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HYDROLOGICAL STUDIES ON BURHI DEHING RIVER IN MARGHERITA SUBDIVISION

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ABSTARCT

Burhi Dehing or Dehing is a large tributary of River Brahmaputra. The river originates in the Eastern Himalayas (the Patkai Mountain Range) in Arunachal Pradesh and flows through Tinsukia (Tinicukeeya) and Dibrugarh Districts in Assam to its confluence with the Brahmaputra at Dihingmukh. Three sampling sites were taken maintaining a distance of 1km from each sampling sites and their physical and chemical parameter analyzed.The Physico-chemical parameters of River Burhi-Margherita subdivision showed variation during the survey period and also fluctuation of all the parameter were seen during the rainy months and dry or less rainy months but although they showed variations they were within the permissible limit of BIS (1982) and WHO (2003).

KEYWORDS: River Burhi Dehing, Physico-Chemical Parameters, Sampling Sites, Variation.

I. INTRODUCTION

North – east India is considered as one of the hot spot of freshwater fish biodiversity of the world (Kottelat and Whitten, 1996) and among the eight states of the north east, Assam has the largest number of fishes with 200 species (Mahanta et al. 2001). A number of workers have studied the fishes of Assam. (Bhattachharjya et al 2001; Biswas and Boruah 2000; Biswas and Boruah 2002).

A suitable environment is necessary for any organism, since life depends upon the continuance of a proper exchange of essential substances and energies between the organism and its surroundings. The study on the physico-chemical analysis of water is of great significance in removing the constraints which impede the production of inland fish. Fish production is closely correlated with the biological production which in turn depends upon the ecological and physico-chemical conditions of water body. Research studies on limnological aspects are of great significance in developing fresh water fisheries (Love, 1974).Aquatic ecosystems are affected by several health stressors that significantly deplete biodiversity. In the future, the loss of biodiversity and its effects are predicted to be greater for aquatic ecosystems than for terrestrial ecosystems (Sala et al., 2000). Rivers are subjected to various natural processes taking place in the environment, such as the hydrological cycle. As a consequence of unprecedented development, human beings are responsible for choking several lakes to death. Storm water runoff and discharge of sewage into rivers are two common ways that various nutrients enter the aquatic ecosystems resulting in the pollution of those systems.

Fish and most aquatic organisms are cold-blooded. Consequently, their metabolism increases as the water warms and decreases as it cools. Each species of aquatic organism has its own optimum (best) water temperature. If the water temperature shifts too far from the optimum, the organism suffers. Fish can regulate their environment somewhat by swimming into water where temperatures are close to their requirements. Fish usually are attracted to warm water during the fall, winter and spring and to cool water in the summer. Fish can sense very slight temperature differences. When temperatures exceed what they prefer by 1-3 ^{o}C, they move elsewhere. Fish migration often is linked to water temperature. In early spring, rising water temperatures may cue fish to migrate to a new location or to begin their spawning runs. The autumn drop in temperature spurs baby marine fish and shrimp to move from their nursery grounds in the estuaries out into the ocean, or into rivers, as the case may be. All sorts of physiological changes take place in aquatic organisms when water temperatures change.

Dissolved oxygen is oxygen that is dissolved in water. It gets there by diffusion from the surrounding air; aeration of water that has tumbled over falls and rapids; and as a waste product of photosynthesis. Fish and aquatic animals cannot split oxygen from water (H_2O) or other oxygen-containing compounds. Only green plants and some bacteria can do that through photosynthesis and similar processes. Virtually all the oxygen we breathe is manufactured by green plants. A total of three-fourths of the earth's oxygen supply is produced by phytoplankton in the oceans. If water is too warm, there may not be enough oxygen in it. When there are too many bacteria or aquatic animal in the area, they may overpopulate, using DO in great amounts.

How much DO an aquatic organism needs depends upon its species, its physical state, water temperature, pollutants present, and more. Consequently, it's impossible to accurately predict minimum DO levels for specific fish and aquatic animals. For example, at 5 ^{o}C (41 ^{o}F), trout use about 50-60 milligrams (mg) of oxygen per hour; at 25 ^{o}C (77 ^{o}F), they may need five or six times that amount. Fish are cold-blooded animals .So they use more oxygen at higher temperatures when their metabolic rate increases.

Carbon dioxide quickly combines in water to form carbonic acid, a weak acid. The presence of carbonic acid in waterways may be good or bad depending on the water's pH and alkalinity. If the water is alkaline (high pH), the carbonic acid will act to neutralize it. But if the water is already quite acid (low pH), the carbonic acid will only make things worse by making it even more acid. Carbon Dioxide is present in water in the form of a dissolved gas. Surface waters normally contain less than 10 ppm free carbon dioxide, while some ground waters may easily exceed that concentration. Aquatic plant life depends upon carbon dioxide and bicarbonates in water for growth. Microscopic plant life suspended in the water, phytoplankton, as well as large rooted plants, utilize carbon dioxide in the photosynthesis of plant materials; starches, sugars, oils, proteins. The carbon in all these materials comes from the carbon dioxide in water. Green plants carry on photosynthesis only in the presence of light. At night, they respire and burn the food they made during the day. Consequently, more oxygen is used and more carbon dioxide enters waterways at night than during the daytime. When carbon dioxide levels are high and oxygen levels are low, fish have trouble respiring (taking up oxygen), and their problems become worse as water temperatures rise. As you can see from the table, even small amounts of carbon dioxide can affect fish.

Alkalinity is a total measure of the substances in water that have "acid-neutralizing" ability. Alkalinity is not a pollutant. It is always confusion between alkalinity and pH but pH measures the strength of an acid or base, alkalinity indicates a solution's power to react with acid and "buffer" its pH — that is, the power to keep its pH from changing. Alkalinity is important for fish and aquatic life because it protects or buffers against pH changes (keeps the pH fairly constant) and makes water less vulnerable to acid rain. The main sources of natural alkalinity are rocks, which contain carbonate, bicarbonate, and hydroxide compounds. Borates, silicates, and phosphates may also contribute to alkalinity.

The concentration of total suspended solids (TSS) is important to both river and lake ecosystems for ecological and water quality reasons. Inorganic suspended solids attenuate light, primarily through the process of scattering. High concentrations of suspended solids degrade optical water quality by reducing water clarity and decreasing light available to support photosynthesis. Suspended solids have been shown to alter predator-prey relationships (for example turbid water might make it difficult for fish to see their prey (e.g., insects)). Suspended solids also influence metabolic activity and provide surface area for the sorption and transport of an array of constituents. Deposited solids alter streambed properties and aquatic habitat for fish, macrophytes, and benthic organisms. Deposited sediment may be available for resuspension and subsequent transport during periods of increased stream discharge Suspended solids in most freshwater systems originate from watershed sources, pollutant point sources, and sediment resuspension.

I. MATERIALS AND METHODS

(a) About the study area:

Dehing or Burhi Dehing is a large tributary of the Brahmaputra in Upper Assam. The river originates in the Eastern Himalayas (the Patkai Mountain Range) in Arunachal Pradesh and flows through Tinsukia (Tinicukeeya) and Dibrugarh Districts in Assam to its confluence with the Brahmaputra at Dihingmukh.

Dehing River flows from almost east to west through the area. It has many tributaries such as Digboi, Tingrai, Tipling, Telpani, Deherang and Sessa in the north bank and Tipam and Disam in the south bank. In addition to the tributaries of the Burhi Dihing, there are three other tributaries of the Disang River (in Sivasagar) namely Gela Disam, Tiolo and Demow. Official reports suggest that Burhi Dehing is the erstwhile of Namphuk River.

The Burhi Dehing drains a basin of 6000 km^2. Within this area there are wide contrasts of relief, slope, lithology, vegetation and land use. The Burhi Dehing drainage basin is situated in the temperate zone. The average annual rainfall varies from 210 cm to 388 cm. Rain with thundershowers start intermittently from March to May. Monsoon with heavy rain starts from June and lasts generally up to September, sometimes stretching up to October.
More than 60 percent of the annual rainfall occurs from May to August; thereafter rainfall declines gradually - not exceeding 10 percent of the annual total in September, 5^0 % in October and 2% in November. The month of July has maximum number of rainy days (a day with at least 0.25 mm rainfall, Jackson, 1972) and December has the minimum. The high level and low lying areas of the plains are exclusively under cultivation of tea and paddy respectively.

(b) Aspects of study and methodology adopted:

The study was conducted by taking 3 Water samples from the Burhi Dehing River from 3 different sites. During the study period, February to May 2013 major physico-chemical parameters of the river was analyzed. Prior to sample collection, all bottles were washed with distilled water and were dried in Hot Air oven. Before taking final water samples, the bottles were rinsed three times with the water to be collected. The sample bottles were labeled with date and sampling source. Methods used in the analysis of the physico -chemical parameters are as follows:

1. Temperature of Air and Water by thermometer (graduated 0^0C to 100^0 C)
2. Alkalinity by titrimetric to $p^h = 4.5$ (methyl orange) method.

The requisites for the test are: - Water sample, 0.02 N H_2SO_4, Methyl Orange, Phenolphthalein.

The procedure involved in the test is: -

(a) 50 ml of water sample is taken in a conical flask.

(b) 2 drops of Phenolphthalein is added. If pink colouration appears, its titrated against 0.02 N H_2SO_4 till colour disappears.

(c) If no pink colour is seen, 2-3 drops of methyl orange is added and titrated against the same titrate till pink colour develops.

(d) The test is repeated for 3 times and the mean value is taken for more accuracy.

The total Alkalinity can be calculated by the following formula:-

Total Alkalinity (mg/ lt) = volume of titrant used × 100 / volume of sample taken

= volume of titrant used × 20.

(4) Free Carbon dioxide :- The Requisites of this test are: Water sample, 0.045 N Na_2CO_3, Phenolphthalein indicator and glasswares. The procedure involved in the test is:

(a) 50 ml of water sample is taken in a conical flask and 2-3 drops of phenolphthalein is added. If colour turned pink, free CO2 is absent. If colourless, CO_2 is present.

(b) It is then titrated against 0.045 N Na_2CO_3 till a light pink colour appears. At the end point, volume of titrant used is noted.

(c)The experiment is repeated 3 times and the mean value is taken for more accuracy. The Free CO_2 can be calculated by the following formula:-

Free CO_2 (mg/lt) = Volume of titrant used × 100 / Volume of sample taken

= Volume of titrant used × 20

(5) Total Hardness by EDTA titrimetric method:-

The Requisites of this experiment are:-Standard EDTA titrant (0.01N), Eriochrome Black-T indicator, Ammonia buffer. The Procedure involved in this test is:

(a) 50 ml of water sample is taken in a conical flask.

(b) 1 ml of ammonia buffer is added followed by 5 drops of Eriochrome Black-T indicator. A wine red colour is seen.

(c) It is then titrated against EDTA solution. The end point is clear blue.

(d) The experiment is repeated 3 times and the mean value is taken for more accuracy.

The Total Hardness can be calculated with the help of the following formula:-

Total Hardness (mg/lt) = ml of titrant used × 1000 / ml of sample taken

= volume of titrant × 20

(6) Dissolved Oxygen by Winkler azide modification titrimetric method:-

The requisites of the this experiment are:-(a) 0.02 N Na_2SO_4 soln. (b) Alkaline KI (c) $MnSO_4$, Starch soln. (d) Burette, Pipette, Conical flask, Measuring Cylinder, BOD bottles.

The Procedure involved in this test is:-

(a) Water sample is collected in 125 ml BOD bottle without air bubbles.

(b) Then 1 ml $MnSO_4$ is added followed by 1 ml alkaline KI. It is then shaked well. It leads to formation of precipitate.

(c) The Precipitate is allowed to settle for 10 mins.

(d) After that 1 ml of conc. H_2SO_4 is added and the precipitate is dissolved by shaking. Brown soln. is formed.

(e) 25 ml of the above solution is taken in a conical flask and 2-3 drops of starch soln. is added and the solution develops a blue colour.

(f) This solution is then titrated against 0.025 $Na_2S_2O_3$ till it becomes colourless and the volume of titrant used is noted.

(g) The experiment is repeated 3 times for every sample.

The amount of DO_2 can be calculated with the help of the following formula:-

O_2 in mg/lt = 8×1000×N (0.025) ×Volume of titrant / Volume of sample titrated

= 8× Volume of titrant

(7) Total Dissolved Solid (TDS) by Digital or Portable TDS meter (H.N makers)

(8) p^h by Digital or Portable pH meter (Hanna Makers).

II. RESULTS

The values of the various physico -chemical parameters of Burhi Dehing river are tabulated in Table 1 and the salient features of the findings are summarized below :-

Table 1: Physico-chemical Parameters of River Burhi Dehing

Parameters	February			March			April			May		
	Site 1	Site II	Site III	Site I	Site II	Site III	Site I	Site II	Site III	Site I	Site II	Site III
Air Temperature (^{0}C)	20.6	20.3	20.4	21.6	21.5	21.9	23.1	23.2	23.4	26.1	26.2	26.4
Water Temperature (^{0}C)	19.2	19.4	19.7	20.1	20.3	20.4	21.6	21.9	21.7	23.4	23.5	23.3
T.D.S (mg/l)	65	66.2	68.9	77	74	76.3	91	98	97	63	70	61
DO_2 (mg/l)	5.7	5.92	5.36	6.06	6.4	6.7	6.96	7.2	7.4	5.5	5.9	5.7
Free CO_2 (mg/l)	1.2	1.32	1.41	1.2	0.8	1.46	1.9	2.1	1.72	2.6	2.7	2.2
Alkalinity (mg/l)	63.4	66.9	65.3	59.6	61.2	60.7	55.2	59.21	56.5	59.1	63.2	62.4
Total Hardness (mg/l)	67.2	65.2	69	78	79	78	69	66	70	50	51.4	55.2
pH	7.4	7.2	7.1	7.3	7.3	7.4	7.1	7.4	7.4	7.4	7.1	7.4

III. DISCUSSION

The water temperature is a major factor in determining the laying, hatching, feeding, growth, and survival of all fish. The water temperature of a river is very important for water quality. As water temperature rises, the rate of photosynthesis and plant growth also increases. More plants grow and die. As plants die, they are decomposed by bacteria that consume oxygen. Therefore, when the rate of photosynthesis is increased, the need for oxygen in the water (BOD) is also increased. The metabolic rate of organisms also rises with increasing water temperatures, resulting in even greater oxygen demand.

Temperature has profound effects on the chemistry and biochemical reactions in the organisms present in the water. The atmospheric temperature recorded during the month of February showed minimum temperature during the month of February (20.3 ^{0}C in Site II) which gradually increased in April (23.4^{0}C in Site III) and further increased at the early part of May (Fig 1). Similarly, the water temperature (Fig 2) varied from 19.2^{0}C in Site I (February) to 23.5^{0}C in Site II (May). The lowest water temperature was recorded in February (19.2^{0}C) and the highest was recorded in May (23.5^{0}C).

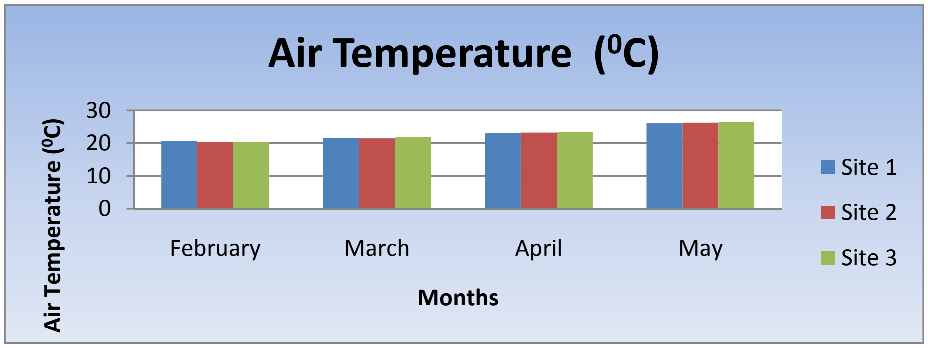

Fig 1: - Monthly variation of Air Temperature in three different sites

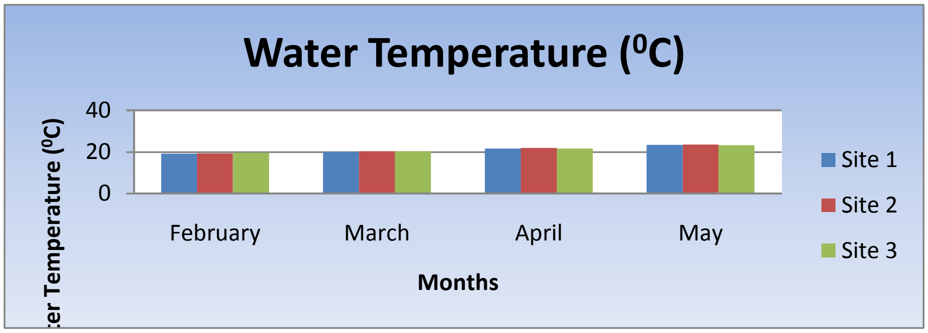

Fig 2: - Monthly variation of Water Temperature in three different sites

Gradient in water temperature is closely associated with ambient temperature (Munawar, 1970) and it is one of the most important factor on the maturity, spawning period and the development of fish (Bhatt et al., 1984). Among the ecological factors, temperature is considered as an important factor that controls the spawning of fishes. Water temperature is one of the important physical parameter that controls the various physiological activities of aquatic biota, Ojha (2002). Dissolved oxygen is essential for metabolism of aquatic animals having aerobic respiration (Wetzel, 1975). Dissolved oxygen is a critical water quality parameter for characterizing the health of an aquatic ecosystem and reflects the physical, chemical and biological processes prevailing in water.

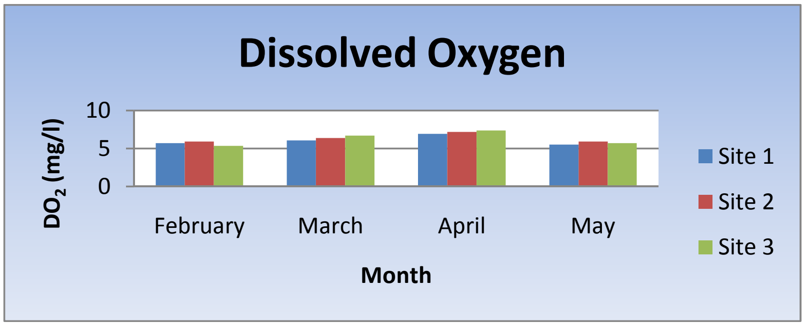

Fig 4: - Monthly variation of D.O. in three different sites

In the present study, the dissolved oxygen content was recorded to be highest in March and the lowest content of DO was recorded in May (Fig 4). Average dissolved oxygen was well within 6.34 mg/l; as such the river water may be regarded as well supplemented with oxygen. Dissolved oxygen is related to temperature and dissolved oxygen decreases with rising temperature, indicating that cold water may retain high dissolved oxygen as compared to warm water Data recorded from the survey reveals that DO concentration was within the recommended standard (WHO, 2003). The present findings (DO value) is well beyond the 8mg/l standard, indicating that the river is not polluted and it also suggest that the river water is favorable for the survival and growth of the aquatic organisms living in the habitat.

Carbon dioxide quickly combines in water to form carbonic acid, a weak acid. The presence of carbonic acid in waterways may be good or bad depending on the water's pH and alkalinity. If the water is alkaline, the carbonic acid present will be useful to neutralize the high pH of water. But if the water is already acidic (low pH), the carbonic acid will only make things worse by making it even more acidic.

The data found after performing experiment to the water sample showed that the free CO_2 value varied from **0.8 mg/l** to **2.7 mg/l** (Fig 5). The highest free CO_2 content was found in **May** and the lowest was recorded in **February** in majority of observations. From February to May the free CO_2 content was almost constant. The variation in CO_2 was due to absorption by plants for photosynthesis and due to the activity of other living organisms. The variation in CO_2 was due to absorption by plants for photosynthesis and due to the activity of other living organisms.

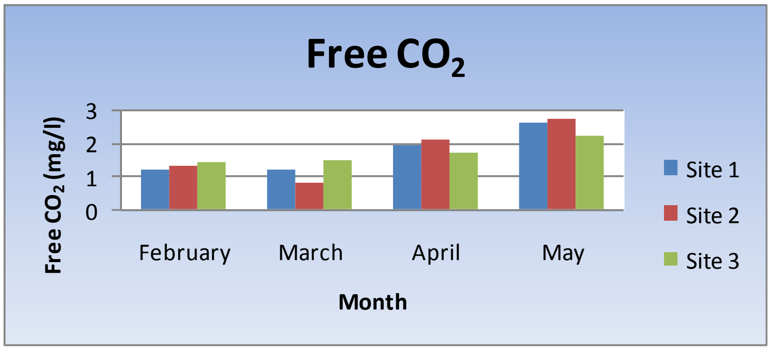

Fig 5: - Monthly variation of Free CO_2 in three different sites

When several days of heavy cloud cover occur, plants' ability to photosynthesize is reduced. When that happens in a pond containing lots of plant life, fish can be hurt in two ways: by low dissolved oxygen and by high carbon dioxide levels. Free CO_2 may be lost in atmosphere if the water is agitated (Welch, 1952).

Alkalinity is a total measure of the substances in water that have "acid-neutralizing" ability. Alkalinity, mainly results from CO_2 and water dissolving out some of the carbonate to form bicarbonate solution. Thus alkalinity is expressed in terms of bicarbonate or carbonate and there is good relationship between free CO_2, carbonate, bicarbonate and total alkalinity. The variation in alkalinity is mainly due to rain, change in photosynthesis of aquatic plants etc.

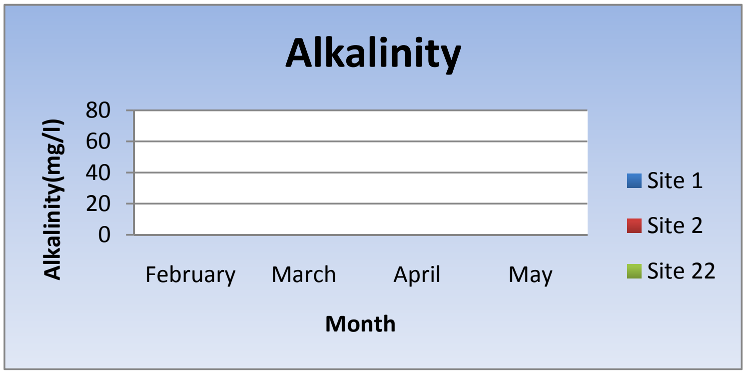

Fig 6: Monthly variation of Alkalinity in three different sites

Total alkalinity of the water ranged between 55.2 mg/l to 66.9 mg/l (Fig 6). The highest alkalinity was recorded in the month of February and the lowest was recorded in April in the majority of observations. Alkalinity showed variation during the survey period, it showed highest during the non- rainy months and gradually lowered during the rainy months. Fresh water having total alkalinity of 40 mg/l or more is considered productive (Moyle, 1946). Klein (1959) suggested that the alkalinity is related to abundance of phytoplankton which dissociates bicarbonates into carbonates and CO_2. Data recorded from the experiment showed that there was fluctuation of alkalinity during the whole survey period. Alkalinity may be due to the waste discharge from the nearby garden.

Hardness or Hard water is water that has high mineral content in contrast with soft water. Hard water has high concentrations of Ca^{2+} and Mg^{2+} ions. Different species of fish have varied water hardness requirements, so it is important to find out what hardness is best for fish. Water hardness affects fish health because it influences osmoregulation. Being open systems, fish are affected by the makeup of the surrounding water. The maximum hardness for many pond fish is between 100 – 300 m g/liter $CaCO_3$.

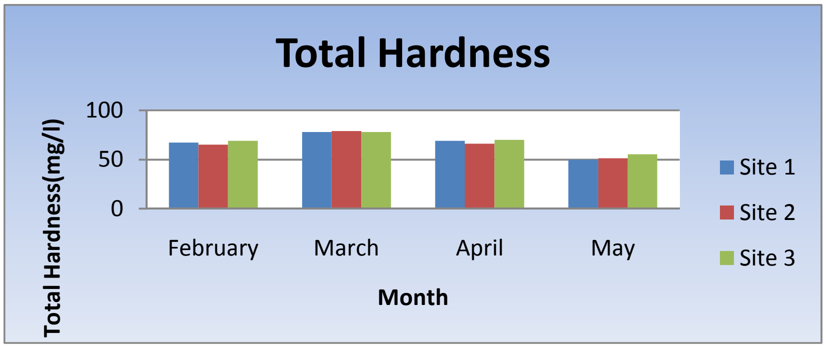

Fig 7: - Monthly variation of Total Hardness in three different sites

Hardness of water was found to be between 50 mg/l and 79 mg/l (Fig 7). Water having 0-75mg CaCO3 L^-1 is considered as soft, 75-150mg CaCO3 L^{-1}as hard, while samples having total hardness of over 300mg CaCO3 L^{-1} is hard. The water samples used in the study showed that total hardness in the range from 50 to 79 $CaCO_3$ mg/l. Manivasakam (1985) assign hardness towards containing >75mg/l of $CaCO_3$ equivalent to Ca and Mg. Evaporation rate is higher in summer and allochthonous sources of hardness influencing chemical in flowing water in rainy season might probably have caused for higher values for total hardness (Bijen, 2005).

Total Dissolved Solids often abbreviated TDS basically refers to all the inorganic and organic substances contained in a liquid in: molecular, ionized or micro-granular (colloidal solution) suspended form. Generally the operational definition is that the solids must be small enough to survive filtration through a sieve the size of two micrometer. Although TDS is not generally considered a primary it is used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of the presence of a broad array of chemical contaminant.

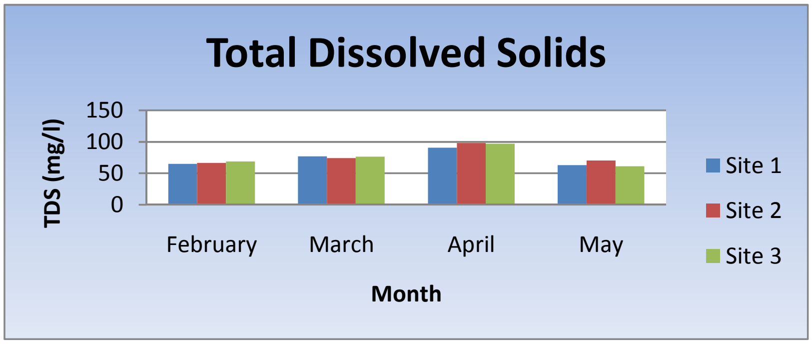

Fig 8:- Monthly variation of Total Dissolved Solids in three different sites

Primary sources for TDS in receiving waters are agricultural and residential runoff, leaching of soil contamination and point source water pollution discharge from industrial or sewage treatment plants. The most common chemical constituents are calcium, phosphates, nitrates, sodium, potassium and chloride, which are found in nutrient runoff, general storm water runoff and runoff from snowy climates where road de-icing salts are applied. The chemicals may be cations, anions, molecules or agglomerations on the order of one thousand or fewer molecules, so long as a soluble micro-granule is formed. More exotic and harmful elements of TDS are pesticides arising from surface runoff. Certain naturally occurring total dissolved solids arise from the weathering and dissolution of rocks and soils. High TDS levels generally indicate hard water. Most aquatic ecosystems involving mixed fish fauna can tolerate TDS levels of 1000 mg/l.

The total dissolved solids were found to be in the range between **61 mg/l and 98 mg/l** (Fig 8**)**. The highest TDS was found in April and the lowest in May in majority of the observations. The values found for TDS were found to be under the permissible limits of (BIS 1982). The minimum value in February may be due to the stagnant like water condition of the water body. The rate was high in May due to heavy rains that occurred during March and May.

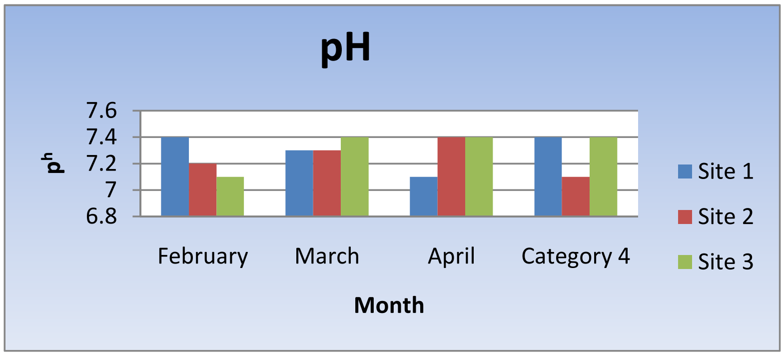

Fig 9:- Monthly variation of pH in three different sites

p^H is the negative logarithm of hydroxyl ions. p^H can be determined with the help of the formula, ph = - log [H^+]. The range of pH ranges from 0-14.Water can be Acidic, Neutral and Basic or Alkaline. If the value of p^H ranges from 0.1-6.9, the water will be acidic in nature. If the pH value is equal to 7, water is neutral in nature. If the value of p^h ranges from 7.1-14, the water will be basic or alkaline in nature.

After the study it can be concluded that the value of p^h ranges between 7.1- 7.4.The value of pH is almost found to remain constant in the entire study from February to May. The variation was observed to be very minimum. Thus the water is slightly alkaline in nature. The acidic water contains more [H^+] ions while the water which is basic or alkaline in nature contains more of [OH^-] ions. Since the nature of the river water was observed to be alkaline or basic in nature so it contains more of [OH^-] ions compared to [H^+] ions. If the nature of the water is found to be more acidic, it is not suitable for the growth and development of the living biota. The water turns toxic due to acidic nature. While slightly alkaline nature of the river water can support the growth and development of the different fresh water biota.

IV. CONCLUSION

Dehing or Burhi Dehing is a large tributary of the Brahmaputra in Upper Assam. The river originates in the Eastern Himalayas (the Patkai Mountain Range) in Arunachal Pradesh and flows through Tinsukia (Tinicukeeya) and Dibrugarh Districts in Assam to its confluence with the Brahmaputra at Dihingmukh. It is one of the important rivers passing through Dibrugarh. Many people's livelihood is dependent on this river not only for the fish but also for many purposes commercially and domestically. Three sampling sites were taken maintaining a distance of 1km from each sampling sites and their physical and chemical parameter analyzed. Physical parameter reading was taken either manually or through electronic devices and for chemical parameter waters were collected from the sampling sites and taken to the laboratory for chemical analysis. From the above findings it was concluded that all the physical and chemical parameter showed variation during the survey period and also fluctuation of all the parameter were seen during the rainy months and dry or less rainy months but although they showed variations they were within the permissible limit of BIS (1982) and WHO (2003).

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