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Flood Impact on Water Quality Parameters at Vadekkekara Panchayath-A Brief Study

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Abstract: ***In this work we carried out a brief study of water sample analysis after a torrential rain accompanied by a flash flood in August 2018 in Vadekkekara Panchayath in Ernakulam district which is one of the most flood hit areas in Kerala where our educational institution is situated. Our aim is to analyse the change in the quality of the water in different water sources after the flash flood. Water samples from tap, well and pond were collected and analysed for fifteen physio-chemical parameters for assessing the quality of water. The results obtained were then compared with Indian Standard Drinking Water specification IS: 10500-2012 and before flood analysed water sample values. The study of physico-chemical and biological characteristics of water sample suggests that water quality analysis must be carried out periodically before treatment to protect the water resources.***
Keywords: Flood, Water samples, water quality, water pollution, Physio-chemical parameters

I. INTRODUCTION

Flood is one of the worst natural disasters. In August 2018 Kerala experienced a high rain fall, which resulted in severe flooding in 13 districts of Kerala. Flood mapping of Meloor Panchayat in Kerala was done by Joy et al[1]. The composition of suspended sediments in the water bodies dramatically changed during this period because of the high speed of flow of water. As a result vast amount of sediment get deposited on the banks of the flooded rivers. Sediment transport during flood in the water bodies has proved to be one of the major contributors to poor water quality. It is the hour of the need to check regularly the quality of the water from different sources to ensure the potability of water. Impact of a flood disaster on sediment toxicity and water quality is studied by various researchers [2-8]. Recently inter-relationship between flood water quality, surface water quality, and human health in urban areas in China was studied by Yuhan Rui et al.[9]. Rahmanian et al [10] collected samples from different residential and commercial areas of Perak state in Malaysia and were found to be within the recommended limits of WHO. Rubao Sun et al. [11] carried out a case study on nine water samples in three rural villages close to Beijing after torrential rain on July 21, 2012 and found out that most of the parameters exceeded the recommended thresholds and unfit for drinking purposes. A change in the quality of river water before, during and after a major flood for drinking purposes was studied by Murshed et al. [12]. Devangee shukla et al. [13] made a comparative study of the quality of water from different sources in Ahamadabad and concluded that Potable water and Habited water in the particular study area of Ahamadabad are ecologically balanced and free from pollution.

II. MATERIALS AND METHODS

A. Description of Study Area

In the present study, water samples were collected selectively from Maliankara in Vadakkekara Panchayath of Ernakulam district, Kerala. Maliankara is located in the north-west corner of Ernakulam district where the Periyar River ends in the Arabian sea. It is spread over an area of about 45 acres having the coordinates 10.1813°N, 76.1943°E. The soil generally range from loam to clay loam and sticky in nature. The climate is generally tropical, heavy rain fall from the southwest and northeast monsoon are common from June to September. The average annual rainfall is about 2250-2500mm. Most of the people in vadekkekara Panchayath is using pond and well water for their day to day activities. Tap water is the main drinking water source for the population of the region

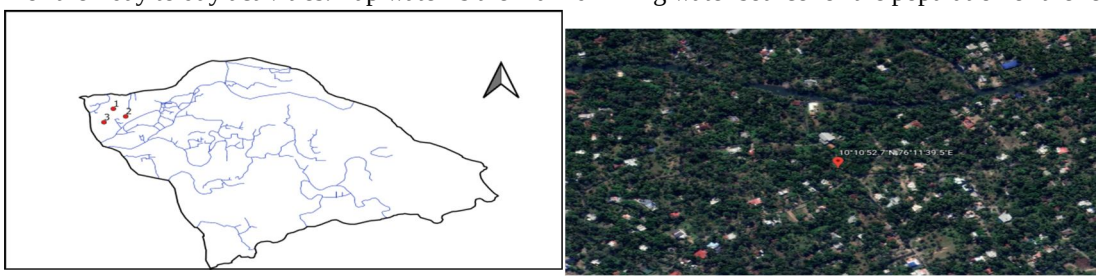

Image: Map of the study area and sample Sites

B. Sample Collection

Tap water, Well water and Pond water were collected from two different locations in Vadekkekara Panchayath. These three sources are the main drinking water resource of the people in this Panchayath. Five water samples were collected from each source in good quality polythene bottles of 1L capacity at room temperature on 18th August 2018. These sample bottles were kept in a dark room to avoid contamination and effect of light. Standard procedures were adopted for the determination of physio-chemical parameters. The selected parameters are pH, Temperature, Electrical conductance, TDS, alkalinity, acidity, Total dissolved solids, Free Carbon dioxide, Hardness of water, Chloride, metals like Calcium and magnesium, dissolved Oxygen, Chemical Oxygen Demand and Biological Oxygen Demand. All reagents used were of analytical grade and double distilled water was used throughout the study. All these analysis were carried out in accordance with standard methods of American Public Health Association (1995).

C. On site Analysis

Colour and temperature were noted at the site of the sample collection as per the standard protocols using calibrated instruments. The pH of the water samples was measured using calibrated pH meter by submerging the pH probe in water.

D. Laboratory Analysis

1) *Electrical Conductivity:* Instrument which has been already calibrated to read the conductivity was directly used for this study by using manufacturer's instructions. The cell was rinsed with the samples to be tested and the conductivity was measured directly and reported as µS/cm at 25˚C.
2) *Total Dissolved Solids (TDS):* Total dissolved solids (TDS) are the amount of organic and inorganic materials, such as metals, minerals, and ions, dissolved in a particular volume of water. When a solvent, such as water, encounters soluble material, particles of the material are absorbed into the water. TDS of water is measured using a potable water quality analyser
3) *Alkalinity:* Alkalinity is generally caused by the carbonates, bicarbonates and hydroxides present in water. Alkalinity is determined by titration with HCl using methyl orange as indicator. Methyl orange is suitable indicator for the determination of bicarbonate alkalinity (pH about 4.5)

$$\text{Total alkalinity} = \frac{Volume\ of\ HCl \times Normality\ of\ HCl \times 50000}{Volume\ of\ the\ sample}$$

4) *Hardness of Water:* Calcium and magnesium are the principle cations imparting hardness, however, to lesser extend cations like iron, manganese and strontium are also responsible for it. Hardness when caused by bicarbonates carbonates of these cations is called temporary hardness since it can be removed by boiling the water. Sulphates and chlorides of these cations cause permanent hardness which can not be removed by simple boiling of water. In general practise the hardness is measured as concentration of only calcium and only magnesium by using water testing kit.
5) *Free Carbondioxide:* The amount of dissolved CO_2 in water can be estimated by titrating with NaOH from the burette with phenolphthalein as indicator. The end point is the appearance of a light pink colour. The amount of CO_2 is calculated in ppm. CO_2 when dissolved in water to give weak acid which can be titrated against a strong base NaOH using phenolphthalein as indicator.
6) *Calcium:* Calcium can be determined by the titration with EDTA using murexide indicator.
7) *Magnesium:* Magnesium may be estimated as the difference between total hardness and calcium as $CaCO_3$ if interfering metals are present in non-interfering in the calcium titration.
8) *Chloride:* The amount of chloride in the given solution is determined by Argentometric titration method.

$$\text{Total chloride content of the given sample mg Cl/L} = \frac{(A-B)\times N\times 35450}{Volume\ of\ the\ sample\ in\ mL}$$

Where,
A=Volume of $AgNO_3$used for titration with sample
B=Volume of $AgNO_3$used for titration for blank
N= Normality of $AgNO_3$

9) *Dissolved Oxygen (DO):* The term dissolved oxygen is used to describe the amount of oxygen dissolved in unit volume of water. It is a measure of the ability of water to sustain aquatic life. DO levels in natural water and waste water depend on physical, chemical, and biological activities in water body. DO can be determined by as given below. Take a glass stoppered BOD bottle of known volume (125ml) and fill it with sample water, avoiding any bubbling. No air should be trapped in the bottle. Open the bottle and pour 2ml of each $MnSO_4$ and alkaline KI solution using separate pipette to the bottom of the bottle, stoppered the

bottle and shake. Allow the precipitate to settle. Then by means of long pipette add 2ml conc. H_2SO_4 and shake the solution. I_2 is liberated. Take 20ml of this solution in a conical flask and add 1ml starch indicator and it is then titrated against sodium thiosulphate. The end point is the colour change from blue to colourless.

10) *Chemical Oxygen Demand (COD):* Chemical Oxygen Demand (COD) is the measure of oxygen required in oxidising the organic compounds present in water by means of chemical reaction involving oxidising substances such as potassium dichromate and potassium permanganate. The estimation of COD is of great importance for water having unfavourable conditions for the growth of microorganism, such as presents of toxic chemicals. In such water, BOD cannot be determined accurately. However, COD too is not a perfect index of organic compounds present in water because, in this reaction, many inorganic compounds are also oxidised, and at the same time some organic compounds remain unaffected. A sample is refluxed in strongly acid solution with a known excess of $K_2Cr_2O_7$. After digestion the remaining unreduced $K_2Cr_2O_7$ is titrated with ferrous ammonium sulphate, the amount of potassium dichromate consumed is determined, and the amount of oxidisable organic matter is calculated in terms of oxygen equivalent.

11) *Biochemical Oxygen Demand (BOD):* Biochemical oxygen demand is the measure of quantity of oxygen used for the microorganisms in the aerobic oxidation of organic matter. It is a quantitative expression of microbe's ability to deplete the oxygen content of the waste water. BOD is evaluated by measuring oxygen in sample before and after incubation in the dark at 20^0C for 5 days. Preliminary dilution and aeration of sample are usually necessary to ensure that not all the oxygen is consumed during incubation.

III. RESULTS AND DISCUSSIONS

Water, the greatest gift of nature is inevitable to mankind. Water analysis is essential where people depend on different water sources for drinking and other living activities. Water used for drinking purpose should have the following characteristics. Water should be obtained from a source that is free from pollution. All kinds of bacteria and microorganism should be absent. It should be colourless, odourless and have an agreeable taste. Soluble mineral salts should not be present beyond the limit. The quality standards for drinking water have been specified by the Bureau of Indian Standards (BIS) IS -10500:2012.

Table 1: Physical and chemical properties of drinking water as per IS: 10500-2012

Sl.No	Parameter	Unit	Standard
1	Temperature	^{0}C	--
2	pH	--	6.5-8.5
3	Total Alkalinity	mg/L	200
4	Free Carbon dioxide	ppm	--
5	Electrical conductivity	µS/cm	--
6	Total Hardness	mg/L	200
7	Ca Hardness	mg/L	75
8	Mg Hardness	mg/L	30
9	TDS	mg/L	500
10	Chloride	mg/L	250
11	DO	mg/L	--
12	COD	mg/L	--
13	BOD	mg/L	--

Table: 2 Physico-chemical characterestics of water samples from different sources (August 2017)

Sl.No	Parameters	Samples					
		Tap Water		Well water		Pond water	
		1	2	1	2	1	2
1	Colour	colourless	Colourless	Colourless	colourless	Greeenish	colourless
2	Temperature (^{0}C)	31.0	30.6	28.7	29.2	30.0	30.5
3	pH	6.12	6.23	5.01	5.32	7.33	7.50
4	Electrical Conductivity (µS/cm)	0.198	0.173	0.252	0.232	0.286	0.343
5	Total dissolved solids	31.186	31.449	132.857	129.946	257	247.748
6	Hardness of Water (mg/L)	0.24	0.26	2.8	2.6	9.6	8.2
7	Dissolved Oxygen (DO) (mg/L)	0.81	0.97	0.57	0.66	0.60	0.69

Table: 3 Physico-chemical characterestics of water samples from different sources
(August 2018)

Sl.No	Parameters	Samples					
		Tap Water		Well water		Pond water	
		1	2	1	2	1	2
1	Colour	colourless	Colourless	yelloish	colourless	Brownsh	yellow
2	Temperature (^{0}C)	30.2	30.7	29.9	30.4	30.3	30.3
3	pH	7.25	7.93	5.34	6.26	8.5	8.12
4	Alkalinity (mg/L)	21.4	20.8	31.8	41.4	100	80
5	Electrical Conductivity (µS/cm)	0.46	0.49	0.37	0.41	0.69	0.71
6	Total dissolved solids (TDS)	51.18	51.44	152.85	149.94	357	347.74
7	Free Carbon dioxide (ppm)	4	5	2	6	10	9
8	Hardness of Water (mg/L)	0.6	0.8	2.1	2.7	11.3	12.6
9	Calcium (mg/L)	0.33	0.48	1.8	2.3	7.1	8.6
10	Magnesium (mg/L)	0.27	0.32	0.3	0.4	4.2	4.0
11	Chloride (mg/L)	41.18	40.20	18.46	14.20	15.12	15.0
12	Dissolved Oxygen (DO) (mg/L)	0.62	0.87	0.47	0.56	0.51	0.59
13	Chemical Oxygen Demand (COD)	1.6	2.7	3.3	4.7	7.87	6.93
14	Biological Oxygen Demand (BOD) (mg/L)	1.2	0.9	5.3	6.7	1.5	2.8

Tap water is colourless and well water is yellowish in colour. But the pond water is slightly brown in colour. The most common cause for the colour of the water may be due to the presence of minerals sediments, complex organic molecules, suspended matter, such as clay, slit, finely divided organic and inorganic matter, soluble coloured organic compounds and phytoplankton and other microscopic organisms and soil run off during flood.

1) *pH:* pH specifies how acidic or basic water is. It is defined as the negative logarithm of the concentration of hydrogen ions. The pH range for portable water is in between 6.5-8.5 according to the WHO standards. Among the five samples studied the pond water has got the highest value of pH. Carbonate minerals and lime stone are two elements that can buffer the pH range in water. When carbonate minerals are present in the soil the buffering capacity of the water is increased. Pond water is usually have a pH range in between 6-8. The slight increase ie 8.5 in the pH for the pond water is due to the more addition of calcium carbonate from the surroundings during the flood. pH values govern the behaviour of chlorine disinfection efficiency, and metal solubility. The graphical representation of the pH values before and during flood is given in the Figure 1.

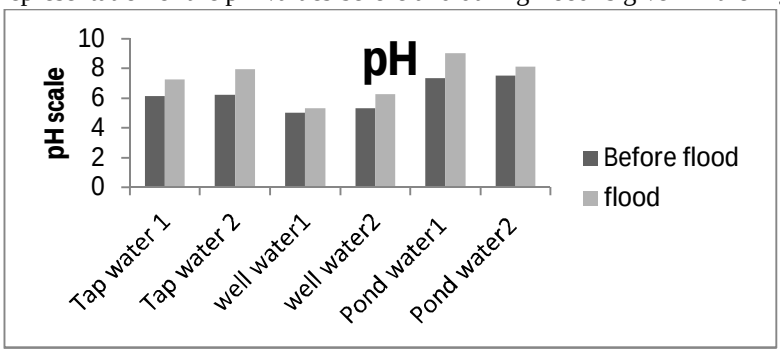

Fig. 1 Variation of pH in different water samples

The pH value of most of the water samples in the study area varies from 5.34 to 8.5 which include in the limit (6.5-8.5) specified by BIS (2012). Acidic character for the well water may be due to the leaching of H^+ ions from the soil and presence of CO_2 in water. Since CO_2 exist in water in a dissolved state, it reacts with oxygen to forms carbonic acid. The presence CO_2 may be due to the occurrence of coliform bacteria.

A. Electrical Conductivity

Electrical conductivity is due to the ions present in water. It is a measure of the ability to conduct an electric current. It is sensitive to variations in dissolved solids, mostly mineral salts. A rise in conductivity after flood indicates pollution. Among the six samples, Pond water shows greater conductivity. The other samples show somewhat similar conductivity. It will also give an idea about the range into which the hardness and alkalinity values are likely to fall. It also gives the information about the dissolved solid content of the water. Ion mobility and temperature of the solution have influence on conductivity. Figure 2 represents variation of electrical conductivity in different water samples.

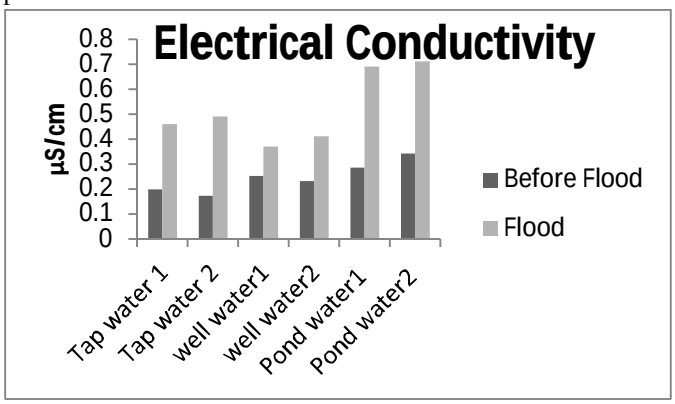

Fig. 2 Variation of Conductivity in different water samples

B. Total Dissolved Solids (TDS)

TDS represents the total concentration of dissolved substances such as minerals, salts, metals, cations or anions dissolved in water. Inorganic salts, as well as a small amount of organic matter are mainly responsible for the TDS. Common inorganic salts that are found in water include cations like calcium, magnesium, potassium and sodium and carbonates, nitrates, bicarbonates, chlorides and sulfates, which are all anions. The ISI specified maximum limit is 500 mg/L. The observed value for sample 1 is 0.6mg/L Sample 2 has 0.8mg/L. Sample 3 has 2.1mg/L. Sample 4 has 2.7mg/L. Sample 5 has 11.3mg/L and sample 6 has12.6mg/L. The water sample from the pond tends to have high levels of dissolved solids, because of high amounts of calcium and magnesium in the ground. These minerals can also come from human activities. During flood the running water carry excess minerals into the water sources and can get deposited in the pond. Turbidity and colour of the water samples indicates the presence of the dissolved matter in the water samples. Variation of TDS in different samples are given in the figure 3.

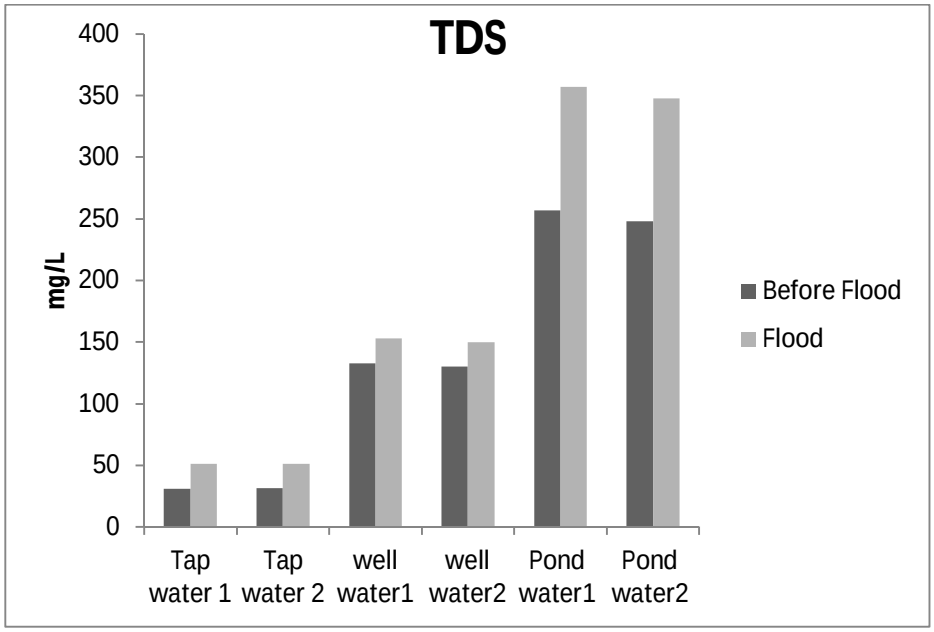

Fig. 3 Variation of TDS in different water samples

C. Total Hardness

Figure 4 represents the variation of total hardness of different samples of water. Among the six water samples, water from the ponds has got highest level of total hardness. The presence of Calcium and Magnesium compounds such as Carbonates, Sulphates etc. mainly contributes to hardness. Iron can also contribute to hardness. Total hardness varies widely from 0.6-12.6 mg/l.

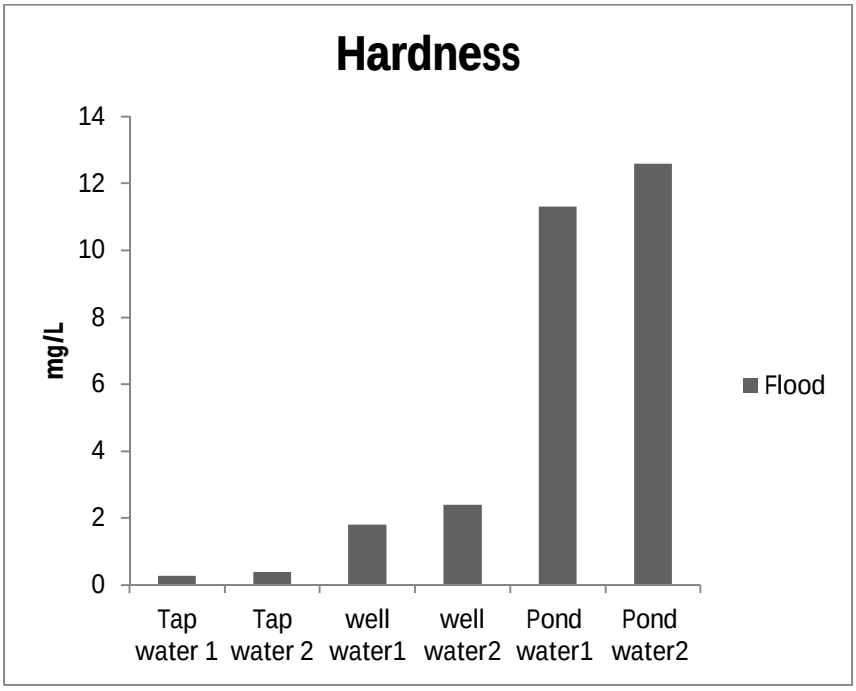

Fig. 4 Variation of Total Hardness in different water samples

D. Alkalinity

Alkalinity for water is due to the presence of carbonates and hydroxide ion. Alkalinity provides an idea about the salts present in water. The alkalinity of water is also due to the presence of bicarbonates formed in the soil, through which the water percolates. It is the measure of the buffer capacity (Capacity of the water to neutralize acid). Among the six samples 5th sample is more alkaline. The graphical representation of the variation of alkalinity in different samples is given in the figure 5.

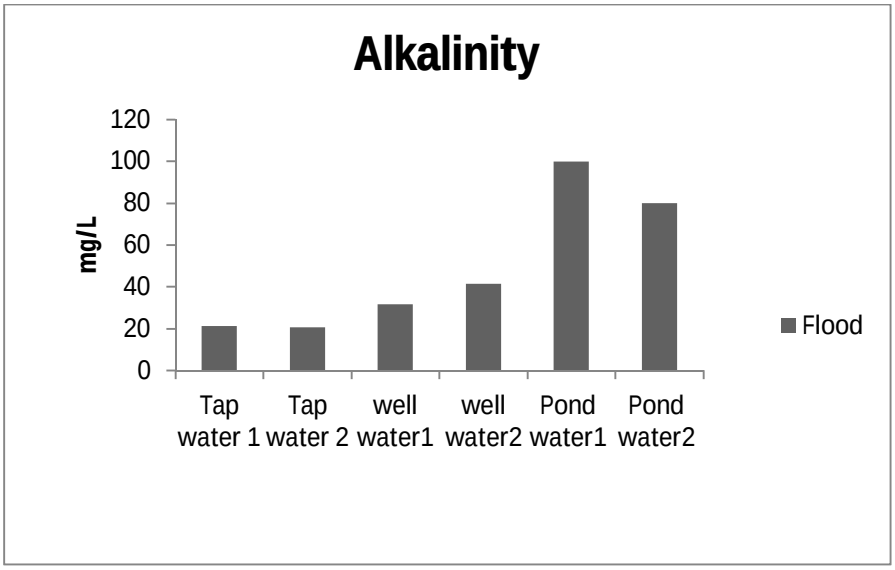

Fig 5 Variation of Alkalinity in different water samples

The highest value of alkalinity for pond water may be due to the addition of flood water containing more alkaline substances and minerals.

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E. Free Carbon Dioxide

High levels of Carbon dioxide enhance the effect of deoxygenation in water. Excessive levels of carbon dioxide may have adverse effects on aquatic life. Among the six samples pond water has got highest free carbon dioxide (Figure 6).

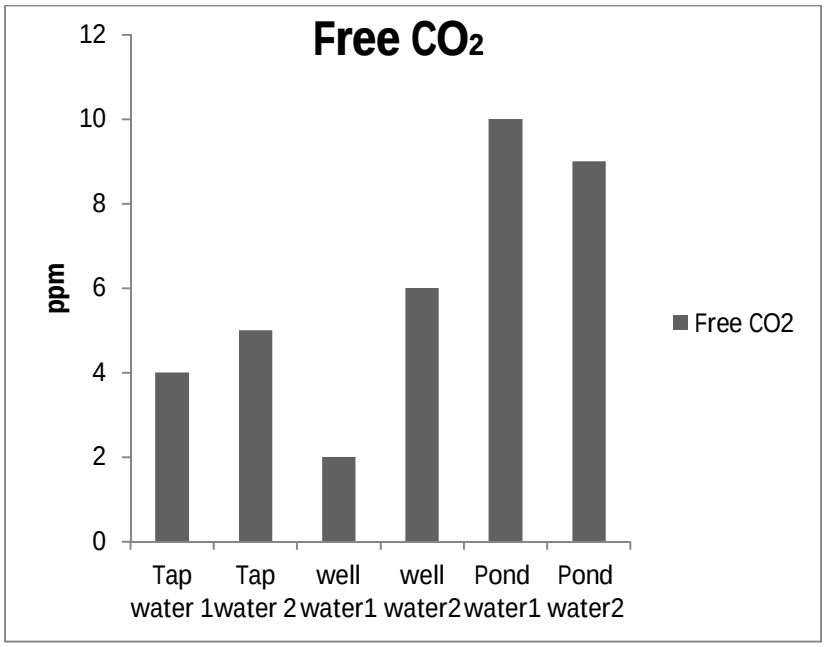

Fig. 6 Variation of Free CO_2 in different water samples

F. Calcium and Magnesium

Calcium is most abundant and most important in human body and adequate intake is essential for normal growth and health. Daily requirement of calcium is 1-2gm. So the presence of calcium is beneficial to health. However high degree of consumption of calcium leads to some health problems. Amount of calcium in six different sources are entirely different for six samples. Among six samples, Pond water has high value of calcium hardness (Figure 7). Amount of magnesium is also entirely different for six samples. Among six samples pond water has high value of magnesium hardness.

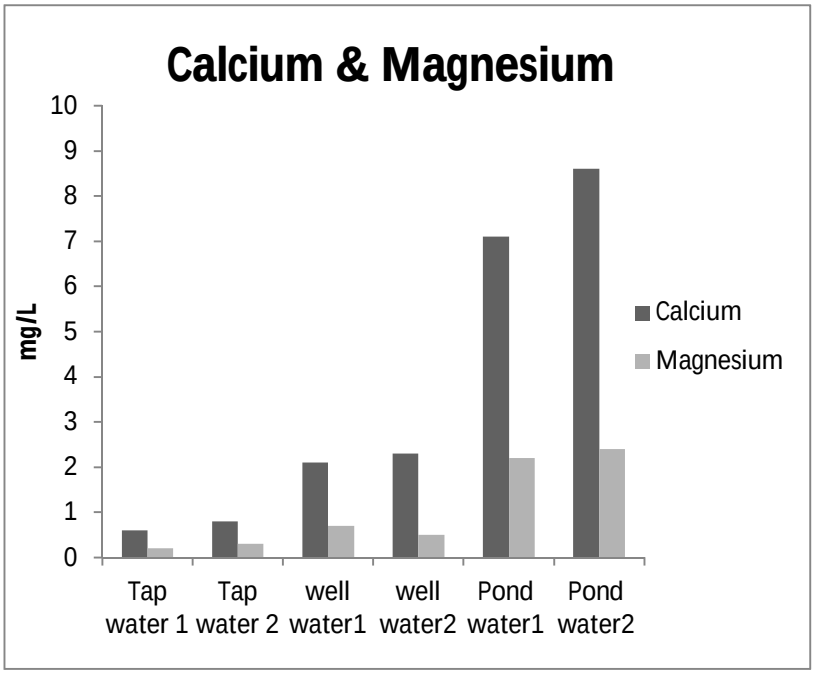

Figure 7 Variation of Calcium in different water samples

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G. Chloride

Presence of chlorine does not raise any health hazard to humans. Usually Chlorine is available in water. High amount of chlorine is found in pipe water when compared to well and pond water. Chlorine content in the well and pond water make it unfit for agricultural irrigation. Chloride content in sample 1&2 are greater than other samples. This is due to the high level of chlorination during the flood period. Figure 8 shows that well and Pond water has got least level of chlorine content where as pipe water contains high level of chlorine content.

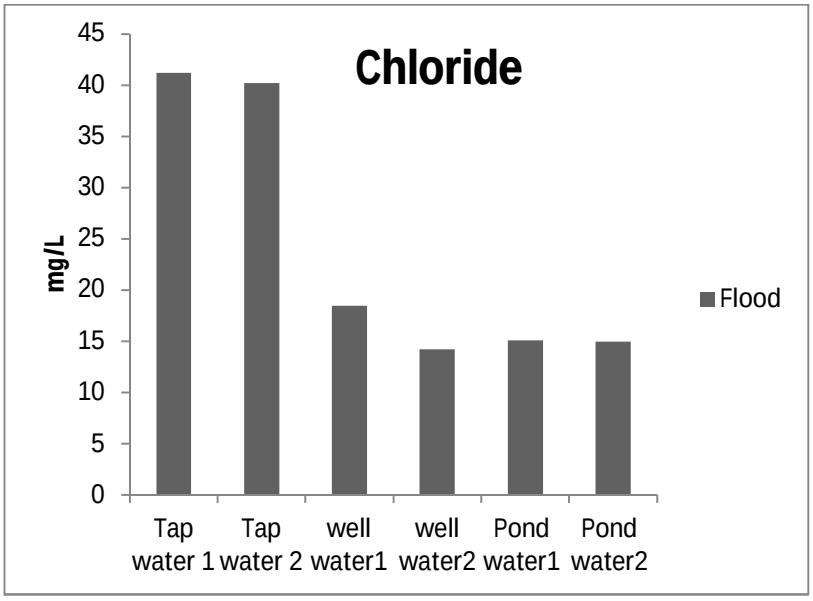

Fig. 8 Variation of Chlorine in different water samples

H. Dissolved Oxygen

The dissolved oxygen in different water samples is given in the figure 9. The dissolved oxygen (DO) is the amount of oxygen dissolved in water. The oxygen dissolves in water from the surrounding through diffusion. Hot water could not able to hold more oxygen. So the amount of oxygen present in hot water will be very less. How much amount of DO an aquatic organism needs depends upon its species, its physical state, water temperature, pollutants present, and more. Consequently, it's very hard to predict the amount of DO levels for specific fish and aquatic animals. Various scientific studies suggest that 4-5 mg/L of DO is the minimum amount required to support a large and diverse fish population. A high DO level in drinking water makes drinking water taste better. However, high DO levels speed up corrosion in water pipes. For this reason, industries use water with the least possible amount of dissolved oxygen. Our studies shows that the amount of DO is less during flood time when compared to the before flood water samples.

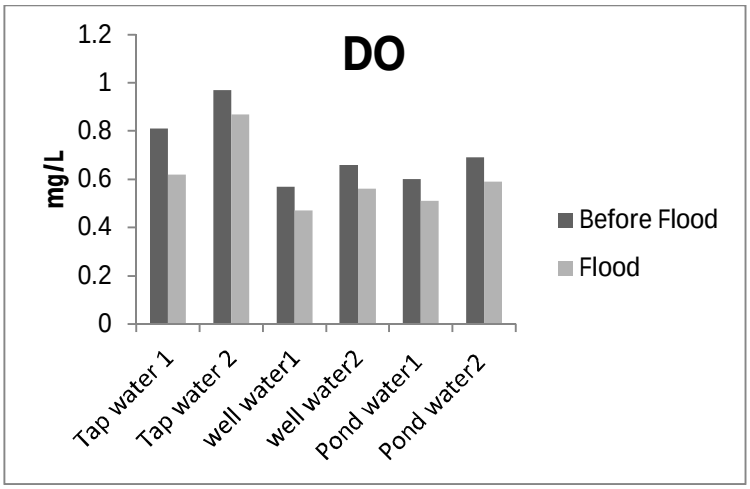

Figure 9 Variation of DO in different water samples

I. Chemical Oxygen Demand (COD)

COD is the amount of the oxygen required to oxidize soluble and particulate organic matter in water. The higher chemical oxygen demand indicates the higher the amount of pollution in the test sample. COD limit is 250mg/L in the drinking water. The results of the analysis of six samples are depicted in the figure 10. All the samples show very high values of COD indicating the high level of pollution in water samples. This may be due to the presence of sewage and mixing of the industrial as well as domestic waste to the water bodies during flood. COD is always greater than BOD.

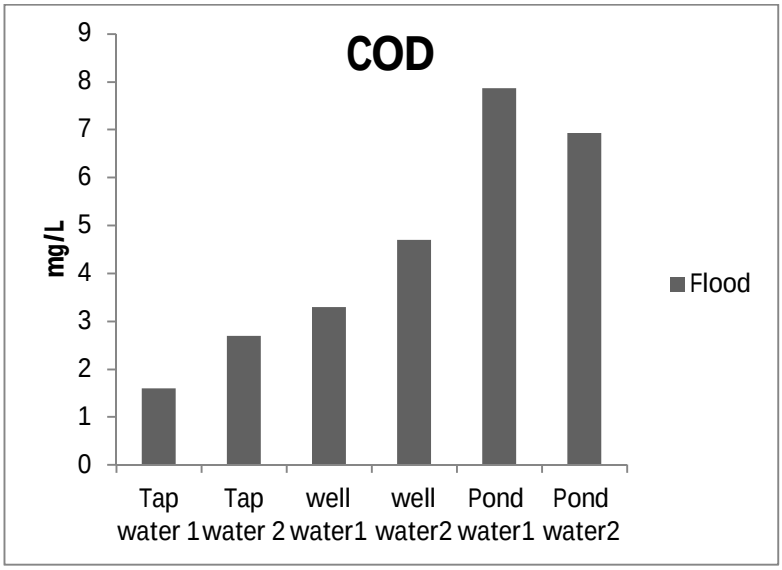

Fig. 10 Variation of COD in different water samples

J. Biological Oxygen Demand (BOD)

It is the amount of oxygen consumed by micro-organisms in stabilizing the organic matter. BOD depends on oxidizable organic matter present in Sample. The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample during **5** days of incubation at 20°C. Among the six samples studied well water shows highest BOD value. Figure 11 represents the various BOD values of different samples of water.

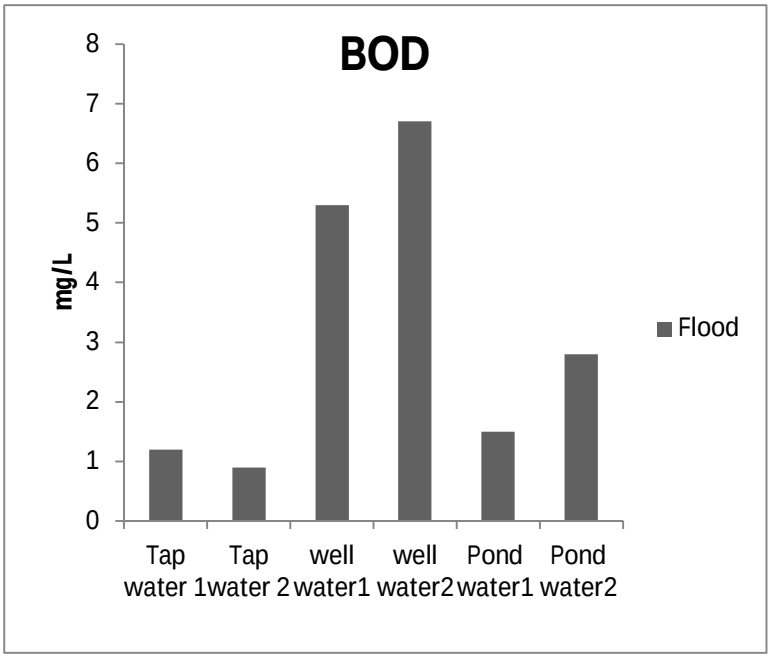

Fig. 11 Variation of BOD in different water samples

IV. CONCLUSIONS

Tap water is colourless well water is yellow in colour. Pond water is brown in colour due to the presence of minerals sediments, complex organic molecules and soil run off during flood. Temperature ranges from 29.9 to 30.7. Low value for well water and high value for tap water. Pond water shows greater conductivity. A rise in conductivity indicates pollution. Among the six samples, pond water sample is more alkaline. Alkalinity of the water is due to the presence of carbonates and hydroxide ion. Pond water has got highest free carbon dioxide. When the CO_2 concentration increases in water the oxygen concentration depletes.TDS is highest for pond water. The amount of dissolved solids is very high in ponds. Pond water shows abnormal value of hardness due to the presence of high level of sulphates and chlorides. Pond water shows high concentration of Calcium and Magnesium, where as pipe water shows high concentration of chloride ions due to the high level of chlorination during flood period. DO value of good quality of water is 5mg/L. All samples show very low value of DO. COD value is high for Pond water and low for tap water. High BOD value is obtained for well water and low value for tap water. Our study revealed that the water from well and pond are not potable during the flood. So we can conclude that the quality of water from pond and well during flood period is not suitable for drinking purpose and can be used for drinking and domestic purposes only after proper treatment.

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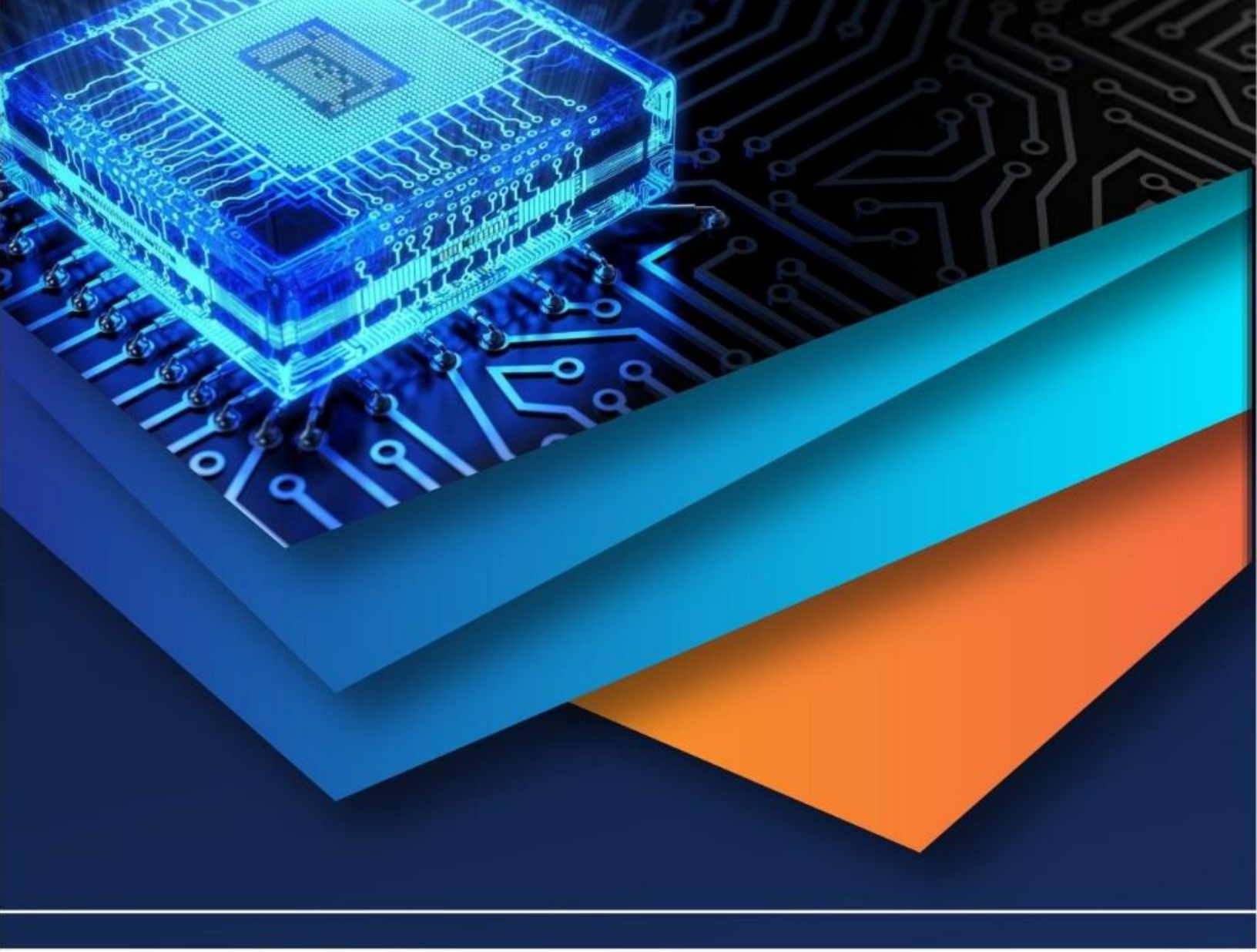

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