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Hydrochemical Study of Patkai Campus: Dimapur Nagaland, India

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Abstract: *The quality of ground water for drinking purposes was assessed using the water assessment, the water for the groundwater of the area by subjecting the samples to a comprehensive physicochemical analysis for calculating the WQI, the following 11 parameters have been considered: pH, total hardness, calcium, magnesium, chloride, nitrite, sulphate, total dissolved solids, iron, manganese and fluoride. The analysis reveals that the ground water of the area needs some degree of treatment before consumption, and it also needs to be protected from the perils of contamination.*

Key Words; *Drinking water, Water Quality Index, TDS, pH, Treatment*

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I. Introduction

Water is an essential substance of life next to only air and is one of the principle elements which influence economic, industrial and agriculture growth of mankind. The quality of water and its management is a vital concern for mankind since it is directly linked with human welfare. Pure water can never be found in nature because pure water contain only two parts of hydrogen and one part of oxygen by volume. Water is also a good solvent due to its polarity; hence, water in nature contains a number of impurities in varying amounts. As water moves though the hydrologic cycle, it acts with atmosphere, soils and sub-surface geologic formations. This course of nature affects the chemical composition and its constituents. The water occupying all the roots within a geologic stratum is referred to as ground water. The secondary porosity developed as a result of weathering governs the total volume of water, a given aquifer can hold. Structural features like fractures and fault zones, subsurface barriers like dykes and sills, colluvial-alluvial deposits, weathered zones and vesicular lava are the favorable locations of groundwater repositories or aquifer. Groundwater makes about 30% of the world’s fresh water supply, which is about 0.61% of the entire world’s water, including oceans and permanent ice. Global groundwater storage is roughly equal to the total amount of freshwater stored in the snow and ice pack, including the North and South poles.

Our finding indicates that the proposed index allows the identification of water performance indicator by temporal and spatial comparisons. Benefits for decision makers and conservation practitioners include a flexible way of prioritization towards the domain with highest concern the broader community benefits from a comprehensive and user-friendly tool, communicating changes in water-quality trends more effectively (Smajgl et al., 2010)

Location of the Study Area.

Study area lies within the co-ordinate of N 25.79-N 25.81 Latitude and E 93.79-E 93.82 Longitude. It forms part of the survey of India (SOI) Top sheet no. s 83G/13(second edition) having an area of about 4.05sq.kms. The area is bounded by Chumukedima, Niuland and Patkai Hill on all the four direction namely North South West and East and is well connected with NH-29 and the commercial center of the state. The elevation of study area may vary from 192 to 237m in height (fig. 1).

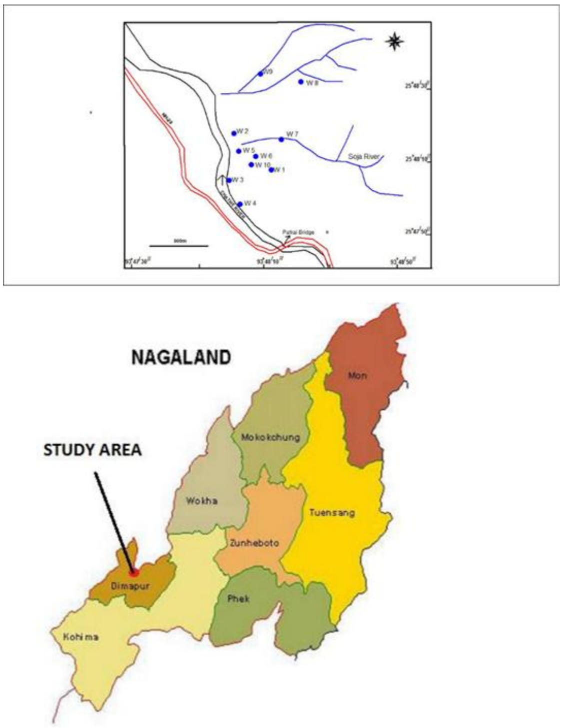

Fig. 1 Location Map of Study Area

General Geology

Dimapur valley is exposed on the North Western side of the outer most Belt of Schuppen known as the "Naga thrust" having strike in NE-SW direction and the remaining part of the district lies within the belt of Schuppen. Rock types and formations encountered in the region are of Tertiary to Quaternary period.

Drainage

The study area is drained by numerous seasonal and perennial streams and rivers. Diphu (Chathe) is the main river draining the area under investigation which is responsible for shaping the geomorphic landscape.Diphu (Chathe) River:It is located at the middle portion of the district flowing into Northern direction and finally converging with Dhansari River at 16 Kms away NNE from Dimapur city at 25°58'24.79"N Latitude, and 93°46'41.58"E Longitude. This perennial river drains a large area of Medziphema, Chumukedima and also parts of Kukhi River and, Dzumha, Dzuku River and Tsungu River (Fig. 2).

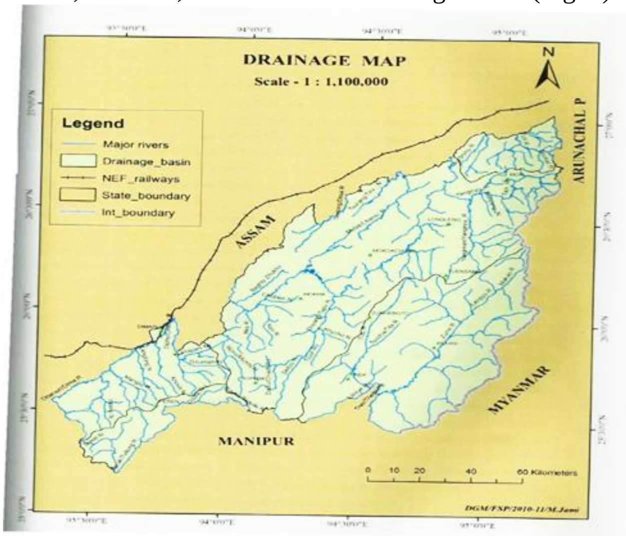

Fig. 2Drainage Map of Study Area

Climate

The climate is warm and temperate in Dimapur. Dimapur has a significant amount of rainfall during the year. This is true even for the driest month. According to Köppen and Geiger, the climate is classified as Cfa (Humid Sub-tropical). The average temperature in Dimapur is 24.0°C. The driest month is December, with 14 mm of rainfall. With an average of 275 mm, the most precipitation falls in July.

The average annual rainfall is 1504.7 mm. The minimum and maximum temperature is the lower plain valley area is 12°C to 37.06°C and has a relative humidity ranging from 74%to 93% during summer; however it is much lesser in the hilly areas where the maximum and minimum temperature varies from 7°C to 27°C. The district experiences a sub-tropical to cool temperature type of climate due to variation in altitude levels.

Vegetation:

Nagaland has lush green vegetation depicting the natural and the cultivated growth in the state. The lush foliage is dependent on the geography of Nagaland. The mountainous slope of the state of Nagaland is rich in the growth of natural vegetation. 8, 62,930 hectares of land or 20 percent of the total land area of the state is covered with the evergreen tropical and sub-tropical forests that are endowed with rich flora and fauna. The forests of Nagaland are enveloped in a dense growth of timber, palms, mahogany, rattan and bamboo trees. Some parts of the forest region are accessible to the people of the state with interiors are impenetrable and home to wild animals.

Geohydrology

Groundwater occurs both in unconsolidated and semi-consolidated formation of Dimapur district. Hydro-geologically, the district is divided into two districts units:-

- Semi-consolidated and
- Unconsolidated formations.

Semi-consolidated formation

Semi-consolidated formation constitutes the hilly terrains and their formation are sedimentary rocks belonging to Barail, Surma and Tipam of Tertiary age comprising of clay, shale, siltstone, ferruginous compact sandstone, pebbles and boulder beds. The rock show increasing degree of compacting from younger to older age. The area is highly disturbed due to tectonic activities in the past. The rock is well jointed and highly fractured. The area show predominantly run off character and ground water occurrence is attributed to development of secondary porosity like fractures, faults and joints etc. As joints are highly fractured, occurrence of ground water is manifested in the form of springs. The discharges of springs are seasonal or perennial depending on the amount of precipitation. They occur in altitude ranging from 300m above mean sea level (msl) to 1200m above msl. Surface water and springs are the only source of water to meet the requirement.

Unconsolidated formation

Unconsolidated formation occurs in the piedmont plains and intermountain valley fill areas along the foothills of Dimapur-Ghaspani areas with aquifer thickness varying from place to place with a limited aerial extend. This types of deposits are developed all along the foothills of Dimapur district. Lithology of the unit is made up of clay, slit, sand, gravels, pebbles, boulders and conglomerate beds of recent alluvial deposits.

Methodology and Instrumentation

Field Investigation

For this study, location of the well was done using GPS and toposheet; coordinates were recorded and marked on the map. The groundwater samples were collected during the pre-monsoon (February) in parts of the wells at the campus of Patkai Christian College (Autonomous) Chumukedima-Seithekema, Dimapur, Nagaland. Detailed studies have been carried out based on water quality aspects with references of drinking, agriculture, industries and drinking purposes. The work was carried out with available literature adding information as much as possible in understanding the groundwater structure, source and discharge and lithology of the area. Water samples were collected from the ring wells and shallow wells in the study area. The samples were stored in suitable containers (plastic bottles)

Fig 3 Collection of Samples in Study Area

Fig 4Collection of Water Sample in the Study Area

II. Methods of samples collection

The bottles in which the samples were to be collected were rinsed 2-3 times with water from the same source that is to be analyzed. In all cases polythene bottles were preferred since some of the metal compounds react with the silica case of glass containers. In the present study polythene bottles of 1½ liter (1500 ml) were used. The bottles were then filled up to the neck with the water samples as well as marked well wise and sealed properly just after the collection (fig4 and 5).

The collected samples were measured for major ions chemistry employing standard water quality procedures. Than it was compared with the national standards (IS) respectively to make sure it is within the recommended limits for human consumption or permissible limit.

Fig. 5 Water Sample Bottles

Laboratory Investigation

Total of 10 well water samples were collected from different areas of Patkai Christian College; Dimapur Nagaland and analyzed at Directorate of Geology and Mining Lab, Dimapur (Govt. of Nagaland). The water samples collected from the wells for analyzed for major ion chemistry, employing the standard water quality procedure (Brown et al., 1974) Hydrogen ion concentration (pH), Total Dissolved Solids (TDS) was measured using multi parameters water analysis kit. The Total Dissolved Solids (TDS) is computed by multiplying the electrical conductivity (EC) by a conversion factor verifying from 0.55 to 0.75, depending on the relative concentration of ions (Hem, 1991). Total Hardness (TH) as $CaCO_3$ and calcium (Ca^{++}) were analyzed titrimetically, using standard EDTA. Magnesium (Mg^{++}) was calculated from the TH and $Ca^{++.}$ Chloride (Cl^-) was determined by standard AgNO3 titration. Sulphate (SO_4^-) was analyzed using a spectrophotometer. All the chemical parameters, except pH (units), are expressed in milligrams per liter (mg/l) fig. 6 & 7.

Fig. 6 Analysis of Water Samples in the laboratory.

Fig. 7 Chemicals used for water analysis.

Water Samples Preservation and Analysis

From the studied area the selected wells are used for drinking, irrigation and domestic purpose. All the water samples were analyzed for 13 physical and chemical water quality parameters including: pH, iron, fluoride and major cations (calcium, magnesium) and major anions (chloride) in Directorate of Geology and Mining, Dimapur, Nagaland using standard methods for the examination of water as shown in Table 1.

Sl.no.	Parameters	Analytical methods
1	D.O	Multi-parameter water analysis kit
2	Calcium (mg/l)	Titration
3	Chloride (mg/l)	Titration (silver Nitrate), Method 4500-B, Standard Method (1992)
4	Carbonate (mg/l)	2320, Standard Method (1992)
5	Fluoride (mg/l)	U.V Spectrometer
6	Iron (mg/l)	U.V Spectrometer

7	Magnesium (mg/l)	U.V Spectrometer
8	Nitrate (mg/l)	Cd. Reduction (Hach – 8171) by Spectrometer
9	pH (mg/l)	Multi-parameter water analysis kit
10	Potassium (mg/l)	3500-B Standard Method (1992)
11	Sodium (mg/l)	3500-B Standard Method (1992)
12	TDS (mg/l)	Multi- parameter water analysis kit

Tab. 1 method used for water samples preservation and analysis

Hydrogeochemistry

Result and Discussion

The result obtained in this investigation called the ''Geochemical Studies of groundwater in the campus of Patkai Christian College (Autonomous), Chumukedima-Seithekima, Dimapur, Nagaland'' are discussed in table 2

Specific Conductance

Specific conductance is the conductance of one centimeter cube of the substances and is represented in micro-ohms/cm at 25°C. The presence of ions in the solution increases conductivity of water. The specific conductance of water samples from the study area varies between 283.67 to 1079.62 micro ohms/cm.

Total Dissolved Solids (TDS)

TDS is defined as the residue of filtered water sample after evaporation. The bulk of TDS includes Bicarbonates, sulphates and chloride of calcium, magnesium, sodium, potassium, silica, potassium chloride nitrate and boron. According to Hem (1959) {3} TDS was calculated using the relationship given below.

TDS (in ppm) = 0.64 * EC (in micro-ohms/cm)

Analysis of water samples of the study area revealed that the presence of TDS varies between 60 to 384 ppm

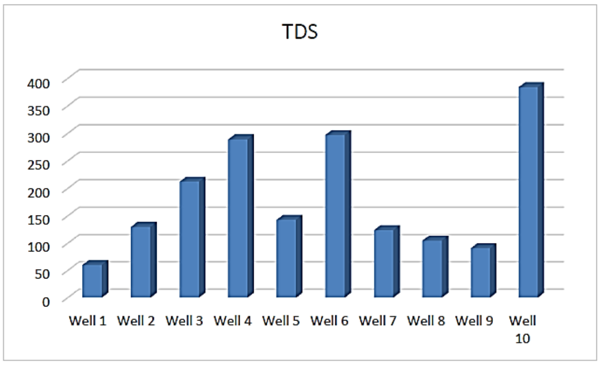

Fig. 8 TDS Graph of Study Area

Remarks: Figure 8 indicates that the TDS is within the acceptable limit of 500 mg/l in all the studied areas. Analysis of water samples of the study area revealed that the presence of TDS varies between 60 to 384 ppm.

Color: Color in groundwater results from degradation process in the natural environment. It may occur due to presence of humid acid, fluoric acid, metallic ions such as iron, manganese, suspended matter, industrial waste, etc. Color is expressed in terms of Hazan Standard Unit.

Odor and taste: These properties are derived from bacteria, dissolved gases (H_2S, methane, etc) mineral matter (Fe^-compounds, dyes, etc). Or phenols. The odor is expressed as disagreeable, earthy, moldy, peaty, sweetish etc. The taste is expressed as brackish, saline, salty etc. The odor and taste are reported in the threshold number.

Turbidity: It is a measure of suspended and colloidal matter in water, such as clay, silt, organic matter, organisms, urban and industrial waste. It is reported in mg/l. It makes the water unfit for domestic purposes and some industries, however it is negligible in groundwater.

The common parameters of water turbidity, pH, TDS and TH have been determined

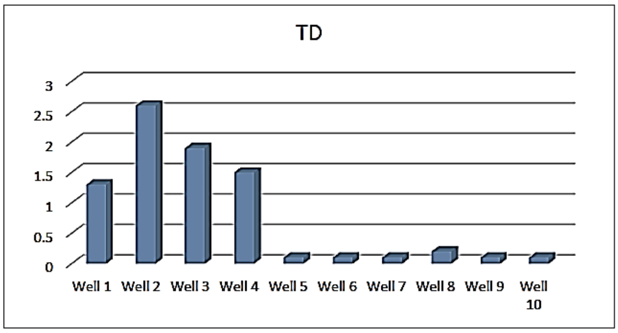

Fig. 9 chart showing turbidity in different wells in the studied area.

Remarks: The figure 9 indicates that Well no 1,2,3,4 have high turbidity than the acceptable limit i.e.,1.0 , where well no 2 has the highest concentration i.e., 2.6 mg/l .Well no 5,6,7 and 10 have the least(withinacceptable limit) i.e., 0.1 mg/l

Temperature: Groundwater temperature varies within wide limits. Below the zone of surface influence, groundwater temperature increases approximately 2.9 °C for each 100m depth in accordance with the geothermal gradient of the earth crust. The rise of temperature of water leads to the speeding up of solubility of gases and amplifies the taste and odor. Water in the temperature of 7^oC to 11^oC has pleasant taste and refreshing. At higher temperature with less dissolved gases, the water becomes tasteless.

pH (Potential of Hydrogen): It is a measure of the acidity or alkalinity of water. The natural water (H_2O) consists of H^+ ions with OH^- ions. The water becomes acidic (pH<7) when H+ ions are in excess than OH- ions and it becomes alkaline (pH>7), when reverse is the case. The neutral water (pH=7), the concentration of H^+ ions and OH^- ions are equal.

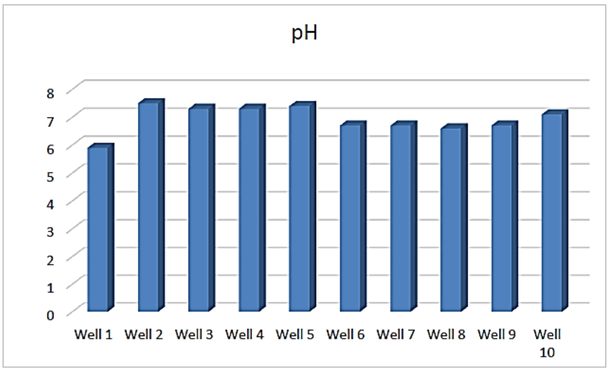

Fig. 10pH Levels of Studied Area.

Remarks: The figure 10 indicates that thepH levels is found to be within the desirable limit , except for one which is found to be below the acceptable limit i.e. Below 6.5, for instance pH reading of 5.9 was recorded in well no 1.

TH (Total Hardness): It is a soap-destroying power of water caused by the presence of Ca and Mg with the combination of CO_3, HCO_3, SO_4 and NO_3 constituents and is reported in mg/l. The TH of two types- temporary hardness (carbonate hardness), and permanent hardness (non-carbonate hardness). The former type is due to the purpose of HCO_3 of Ca and Mg, which can be easily removed by boiling the water, while the later is due to the presence of SO_4, Cl and NO_3 ions of Ca and Mg, which cannot be removed by boiling the water (fig. 11).

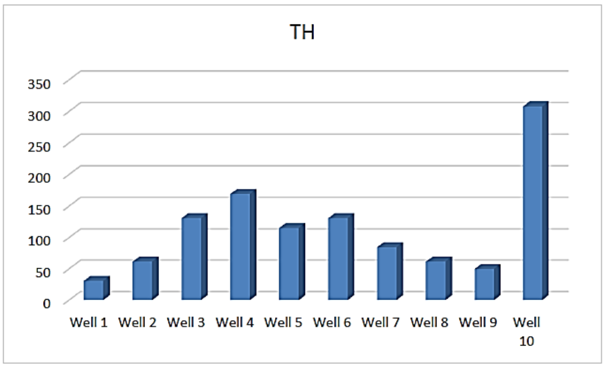

Fig. 11TH Levels of Studied Area.

Remarks: The figure 6.4 indicates that majority of the TH is found to be within the acceptablelimiti.e.,200mg/l, except for one which is found to be above the acceptable limit, for instance TH reading of 307.77 was recorded in well no 10.

TA (Total Alkalinity): The alkalinity of water is the measure of its capacity to neutralize acids. The alkalinity of water is due to salts of carbonates, bi-carbonates, borates, silicates and phosphates along with hydroxyl ions in the fluid state. It is a measure of amount of dissolved CO_3 and HCO_3 ions. The TA value in water is controlled by CO_2(Fig. 12).

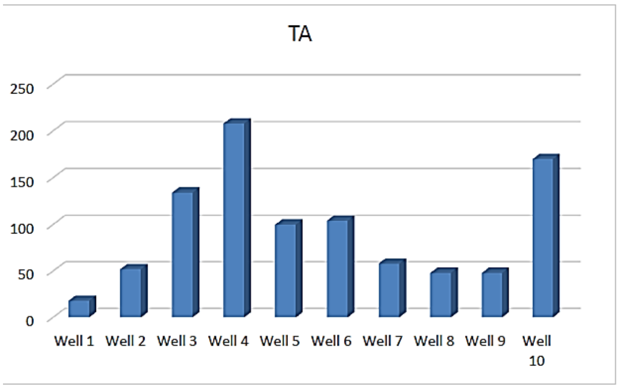

Fig. 12 Distributions of Total Alkalinity Concentrations in the Studied Area.

Remarks: Fig. 12 indicates that majority of the TA as $CaCO_3$is found to be within the acceptable limiti.e.,200mg/l, except for one which is found to be above the acceptable limit, for instance TA reading of 208 was recorded at well no 4.

Calcium: It is a major constituent of most igneous, metamorphic and sedimentary rocks. Principal source of Ca in groundwater are minerals like plagioclase, pyroxene and amphibole among igneous and metamorphic rocks and limestone, dolomite and gypsum among the sedimentary rocks. It is also present in sandstone and shale as the cementing material and absorb ion in soils and rocks. Groundwater generally contains Ca in the range of 10 to 100mg/l. Brine may contain as much as 75,000mg/l (Fig. 13 and Tab. 3).

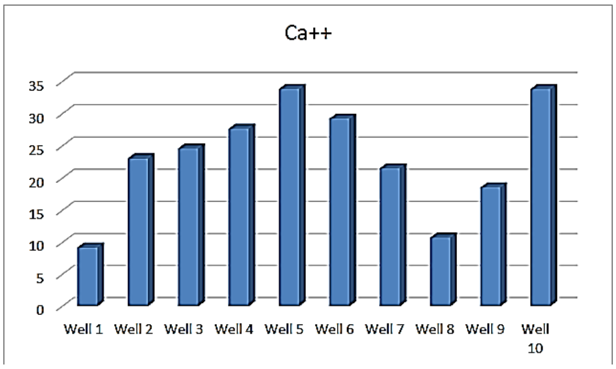

Fig. 13Distributions of Calcium inthe studied area.

Remarks: The fig. 13 indicates that all the calcium concentration at PCC falls within the acceptable limit i.e., acceptable limit is 70 mg/l.

Magnesium: Main source of magnesium in groundwater are dunite and basalt (igneous rocks); schist and amphibolites (metamorphic rocks), dolomite (sedimentary rocks), clay minerals and sea water. Similar to Ca content, the CO_2 can increase Mg in groundwater upto 200mg/l. In groundwater, the Ca content generally exceeds the Mg content in accordance with their relative abundance in rocks. General concentration of Mg is less than 50mg/l in groundwater, but in brines it contains as much as 57000mg/l (Fig. 14).

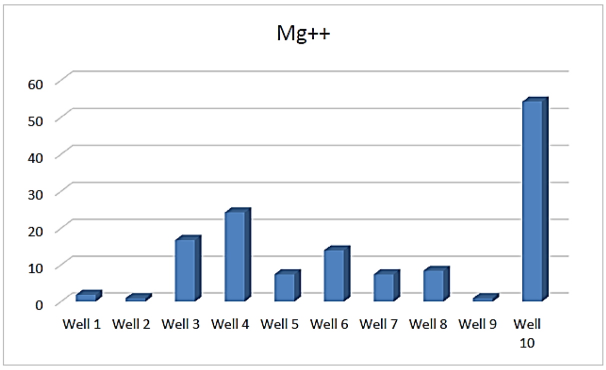

Fig. 14Distributions of Magnesium in the study area

Remarks: The figure 14 indicates that majority of the TH is found to be within the acceptable limiti.e.,30mg/l, except for one which is found to be above the acceptable limit, for instance reading of 54.22 was recorded in well no 10.

Sodium: The taste threshold concentration of sodium in water depends on the associated anion and the temperature of the solution. At room temperature, the average taste threshold for sodium is about 200mg/l. No health based guideline value has been given as the contribution from daily intake of drinking water is small.

Potassium: The common source of K are feldspar (orthoclase and microcline), potash fertilizers, feldspathoids, some nearly as abundant as Na in minerals of the earth's crust. It is also less than Na. Two factors are responsible for these phenomena- one being the resistance of K- minerals formed due to weathering. In groundwater, its concentration is usually 10mg/l and rarely exceeds 15mg/l. Thermal and brine water contain as much as 100 to 2,25,000mg/l respectively.

Chlorine: The content is generally low in rocks. Groundwater gets its chlorine from the ocean through sprays, trapped into rain traps. Other sources of chlorine in groundwater are evaporate deposits, hot springs, volcanic gases, connate water, clay minerals, urban, agricultural and industrial wastes, desert and coastal areas. The concentration of chlorine in groundwater is commonly less than 10mg/l in humid regions and is more than 1000mg/l in arid regions (Fig. 15).

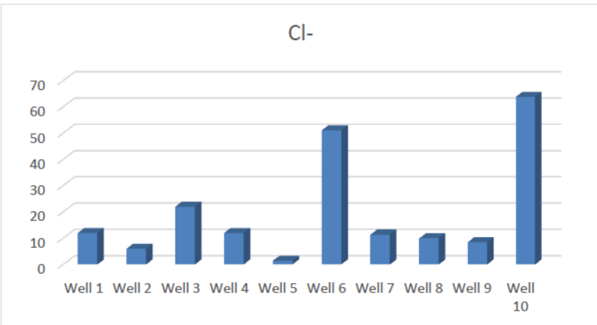

Fig. 15Distributions of Chlorine Concentration in the studied area.

Remarks: The figure 15 indicates that all the chloride concentration at PCC falls within the acceptable limit i.e., acceptable limit is 200 mg/l.

Fluorine: Fluorite, apatite, hornblende, micas and clays are the major contributors of fluorine in the groundwater. Other sources are chemical fertilizers, climate, drainage conditions and topography. The concentration of fluorine in groundwater is limited due to low solubility of its source material. Groundwater contains F generally less than 1mg/liter, but in some areas the concentration reaches above 5mg/liter (Fig. 16).

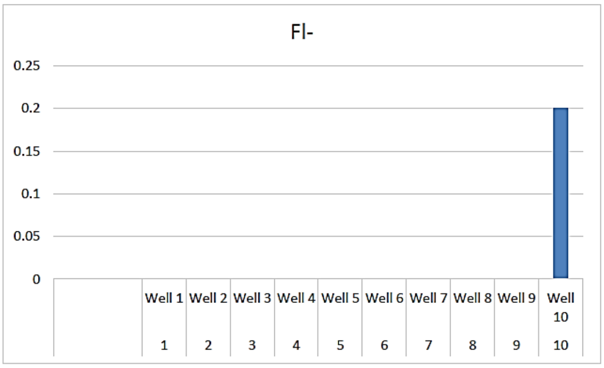

Fig 16Distribution of Fluoride Concentration in the Studied Area.

Remarks: Figure 16 indicates that the fluoride is within the acceptable limit of 1.0 mg/liter in well no 10, while in all the other studied area fluoride was not detected.

Sulphates: The presence of sulphate in drinking water can cause noticeable taste and very high levels might cause a laxative effect in unaccustomed consumers. Taste varies with the nature of the associated cations, taste thresholds have been found to range from 250mg/1 for sodium sulphate to 1000mg/1 for calcium sulphate. It is generally considered that taste impasement is minimal at levels below 250mg/liter. No health based guideline value has been derived for sulphate (Fig 17).

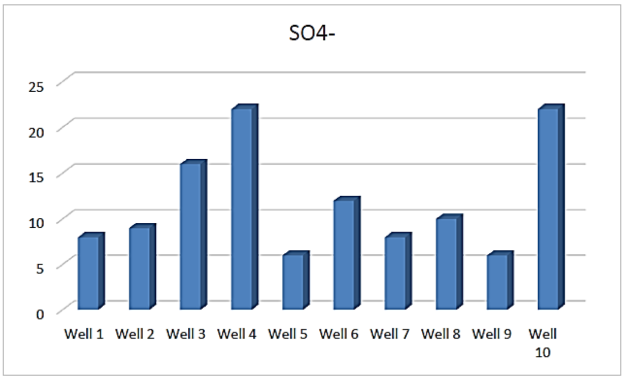

Fig 17Distributions of Sulphate Distributions in the Studied Area

Remarks: Figure 17 indicates that the sulphate is within the acceptable limit of 200 mg/literin all the studies area.

Iron: The Presence of Iron in drinking water can noticeable and high level might cause a laxative effect to consumers. Taste varies with the nature of the associated cations (fig. 18).

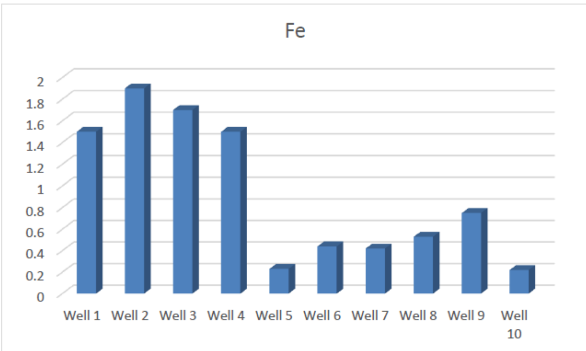

Fig. 18 Distributions of Iron Concentrations in the studied area.

Remarks: Figure 18 Indicates that majority of the wells i.e., well no 1,2,3,4,6,7,8,9 have high iron than the acceptable limit 0.3 , where well no 2 has the highest level of 1.9 mg/liter .

Trace elements: Trace elements includes Mn, B, Ar, Ba, Be, Bs, Cd, Cr, Co, Cu, Ni, Sn, Tn, Ti, and Zn. Generally these elements do not exceed 1mg/1 in groundwater. However, higher content of Zn, Cu and Pb can be found in mine water, having low pH.

Similarly Zn, Ar, and Pb are associated with ore-bodies and Cr, Cu, Pb, Cd, Ar, and Tn may occur through industrial disposal.

In analytical chemistry, a trace element is an element in a sample that has an average concentration of less than 100ppm measured in atomic count, or less than 100micrograns per gram. In biochemistry, a trace element is a chemical element that is needed in very minute quantities for the proper growth, development, and physiology of the organism. Trace elements are required by the human body for proper functioning but unlike most vitamins and minerals that our bodies need; trace elements are needed only in extremely low quantities. IN geochemistry, a trace element is a chemical element whose concentration is less than 1000ppm or 0.1% of rock composition. The term is used mainly in igneous petrology. Trace element will either prefer liquid or solid phase. Compatible with a mineral, it will prefer a solid phase (e.g. Ni compatible with olivine).

Radionuclide: These are unstable nuclide that tend to decaying to other species of nuclide and are measured in micron curies (M c). Uranium (U235 and U232) is present in groundwater generally in the range of 0.00005 to 0.00001mg/1. radon (Rn232) is usually less than 3×10-5Mc/ml. tritium (H3) ranges between 1 to 10 tritium units (TU), each unit producing roughly 3.2×10-9Mc/ml activity.

Dissolved gases: Most groundwater contains dissolved gases derived from natural sources. Those involved in the normal geochemical cycle of groundwater include the atmospheric gases-carbon dioxide (CO2), oxygen (O2) and nitrogen (N2). Other derived and hydrogen sulphide (H2S). The solubility of gases varies directly with pressure and inversely with temperature.

Biological impurities: Bacteria and micro-organisms present in water are too small to be seen by the naked eye. Some of the bacteria are harmless; while some are disease causing bacteria know as pathogenic bacteria. Coliform, which are present in the intestine of human beings and other warm-blooded animals, are transmitted through faecal matter. Although coloforms are harmless; their presence in groundwater indicates the possibility of the presence of the pathogenic bacteria. Actinomycetes and fungi can be abundant in surface water source, including reservoirs and they can also grow on unstable materials in the water supply distribution system such as rubber. They can produce geosmin, 2-methyl isoborneol and other substance, resulting in objectionable tastes and odors in the drinking water. Blooms of cyano-bacteria and other algae in reservoirs and river water may impede coagulation of filtration, causing colration turbidity of water after filtration. They can also produce geosmin 2-methyle isobormeal and other chemicals, which have taste threshold in drinking water of a few nanograms per liters.

Remarks: Figure 18 Indicates that majority of the wells i.e., well no 1,2,3,4,6,7,8,9 have high iron than the acceptable limit 0.3 , where well no 2 has the highest level of 1.9 mg/l.

Graphical Presentation of Hydrochemical Data.

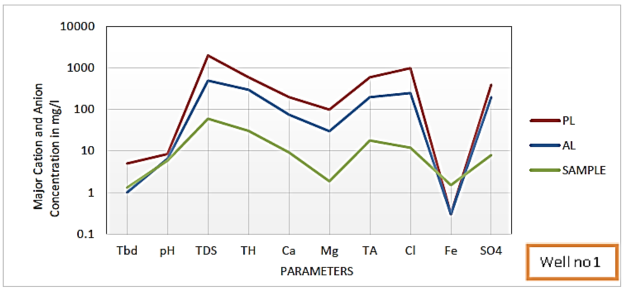

Fig. 19Well 1 *Result* as Per BIS

Remarks: The above water sample doesn't conforms to IS: 10500-2012(Second Revision), Drinking water specification with respect to the test conducted for Turbidity, pH and Total Iron

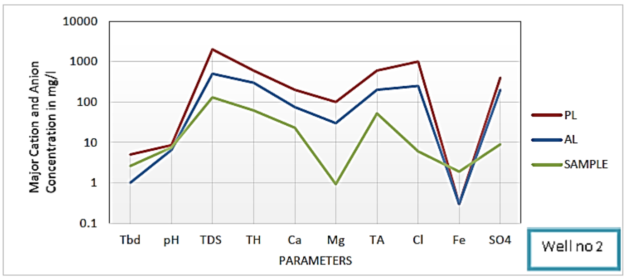

Fig. 20Well 2 Results as Per BIS

Remarks: The above water sample doesn't conforms to IS: 10500-2012(Second Revision), Drinking water specification with respect to the test conducted for Turbidityand Total Iron.

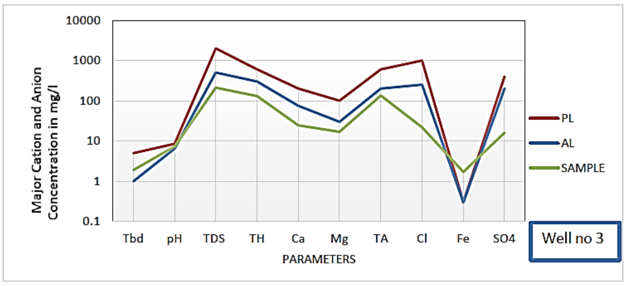

Fig. 21 Well 2 Results as Per BIS

Remarks: The above water sample doesn't conforms to IS: 10500-2012(Second Revision), Drinking water specification with respect to the test conducted for Turbidityand Total Iron.

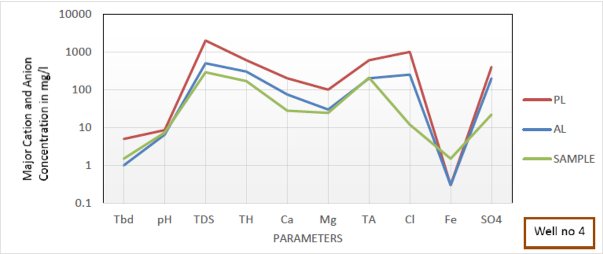

Fig. 22 Well 2 Results as Per BIS

Remarks: The above water sample doesn't conforms to IS: 10500-2012(Second Revision), Drinking water specification with respect to the test conducted for Turbidity, Total Alkalinity and Total Iron.

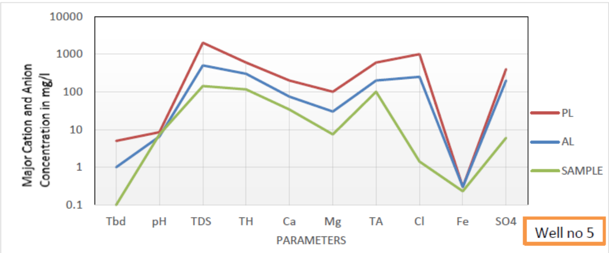

Fig. 23 Well 2 Results as Per BIS

Remarks: The above water sample conforms to IS: 10500-2012(Second Revision), Drinking water specification with respect to the test conducted.

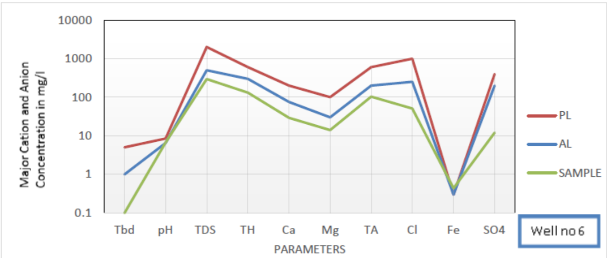

Fig. 24 Well 2 Results as Per BIS

Remarks: The above water sample doesn't conforms to IS: 10500-2012(Second Revision), Drinking water specification with respect to the test conducted for Total Iron.

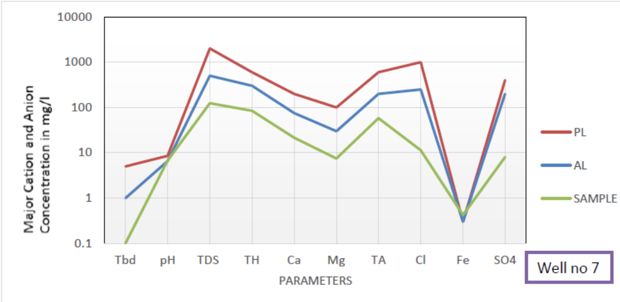

Fig. 25 Well 2 Results as Per BIS

Remarks: The above water sample doesn't conforms to IS: 10500-2012(Second Revision), Drinking water specification with respect to the test conducted for Total Iron.

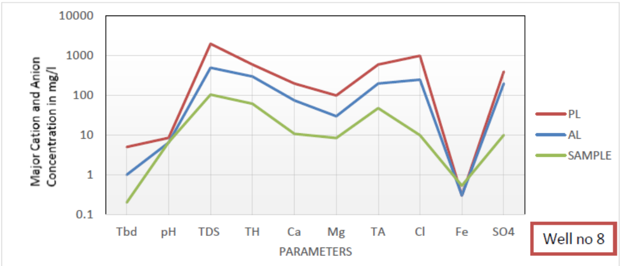

Fig. 26 Well 2 Results as Per BIS

Remarks: The above water sample doesn't conforms to IS: 10500-2012(Second Revision), Drinking water specification with respect to the test conducted for Total Iron.

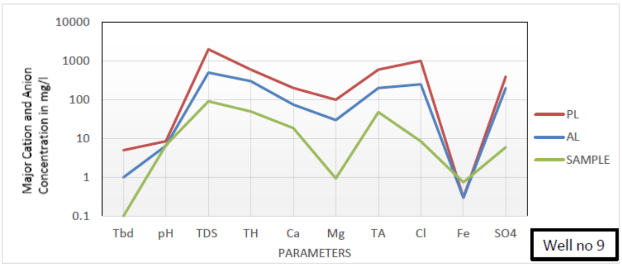

Fig. 27 Well 2 Results as Per BIS

Remarks: The above water sample doesn't conforms to IS: 10500-2012(Second Revision), Drinking water specification with respect to the test conducted for Total Iron.

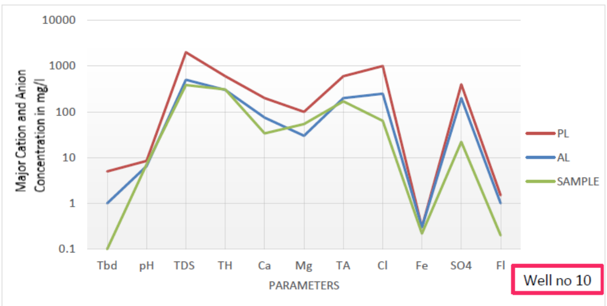

Fig. 28 Well 2 Results as Per BIS

Remarks: The above water sample doesn't conforms to IS: 10500-2012(Second Revision), Drinking water specification with respect to the test conducted for Total Hardness and Magnesium

Tab. 2Sources/Wells Which Exceed The Maximum Permissible Standards For Drinking Water.

BIS ,IS: 10500-2012(Second revision)		Data	
Parameters	Acceptable limit	No. of samples exceeding the maximum permissible limit	Well no. exceeding the Requirement (Acceptable limit)
TD (mg/l)	1	4	1,2,3,4
pH (mg/l)	6.5-8.5	nil	-------
TDS (mg/l)	500	nil	-------
TH (mg/l)	200	1	10
Ca++ (mg/l)	75	nil	-------
Mg++ (mg/l)	30	1	4
TA (mg/l)	200	nil	-------
Cl- (mg/l)	250	nil	-------
Fe (mg/l)	0.3	8	1,2,3,4,6,7,8,9
So4- (mg/l)	200	nil	-------
Fl- (mg/l)	1	nil	-------

Tab. 3Calcium chloride hardness of water result per United States geological survey

Range(mg/l)	Description	Well No.
0-60	Soft	1,9
61-120	Moderately hard	2, 4, 5 ,7 ,8
121-180	Hard	3, 6 ,10

III. Conclusion

The interpretation of hydro-chemical analysis collected from 10 wells of PCC reveals that. Comparison of data with Bureau of Indian Standard (IS: 10500 (2012) Drinking Water Specification (Second Edition) only well no 5 conforms to all the standards with respect to test conducted.The result shows higher concentration of iron than the acceptable limit 0.3 i.e., 8 out of 10 wells in total exceed the limit. The highest ranging from 1.5 to 1.9.Turbidity is also found to be high in some samples as welli.e., 4 out of 10 wells.Many of the test results from wells do notconforms to Bureau of Indian Standard (IS: 10500 (2012) Drinking WaterSpecification (Second Edition).The only pH value which do not conforms to the BIS standard is from well No. 10,which show a lesser pH value than the acceptable limit i.e., 5.9 to that of acceptable limit of 6.5-8.5. Magnesium occurrence at well No. 10 show higher concentration than the acceptable limit of 200 i.e., 307.77. Likewise total alkalinity shows 208 while the acceptable limit is only 200.Fluoride was detected only in well No. 10, which occur within the acceptable limit.

Sample ID	Locality	Parameters										
		Turbidity	pH	TDS	T.Hmg/l	Ca++ mg/l	Mg++ mg/l	T.A mg/l	Cl- mg/l	Fe mg/l	SO4- mg/l	Fl- mg/l
1	Well 1	1.3	5.9	60	30.78	9.23	1.87	18	11.97	1.5	8	ND
2	Well 2	2.6	7.5	130	61.55	23.08	0.93	52	5.99	1.9	9	ND
3	Well 3	1.9	7.3	212	130.8	24.62	16.83	134	21.98	1.7	16	ND
4	Well 4	1.5	7.3	289	169.27	27.69	24.3	208	11.96	1.5	22	ND
5	Well 5	0.1	7.4	143	115.41	33.86	7.48	100	1.42	0.23	6	ND
6	Well 6	0.1	6.7	297	130.8	29.24	14.02	104	51.04	0.44	12	ND
7	Well 7	0.1	6.7	124	84.64	21.54	7.48	58	11.34	0.42	8	ND
8	Well 8	0.2	6.6	105	61.55	10.77	8.41	48	9.93	0.53	10	ND
9	Well 9	0.1	6.7	91	50.01	18.56	0.94	48	8.5	0.75	6	ND
10	Well 10	0.1	7.1	384	307.77	33.85	54.22	170	63.81	0.22	22	0.2

Tab.4Result of the Analysis of Water Samples

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