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PHYSICO-CHEMICAL CHARACTERISTICS OF THE GROUND WATER TABLE AFTER MONSOON: A CASE STUDY AT CENTRAL TRAVANCORE IN KERALA

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Abstract

Water quality plays an important role in maintaining plant and animal life. Lack of good quality drinking water and water for sanitation cause health problems. Water quality characteristics arise from a group of physical, chemical and biological factors. The dynamic balance of the aquatic system can be destroyed by human activities resulting in water pollution.Well water has traditionally considered as a safe resource of water for consumption without treatment and extensively used for individual water supply in rural and many urban areas.In this paper a preliminary analysis is done to explore the water quality of selected wells in order to correlate the effect of pollution on water quality at these locations. Water samples are collected from different regions of Vazhappally area located on central travancore of Kerala. These sites are important because people depend only on well water for drinking purpose. The samples are collected from ten locations and analyzed for chemical parameters such as pH, conductivity, salinity, turbidity, acidity, alkainity, hardness, total phosphates, dissolved oxygen, biological oxygen demand, total dissolved solids and Iron content. Samples are also analysed for coliform bacteria which cause pathogenic diseases. Remarkable differences are observed mainly in biological oxygen demand, acidity and hardness. Finally, an attempt has been done to correlate the observed chemical parameters and the waterquality standards.

Keywords: Coliform bacteria, Ground water in Kerala, Physico-chemical characteristics, Water quality,Well water

Introduction

Pure water is a very much essential element for life and study of water quality thus has great importance. It gives an idea about the pollution of water resources and the possible reasons for water contamination. Thus the study of water bodies by checking out the physico-chemical characteristics provides a scientific tool to monitor and manage such type of water bodies (Bajpai et al., 2013). Physico-chemical analysis of wetlands which correlate water quality parameters are available in literature (Hiren and Sheju, 2013). The study of Physico-chemical parameters of river system in Kerala also shows higher risk of pollution due to anthropogenic activities (Mohan et al., 2006). Various research groups have analyzed the ground water quality at different locations of Kerala and the results are published (Harikumar et al., 1997; Dinesan et al., 2007; Abdul Hameed and Nazimuddin 2004).

Water well is an excavation or structure created in the ground by digging, drilling or boring to draw water from ground water aquifers. Wells can be very great in depth, water volume and water quality. Shallow pumping wells can often more susceptible to contamination since impurities from the surface easily leach to shallow sources. The risk of contamination for these wells is relatively greater in comparison with deeper wells. In India more than 90% of rural population depends on well water for domestic purposes.

According to recent research articles, ground water resources in Kerala are at a higher risk of environmental pollution and are susceptible to contamination (Hameed et al., 2000). The main factors that contribute to ground water contamination include microorganisms, chemicals, plant debris and other anthropogenic sources. Most of the bacteria, fungi and parasites that contaminate water are produced from faecal matter of humans and other mammals. One of the common bacterial contaminant is *E.coli* which is present in the gastrointestinal track of Humans and other warm-blooded animals and can be considered as the most accurate indicator organism of faecal matter contamination (Adam and Trond, 2012).

Chemical contamination is one of the prominent problems associated with ground water. The main chemical contaminants include pesticides (Majid et al., 1991) and Heavy metals (Kamala et al., 2010; Yokota et al., 2001). For instance Iron is one of the most distressing constituent of ground water in India causing staining. Higher levels of iron content in water can also generate the growth of Iron bacteria (Kamala et al., 2010).

In this work an attempt has been done to study the physico-chemical characteristics of groundwater table after monsoon at central Travancore. In order to trace the microbial contamination levels in the area, bacterial analysis for *E. Coli* was also done.

Materials and methods

Study Area

Vazhappally Village (9.2730^0N, 76.3200^0E) is located in Kottayam district of Kerala in India as shown in Fig 1. It is one of the earliest settlements in the state of Kerala. As of 2001 India census, Vazhappally village had a population of 10849 with 5438 males and 5411 females. The study area is an important pilgrimage centre in central Travancore. One of the most worshiped temples of Kerala called 'Vazhappally Mahadeva temple' is located in the study area and has also become the source of attraction for the people not only from Kerala

but from every corners of the world**.** Water is available during dry season also. But people are less scared about the quality of water and the side effects of water pollution.

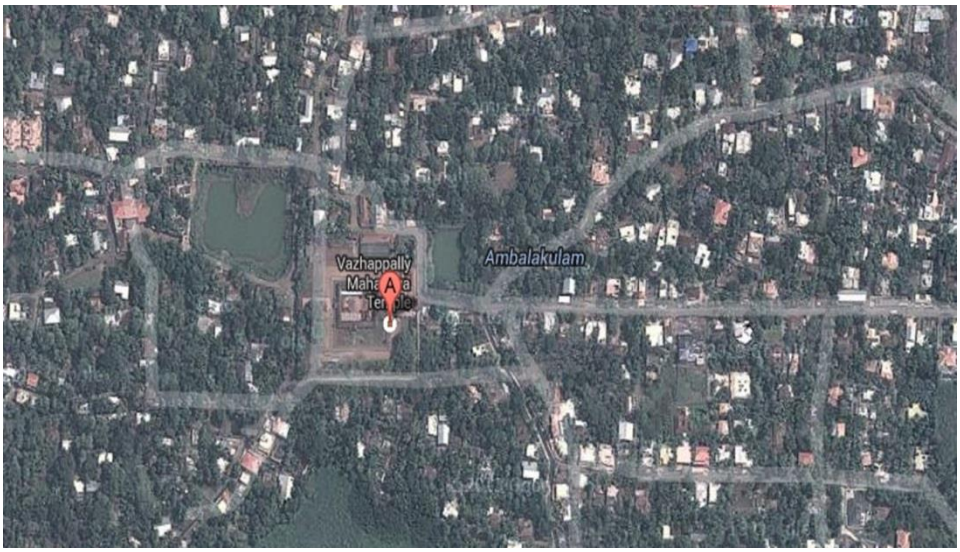

Figure 1. Satellite View of the Study Area

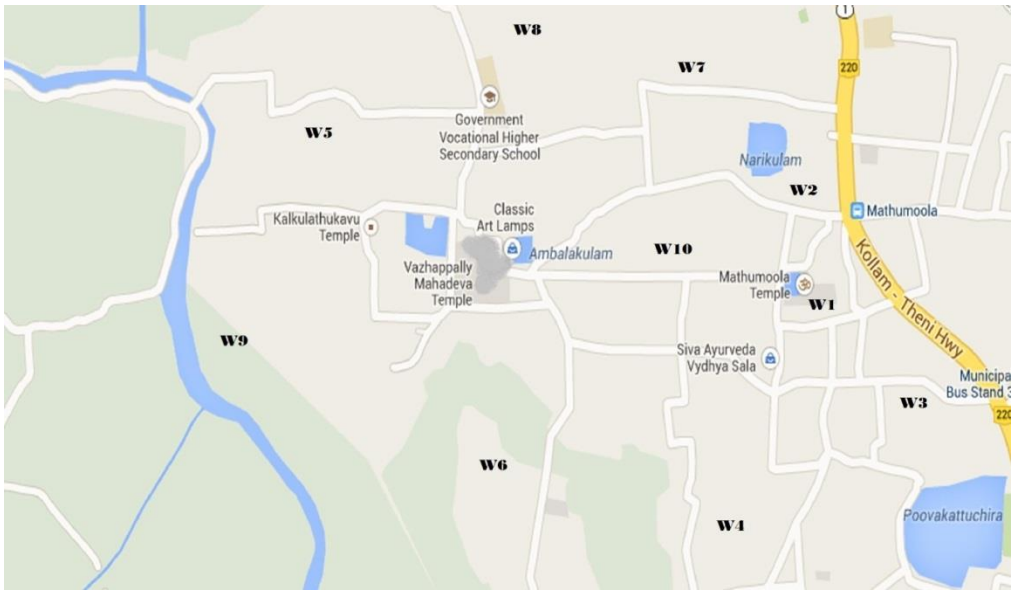

Figure 2. Sampling Locations in the Study Area

Analytical Methodology

All the experiments are done according to the standard procedures (APHA, 2005). Total coliform count is estimated by plate counting method and the count was expressed as colony forming unit (CFU) per milliliter. Iron content is estimated by Atomic absorption spectroscopic technique. Ten locations are selected at different region of the study area and three samples are collected from each sampling point (as shown in Fig 2) and the mean

values of the observations are recorded. The sampling is done during post Monsoon in November. The sampling points are denoted using codes starting from W1 to W10.

Results and Discussion

The well water samples are collected from the ten predefined locations of Vazhappally village. The results of the chemical analysis are summarized in Table 1. Drinking water quality standards is given in Table 2.

Table 1.Physicochemical Analysis of the Water Samples from Vazhappally Area (W1-W10)

Sampling Sites	W1	W2	W3	W4	W5	W6	W7	W82	W9	W10
pH	5.42	5.52	5.58	5.94	6.2	5.89	5.57	5.83	6.28	6.04
Total dissolved Solids(mg/L)	140	130	120	140	120	90	220	150	130	140
Dissolved Oxygen (ppm)	7.5	7.6	7.7	7.2	6.7	6.3	6.9	6.3	5.8	6.8
BOD (ppm)	2	1.6	1.8	1.7	1.2	0.5	1.3	0.8	0.9	0.6
Conductivity (mS/cm)	0.21	0.2	0.19	0.21	0.2	0.14	0.35	0.23	0.2	0.23
Turbidity(NTU)	0	0	0	0.118	0.236	0.078	0.905	0.396	121.9	0.356
Salinity (g/Kg)	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2
Acidity(mg/L)	22.2	11	22	25	34	27	40	23	38	33
Hardness(mg/L)	79	51	55	55	55	30	75	48	32	50
Alkalinity(mg/L)	20	10	18	22	37	19	20	18	22	31
Phosphate (mg/L)	0.81	1.13	1.07	1.06	1.18	0.86	0.91	1.18	1.77	0.97
Coliform (CFU)	0	0	0	5	1	0	0	0	2	0
Iron (ppm)	0.15	0.15	0.17	0.34	0.20	1.6	0.48	0.6	1.5	0.21

Table 2 a. Water Quality Parameters and Standards

SL NO.	PARAMETERS	UNITS	DRINKING WATER IS: 10500 - 1991	
			DESIRABLE	MAXIMUM
1.	Colour	Hazen units	5	25
2.	Odour	-	Unobjectionable	-
3.	Taste	-	Agreeable	-
4.	Turbidity	NTU	5	10
5.	pH value	-	6.5 to 8.5	No relaxation
6.	Total hardness (as $CaCO_3$)	mg/l	300	600
7.	Iron	mg/l	0.3	1.0
8.	Dissolved Solids	mg/l	500	2000
9.	Alkalinity	mg/l	200	600

Table 2 b. Water Quality Parameters and USPH Standards

SL NO.	PARAMETERS	USPH STANDARD (Max. permissible)
1.	Colour	Colourless
2.	Odour	Odourless
3.	Taste	Tasteless
4.	Turbidity	5 NTU
5.	pH value	6.0-8.5
6.	Total Phosphate	0.1mg/L
7.	Iron (filterable)	<0.3ppm
8.	Coliform cells/1000mL	100CFU
9.	Total dissolved solids	500mg/L

Analysis of pH

The pH values of water are controlled by relative quantity of bicarbonates and CO_2 in the system. Low values of pH indicate high acidity, which can be caused by the deposition of acid-forming substances in precipitation (Hiren and Sheju, 2013).All the samples show slightly acidic pH. The permissible limit of pH is 6.5 to 8.5(BIS, 1983). The values ranged between 5.42 and 6.2. Minimum value was observed in W1, which is most acidic out of ten samples. Maximum value of 6.28 was observed for W9, which is within the desired limit.

Total dissolved solids (TDS) and Total Hardness

TDS is the measure of inorganic salts and small amounts of organic matter present in water. The prominent ionic species contributing to TDS values are carbonates, bicarbonates, chloride, sulphate, nitrate, sodium, potassium, calcium and magnesium. The range of values observed is from 0.09g/L (W6) to 0.22g/L (W7). This observation is reflected in Hardness measurements. The values of TDS and Total Hardness follow a linear relationship as shown in Figure 3. The hardness is caused by the presence of carbonates of Ca^{2+} and Mg^{2+} and this is one of the controlling factors of total dissolved solids. It is observed that the more the concentrations of calcium and magnesium ions, higher the values of TDS at those locations.

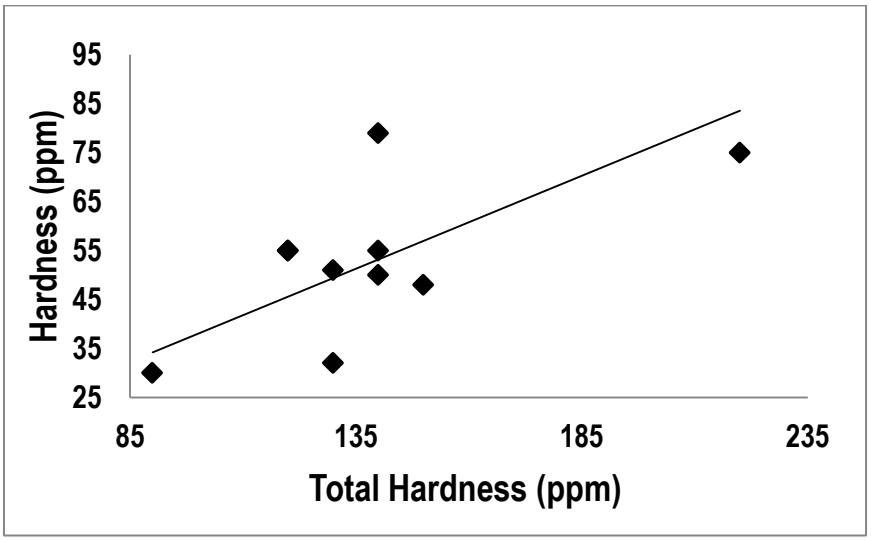

Figure 3: Correlation between TDS and Total Hardness

Dissolved Oxygen

The amount of gaseous oxygen (O_2) dissolved in well water samples are measured as a part of this study. Gaseous oxygen gets into water by diffusion from the surrounding air by aeration and also from aquatic photosynthesis (Cyril et al. 2014). The permissible limit of dissolved oxygen in drinking water is 5ppm and above (BIS, 1983). In all the sampling points the dissolved oxygen level ranged from 5.8 in W9 to 7.7 in W3.

Biological Oxygen Demand

The Biological oxygen demand (BOD) is considered as a measure of how much oxygen is used by microorganisms in aerobic oxidation or for the breakdown of organic matter in aquatic ecosystems. If the amount of organic matter in the aqueous system is high relatively more amount of oxygen is required for aerobic oxidation (Cyril et al. 2014). Consequently there is depletion of dissolved oxygen available to other aquatic life. The BOD values of the sampling points are given in Table 1.

Alkalinity

Alkalinity is the buffering capacity of waterand can be taken as the overall measure of the substance in water that has an 'acid-neutralizing ability' (Hiren and Sheju, 2013). These factors include bicarbonates, hydroxide and phosphates (Mohan et al. 2006). The value of alkalinity ranged from 10mg/L in W2 to 37 mg/L in W5. All the values are within the desirable limit.

Total Phosphates

Phosphate is one of the important nutrients that control the growth of phytoplankton and the other small organisms in water (Cyril et al., 2014).Phosphorus in water generally exists in the form of orthophosphates, polyphosphates and organic phosphates. Organic phosphates are formed primarily by biological processes. The values ranged from 0.81mg/L to 1.186mg/L. All the values are in the permissible limit.

Salinity and conductivity

The observed values of salinity and conductivity are within the desirable limit.

Turbidity

Turbidity gives a measure of suspended material in the water causing reduction in the transmitted light. It can be due to the presence of clay, colloidal organic particles, microscopic organisms etc. It is a major factor affecting quality of drinking water. On analysis it is found that W9 is very much turbid showing a relatively high value of 121.9 NTU. The sampling site (W9) is close to paddy fields and the organic matter contents leached from the soil is one of the possible reasons for the presence of suspended colloidal particles. The water in this well cannot be used for domestic purposes due to extremely high amount of colloidal dispersions. The main problem caused by turbidity is the interference with disinfection processes. Suspended matter can also carry pathogens. These types of samples can be treated by different methods using activated carbon filter, mechanical filter (sand or cartridge) and also by reverse osmosis or distillation.

Total Coliforms

Coliforms are pollution indicators and are present in water due to faecal contamination of water. Coliform bacteria can enter wells through direct discharge of waste from mammals and birds, and from human sewage. According to water quality standards drinking water should be free from coliforms. In W4, W5 and W9 coliform contamination was observed. All other samples were free from coliform bacteria. Reduction of faecal coliforms may require use of chlorine and other disinfectants.

Iron

The permissible limit of iron in drinking water is 0.3 ppm to 1ppm. Iron can be present in water as soluble ferrous ion (Fe^{+2}) or insoluble ferric ion (Fe^{+3}). The concentration of iron was found relatively high in W6 and W9 which showed the values1.668ppm and 1.542ppm respectively. Both the values are higher than permissible limit. Excess iron can be removed by treatment methods including ozonation and catalytic filtration.

Conclusion

The study examined most of the essential biological and chemical parameters to examine pollution at the sampling sites. As a part of the experiments analysis were done to explore the water quality in order to correlate the effect of contamination at those locations. Most of the wells in the study area can be used for daily requirements. There are exceptional cases (W6 and W9) and an effort has been done to suggest possible treatment methods for them.

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