A REPORT ON GROUND WATER QUALITY ASSESSMENT OF CENTRAL UNIVERSITY OF KERALA CAMPUS, PERIYE, KASARAGOD

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TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1. 1. Ground water: An Inevitable resource

Water is a vital resource which covers almost 71% of the earth surface. About 97% of this water is in the ocean, and the rest 2% is frozen. Almost 96% of the remaining water is the ground water which is accessible part from surface water. In areas where surface water is not available groundwater constitutes the significant part of active fresh water resources all over the world. This finite resource has to be well explored for drinking, irrigation, domestic and other industrial needs. The occurrence and distribution of groundwater resources are confined to certain geological structures and formations. Thus, proper exploration technique must be undertaken to solve the problems of exploitation and management of groundwater. The most advanced and time-tested surface method of groundwater investigation include electrical resistivity method of geophysical prospecting.

Groundwater constitutes one portion of the earth's water circulatory system known as the hydrological cycle (Todd, 1980). This is consequence of a number of processes occurring simultaneously in the atmosphere that completes the cycle. The water evaporates from the water bodies and even from plant bodies by the processes of evaporation and transpiration respectively. On reaching favourable conditions or at the dew point temperature condensation takes place and finally precipitate to the earth as rain or in any other form. The water hence reaching the earth surface either infiltrates downwards through the pores adding to the water table or the ground water storage. Under certain circumstances when time is not enough to infiltrate or in steep terrains run off or overland flow dominates, which eventually adds to the surface water bodies.

1.2. Scope and objectives of the Study

The Pullur-Periye panchayath including Central University of Kerala campus faces acute water shortages in summer especially in the months of February, March and April. The open wells of the area get dried up quickly and people depends on borewells which is also affected with declined water levels in summer. The main objective of the present study is to assess the quality of water discharged from borewells in the campus for drinking purpose.

1.3. Location and setting

The permanent campus of the Central University of Kerala spans an area of 310 acre at Tejasiwni Hills, Periye, Kasaragod, the northernmost district of Kerala state, India (Fig. 1.1). The area is occupied between the north latitudes of 12° 22′51.04” and 12° 23′53.14”, and East longitudes of 75°05’44.69” and 75°05’29.04”. Politically this area included in Periye Pullur Grama Panchayath.

1.4. Physiography

The Central University of Kerala is a part of Midland area of Kasaragod. The study area undulating topography with small hillocks and valleys. The altitude varies from 44 to100 meters above mean sea level. The coastal plain is about 8 km distance from the study area.

1.5. Geology and Hydrogeology

Kasaragod is a part of Precambrian metamorphic shield in which majority of the area is occupied by Archean rocks. Geologically the district can be divided into five belts: southern Charnockitic rocks, Northern Gneiss, Syenite pluton in central, isolated capping of sedimentary rocks (Warkalli Formation) confined to coastal tract, Quaternary sediments of the coastal plain (District Survey Report, 2016). These rocks are extensively lateritised in most part of the district. It covers all the underlying rock formation except Quaternary deposits. Generally it is 5 to 15-metre-thick, hard, ferruginous and bauxitic at places (District Survey Report, 2016). The laterite is the main aquifer of groundwater as well.

The study area is also a lateritic terrain (Fig. 1.1) with thick sequence of laterite with no parent rock visible. Laterite in the area is ferruginous, porous and hard. Due to the porous nature the wells, laterite gets recharged fast and water escapes as subsurface flow.

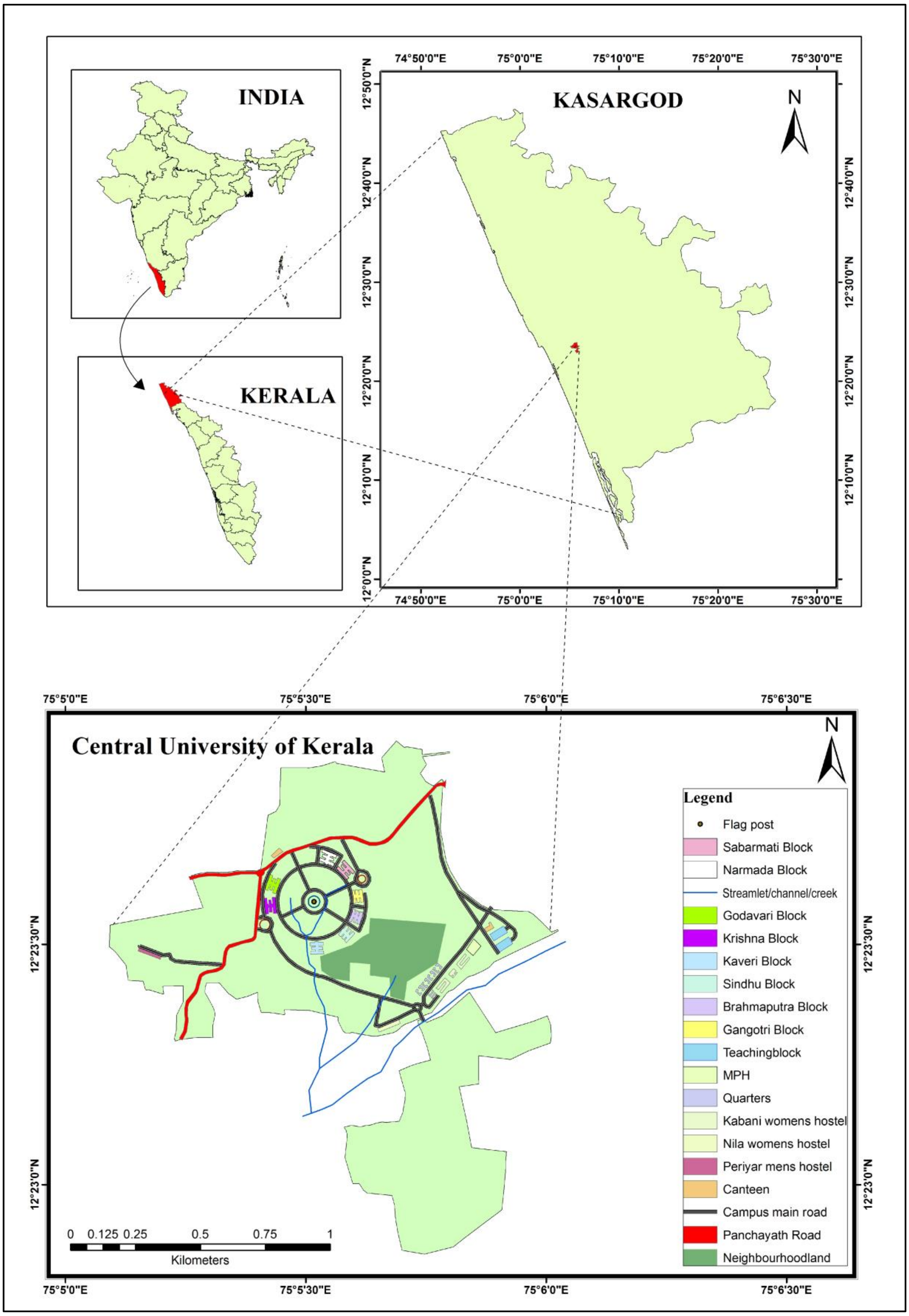

Fig 1.1. The location map of the study area (Central University of Kerala).

1.6. Soil

The laterite is covered by lateritic soil, having thickness of 0.5 to 1 meters. The laterite is generally underlain the lithomarge clay and which is the preliminary laterization front.

1.7. Climate

The district including the study area receives an average of about 3500 mm rainfall annually. The major source of rainfall is southwest monsoon from June to September which is contributing nearly 85.3% of the total rainfall of the year. The north east monsoon contributes only 8.9% and remaining 5.8% is received during the month of January to May as pre monsoon showers. Out of the 106 rainy days in a year, 87 days occur during south west monsoon (CGWB, 2013). The average mean monthly maximum temperature ranges from 29.2°C to 33.4°C and minimum temperature ranges from 19.7°C to 25°C (CGWB, 2013). The temperature is more during the months of March, April, May and less during December and January. Relative humidity is more during morning hours and less during evening hours. During the morning hours it ranges from 87.1% to 98.7% and during evening hours it ranges from 54.4% to 86.5%. The wind speed ranges from 2.1 to 3.3 km/hour. The wind speed is high during the months of March to June and less during the months of September to December. Sunshine ranges from 3.2 to 10.2 hours/day. Maximum sunshine is during the month of February. The months of June to August records the minimum sunshine due to cloudy sky. Good sunshine hours are recorded in the months of November to May.

CHAPTER 2

METHODOLOGY

2.1. Collection of water samples

The ground water samples from 6 borewells and 4 open wells were collected to assess the water quality. The water samples were collected in 1 litre plastic cans (Fig. 2.1). The bottles were cleaned and rinsed with water thoroughly prior to collection. The water samples were transported to laboratory immediately for analysis.

Fig. 2.1. Water samples in one litre plastic cans.

2.2. Measurement of pH, Electrical Conductivity, Total Dissolved Solids, Salinity

In situ measurement of pH, Electrical conductivity (EC), Total dissolved solid (TDS), Salinity and temperature of water samples were carried out using a portable water quality analyser. The Multi-Parameter PCSTestr 35 (EUTECH make; Fig. 2.2) was used for this purpose which has an accuracy of 0.01 pH and 0.01 conductivity, TDS and salinity and 0.5 ^{0}C temperature.

Fig. 2.2. Multi- Parameter PCSTestr 35 (EUTECH).

2.3. Measurement of Potassium

The concentration of potassium in groundwater sample was estimated using the flame photometer. Microprocessor Flame Photometer (ESICO, MODEL 1382) was used for this purpose (Fig. 2.3). The flame photometer was calibrated using standard samples of sodium, potassium and calcium. The flame photometer works on the principle that each metal emits a characteristic light intensity when it is introduced to the flame. The wavelength of colour and its intensity varies with respect to characteristic metals. The presence of sodium imparts a yellow colour to the flame while orange and lilac colours indicate calcium and potassium respectively. The concentration of each cation is displayed when the sample is introduced to the flame photometer through nebuliser.

Fig. 2.3. Microprocessor Flame Photometer (ESICO, MODEL 1382)

2.4. Measurement of Magnesium, Iron, Chloride, Sulphate, Fluoride and hardness

Palintest Photometer 7100 was used to estimate the concentration of cations like magnesium, iron and anions like chloride, sulphate and fluoride (Fig. 2.4). It works on the principles of optical absorbance and scattering of visible light. The Palintest photometric reagents create visible colours with specific analytes and intensity of colour produced is measured using the photometer and the data is compared with the calibrated data already stored in the device producing the results.

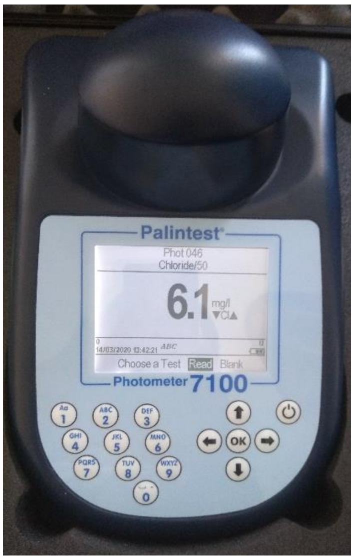

Fig. 2.4. Palintest Photometer 7100

About 10 ml of water sample was taken in a cuvette and inserted into the sample chamber as blank solution. Blank reading was taken after covering it with light cap. After that, blank solution is taken out and standard tablet (for respective ions) is crushed and dissolved in the sample. Then sample is inserted in to the chamber and reading was taken after selecting appropriate option in the Photometer. The concentration is displayed as mg/l.

CHAPTER 3

WATER QUALITY ANALYSIS OF OPEN AND BOREWELL SAMPLES

3.1. Water Quality Evaluation of domestic and drinking purpose

The quality of ground water plays an important role as it is used for human consumption and other domestic purposes. Ground water which occurs beneath the earth is considered to be free from contamination, but the anthropogenic and other natural factors affect the quality of ground water and the evaluation of the ground water is hence necessary (Jain et al., 2009). In the present study, the hydrochemical parameters of the water samples from 4 open wells and 6 bore wells of the study area are analysed and compared with established standards. The various parameters analysed and the data obtained for open and bore wells are given in Table 3.1.

3.2. pH

pH is a measure of the hydrogen ion concentration of a solution. Solutions with a high concentration of hydrogen ions have a low pH and solutions with a low concentration of H^+ ions have a high pH. The pH is less than 7.0 is considered to be acidic and its basic or alkaline when the pH exceeds 7. Neutral water has a pH of 7. pH values between 6.5 and 8.5 usually indicate good quality of water. The pH of the open well samples fall over a range of 6.8-7.5 with an average of 7.1. The water in the bore well exhibit pH value in 6.8 to 7.8 range. The value is within WHO and BIS standards.

3.3. Electrical Conductivity

Electrical conductivity (EC) in natural waters is the normalized measure of the water's ability to conduct electric current. Pure water will not conduct electricity. Most salts in water are present in their ionic forms and are capable of conducting current, hence it makes a good indicator to access ground water quality. Water with high conductivity values is objectionable to both drinking and can cause corrosion to industrial systems. The conductivity is a measure of the extent of mineralization that can be due to entrapment, ground water recharge and solubisation of minerals from soils (Paul and Sen, 2012).

Sample No	Location	pH	EC	TDS	Salt	K	Mg	Fe	Cl^-	SO_4^{2-}	F^-	Hardness
			µS/cm	ppm	ppm	ppm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
OW-1	Nila	7.5	213	151	103	1.9	3	0.01	17	4	0.28	75
OW-2	South Gate	7.4	192	137	93.6	1.94	2	0	24	3	0.02	70
OW-3	Teaching Block 1	7.25	187	130	89.5	2.4	5	0	2	1	0.17	65
OW-4	Sub-Station, TB1	7.7	302	214	144	2.3	2	0.01	4	4	0.3	95
BW-1	Brahmaputra	7.84	201	142	97.7	1.01	1	0.03	5	1	0.23	75
BW-2	Sindhu	6.8	88	62.4	47.3	0.74	2	0.01		5	0.21	30
BW-3	Kaveri	6.9	35.7	25.5	25	0.19	4	0.03	9	0	0	5
BW-4	Yamuna	6.81	32.9	30	28	0.04	1	0.02		0	0.22	5
BW-5	Kabini	7.1	41	28.9	27.8	0.12	1	0.01		1	0.04	10
BW-6	Krishna	7.5	38	26.4	31	0.005	0	0.25		4	0.06	5
WHO (2008)		6.5-8.5	-	1000	-	-	-	0.3	250	500	1.5	300
BIS (2012)	Desirable limit	6.5-8.5	-	500	-	-	30	0.3	250	200	1	200
	Permissible limit	6.5-8.5	-	2000	-	-	100	0.3	1000	400	1.5	600

Table 3.1. Physico-chemical parameters of groundwater samples from open and bore wells of CUK campus.

The conductivity range in open wells occurs between 32.9 and 41 μS/cm with an average of 36.9 μS/cm. In the bore well samples the conductivity occurs in a range between 88 to 302 μS/cm with an average of 197.2 μS/cm.

3.4. Total Dissolved Solids (TDS)

The total dissolved solids (TDS) indicate the concentration of all dissolved minerals and can be used as a measure of salinity (Suresh and Kottureshwara, 2009). The major salts dissolved in natural water includes carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron, manganese etc. High values of TDS can be due to high concentration of ions from minerals of the underlying rock or the soil layers and anthropogenic sources like fertilizers, organic matters from waste water and even acid rain. Excessive quantities of dissolved solids make water unsuitable for drinking, industrial and agricultural purposes. The TDS in open wells recorded a minimum value of 25.5 ppm and a maximum of 30 ppm with an average of 27.7 ppm. In bore well samples, the dissolved solids fall over a wider range from 62.4 to 214 ppm (average = 139.4 ppm). Thus, the water in open wells has a lower amount of dissolved solids. The water can be categorised as freshwater since it has total dissolved solids less than 1000 ppm. The range is well within WHO and BIS standards.

3.5. Salinity

Salinity is the total sum of dissolved particles and ions in ground water. Hence it is closely related to the total dissolved solids (TDS) and conductivity of water. It is commonly attributed to the presence of ions like chloride, bicarbonate, sodium, calcium, magnesium, sulfates and other trace ions. The source of these salts can be due to the dissolution of soil, rock or organic materials. The salt content in the waters of open wells is comparatively lower within a range of 25 to 31 ppm with an average value of 27.8 ppm. Water from bore wells have higher salinity range from 47 to 144 ppm with average salinity of 95.8 ppm.

3.6. Potassium

Potassium is one of the important alkali metalspresent in natural water and it is released during the process of weathering of the principal potassium minerals of silicate rocks are the feldspars orthoclase and microcline ($KAlSi_3O_8$), the micas, and the feldspathoid leucite ($KAlSi_2O_6$) (Sajil and James, 2016). In dilute natural waters the concentration of potassium will be almost similar to the sodium concentration. The values of potassium are found to vary from 0.01 to 0.2 ppm with an average of 0.09 ppm in open wells. 0.4 to 0.6 ppm is the common range of potassium concentration. The bore well samples have a slightly higher potassium concentration between 0.74 to 2.4 ppm with an average of 1.7 ppm.

3.7. Magnesium

Magnesium occurs in groundwater similar to calcium by the chemical weathering of rocks. The magnesium sources are silicate magnesium minerals, chiefly amphiboles, pyroxene, olivine and biotite (Bindu, 2014). Excess of Magnesium affects quality of soil, which results in poor yield of crops. Magnesium concentration in open well samples occur within a range of 0 to 4 mg/l with an average of 1.5 mg/l. Borewell samples exhibit Mg concentration of 1 to 5 mg/l (average = 2.5 mg/l). Thus, bore well samples, in general, contains higher concentration of magnesium attributing to its hardness as the mineral interaction with water and the resultant ions are more at greater depths. However, the range is well within WHO and BIS standards.

3.8. Iron

Iron is the second most abundant metallic element in the Earth's crust. Iron may be present in water in varying quantities, depending upon the geology of the area and other chemical components of the water way. The chemical behavior of iron and its solubility in water depend strongly on the oxidation intensity in the system in which it occurs; pH is a strong influence as well. The major sources of iron in the water resources are industrial wastes, mine drainage water and iron bearing ground water and are common in rocks. Iron in open well samples are observed within a range of 0.01 to 0.25 mg/l with an average of 0.08 mg/l. The analysis of bore well samples also showed a low iron content of 0 and 0.03 mg/l. Both the bore well and open well samples have concentration within the permissible limits prescribed by WHO and BIS (0.3 mg/l).

3.9. Chloride

Very low concentration of chloride indicates natural and unpolluted water. Excessive chloride concentration leads to salinity. Chloride in natural waters can be derived from varying sources such as weathering and leaching of sedimentary rocks and soils, domestic and industrial waste discharge or even sea water intrusion (Suresh and Kottureshwara, 2009). Only one open well sample exhibit chloride content with a value of 9 mg/l. The analysis of bore well samples resulted in slightly higher concentration of chloride from 2 to 24 mg/l (average = 10.4 mg/l). However, both are within the permissible limits (250 mg/l) of BIS and WHO. The low concentration of chloride is indicative of the purity of the water and less industries in the study area resulting in lower pollution rate.

3.10. Sulphate

Sulphate can be commonly found in all-natural water in appreciable quantities. The major sources of sulphate include sulphur minerals and sulphides of heavy metals which commonly occurs in igneous rocks and metamorphic rocks Sulphate is usually found in smaller concentration than chloride in water. Sulphate is one of the major dissolved components of rain. High concentrations of sulphate in the water we drink can have a laxative effect when combined with calcium and magnesium, the two most common constituents of hardness. The concentration of sulphate in the open well varies between 0 to 4 mg/l with an average of 1.25 mg/l. The bore well samples studied were found to have a sulphate concentration within 1 to 5 mg/l. Both the open well and bore well samples have sulphate concentration within permissible limits of water quality standards of BIS (200 mg/l) and WHO (500 mg/l).

3.11. Fluoride

Fluoride is an element commonly found in groundwater. Desired amount of fluoride present in ground water can be beneficial whereas higher concentration can lead to many health issues and other crisis. The natural sources of fluoride can be attributed to the weathering of fluoride bearing minerals like apatite, fluorite, biotite and hornblende. Agricultural fertilisers and combustion of coal are the anthropogenic sources of fluoride in groundwater (Brindha and Elango, 2011). The fluoride concentration in open well samples occurs within a range of 0 to 0.22 mg/l with an average of 0.08 mg/l. The bore well samples also have a lower concentration ranging between 0.02 and 0.3 mg/l. Therefore, the total fluoride concentration is considered to be low in the study area. All samples fall within the permissible limits of BIS (1 mg/l) and WHO (1.5 mg/l).

3.12. Hardness

Hardness is caused by compounds of calcium and magnesium, and by a variety of other metals. Hardness was originally a measure of the capacity of water to react with soap, where hard water requires more soap to create a lather. General guidelines for classification of waters are: 0 to 60 mg/L (milligrams per liter) as calcium carbonate is classified as soft; 61 to 120 mg/L as moderately hard; 121 to 180 mg/L as hard; and more than 180 mg/L as very hard. The hardness of open well samples vary between 5 and 10 mg/l (average 6.25 mg/l). Whereas, hardness of borewell water ranges from 30 to 95 mg/l (average = 68.3 mg/l). Hence, open well sample fall in to the category of ‘soft’ and bore well water ‘moderately hard’ category. However, the range is well within WHO and BIS standards.

CHAPTER 4

CONCLUSIONS

Water is an indispensable resource and assessment of its quality and quantity is essential for all life sustaining systems including the human society. Therefore, a better understanding of groundwater potential together with water quality assessment is very essential for planning and management of water resources. The ground water quality of the Central University of Kerala campus at Periye was evaluated by analysis of 10 water samples collected from both open wells and bore wells. The various physio-chemical parameters including temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), salinity, magnesium (Mg), potassium (K), iron (Fe), chloride (Cl), sulphate (SO_4), fluoride (F) and hardness were analysed. The values determined were then compared with water quality standards of BIS and WHO. The study documents a slightly higher concentration of various parameters for borewell water as compared to that of open well. However, the values of various physical and chemical parameters are within WHO and BIS standards. Hence, water from both open and bore well are suitable for drinking purpose.

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