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Environmental Impact Assessment of Water Quality of Major Ponds of Raipur City

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Abstract

India is rich in water resources, being endowed with a network of rivers and blessed with snow cover in the Himalayan range that can meet a variety of water requirements of the country. However, with the rapid increase in the population of the country and the need to meet the increasing demands of irrigation, human and industrial consumption, the available water resources in many parts of the country are getting depleted and the water quality has deteriorated. Indian rivers are polluted due to the discharge of untreated sewage and industrial effluents. Specially the New born state Chhattisgarh is famous for ponds. The key population of state is basically live on the water of river and ponds. The Capital of this state, Raipur city is also rich in ponds and people are using it extensively. A question arises that can this easily available water in ponds, be useful for domestic as well as drinking purpose? To find out the fact the present study had been conducted for four major ponds at six usable places and water samples were tested for seven vital parameters viz. Turbidity , pH ,Hardness ,Chloride, DO (Dissolved Oxygen), BOD(Biological Oxygen Demand) & COD (Chemical Oxygen Demand).Four Major Ponds of Raipur City namely : Budha Pond, Kankali Pond, Bhaiya Pond, Maharajabandha Pond were taken for the study.

The study results of all the Pond samples (3 samples taken at each place) were analysed which indicated that the quality of water of Budha Pond satisfies the water quality IS specifications. So the quality of water was found to be better than all remaining Ponds. But at one place in Budha Pond, the water was more turbid and same thing happened in Kankali Pond at two places. In Bhaiya Pond and Maharajabandha Pond at one place maximum turbidity was reported as much as 11.2 NTU (Nephelometric Turbidity Units). Observations also revealed that in Budha Pond at one place the pH was found to be 9.4, as found in Kankali Pond, Bhaiya Pond & Maharajbandha Pond at one place showing that water at above all places was reported to be slightly alkaline in nature. On the other hand at the different places in the Ponds, hardness crossed the permissible limit. The maximum hardness was reported as 920 mg/l. DO (Dissolved Oxygen) content at certain places is beyond the permissible limit. The maximum DO was reported as 10.2 mg/l. Chloride, BOD & COD contents in all the Ponds satisfies the permissible limit so the water is recommended to be used for industrial & domestic use except for some places. Thus in a nut shell the Pond water requires treatment to make it available to the general public for Domestic as well as Drinking purposes and making it also hygienic.

Keywords: Water Quality, Ponds, Turbidity, pH, Hardness, Chloride, DO, BOD, COD

1.Introduction

Chhattishgarh is the newly born state and the city of Raipur is its Capital. Sudden change in the status of Raipur city was observed in the field of construction as well as Industrial activities at the

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sudden augmentation in population . To accommodate and fulfill the present and future water demands it is essential to save and to utilize to its optimum the available raw water. Raipur city is also rich in ponds and people are using it extensively. The available raw water should be treated and purified before they can be supplied to the general public for their domestic, industrial or any other uses. The extent of treatment required to be given to water, depends upon the characteristic and quality of the available water, and also upon the quality requirements of the intended use. In general, the public water supplies are mainly designed from the view points of the quality requirements of drinking water, and simultaneously they should be made reasonably suitable for industrial purposes like stem generation, dyeing, brewing, etc.

The available water must, therefore, be made safe, good in appearance, and attractive to human taste and tongue. Various methods which are used to make the water safe and attractive to the consumers are described below. However, the methods adopted for purification depend mostly upon the character of the raw water. This is a composite of a series of articles dealing with the chemical makeup of pond water as to how to measure what is in it, what is good, what is bad, and what to do about it. Partial determination of the quality of this liquid environment can be made through chemical measurements.. Most often, the type of water being tested determines what parameters, or analytes, the analyst looks for. For example, chlorine is an important parameter in finished drinking water, but is not usually a factor in natural water. This section lists common water quality parameters important in drinking water, wastewater, and natural water. Many parameter listings include descriptions of the effects of analyte levels on living organisms.

Water quality includes physical, chemical & biological factors that influence the beneficial use of water Unfortunately, ponds have never been tested and water quality problems are usually only detected after they cause a problem. This fact sheet discusses some common water quality parameters that may cause problems in ponds and how to detect and treat them to make the water available to the human population. Concerns about pond water quality are directly related to the use(s) of the pond. For example, a pond used to supply drinking water for animals should be tested for different parameters than a pond used exclusively for fishing.

Pond Use	Important Water Quality Parameters
Animal drinking water	Bacteria, pH, metals, nitrate, blue-green algae, pesticides
Swimming	Bacteria, turbidity, parasites
Fishing	Temperature, dissolved oxygen, pH, pesticides
Irrigation	Aquatic herbicides, pH, metals
Aesthetic beauty	Turbidity

Various tests which needed to be carried out and their significance is again described in the following texts.

2. Test on Collected Samples

2.1 pH Test

The pH value of water indicates the logarithm of reciprocal of hydrogen ion concentration present in water. It is thus an indicator of the acidity or the alkalinity of water. pH measures the relative acidity of the water. A pH level of 7.0 is considered neutral. Pure water has a pH of 7.0. Water with a pH level less than 7.0 is considered to be acidic. The lower value of pH indicates the more acidic water. Water with a pH greater than 7.0 is considered to be basic or alkaline. The greater value of pH indicates greater alkalinity. The pH of natural potable water

should be between 6.5 and 8.5. Fresh water sources with a pH below 5.0 or above 9.5 may not be able to sustain plant or animal species.
Industries and motor vehicles emit nitrogen oxides and sulfur oxides into the environment. When these emissions combine with water vapor in the atmosphere, they form acids. These acids accumulate in the clouds and fall to earth as acid rain or acid snow. Acid rain damages trees, crops, and buildings. It can make lakes and rivers so acidic that fish and other aquatic organisms cannot survive. Thus ph test help to indicate how safe is the water to be used.

2.2 Hardness Test

Water hardness was understood to be a measure of the capacity of water to precipitate soap. Soap is precipitated chiefly by the calcium and magnesium ions, present. Other polyvalent captions may also precipitate soap. In conformity with the current practice, total hardness is defined as the sum of the calcium and magnesium concentrations, both expressed as calcium carbonate, in milligrams per litre.

The determination of water hardness is a useful test that provides a measure of quality of water for households and industrial uses. Originally, water hardness was defined as the measure of the capacity of the water to precipitate soap. Hard water is not a health hazard. People regularly take calcium supplements. Drinking hard water contributes a small amount of calcium and magnesium toward the total human dietary needs of calcium and magnesium. The National Academy of Science states that consuming extremely hard water could be a major contributor of calcium and magnesium to the diet. Hard water does cause soap scum, clog pipes and clog boilers.
Soap scum is formed when the calcium ion binds with the soap. This causes an insoluble compound that precipitates to form the scum you see. Soap actually softens hard water by removing the Ca2+ ions from the water.
When hard water is heated, CaCO3 precipitates out; this then clogs pipes and industrial boilers. This leads to malfunction or damage and is expensive to remove.

2.3 Turbidity test

Turbidity refers to how clear or how cloudy the water is. Clear water has a low turbidity level and cloudy or muddy water has a high turbidity level. High levels of turbidity can be caused by suspended particles in the water such as soil, sediments, sewage, and plankton. Soil can get in the water by erosion or runoff from nearby lands. Sediments can be stirred up by too much activity in the water, either by fish or humans. Sewage is a result of waste discharge and high levels of plankton may be due to excessive nutrients in the water. If the turbidity of the water is high, there will be many suspended particles in it. These solid particles will block sunlight and prevent aquatic plants from getting the sunlight they need for photosynthesis. The plants will produce less oxygen thereby decreasing the Dissolved Oxygen (DO) levels. The plants will die more easily and be decomposed by bacteria in the water, which will reduce the DO levels even further. Suspended particles in the water also absorb additional heat from sunlight which will result in warmer water (see temperature). Warm water is not able to hold as much oxygen as cold water so DO levels will decrease, especially near the surface. Suspended particles are also destructive to many aquatic organisms such as macro invertebrates found in water. They can clog the gills of fishes and interfere with their ability to find food. They can also bury bottom dwelling creatures and eggs. Suspended particles can transport pollutants through the water.

2.4 Chloride content Test

Chloride are generally present in water in the form of sodium chloride and may be due to: leaching of marine sedimentary deposits, pollution from sea water , brine or industrial and domestic wastes, etc .Their concentration above 250 mg/l produce a noticeable salty taste in drinking water and are thus objectionable. Chlorides are found to occur in all the natural waters, & their quantity may vary widely, depending upon various factors. For example, upstream hilly reaches of rivers may have lesser chlorides while the downstream reaches may have more chlorides. Chlorides in reasonable concentrations are not harmful to humans. At concentration above 250mg/l, they give a salty taste to the water, which is objectionable to many people. For this reason, chlorides are generally limited to 250mg/l in supplies intended for public use. The chloride content of water to be used for irrigation is generally controlled along with the total salinity of the water. Salt sensitive crops may usually require water having chloride concentration as given for the drinking water standards. The sudden increase of chloride in waters having low chlorides is also an indication of organic pollution. Before, the development of bacteriological procedures, chemical tests for chlorides and nitrogen (in its various forms) were largely used to detect contamination of ground waters, however, this use of chloride testing has now a days been replaced by the more sensitive bacteriological tests.

2.5 Dissolved Oxygen (DO) Test

Dissolved oxygen (DO) is the amount of oxygen that is dissolved in water and is essential to healthy streams and lakes. The dissolved oxygen level can be an indication of how polluted the water is and how well the water can support aquatic plant and animal life. Generally, a higher dissolved oxygen level indicates better water quality. If dissolved oxygen levels are too low, some fish and other organisms may not be able to survive (see macro invertebrates). Much of the dissolved oxygen in water comes from oxygen in the air that has dissolved in the water. Some of the dissolved oxygen in the water is a result of photosynthesis of aquatic plants. Other factors also affect DO levels such as on sunny days high DO levels occur in areas of dense algae or plants due to photosynthesis. Stream turbulence may also increase DO levels because air is trapped under rapidly moving water and the oxygen from the air will dissolve in the water.

In addition, the amount of oxygen that can dissolve in water (DO) depends on temperature. Colder water can hold more oxygen in it than warmer water. A difference in DO levels may be detected at the test site if tested early in the morning when the water is cool and then later in the afternoon on a sunny day when the water temperature has risen. A difference in DO levels may also be seen between winter water temperatures and summer water temperatures. Similarly, a difference in DO levels may be apparent at different depths of the water if there is a significant change in water temperature.

Dissolved oxygen levels typically can vary from 0 - 18 parts per million (ppm) although most rivers and streams require a minimum of 5 - 6 ppm to support a diverse aquatic life. Additionally, DO levels are sometimes given in terms of Percent Saturation.

2.6 Biological Oxygen Demand (BOD) Test

Micro-organisms such as bacteria are responsible for decomposing organic waste. When organic matter such as dead plants, leaves, grass clippings, manure, sewage, or even food waste is present in a water supply, the bacteria will begin the process of breaking down this waste. When this happens, much of the available dissolved oxygen is consumed by aerobic bacteria, robbing other aquatic organisms of the oxygen they need to live.

Biological Oxygen Demand (BOD) is a measure of the oxygen used by microorganisms to decompose this waste. If there is a large quantity of organic waste in the water supply, there will also be a lot of bacteria present working to decompose this waste. In this case, the demand for oxygen will be high (due to all the bacteria) so the BOD level will be high. As the waste is consumed or dispersed through the water, BOD levels will begin to decline.

Nitrates and phosphates in a body of water can contribute to high BOD levels. Nitrates and phosphates are plant nutrients and can cause plant life and algae to grow quickly. When plants grow quickly, they also die quickly. This contributes to the organic waste in the water, which is then decomposed by bacteria. This results in a high BOD level. The temperature of the water can also contribute to high BOD levels. For example, warmer water usually will have a higher BOD level than colder water. As water temperature increases, the rate of photosynthesis by algae and other plant life in the water also increases. When this happens, plants grow faster and also die faster. When the plants die, they fall to the bottom where they are decomposed by bacteria. The bacteria requires oxygen for this process so the BOD is high at this location. Therefore, increased water temperatures will speed up bacterial decomposition and result in higher BOD levels.

When BOD levels are high, dissolved oxygen (DO) levels decrease because the oxygen that is available in the water is being consumed by the bacteria. Since less dissolved oxygen is available in the water, fish and other aquatic organisms may not survive.

2.7 Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) is defined as the quantity of a specified oxidant that reacts with a sample under controlled conditions. The quantity of oxidant consumed is expressed in terms of its oxygen equivalence. COD is expressed in mg/L O2.
Chemical oxygen demand (COD) is a measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite. COD measurements are commonly made on samples of waste waters or of natural waters contaminated by domestic or industrial wastes. Chemical oxygen demand is measured as a standardized laboratory in which a closed water sample is incubated with a strong chemical oxidant under specific conditions of temperature and for a particular period of time. A commonly used oxidant in COD is potassium dichromate ($K_2Cr_2O_7$) which is used in combination with boiling sulfuric acid (H_2SO_4). Because this chemical oxidant is not specific to oxygen-consuming chemicals that are organic or inorganic, both of these sources of oxygen demand are measured in a COD. The significance of COD is,
Measures pollution potential of organic matter
Organic matter + oxidant $\Rightarrow CO_2 + H_2O$
Decomposable organic matter results in consumption of DO in the receiving Streams
Chemical oxygen demand is related to biochemical oxygen demand (BOD), another standard test for assuring the oxygen-demanding strength of waste waters. However, biochemical oxygen demand only measures the amount of oxygen consumed by microbial oxidation and is most relevant to waters rich in organic matter. It is important to understand that COD and BOD, do not necessarily measure the same types of oxygen consumption. For example, COD does not measure the oxygen-consuming potential associated with certain dissolved organic compounds such as acetate. However, acetate can be metabolized by microorganisms and would therefore be detected in an assay of BOD. In contrast, the oxygen-consuming potential of cellulose is not measured during a short-term BOD assay, but it is measured during a COD test.

3. Observations

The observations for different water samples are tabulated below: Name of Ponds at Raipur considered for analysis were: 1.Budha Pond (B1-B6), 2.Kankali Pond (K1-K6) 3. Bhaiya Pond (T1-T6), 4.Maharajbandha Pond (M1-M6)

Table No. 3.1 Collection of Samples at Different Location of Ponds Observations

S.N.	Sample No.	Turbidity (NTU)	pH	Hardness (mg/l)	Chlorine (mg/l)	DO (mg/l)	BOD	COD
Drinking Water….. IS:10500-1991		5-10	6.5-8.5	300-600	0.2-0.5	4-8	NIL	NIL
1	B-1	6.00	8.20	520	0.24	6.50	NIL	NIL
2	B-2	11.20	9.40	740	0.26	10.20	Traces	Traces
3	B-3	6.22	8.25	510	0.25	6.40	Nil	Nil
4	B-4	5.00	7.20	400	0.22	4.20	Nil	Nil
5	B-5	9.80	8.60	800	0.15	8.20	NIL	NIL
6	B-6	5.20	7.00	410	0.21	4.20	NIL	NIL
7	K-1	10.80	9.20	840	Traces	9.20	Traces	Traces
8	K-2	6.20	8.40	530	0.25	6.20	Nil	Nil
9	K-3	10.90	9.00	920	Traces	8.80	Traces	Traces
10	K-4	9.70	8.80	820	0.16	8.40	NIL	NIL
11	K-5	9.80	8.70	830	0.18	8.60	NIL	NIL
12	K-6	9.60	8.50	810	0.17	8.50	NIL	NIL
13	T-1	6.00	8.25	580	0.26	6.60	NIL	NIL
14	T-2	6.30	8.20	540	0.25	6.40	NIL	NIL
15	T-3	7.25	8.55	610	Traces	7.80	NIL	NIL
16	T-4	9.85	9.00	750	Traces	7.90	NIL	NIL
17	T-5	8.50	7.80	545	0.22	7.85	NIL	NIL
18	T-6	10.80	9.20	745	0.27	8.50	Traces	Traces
19	M-1	8.60	7.70	540	0.24	7.35	NIL	NIL
20	M-2	11.20	9.00	865	0.45	9.40	Traces	Traces
21	M-3	8.70	7.50	540	o.25	7.85	NIL	NIL
22	M-4	8.90	7.90	640	o.35	8.42	NIL	NIL
23	M-5	5.20	7.00	350	0.21	4.30	NIL	NIL
24	M-6	9.80	8.80	760	0.10	8.65	NIL	NIL

4. Results

At six places in four ponds of Raipur city, six different water samples were collected for water quality analysis and represented in graphical form. The result of analysis depicted as per Indian Standard– Specifications (IS 10500: 1991) for Drinking Water/ Domestic use were as below:

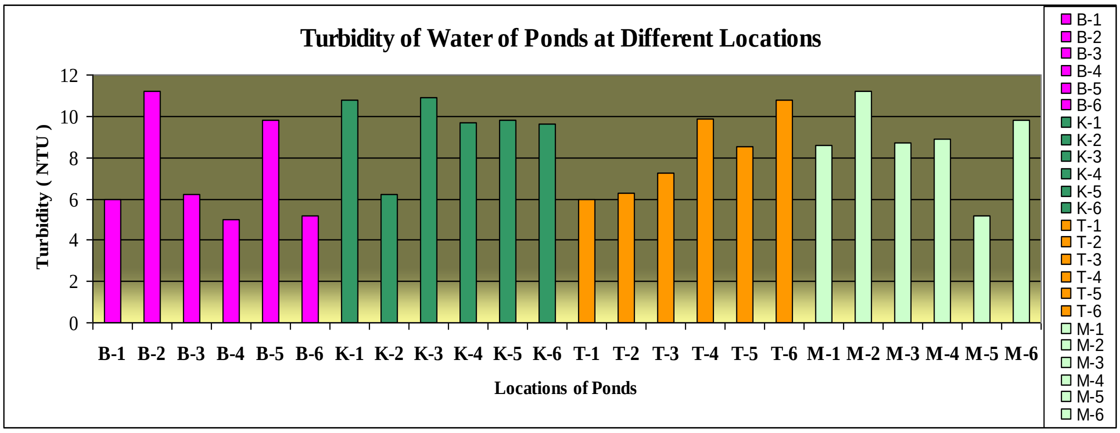

Figure 1: **Turbidity of Water of Ponds at Different Locations**

- Turbidity at different locations found, as shown in Figure 1 ie. at Budha Pond – B-2, Kankali Pond K-1 & K-3, Bhaiya Pond T-6 and Maharajbandha Pond M-2, to be beyond the permissible limit as per IS Specifications .

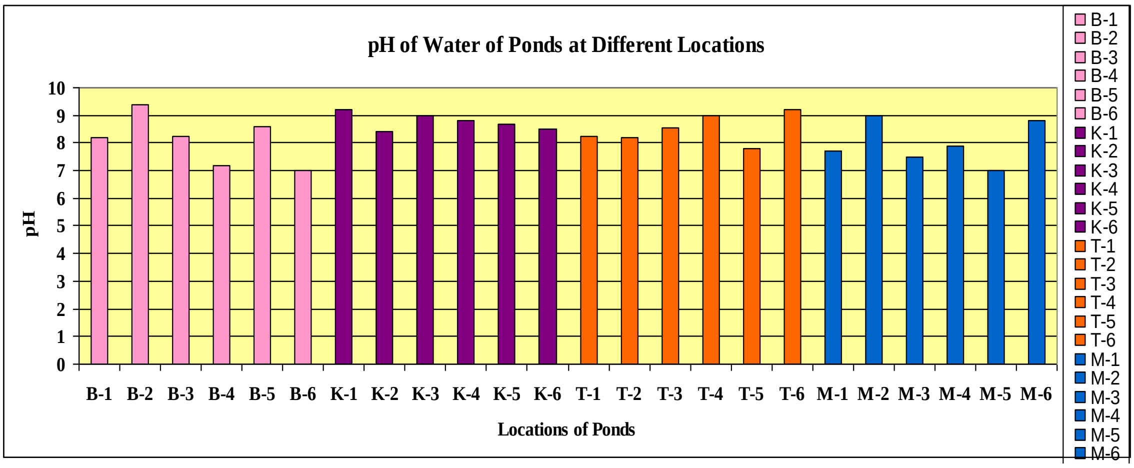

Figure 2:**pH of Water of Ponds at Different Locations**

- pH at different locations found as shown in Figure 2 ie. at Budha Pond – B-2,B-5,B-6, Kankali Pond K-1,K-3,K-4,K-5,K-6, Bhaiya Pond T-3,T-4,T-6 and Maharajbandha Pond M-2& M-6, to be beyond the permissible limit as per IS Specifications .

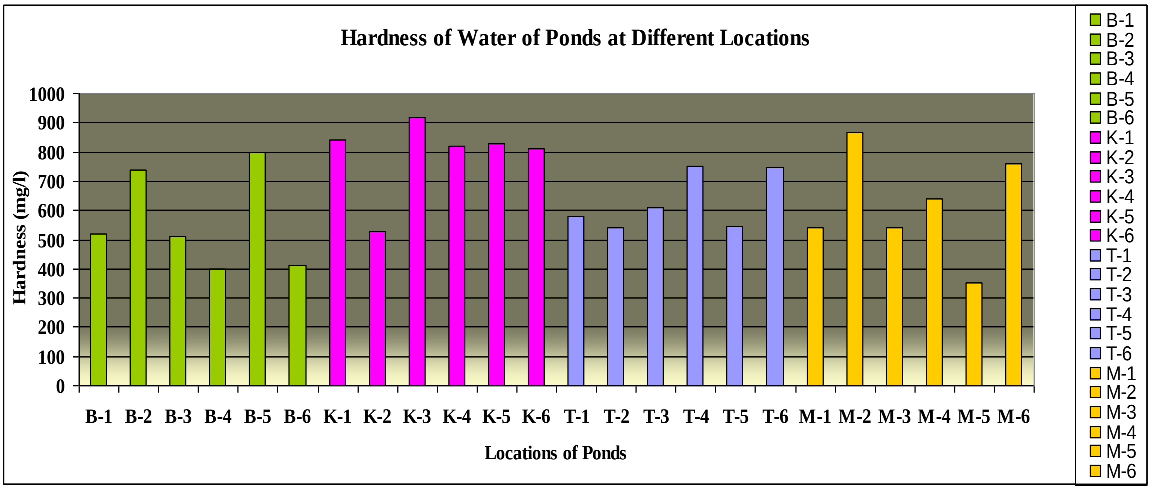

Figure 3: **Hardness of Water of Ponds at Different Locations**

- Hardness at different locations found as shown in Figure 3 ie. at Budha Pond – B-2,B-5 Kankali Pond K-1,K-3,K-4,K-5,K-6, Bhaiya Pond T-3,T-4, T-6 and Maharajbandha Pond M-2,M-4,M-6, to be beyond the permissible limit as per IS Specifications
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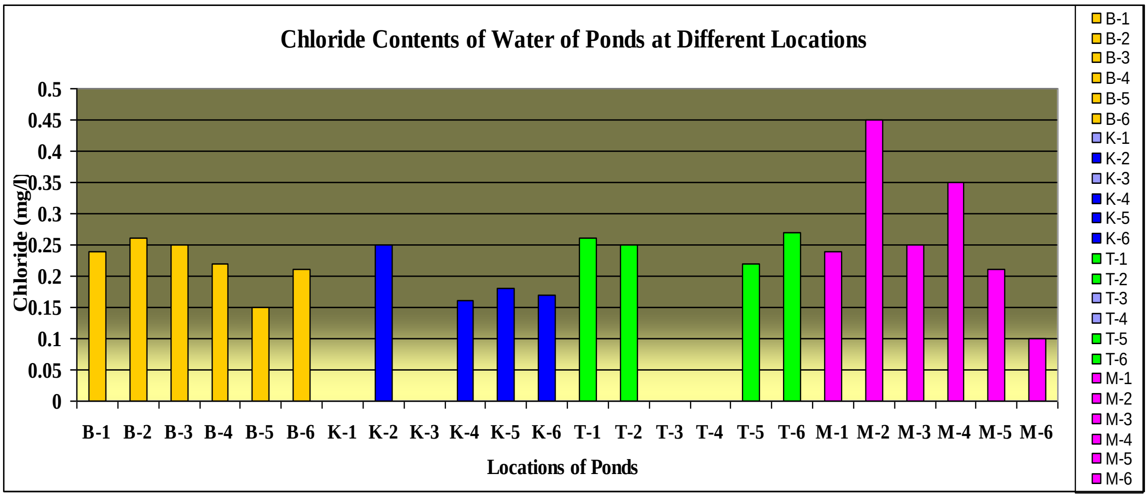

Figure 4: **Chloride Contents of Water of Ponds at Different Locations**

- Chloride Contents at different locations found to be in within the permissible limit as per IS Specifications as shown in Figure 4.

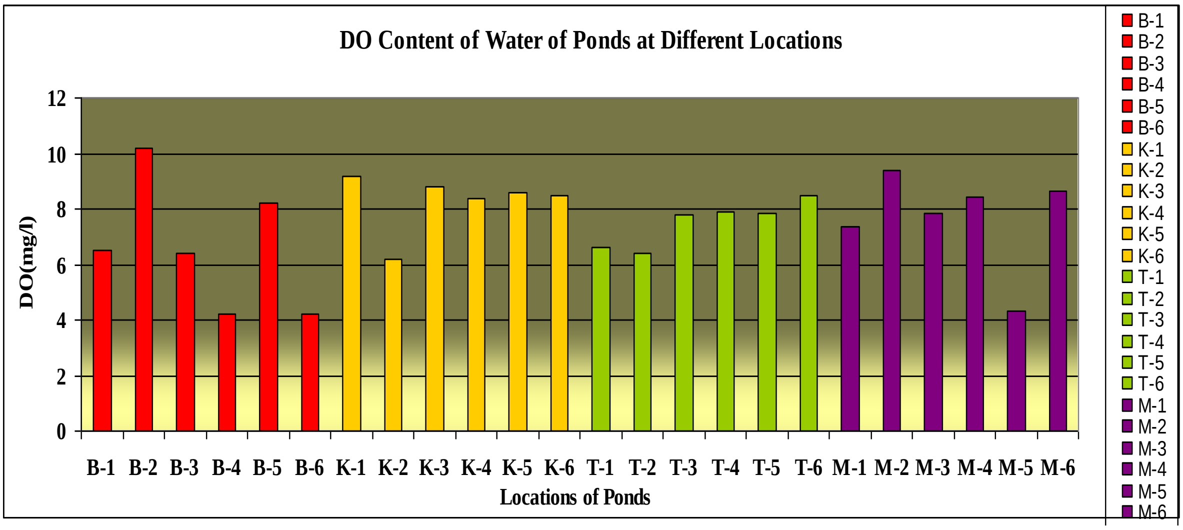

Figure 5: **DO Content of Water of Ponds at Different Locations**

- Do Contents at different locations found as shown in Figure 5 ie. at Budha Pond – B-2, B-5, Kankali Pond K-1,K-3,K-4,K-5,K-6, Bhaiya Pond T-6 and Maharajbandha Pond M-2,M-4,M-6, to be beyond the permissible limit as per IS Specifications.

5. Conclusions

The experimental results of all the Pond samples were analysed, which indicated that the quality of water of Budha Pond satisfies the water quality as per IS specifications (IS 10500: 1991). So the quality of water was found to be better than all remaining Ponds. But at one place B-2 in Budha Pond, the water was found to be more turbid and same thing happened in Kankali Pond at K-1, K-3 in Bhaiya Pond at T-6 and in Maharajabandha Pond at M-2. The maximum turbidity was reported as 11.2 NTU. Observations also indicated that in Budha Pond at place B-2 maximum pH was found to be 9.4, same thing happened in Kankali Pond at K-1, in Bhaiya Pond at T-6 and in Maharajbandha Pond at M-2. The water at above all the places in Ponds was reported to be slightly alkaline in nature. On the other hand at the different places K-1, K-3, K-4, K-5, K-6, B-2, B-5, T-3, T-6, M-2, M-4 & M-6 in the Ponds, hardness crosses the permissible limit. The maximum hardness was reported as 920 mg/l. DO content at the places B-2, B-6, K-1, K-3, K-4, K-5, K-6 , T-6, M-2, M-4, M-6 is beyond the permissible limit. The maximum DO was reported as 10.2 mg/l. Chloride, BOD & COD contents in all the Ponds satisfied the permissible limit so the water is recommended to be used for industrial & domestic use except for some places. In nut shell it was observed that at certain places viz.B-2,K-1,K-3,T-6 & M-2 the water quality violates the permissible limit as per the IS specification, except the chloride content, thus it is mandatory to treat the pond water to make it available to the majority of population fulfilling their future demand and a hygienic future .

From past and recent steadies generally focused on pond fish culture or aquatic life which deals Water quality includes all physical, chemical and biological factors that influence the beneficial use of water. Water quality within an aquaculture pond is continuously changing depending on certain conditions. These behavioural changes are referred to as "Pond Dynamics" But present study was focused on maximum utilization of water for domestic use and to uphold hygienic condition.

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