either be chemically reduced by a cold vapor technique or be thermally reduced in a graphite furnace before analysis. AAS method usually gives better sensitivities (as low as 50 µg/kg) than any other method such as Calorimetric. By this method several hundred samples can be analyzed within a workday if the samples are already prepared, so it is a time saving method. In flame technique and cold vapor techniques, the sample must be in solution. Atomic absorption spectrophotometric analysis has been used in the present study for determination of fresh water elements in DPHE, Jhenaidah.

III. RESULTS AND DISCUSSION

The temperature and turbidity of different location at different months of Vahirab River is plotted in Fig. 1. It is observed from the figure that in river Vahirab the highest temperature (31.5℃) was during August and September at Sankarpasha Ferryghat (Z-1) and Akij Leather (Z-2) whereas the lowest temperature (28℃) was in October at Kalibari ghat (Z-3). High water temperature at Akij Leather (Z-2) may be caused by water effluent from industrial activities by Leather factory. Warm water enters the river, raises the temperature of the downstream area. In Sankarpasha Ferryghat, the temperature was high during August and September, because when the temperature was measured the river water was turbid. The sun heated the river water. The turbid water captured more heat from the sun than clear water did. High turbidity levels may increase temperatures [25]. On the other hand, the highest turbidity (947 NTU) was observed at Labanchara Rupsha ghat (V-4) during July-13 and current turbidity varies with downstream and upstream flows [26].The turbidity of Labanchara Rupsha ghat (Z-4) during July-13 was higher due to the downstream river flow and there are some Industries in the bank of the river. During July-13 turbidity was higher than any other months; this may be due to the fact that at the time of sampling rainfall had been occurred before two days ago. The results of present experiment clearly indicate that the water of Vahirab River is almost highly turbid with moderate temperature.

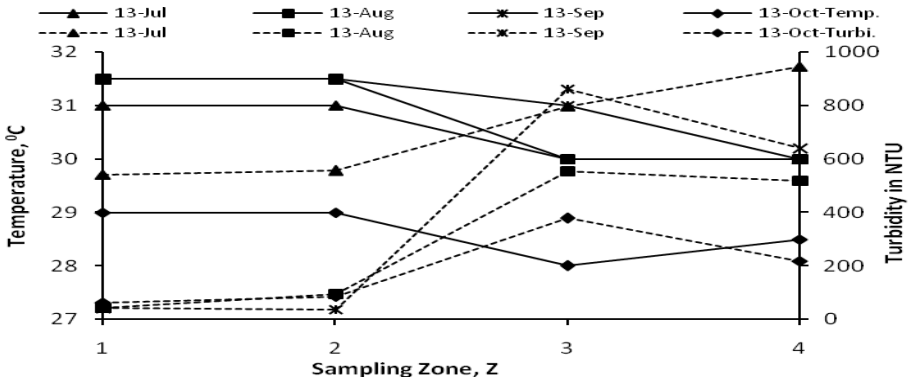

Fig. 1: The temperature and turbidity of different location at different months

From Fig. 2, it is observed that in river Vahirab the maximum pH was 8.01 at Sankarpasha Ferryghat (Z-1) in September-13; however, the minimum pH of 7.2 was observed at Akij Leather (Z-2) in August. At all the sites pH values were observed within the permissible limit. The relatively high pH (8.01) in September-13 at Sankarpasha Ferryghat may be contributed by the local discharges which contain alkaline effluents from surrounding Bazar and households. Therefore total hardness is relatively higher at Z-1 by discharging of Himalaya cement factory effluents that may contribute to the hardness of the river water. It is important to note that there is no legal limit or standard for hardness in water.

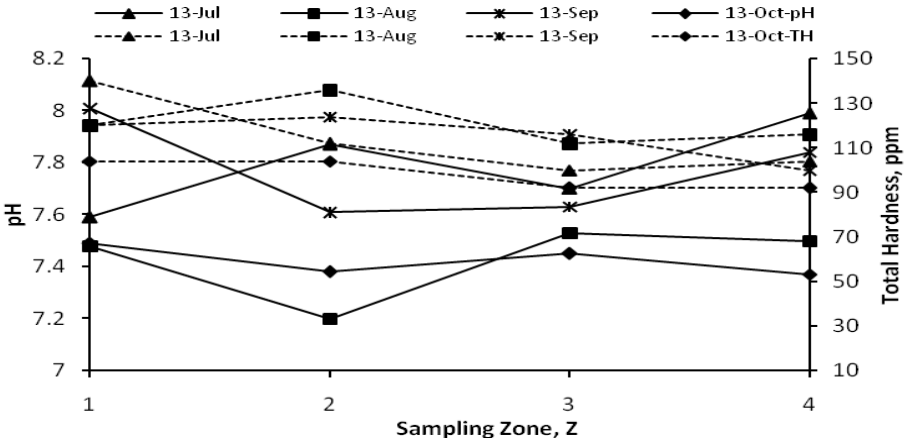

Fig. 2: pH and total hardness of different location at different months

This is primarily because the constituents that contribute to hardness are not toxic; that is, they do not cause harmful health effects. The results indicate that the water of Vahirab River is safe for fish, other aquatic life, irrigation, recreational activity.

The Dissolved Oxygen and Biological Oxygen Demand of water of the study area at different locations in different months were 1.22 mg/L to 5.51 mg/L and 5.79 mg/L to 0.22 mg/L; respectively which are plotted in Fig. 3. From the observation of the figure, it was visualized that the highest DO 5.51 mg/L was observed at Kalibari ghat during October and lowest 1.22 mg/L was observed at Sankarpasha Ferry ghat during August. As well as, the standard BOD value for inland surface water is 6 mg/L or less and if it is above this value, it can result threat to the aquatic ecosystem. The BOD at Labanchara Rupsha ghat is high due to the disposal of untreated sewage, such as from household latrines on the bank of the river. From graph it is visualized that the BOD values during August were higher than any other months. Hard rain was taken place before two days ago during sampling which was the cause of high BOD values. From the data and above discussion it is clear that the water of the river during study period were in safe limit for irrigation, domestic use, recreational activities etc. but not good for drinking purpose in respect to DO and BOD.

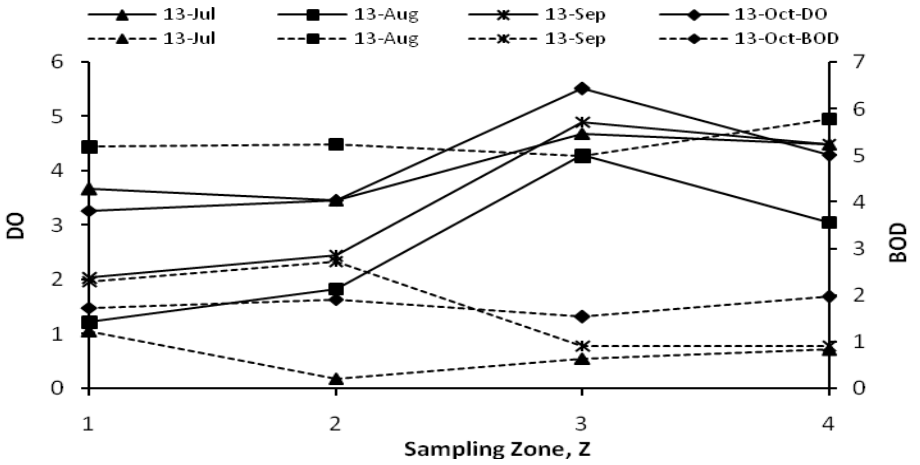

Fig. 3 : DO and BOD of different location at different months

The Chemical Oxygen Demand (COD) and Chloride concentration of water of the study area at different months in different locations of Vahirab River were 3.80 mg/L to 10.80 mg/L are plotted in Fig. 4. It is visualized that the highest and lowest COD 10.80.mg/L, 3.80 mg/L were observed at Z-3 during September and August; respectively. At the time of sample collection from Kalibari ghat there was raining heavily and contaminated storm water washed off of trading area, called urban runoff was exposed to receiving water body. This may be the cause of high COD values at that point. But the highest value of chloride concentration 34 ppm was observed at Z-1 and Z-2 during July due to various kind of mixed potash fertilizer warehouse, leather processing and lowest value of chloride concentration 9 ppm was observed at Z-3 during September.

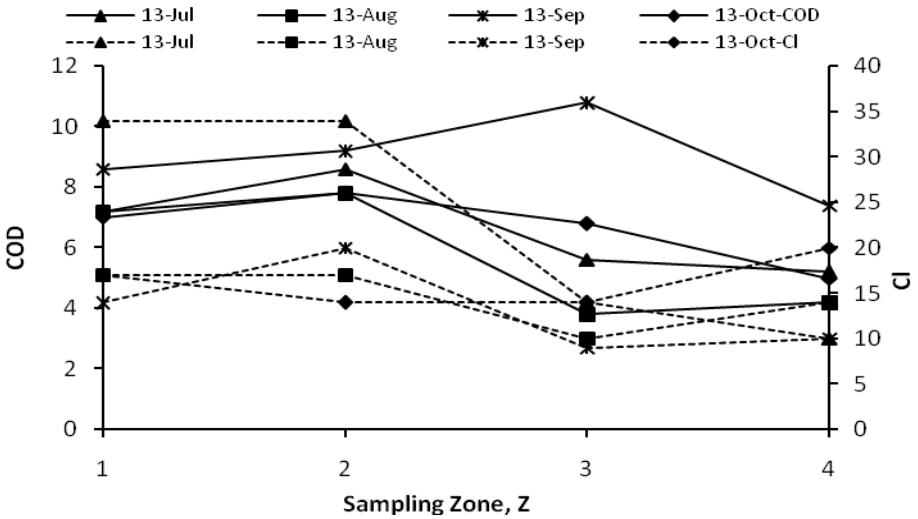

Fig. 4 : COD and Chloride concentration of different location at different months

In the Fig. 5 observed that Lead and Iron concentration in water at different locations in different months were 0.025 ppm to 0.004 ppm and 0.10 ppm to 2.6 ppm; respectively. From that the highest Lead concentration 0.025 ppm was observed at Z-3 during September and lowest Lead concentration 0.004 ppm was observed at Z-1 during September. The concentration of Lead in the study area did not exceed the permissible limit (0.05 ppm) prescribed by BDS guideline. Comparatively higher value of lead concentration is might be due to the addition of civic wastes and industrial effluents from battery manufacturing factory in Shiromony, the industrial area which are also discharging their effluents directly into the river [27-29]. Iron concentration in river Vahirab the maximum concentration of Fe was 2.6 ppm during July at Z-4 due to downstream area whereas the minimum concentration of Fe was 0.10 ppm in September at Z-1.

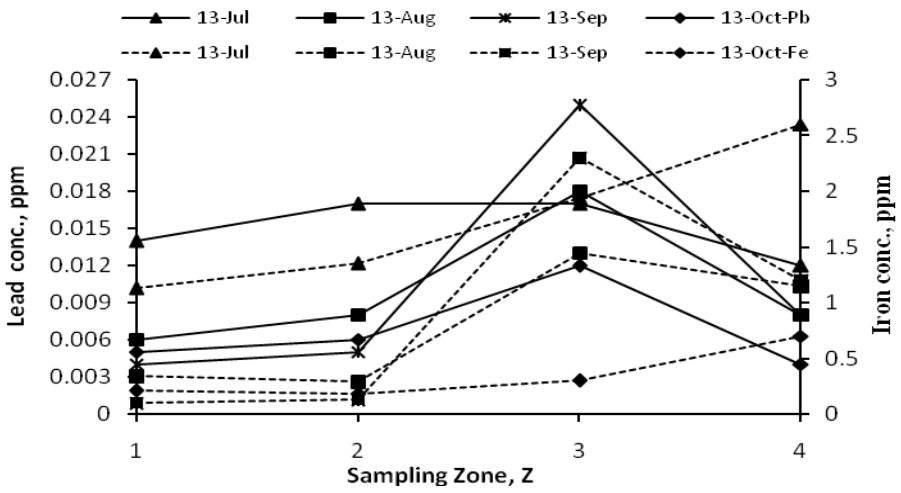

Fig. 5 : Lead and Iron concentration of different location at different months

Arsenic (As) and Cadmium (Cd) in water of the study area at different locations in different months were 0.001 ppm to 0.004 ppm and 0.00015 ppm to 0.0094 ppm; respectively are plotted in Fig. 6. From the Figure, it is visualized that the highest As concentration 0.004 ppm was observed at Akij Leather (Z-2) during August and lowest As concentration 0.001 ppm was observed at Sankarpasha Ferry ghat (Z-1) during July. The concentration of As at different locations in the study area was much below the proposed water quality standards (0.05 ppm). On the other hand, the highest value of Cd concentration was 0.0094 ppm during July-13 at Sankarpasha Ferry ghat (Z-1) and lowest value of Cadmium concentration was 0.00015 ppm during September-13 and October-13 at Akij Leather (Z-2). The concentration of Cd at different locations in the study area was much below the proposed water quality standards (0.005 ppm). From the data and above discussion it is clear that the water of the river during study period were in safe limit in respect to As and Cd concentration.

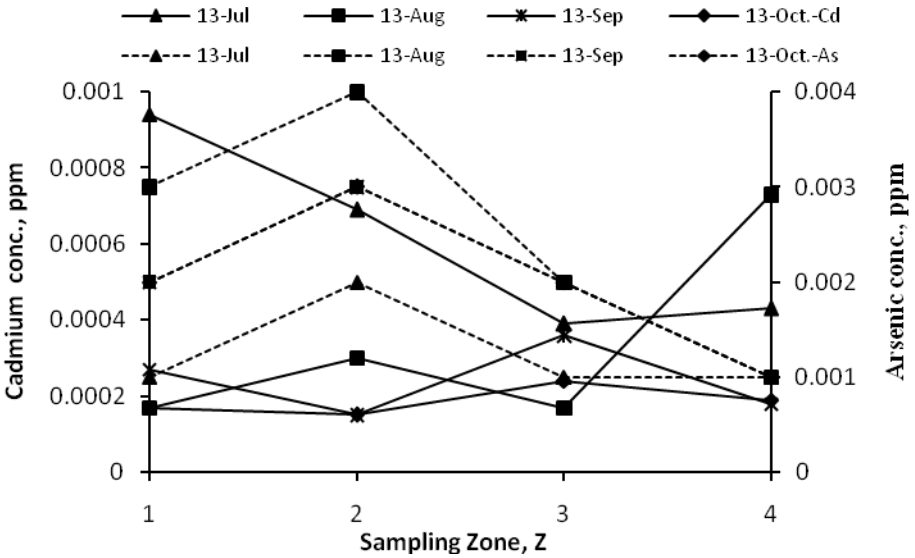

Fig. 6 : Cd and As concentration of different location at different months

In Fig. 7, the Cr concentration of the study area are plotted. At the time of study period the highest value of Chromium concentration was 0.006 ppm during August-13 and September-13 at Kalibari ghat (V-3) and lowest value of Cr concentration was 0.001 ppm during August-13 at Akij Leather (V-2) and Labanchara ghat (Z-4), also October-13 at Sankarpasha Ferry ghat (Z-1). The concentration of Chromium at different locations in the study area was much below the proposed water quality standards (0.05 ppm). From the data and above discussion it is clear that the water of the river during study period were in safe limit in respect to Cr concentration.

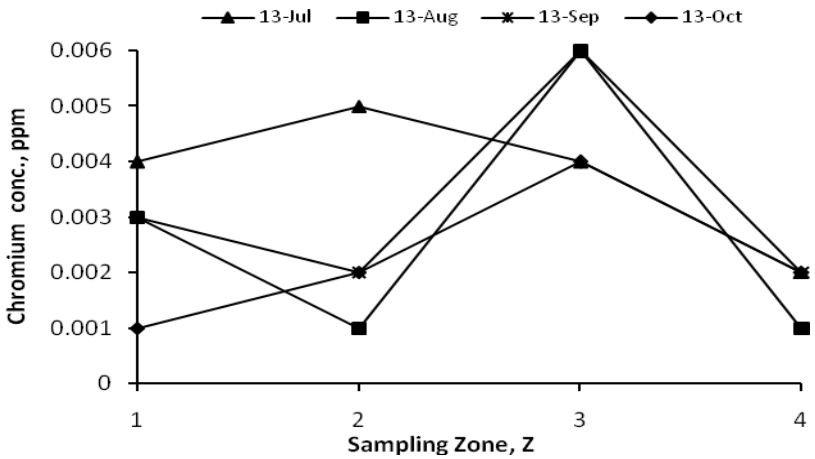

Fig. 7 : Chromium concentration of different location at different months

IV. Conclusion

The samples of water were collected from different areas of Vahirab River from Noapara, Jessore to Labanchara, Khulna, Bangladesh to analyze the physico-chemical parameters and also fresh water elements. The investigation was done during July to October, 2013. The results of the investigation can be summarized as the values of pH, Cl^- , hardness, As, Pb, Cd and Cr were within standard limit but the values of temperature, turbidity, DO, BOD, COD and Fe were not within acceptable limit due to industries, slum-dwellers, bazar, warehouse etc. situated on the bank of river Vahirab as recommended by WHO and BDS guidelines.The findings of the present study would be helpful as baseline information for developing of monitoring, management and conservation of Vahirab river ecosystem in future. However, the investigations covering all the months in a year and more sampling area would be necessary to make concluding remarks on aquatic ecology of the river.

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