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Assessment of Physico- Chemical Quality of Drinking Water in Araku Valley Mandal of Visakhapatnam District, Andhra Pradesh, India

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Abstract:
Water is an essential unique universal solvent needed for any living organism. Life is not possible on this planet without water. Drinking water quality is directly related to health. The world's thirst for water is likely to become one of the most pressing issues of the 21st century. The study was conducted for different(12) water quality parameters, for five water samples collected from different sources (bore, open well, spring) basing on the consumption level of the local tribals of Araku valley, Mandal, Visakhapatnam District, Andhra Pradesh, India, and analyzed, for their physico-chemical parameters. The analysis include physical and chemical parameters are pH, EC, Turbidity, Hardness, TDS, F, DO, Mg, Cl, Ca, No3, SO_4 etc. On comparing the results against the drinking water quality standards lead by BIS (ISO:100500,1994) and WHO, It was observed that the parameters, Total solids, Electrical conductivity and turbidity was higher than the prescribed limits while other parameters were lower than the limits. On comparsion of the consumptional drinking water sources, the well water and spring is more contaminated than the bore. The results showed that, the water in this area is not safe and needed treatment before it is consumed by the local tribal people.

Keywords: *Physical, Chemical parameters, drinking water WHO, BIS, TDS, DO*

1. Introduction

Water is essential for survival. In many parts of the world today ground water is the only source of fresh water where surface waters are either absent or polluted (Haniffa et al., 1993). Man's continual existence depends very much on its availability (Lamikanara 1999, FAO 1997). The provision of portable water to the rural and urban population is necessary to prevent, health hazards (Leno 2002). Before water can be described as potable, It has to comply with certain physical, chemical and microbiogical standards, which are designed to ensure that the water is palatable and safe for drinking. Potable water is defined as water that is free from diseases producing microorganisms and chemical substance deleterious to health. In present study, water is obtained from sources such as springs, wells and bores. A supply of safe drinking water is needed for human development, health and well being. Chemical contamination of drinking water is often considered a low priority than microbial contamination by regulators, because adverse health effects from chemical contamination are generally associated with long term exposure, where the effects from microbial contamination is usually immediate (WHO, 2007) Raj Pramukh et al.,(2004) emphasized that safe drinking water could make a tremendous impact on the quality of life in many villages, because availability of safe drinking water has a direct impact on the working conditions and health of the people and their productive capacity. Spring water is vital to man's existence, early human civilization centered on spring and streams. When ground water appears on the surface, are formed springs. Springs are a good surface of water supply for small towns, especially near hills or bases of hills. Spring water is also likely to contain minerals dissolved from subsoil layers. Water of good drinking quality is of basic importance to human physiology and man's continued existence depends very much on its availability (Lamikanra, 1999; FAO, 1997). The provision of portable water to the rural and urban population is necessary to prevent health hazards (Lemo, 2002). Before water can be described as potable, it has to comply with certain physical, chemical and microbiological standards, which are designed to ensure that the water is potable and safe for drinking (Tebutt, 1983).

Thus, there is a need to look for some useful indicators, both chemical and physical that can be used to monitor both drinking water operation and performance. The study area has no major industry in and around, yet household waste water and agricultural runoff are directly discharged into the area.

The main objectives of the study include:

- To assess the quality of drinking water consumed by Tribal Community by Physical, Chemical parameters.

- To find the possible impacts of ground and surface water pollution.

2. Materials and Methods

2.1. Study Area

The study area is located in Araku valley regions which are on the northeastern part of of Visakhapatnam district, Andhra Pradesh India. The Araku division consists of the hilly regions covered by eastern Ghats with an altitude of about 900 meters dotted with several peaks exceeding 1200 mts above the sea level. The area lies between longitude of E 18^o 10' 0" N and latitude E 83^o 0' 0" E. The climatic conditions are cool in this area on an account of green vegetation, elevation and thick forest. The temperature gets down on the onset of the south west monsoons and its tumbles to a mean minimum of 4^{o}c by January of every year, after which there is a reversal trend till the temperature reaches to mean maximum of 34^{o}C by the end of May, that is April to June are the warmest months. The area receives an average rainfall is 178.1cm on every year.

2.2. Sample Collection

Water samples were collected from Open wells, bore wells and springs at different villages from Sunkarametta panchyat of Araku valley mandal, Visakhapatnam district Andhra Pradesh, India. The sites are represented in Table 1. The samples are obtained according to the consumption of the local tribal community. Samples were collected in a clean plastic can of 2 lit capacity for physico-chemical analysis, the samples collected, serves as a representative sample. The collected samples were transferred to the laboratory by following all the precautions laid by standard methods (APHA, 1995). Temperature, Electrical Conductivity PH, DO were determined within the field of collection, the other parameters like TDS, Ca, Mg, NO_3, SO4,chlorides, fluorides etc. Were analyzed in the laboratory within the stipulated period. Physical and Chemical parameters are analyzed as per the standard method assessment of Ground water quality prescribed in standard method for the examination of water and wastewater American public health association (APHA 1995)

2.3. Sample Location and Samples Collected: Table-1

S. no	Name of sampling area	Sample code	Longitude Latitude
1	MADAGADA(Spring)	S_1	N 18° 10′ 44.3″ E 82° 57′ 57.7″
2	SARABAGUDA(Well)	S_2	N 18° 10′ 44.3″ E 82° 57′ 57.7″
3	BEDDAGUDA(well)	S_3	N 18° 19′ 53″ E 82° 49′ 44.3″
4	PANIRANGINI (Bore)	S_4	N 18° 17′ 92″ E 82° 47′ 36.5″
5	PADMAPURAM(Well)	S_5	N 18° 14′ 27.3″ E 82° 42′ 44.0″

Table 1

2.4. Analysis

A total of 5 samples were collected from Oct 2012 respectively in Table1. The temperature was determined using a mercury thermometer (Tenson Delux male) on the spot,and the pH was measured by pH meter (Elico make) Electrical conductivity was measured by using a digital conduct meter (systronic make). The conductometre was calibrated using 0.1 N KCL solution and (systematic make) Nephlo/Turbido meter was used for turbidity determination. The samples are also analyzed for TDS, Total hardness, nitrate (NO_3), calcium, Mg, chloride by using Titration methods. DO was determined by WINEUR'S Iodometric method. The Flouride was determined by SPADAN'S Spectrophotometric. Method. (Systronic make). Turbidimetric method was employed for the estimation of sulfate (SO_4), nitrate amount was derived by using the phenol disulphonic acid method. All the results were compared with the BIS (ISO-100500, 1994) and WHO standards for drinking water quality.

3. Result and Discussion

The result and comparison of sample parameters with the WHO and BIS standards of drinking water quality are presented in the following table: 2

s.no	parameters	S_1	S_2	S_3	S_4	S_5	ISO(10500:2004) (Desirable limit)	WHO (Maximum allowable limit)
1	PH	6.0	6.2	7.4	7.1	6.9	6.5-8.5	6.5-8.5
2	TURBIDITY	5.0	10.3	7.5	5.8	9.3	5-10 NTU	
3	CONDUCTIVITY	200	130	250	222	633	300-400us/cm	-
4	TOTAL SOLIDS	1380	930	1350	1560	1423	500mg/L	-
5	TOTAL HARDNESS	84	52	52	92	144	300mg/L	-
6	CALCIUM	44	40	26	24	20	75mg/L	75mg/L
7	MAGNESIUM	40	22	36	68	24	30mg/L	50mg/L
8	CHLORIDES	12.7	32.7	16.5	14.6	10.9	250mg/L	250mg/L
9	FLOURIDES	0.79	0.87	0.64	0.74	0.84	1mg/L	1.0-1.5mg/L
10	SULPHATES	0.90	0.92	1.83	1.92	0.85	200mg/L	500mg/L
11	NITRATES	BDL	0.5	BDL	BDL	0.5	-	3mg/L
12	DO	4.9	1.2	5.6	5.9	5.4	-	5.0mg/L

Table 2: WHO-World Health Organization

3.1. pH

In the present study the pH recorded varied from 6.0 to 7.1 with a mean pH of 6.72. Low ph-value 6.0 was recorded in the MADAGADA spring water sample and high pH value7.0 was recorded in Beddaguda (Well water sample). The maximum permissible limit of WHO is 6.5- 8.5. The pH levels were in permissible limits in all the water samples. Though pH does not have a direct effect on health, all biochemical reactions are sensitive to the variation of pH [Jeyakumar et al., 2003]. It was observed that the relative quantities of calcium, carbonate, and bicarbonates influence the pH value of water. The water tends to be more alkaline when it possesses carbonates (Zafar, 1996; suryanarayana, 1995).The pH of all the samples was within the permissible limits of WHO.

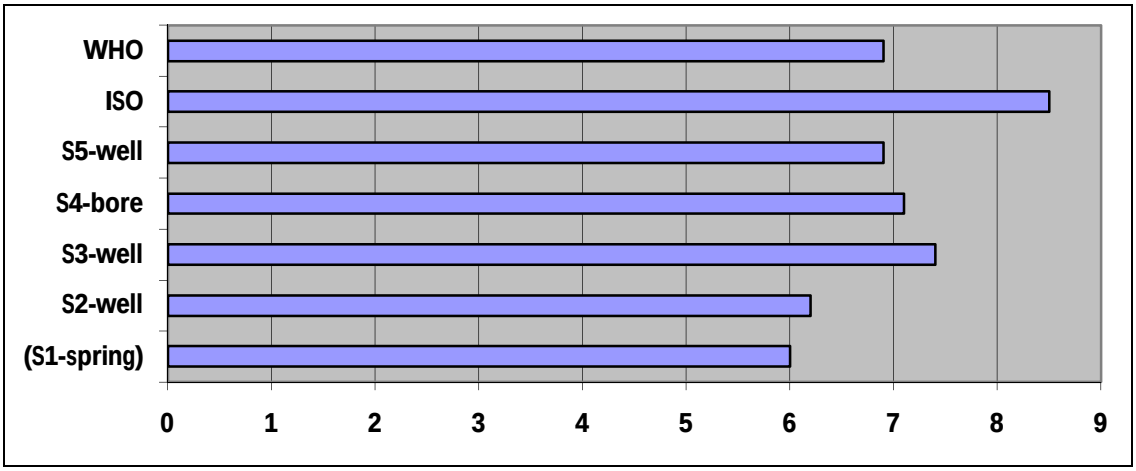

Figure 1: pH variations of the different soures

3.2. Turbidity

The turbidity indicates clarity of water and is caused by living and nonliving suspended matter and color producing substances. The readings of the Sarabaguda (.open well),BEDDAGUDA (well), PANIRANGINI(bore) were above the WHO and BIS standards with the values of 10.3NTU, 7.5NTU and 9.3NTU respectively, Presence of suspended particles and other materials are usually responsible for high turbidity values, similarly higher turbidity values were reported by(medudhula et al., 2012.) The soil particles may have found their way into the waters from the unstable side's thereby increasing turbidity of the water. (Garg et al ., 2006) . The presence of inorganic nutrients such as nitrogen and phosphorus, which mat stimulate the growth of algae, also contribute to turbidity (Sawyer, ect, all 2000). In the study turbidity was not within acceptable limits if BIS.

3.3. Electrical Conductivity

The amount and nature of many dissolved substances in the water influence their ability to Electric Conductivity. The recommended permissible limit for electrical Conductivity is 300 us/cm to 400µs/cm. By analyzing, 90% of the samples showed Electric Conductivity ranged from 130-633 us/cm, lower than the permissible units, except the sample in Padmapuram (spring) and well water samples, respectively.recorded 633 us/cms and 250 us/cms, The Electrica conductivity found higher than the limit in spring water this may be due to the higher concentration of total dissolved solids. Kuchekar S.R. et al.,(2008) observed that the Electrical conductivity of water samples was higher in monsoon than in the post monsoon the reason may be during monsoon, the slit carried through runoff got mixed with the water and resulted in high Electrical conductivity. The similar observations were reported by Rao N.S, et al.(2004).

3.4. Total Dissolved Solids

Total dissolved solids are a measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro granular suspended form Balachandar.D et al, (2010).. The minimum values were recorded to be 930 mg / L in PANIRANGINI bore water, whereas the maximum value of 1560 mg/L was noted in MADAGADA spring water. The concentration in spring samples that is BEDDAGUDA and MADAGADA recorded 1350mg/L and 1380 mg/L respectively, which above the permissible limit, however high total dissolved solid in found in the bore water are below the concentration of bore water. Though the total solids concentrations lower than the WHO & BIS values still indicated the pollution (Christopher 2011). The low level of TDS indicates that the recharging of underground water through either rain water or by the water from nearby canals (Gupta 2009).

3.5. Total Hardness

Total Hardness ($CaCO_3$) of all the samples were ranged between52mg/L to144 mg/L, and recorded total hardness, low in all samples when compared with the BIS standards. The Hardness is due to due to the presence of calcium, Magnesium, chlorides and Sulphate Ions which range from 52- 144 mg/L. The total hardness value of KINANGUDA well water was found maximum with 144mg/L and PANIRANGINI (bore) recorded minimum with 52 mg/l . The maximum persisted limits (WHO) is 300-600 mg/l Hard Water chokes water pipes deposits incrustation on utensils and increase soap consumption Nabanita Haloi(2011) .

3.6. Calcium

The calcium content of the sample ranged from 20-44 mg/L.The minimum value was found to be 20 mg/L in PADMAPURAM open well and maximum concentration was found in spring water sample of MADAGADA i.e. 44 mg/L, the values were below permissible limits. Calcium may be added to water system as it passes through soil and rock containing large amounts of these elements in mineral deposits (Renn, 1970).

3.7. Magnesium

The magnesium concentration in PADMAPURAM which is a well water sample is maximum and it is 124 mg/L and at SARABAGUDA is well water sample with 22 mg/L. When compared with other samples, the values of magnesium in all water samples are below the permissible limit, according to the WHO the limit is 30mg\L. Total hardness, calcium hardness and magnesium hardness were found to be below the permissible limits similar observations were recorded by Geeta(2012).Hardness has no adverse effect on human health and the water with hardness of 200mg/L may cause the seal deposition in water distribution system and more soap consumption. Water with hardness less than 100mg/L is more corrosive for water pipes(WHO 1992).

3.8. Chlorides

In the current study Chlorides ranged from 10.9 mg/L to 32.7mg/L which are below the permissible limit of 250mg/ l(BIS 1991), though chlorides below the permissible limits its presence denotes pollution hence required treatment before use. The minimum concentration was found in PADMAPURAM open well i.e 10.9mg/L whereas maximum is recorded in SARABAGUDA which is a spring 32.7 mg/L value when compared to other sources, when comparing the maximum concentration may be due to minerals in well water than the surface spring water.In general chlorides occurs in all types of waters contribution of chloride in ground water is due to minerals(Das and Malik1998).

3.9. Sulphates

The sulphates values were found to be below the permissible limit of 200mg/L (BIS, 1991) . The minimum values were 0.85mg/l in PADMAPURAM open well water, whereas the maximum value was 1.92mg/l in PANIRANGINI bore sample, may due to dissociation of mineral content. The intermediate value was noted in the PANIRANGINI (bore). Sulphate is the most common ion present in water. It can produce a bitter taste at high concentration. One of the occurrences of Sulphates in natural waters, maybe the breakdown of Organic substances in the soil (Alexander 1961).

3.10. Nitrates

Nitrates generally occur in trace level in surface waters, but may attain high levels in some ground waters one of the reasons may be application of fertilizers to lands also contribute nitrate to ground water (Peavy et al., 1986). The maximum value is 0.5 mg/L noted in SARABAGUDA and BEDDAGUDA both are open well water samples and the minimum is negligent, below the dectactable level, (BDL). In PANIRANGINI bore water, MADAGADA which is spring, BEDDAGUDA is an open well water sample. The nitrates concentration in all the samples were below the desirable limits (BDL).

3.11. Flourides

The presence of fluoride in drinking water is essential and WHO (1984) prescribed limits is 1.5 mg/L. The fluoride concentration in SUKURGUDA which is a well sample was observed maximum with 0.87 mg/l where as minimum at BEDDAGUDA which is a spring sample with a value of 0.64 mg/L, when compared with the other samples. Flouride concentration of 1mg/l in drinking water has no biological side effects (Leone et al 1954). It can enter human body through food, toothpaste, mouth rincers and other edible products.

3.12. DO (Dissolved Oxygen)

It is one of the most important parameter in evaluating water quality and signifies the physical and biological dealing with the water supply. The oxygen content in water samples depends on a number of physical, chemical, biological and microbiological processes (Nurchihan et al., 2009). The minimum value was noted in SARABAGUDA well sample 1.2 mg/L, whereas maximum value was noted in PANIRANGINI which is a bore sample recorded a 5.9 mg/L All the values was observed to be little above to permissible limits of the WHO standards which is 5mg\L.

Graphical representation of the comparison of the physico-chemical parameters with the ISO and WHO standards.(All values are in mg/L except pH, Electrical conductivity, and turbidity)

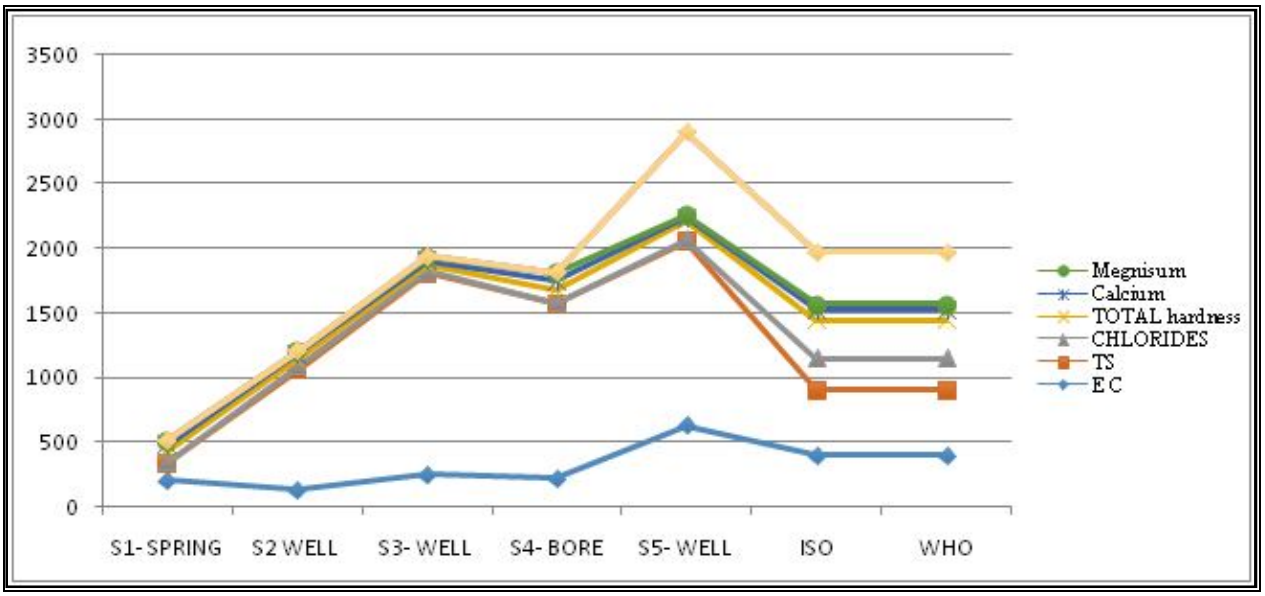

Figure 2: EC, Total solids, chlorides, total hardness, calcium, magnesium. mg/L comparing with standards

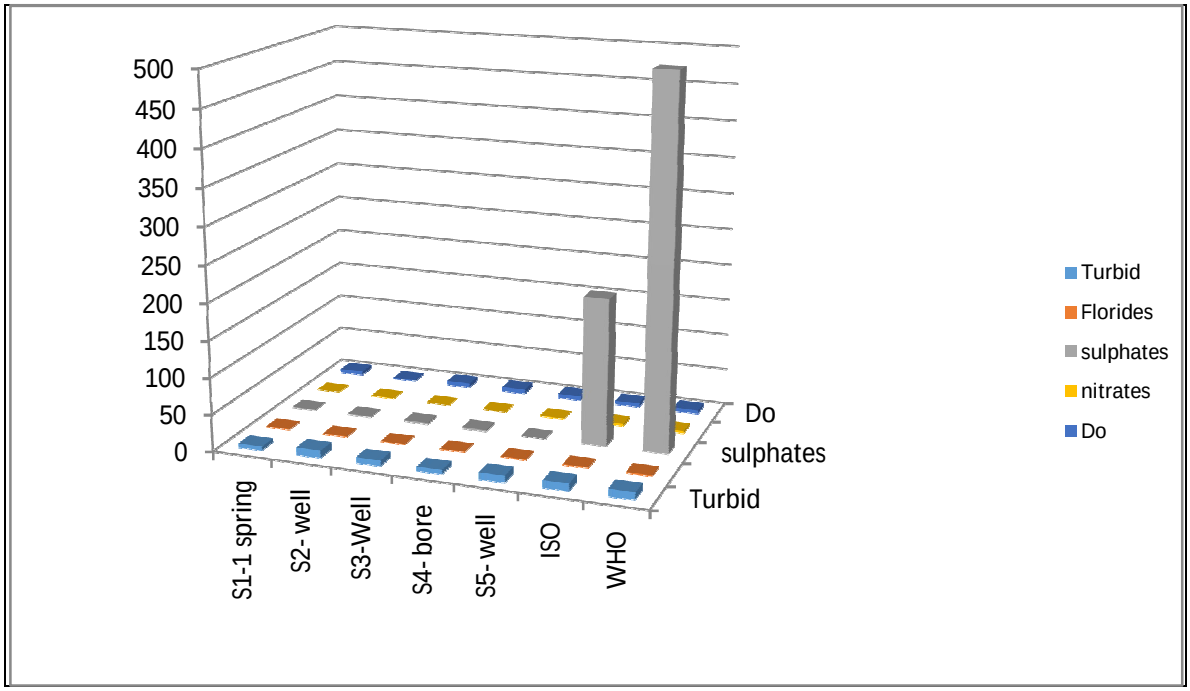

Figure 3: Comparision of Turbidity, fluorides, sulphates, nitrates and DO with standards in mg/L (turbidity in NTU)

4. Summary and Conclusion

A total of five water samples were anlysed for 12 physico- chemical parameters and resulted, the study elevated that the water in the tribal areas of Visakhaptnam, District, Araku valley mandal was found to be below the permissible limits, in parameters like, chlorides, Total hardness, Calcium, Megnesium, Flourides, Sulphates, Nitrates, and pH but Turbidity, Total solids, Electrical conductivity and In some extent Dissolved oxygen found above the range of permissible limit of the WHO and BIS standards.

From this study it is evident that, the concentrations of physical, chemical content in spring and well found higher than the bore water. Hence the bore water is preferred for drinking for the local tribal community than the spring and well, in the absence of other alternative sources. The particular water from its sources which high in some parameters like turbidity and Total solids may be due to mixing of surface runoffs and the silts carried, in rainy season, and this water is recommended to be treated or filtered before it is utilized for drinking .

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Annexure

The Well Water, Spring, Sources in the Study Area

Figure 1: Spring in araku valley

Figure 2: Well in sarabaguda

Figure 3: Spring in Madagada