CONSEQUENCES OF WATER POLLUTION- AN INCIDENT, IN RIVER PANGA, DISTRICT JALPAIGURI WEST BENGAL

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Abstract

The concerned project was aimed to observe and analyze an incident that carried a direct connection with the issue of surface water pollution. The central focus of this project, River Panga, is a small rivulet in District Jalpaiguri, West Bengal (WB), India. It came to notice with utter shock that due to some unfortunate and unwanted cause a large number of fishes died and floated over the surface of River Panga on 10th May, 2015. This unnatural and harmful incident on aquatic life created a keen interest to carry out a quality assessment of the River water which ultimately aims to look for the preliminary cause of that situation. The water of River Panga collected from two points- near to contamination Zone (P_1) and incident point (P_2) after the event and analyzed in laboratory to measure some Physico-chemical parameters like Temperature (T), Hydrogen Ion Concentration (pH), Electrical Conductivity (EC), Total Dissolved Solid (TDS), Total Hardness (Total-H), Calcium Hardness (Ca-H), Calcium (Ca), Magnesium Hardness (Mg-H), Magnesium (Mg), Alkalinity, Dissolved Oxygen (DO), Nitrate (NO_3^-), Nitrite (NO_2^-), Ortho Phosphate (PO_4^-), Chloride (Cl^-), Manganese (Mn), Iron (Fe as FeS), Arsenic (As), Total Coliform and Fecal Colifom. The findings of the analysis showed that the water of River Panga was hard. The amount of manganese present was beyond the Environmental Protection Agency (EPA) limit and iron was greater than tolerable limit of fish species. The DO level at the two study points reached at an alarming condition and this was the cause of the mortality of fishes at P_2. Moreover it was evident that pollution at P_2 was more than that of P_1. Investigation showed that the industrial effluent may responsible for the pollution of River Panga as an industrial growth at Raninagar, Jalpaiguri is situated at the catchment area (near P_1) of this river. The other important point noted at the time of inquiry that the local people, who used the water daily, suffer from skin diseases. So, the work quite significantly marked that the aquatic life and the local people who are dependent on the river water are under risk.

IndexTerms - Water pollution, physico-chemical parameters, river Panga, alarming, skin problem, Dissolved Oxygen, Industrial growth

I. INTRODUCTION

Among various types of environmental pollution, water pollution, is a vital threat to human health and becomes the most remarkable issue of the sustainable development. The natural water find in river, lakes, ponds are known as surface water. 0.0001 percent of total water of earth is surface water (Ahluwalia VK 2015). This small portion of fresh water is under several stresses due to pollution. Organic waste contains high oxygen demanding substances which leads to depletion of dissolved oxygen. This has a great effect on whole eco system. Intense nutrient loading may lead to eutrofication. On the other hand industrial disposal of many toxic pollutants polluted the river water very badly. Thermal pollution is also occurred by industries which reduces dissolve oxygen (Goel A 2008).

Works on water pollution carry an important impact in the field of environmental studies. Water quality evaluation is considered as critical issue in recent years, especially when freshwater is becoming a scarce resource in the future (Varol M et al. 2012). Niemi GJ et al. (1990) reported that human activities mainly affect surface water quality through effluent discharges and agricultural chemicals. Natural water contains different types of impurities that are introduced into aquatic system by several ways such as weathering of rocks, leaching of soils, dissolution of aerosol particles from the atmosphere and from several human activities including mining, processing, use of metal based materials (Adeyeye EI 1994; Ipinmoroti K, Oshodi O 1993). The work had been done on Haithe River Basin by Kong P et al. (2018). They worked on sediment pollution caused by heavy metals present in surface water. To identify the sources of pollution along with the treatment of such pollution can be considered as necessary steps for promoting sustainable use of water. Alrumman SA et al. (2016) worked on sources and treatment of water pollution.

About 63 per cent of the water resources of the entire State of West Bengal are carried out by eight basins of North Bengal (in WB). The eight river basins of North Bengal drain from the southern slope of the Himalaya and carry about 98679 MCM of surface water annually (Rudra K 2009). The literature survey showed that deficit amount of water is growing day by day in the state of WB. It is to mention that alarming condition will be reached by 2025 when the scarcity of water will be greater than 50% (Rudra K 2009). So, in this scenario maintaining the quality of surface water is very important.

District Jalpaiguri is an important basin of River Tista, Karola, Jaldhaka of North Bengal. The district faced some unwanted incidents in recent years. On May 10, 2015, hundreds of dead fish were found floating in the River Panga (The Telegraph, Published: 11. 05. 15). The same situation happened in nearby rivers Tista and Karola on December 11, 2012 and November 29, 2011 respectively. The pollution status of River Karola and Tista had been measured by same author (Das A 2016; Das A 2017; Mandal HS et al. 2012) previously but very useful and significant part of the recent work was that, the concerned analysis was done just after 15 days of the incident and it would be possible to focus on quality of water immediate after the sudden death of aquatic life.

The investigation also pointed out a skin disease among the local people, who used the River water daily. These symptoms were very specific for this area. Therefore the main objective of the work is to evaluate the quality of water of River Panga after the incident happened on 10th May, 2015 and to search some preliminary causes of the sudden death of fish species. Thus measurement of some physico- chemical parameters was carried out at two points P_1 and P_2 for the purpose.

II. Study Area

The District Jalpaiguri situated between Lat. about 25^0 N and Long. about 85^0 E. Panga is a small rivulet that flows from Baikunthapur forest in the district Jalpaiguri, West Bengal, India. Then it passes through Baikunthapur forest, some tea gardens, an industrial belt (Rani Nagar), grassland and agricultural field. The southern part of the district has piedmont planes and gradually converted into alluvial plains. There are three seasons felt namely summer, monsoons and winter. Mainly summer season is hot with temperatures ranging in the mid-thirties (Celsius). The highest recorded temperature in Jalpaiguri was 41.3 degree Celsius. Monsoons are rainy season and high volume of rainfall take place in every year, sometimes flood may occur severely in the area. Winters are very cold and chilly Himalayan winds blow throughout the city. Temperatures are around 8 to 14 degrees Celsius during this period. The lowest recorded temperature in Jalpaiguri City was 2.1 degree Celsius. However, the climate is changing day by day drastically due to the effect of high pollution in the area. Two points were selected on River Panga. P_1 was at near an industrial estate Raninagar, Jalpaiguri (near to contamination zone) and P_2, Panga Bridge near Chaul Hati, where the incident took place i. e. incident point.

Fig. 1 Position of West Bengal and Jalpaiguri in India map

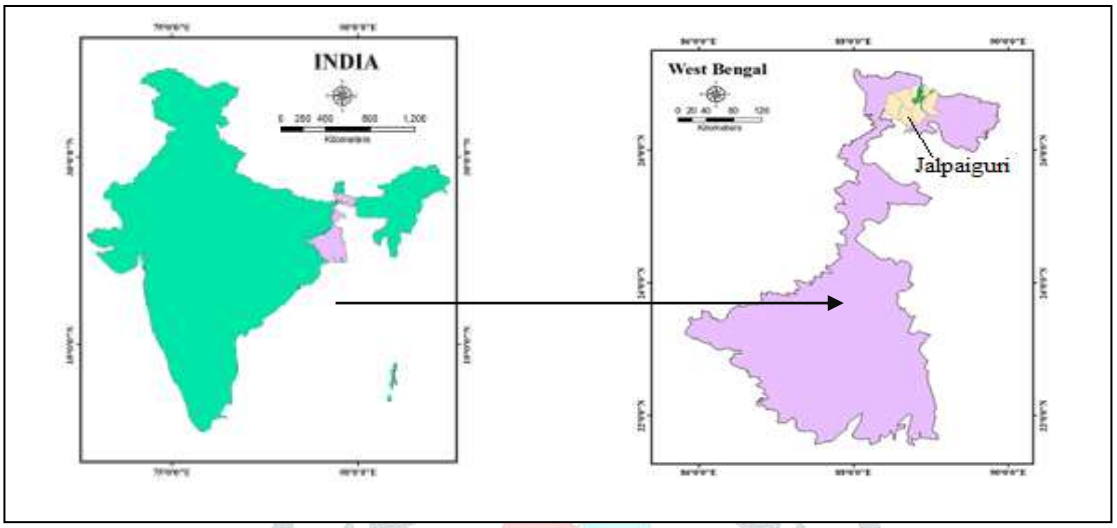


Fig. 2 River Panga and two sampling points including The Industrial growth at Raninagar

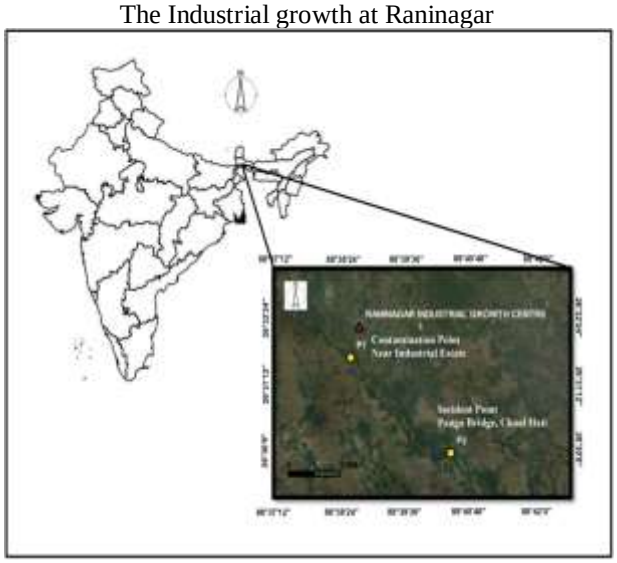


Fig. 3 Children collected dead fish from Panga (The Telegraph, Published: 11. 05. 15) captured by Biplab Basak

III. Experimental

Test samples were collected from the specified spots and transported to laboratory in ice box. Temperature and Total Dissolved Solid were recorded in the spot. Biological Oxygen Demand bottles of 500 ml (Borosil) were used for the collection of water samples for the determination of Dissolved Oxygen. Samples were collected possibly from a depth of 0.5 metre keeping the mouth of the bottle towards the flow direction and caped under water (APHA 2005).

The water *T* was recorded with the help of a standard centigrade (Celsius) thermometer (Scaling 0 – 110^0 C) after dipping it in the river water for about 2 minutes.

pH value of the water sample was determined directly using water analyzer kit (PE-138, Elico Limited) with a glass electrode. The instrument was often standardized for the measurement of pH with standard solutions of fixed buffered pH. The *EC* and *TDS* values were measured by the same instrument directly with the help of the conductivity electrode supplied with it and direct reading of TDS was obtained after selection of standard conversion factor. The conductivity measuring systems were also standardized frequently with standard Potassium Chloride (KCl) solutions as specified in the instrument manual. The results were expressed in micromhos/cm. *DO* was determined by Water analyzer kit (PE-138, Elico Limited). The instrument was provided with membrane electrode for the direct measurement of DO (appropriate calibration had been done, prior measurement); Every time prior measuring the DO values the instrument was calibrated with the solutions of zero DO. The results were expressed in ppm.

Total- H was determined by using EDTA titrametric method. Sample was titrated with Ethylene di Ammine Tetra Acetate (EDTA) solution after the addition of ammonia buffer and Total Hardness Tablet (BDH).

Ca-H was measured by Titrametric method using EDTA and Ca-H indicator tablet. *Mg-H* was calculated by subtracting the Ca-H value from that of the Total- H. Amount of Ca and Mg were evaluated from Ca- H and Mg-H. All the hardness results including Ca and Mg had given in mg/l.

Alkalinity was directly determined by titration with 0.02 (N) H_2SO_4 using phenolphthalein and mixed indicator (methyl red and bromo cresol green) (Manivasakam N 1980).

The Cl^- *ion* concentration was estimated by silver nitrate method. Direct titration of the water sample was done since it was expected that the interfering ions viz. iron, bromide, iodide etc. would remain in negligible concentration. A blank titration was always done. The completion of the reaction was indicated by the change of colour from light yellow to red with the addition of dichromate solution. The concentration of the ion was measured from the titre value and expressed in mg/l (APHA 2005).

PO_4^{3-} was measured spectophotometrically by stannous chloride method using double beam UV-VIS Spectrophotometer model SL-210 (Elico Limited), amount expressed in mg/l. *Iron* was measured spectrophotometrically by ∞-∞ Bipyridyl method at 565 nm in double beam UV-VIS Spectrophotometer model SL-210 (Elico Limited). The soluble *Mn* compounds were oxidized to permanganate by persulphate in acid solutions and resulting colour of the permanganate solution was measured photometrically at 545 nm. Results were provided in mg/l.

NO_3^- was determined by Analyzer Kit (Photometric DMP Method) at Public Health Engineering Laboratory, Jalpaiguri (PHE lab). NO_2^- *nitrogen* also measured in PHE Lab. *As*, was measured using density meter at PHE Lab. All the results were expressed in mg/l. *Coliform* was done in jalpaiguriin PHE Lab and results were given in C. F. U/ 100 ml.

IV. Result and Discussion

The experimental data submitted in the work was results of one time sampling. It is important to explain here that the work had focused a particular incident and data collected on last of May, after the incident. The district faced heavy rain and flood from mid of June to August; as a result analysis was not suitable in this time, it would give an incorrect impression.

The water of River Panga was not transparent in appearance, it had foul and putrefying odours and algal growth found. Algal growth preferred by warm water, high sunlight, sufficient source of nutrients especially nitrates, phosphates and carbon dioxide. So the summer season is the main growth period of algae than winter. The late summer and early rainfall enhance the condition so effectively that the water body experience a heavy growth of algae. This condition is called an algal bloom (Palmer CM 1980). Moreover with the heavy growth of algae, they float on the surface of the stream and get concentrated in the backwater. The bacteria decompose them using huge amount of dissolved oxygen which in turn reduces the oxygen level of the stream and death of aquatic life take place, the stream develops foul and putrefying odours (Glibert PM 2014). The situation may lead to change the water environment, and even threaten the aquatic ecosystems to function (Lijklema L 1995; Smith VH et al. 1999; Tekile A et al. 2015). The analysis reflected similar condition in River Panga. After 15 days of the incident, still river water carried deficit amount of DO, the amounts were 3.0 and 2.4 ppm respectively in two points (Table 1) which should be 4.0 ppm. (Glibert PM (2014). The T in both points was 28ºC.

Cl^- ion is the common anion found in water and sewage. The amount of Cl^- in a water sample can give an indication of the quantity of sewage effluent in river water. Regarding irrigation waters, Cl^- is the most troublesome anion and generally more toxic than sulphates to most plants (Goel A 2008). The prescribed limit for Cl^- to aquatic life was 230 mg/l on average period of three years exposure whereas one hour exposure the amount must not be exceed 860 mg/l, but this criteria inadequate when chloride present as potassium, Calcium, or Magnesium. Substantial amount of species have very narrow range of Cl^- susceptibility (U.S. Environmental Protection Agency 1988). The amount of Cl^- was 6.9 and 17.1 mg/l respectively (Table 1) and were within the limit.

Alkalinity of water is its acid-neutralizing capacity. It is the sum of all the titrable bases. The amount was 10 and 36 mg/l at P_1 and P_2 respectively. The limit for aquatic life is 90 mg/lit.

Table 1: Water quality parameters of River Panga, *Two points were selected: P_1 near Raninagar Industria Growth Centre and P_2 near Panga bridge, Chaulhati .*

Sl. No.	Parameters	P_1	P_2	Limit of EPA (Human)	Important limits for Aquatic Life
1	**T ^{0}C**	28^0 C	28^0 C		
2	**pH**	7.28	7.20	6.5-8.5	-
3	**EC in µmho/cm**	82.61	96.02	2500	Less than 350
4	**TDS in mg/l**	46.62	53.64	2000	1000
5	**Alkalinity mg/l**	10	36	600	90
6	**Total- H as $CaCO_3$ mg/l**	176	152	< 200	20-300
7	**Ca-H in mg/l**	12.8	16	-	-
8	**Mg-H in mg/l**	163.2	136	-	-
9	**Ca (as Ca) mg/l**	5.12	6.4	-	Ca: Mg ratio< 1:20 and >8:1
10	**Mg (as Mg) mg/l**	39.82	33.18	No limit	
11	**DO in ppm**	3.0	2.4	3	4
12	**NO_3^- mg/l**	8.2	8.8	50	80
13	**Mn mg/l**	0.34	0.31	0.05	1.3 (150-174 Total- H) 1.4 (175-199 Total- H)
14	**NO_2^- as N mg/l**	0.07	0.068	0.5	5
15	**Iron mg/l**	2.6089	0.8545	1	0.5
16	**PO_4^{3-} (mg/l)**	0.0298	0.0298	No limit	0.1
17	**As (mg/l)**	<0.01	<0.01	<0.05	< 0.01
18	**Cl^- (mg/l)**	6.9	17.1	250	230 mg/l
19	**Total Coliform C. F. U/ 100 ml**	60	50	-	-
20	**Faecal Coliform C. F. U/ 100 ml**	20	25	-	-

Total- H in water is due to the natural accumulation of salts from soil and geological formation or from direct pollution by industrial effluents. The Hardness as $CaCO_3$, 0-75 mg/l soft, 75-100 mg/l moderately hard, 150-300 mg/l hard, above 300 mg/l is very hard (Das A 2016). Its correlation with water body gives direct and indirect information about bacterial activity, photosynthesis, availability of nutrients, etc. (Asaolu SS et al. 1997). If the hardness becomes higher due to pollutants with reduction in dissolved oxygen concentration then fish and insect life can die (Premlata V 2009). The water of River Panga was hard and had a reduced amount of DO values reflecting the same situation after the incident. Total Hardness was 176 and 152 mg/l (Table 1) at two points. The suitable limit for hardness is 20-300 mg/l with a good DO level for aquatic life. Ca: Mg ratio, less than 1:20 and higher than 8:1 are harmful for hatching, feeding development and survival to larval growth (Liu S et al. 2016). The ratio was 1: 8 and 1: 5 (approx) in present case.

The level of TDS of a water course may be taken as a measure of the intensity of pollution (Mishra SP 2006). Water with high concentrations of dissolved minerals such as salt will have a lower DO concentration than fresh water at the same temperature (Water Quality 2009). Most aquatic ecosystems involving mixed fish fauna can tolerate TDS levels of 1000 mg/l (Boyd EC 1999). Amount of TDS was below the tolerable range, 46.62 and 53.64 mg/l in two points (Table 1) respectively.

EC of water mainly related to dissolved substances of water. The two points of River Panga had EC value 82.61 and 96.02 µmho/cm (Table 1). The value of pH suggested that the river water was almost neutral (Table 1) in nature.

NO_2^- is more toxic than nitrate. It can affect children, young animals and cattle by conversion of haemoglobin to methaemoglobin. The amount of nitrites was 0.07 and 0.068 mg/l where nitrate had the values 8.2 and 8.8 mg/l (Table 1) in P_1 and P_2 respectively. NO_2^- content greater than 0.75 mg/l can make a stress and higher than 5 mg/l has a toxic effect on fish. The limiting value of NO_3^- is 80 mg/l (Lenntech).

Iron enhances the bacterial growth in water. The water in P_1 (2.6 mg/l) had greater iron content than P_2 (0.85 mg/l) (Table 1) and excess than tolerable limit of aquatic life. Fe^{2+} get converted to Fe^{3+} at pH >6.5 (> 7 for River Panga). Excess quantity of iron (Fe^{3+}) also has toxic effect on some aquatic organism (Cadmus P et al. 2018) and the tolerable limit is 0.5 mg/l for them.

Arsenic is a toxic pollutant but in present case the value was less than 0.01 mg/l.

Mn also can create some health problems. Panga carried manganese more than its desirable limits (EPA) – 0.34 (P_1) and 0.31 mg/l (P_2) (Table 1). The effect of Mn concentration on aquatic life is Hardness dependent. It is observed that with increasing hardness of water the adverse effect of Mn increased. According to Reimer PS (1988) for aquatic life limit of Mn concentration is 1.3 mg/l at Total- H (150-174 mg/l) and Total- H between (175- 199 mg/l) the threshold value for Mn is 1.4 mg/l. In present case Total- H 176 and 152 mg/l in P_1 and P_2 respectively, hence the tolerance limit would be 1.3 to 1.4 mg/l.

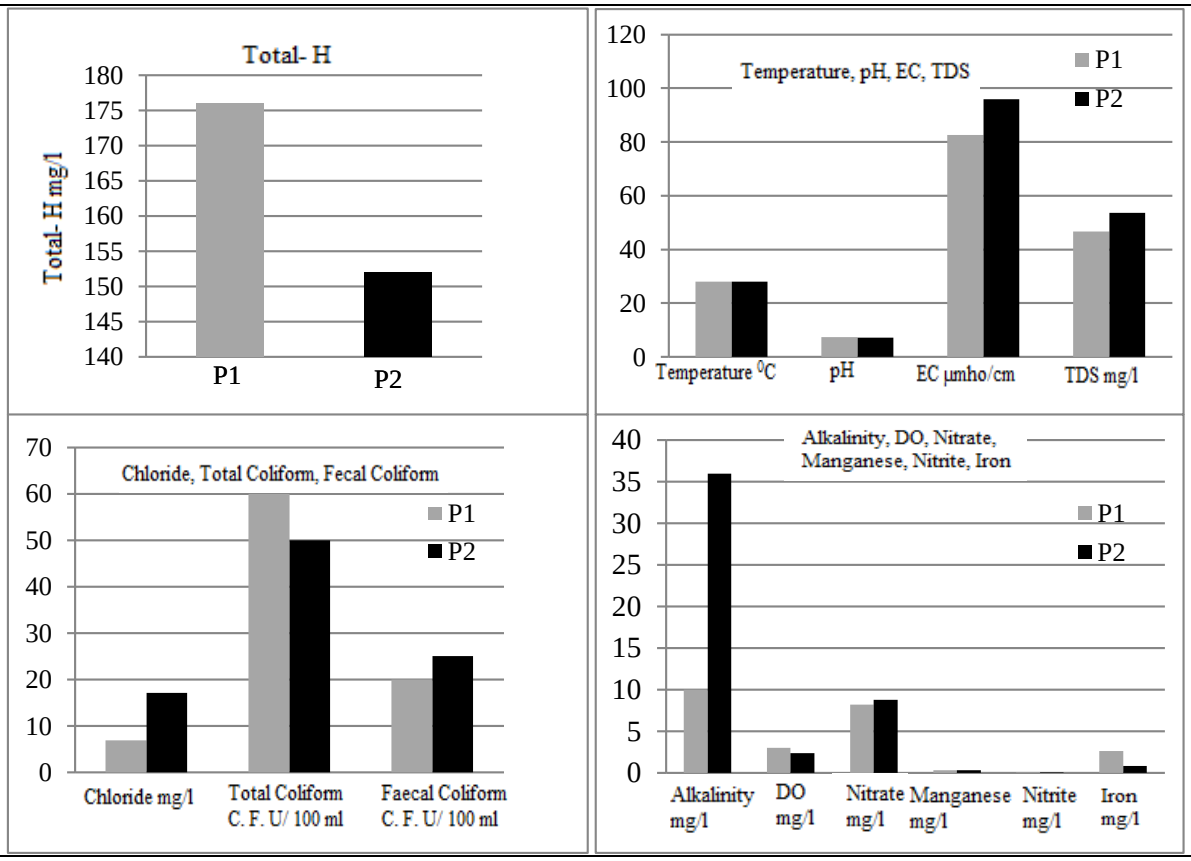
PO_4^{3-} in River Panga was 0.0298 mg /lit in both the two points (Table 1). The amount greater than 0.1 mg/l accelerates plant growth (Oram B).

The River water also had some growth of micro organism which may cause water born diseases. Total Coliform was 60 and 50 C. F. U/ 100 ml; Fecal Coliform was 20 and 25 C. F. U/ 100 ml. in two points P_1 and P_2
(Table 1).

Graph had been plotted in (Fig: 4) to compare the water quality at point P_1 and P_2. It showed that. Total- H and Total coliform had a greater value at point P_1. Most of the other parameters were greater at the incident point (P_2). The DO value at P_1 was greater than P_2 though the difference was very low. The results proved that the water became more degraded at point P_2. The point P_1 was selected near to an Industrial growth as mentioned above. So, there was a possibility of mixing industrial sewage at that point. Probably the depletion of water quality takes place after some distance of contamination point, as the pollutants need some time to be dissolved in the stream and to enter planktonic tissues (Goel A 2008). This fact was well supported by our findings.

The local people complained about a problem that they suffered from skin diseases like itching, rashes on their hands and legs. Probably they are being attacked from skin diseases after some day's exposure to River water. The silt bearing surface runoff, excessive amount of sediments inhibit sunlight to penetrate through water and reduce the photosynthesis of aquatic plants. So the water body faces low production of oxygen which hampers the quality of water. This polluted water can affect to the human health by penetrating through skin (skin diseases) and after consuming of contaminated water and food (Tekile A et al. 2015).

Fig 4: Plot of water quality parameters at P_1 and P_2 for a comparative analysis of water quality at two points



V. Conclusion

The investigation was based on a sudden death of fish species in River Panga due to water Pollution. The analysis established that the water quality of River Panga had some remarkable values regarding DO, Total- H and iron content. The amount of manganese was also beyond the EPA limit. So, from these preliminary observations we can conclude that the extremely low value of DO and hard water of the River created a very critical condition for the survival of aquatic life and mortality of fish species took place. One significant point was that P_2 was more polluted than P_1, though P_1 was nearer to the probable contamination zone. This was because the pollutants need some time to be dissolved in the stream and enter into planktonic tissues. During this period the River flowed downstream from P_1 to P_2 and incident occurred at P_2.

To find out the cause of incident, the preliminary idea said that somehow the water got contaminated by toxin that reduced the DO level very effectively. There is an industrial growth in the vicinity of P_1. So, the possibility of releasing sewage from that area cannot be ignored. Thus, monitoring of some heavy metals is also desirable for the future investigation, as presence of heavy metals in water indicates mixing of industrial effluent.

Suffering from skin diseases among the local people was another important aspect of this study and the problem was area specific. So, longtime thorough examination is needed.

P_2 is a rural area named Chaulhati (Chaul means Rice). Fishing and farming are the main occupation of the poor people of this locality and they also depend on the river water for their household work. The people are less literate and unaware about the effect of pollution. Irrigation using this water is also harmful because toxic substances may accumulate through roots of many plants like paddy and paddy is the main crop of this area. Hence this unpleasant incident may affect the whole habitat adversely and last for a long time as the toxin can enter into the food chain.

Finally, it is true that River Panga is a very small river but its pollution is serious. So, it could be said that surface water is polluted all over the earth even it may be a small stream.

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