Journal of Multidisciplinary Engineering Science Studies (JMESS)
ISSN: 2912-1309
Vol. 1 Issue 1, November - 2015

Assessment Of Ground Water Quality Outside Belgaum City, Karnataka State, India

Ground Water Quality, Belgaum

Dr. Naik V. K
Professor & Head, Department of Civil Engineering,
Indur Institute of Technology,
Siddipet, Telangana State, India
email: vknaik3@yahoo.com

Dr. Suresh B
Asst. Professor, Department of Civil Engineering,
Bapuji Institute of Engineering & Technology,
Davanagere, Karnataka State, India
email: drbssmg@gmail.com

***Abstract*—Assessment of ground water quality was studied for selected bore-wells at the outskirts of Belgaum city, in Karnataka State. The study area selected due to the fact that a large area of the land is under agriculture and many farmers use this ground water, both for agriculture and drinking purpose. A small stream, called 'Bellary Nallha' passes through these agricultural lands, where water flows only during monsoon and raw sewage from the part of Belgaum flows throughout the year. A total of 10 bore-wells were selected for the study purpose and samples were collected during April, May 2015, which were analyzed for 17 physico-chemical parameters. Results indicated a very serious impact of the nallha on these bore-wells. Although the pH-value maintained its concentration in the alkaline range, yet other parameters showed alarming increase in their concentrations. DO recorded just around 5 to 6 ppm, TDS around 1000 ppm and more, total hardness 500 – 1200 ppm, chloride around 300 – 650 ppm, sulphates 60 – 75 ppm, nitrates 40 – 80 ppm, calcium 76 – 200 ppm etc. for most of the bore-wells. Almost all major parameters exceeded the WHO and BIS values for drinking water standards, indicating the contamination of ground water and also unfit for the human consumption.**

Keywords— Bellary Nallha, Agriculture, stream, raw sewage, Western Ghats

Introduction: Potable water is an essential commodity on earth for any life to survive, and is the basic right of every human. Water, meeting at least the minimum drinking water standards, is increasingly become scarce due to rapid urbanization and industrialization without paying proper attention to safe guard the water sources against contamination. Ground water sources are getting contaminated due to human interference, like waste dumping in unscientific manner, effluent and sewage discharge without proper treatment etc. Most of the villages in the study area depend on the ground water past many decades, in the absence of any proper water supply system by the Government. However, due to lack of knowledge and awareness the villagers continuously consuming the water without being aware of the adverse health effect due to poor quality. In view of the serious adverse effect on the local population due to consumption of water without aware of its quality, it was felt that a study is required to be conducted in order to ascertain the safety of the people consuming such water.

Study Area: This study on water quality of ground water source is conducted at the outskirts of Belagavi city. The city is located around 400 km from Bengaluru on the south and 350 km from Pune (Maharashtra State) at the north on NH 4. The city is having a population of around 8 lakh and is an important district head quarter of the State of Karnataka. The city also receives good rains during monsoon due to its proximity to Western Ghats. However, in recent past this has decreased and during 1985 to 1996 the rainfall was less by 30% against the annual average of 1033 mm. Topography of the area is undulating terrain, with elevated on north, west and south, whereas the eastern side having depression. The city is 796.560 m above MSL with average temperature varying 16^0 to 18^0 C during winter and 35^0 to 38^0 C during summer. The city is lying between longitudes 75^0 to 76^0 E and latitudes 16^0 to 17^0 N. The study area selected is around 5 km away from the city limit on the eastern side as shown in Figure 1. The area comprises red soil; laterite and weathered basalt which are the litho units that are water bearing. As the area does not fall under the corporation limit, people here, mostly farmers, depend on the ground water sources. One of the major problems is that a nallha passes-by close to this area, which for the most part of the year carries sewage from the city. People complained about the contamination of the bore-wells due to sewage, especially during lean period.

Materials and Methods: Samples from groundwater were collected from 10 locations in the study region during pre-monsoon period (April/May 2015). The parameters like pH, EC, temperature and DO were recorded on the site during sample collection using potable kit as per the procedures and guidelines mentioned in APHA manual. Remaining parameters were analyzed in the laboratory adopting standard procedures as recommended by the American Public Health Association. Sample collection locations were as presented in Figure 1. Recorded values of analyzed parameters are listed in Table 1. Recorded analytical data can further be used for the classification of water for utilitarian purposes and for ascertaining various factors on which the chemical characteristics of water depend.

Results and discussions: Industrial and domestic effluents are the major sources of surface and ground water contamination [7]. As stated, water samples from 10 bore-wells were analyzed for various physical and chemical parameters. A total of 17 parameters were studied for their concentrations to assess the contamination level. Analyzed results were then compared with the standard values of EPA – US and the WHO guidelines for drinking water.

Result for pH values of the samples collected showed marked variation in the values. It ranged from a maximum of 8.4 to a minimum of 7.4, with an average of 7.95, as presented in Table-1, which shows all samples fall in the alkaline range and within the limits as prescribed by WHO and EPA standards. Variation of pH-value for the samples is presented in Figure 3.

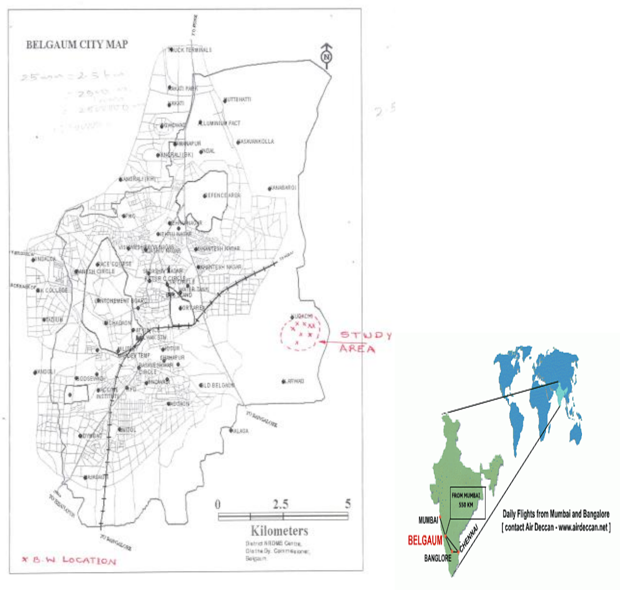

FIG. 1. LOCATION OF BELGAUM CITY AND STUDY AREA

Electrical Conductivity values ranged from 242 µS /cm to 2373 µS /cm at 25^{0}C, with an average of 1588.5 µS /cm, which is much higher than the maximum limit under WHO and EPA guidelines. Nearly 75% of bore wells exceeded the limit, whereas the EC values for other bore wells were well within the limit of the WHO and EPA guidelines, as presented in Figure 2. Excess salt increases the osmotic pressure of the soil that can result in physiological drought conditions. Large concentrations in EC values may probably due to lithologic composition and anthropogenic and due to high concentration of ionic constituents present in the water bodies [8].

Total Hardness recorded higher concentrations than the BIS and WHO limits for drinking water standards. Impart of hardness to the water is mainly due to the presence of cations, such as calcium and magnesium, and anions – carbonates, bicarbonates, chlorides and sulphates. There are no reports of any health hazards due to higher concentration of hardness. However, some concerns were attached to heart diseases due to the presence of excess hardness in water [8]. Total hardness in the range of 150 – 300 ppm and above may cause kidney problems and kidney stone formation. Further, water with higher hardness causes unpleasant taste and increases commotion of soap. Hard water is also not suitable for domestic use. In the present study area, total Hardness ranged between 308 to 1264 ppm, with average concentration of 655.2 ppm, and eight of the ten bore-well samples exceeded the maximum limit of 500 ppm as per WHO guidelines, which is evident from Figure 2, and no sample meets the desirable limit of 100 ppm.

TABLE I RESULTS OF PHYSICO-CHEMICAL ANALYSIS

Parameter	BW1	BW2	BW3	BW4	BW5
TUR*	1.2	4.3	4.2	2.9	2.4
COND#	1770	1983	720	2373	1570
pH-value	7.9	8.1	8.2	7.4	8.2
DO	5.2	6.9	5.1	6.4	6.8
TDS	973.5	1090.7	396.3	1305.2	863.5
TH	620	872	352	1264	632
Chloride	338	638	92	684	378
Sulphur	154	57.4	97.3	20.3	135.9
Fluoride	0.5	1.7	1.5	1.5	1.6
Nitrate	62.8	83.3	31.1	30.2	48.2
T.Alkalinity	400	244	320	232	292
Sulphates	21.5	76.5	65	63	60
Magnesium	40.5	72.5	38	74	45
Phosphate	0.1	0.1	0.2	ND	0.3
Potassium	3.9	2.0	3.1	1.8	2.8
Calcium	208	89.6	83.2	184	107
Total Iron	ND	0.12	0.06	ND	ND

Note: *NTU ; # µS/cm

TABLE I RESULTS OF ANALYSIS (CONTD…)

Parameter	BW6	BW7	BW8	BW9	BW10
TUR*	4.0	2.0	2.1	0.5	2.1
COND#	2120	242	2152	1575	1380
pH-value	7.4	8.4	7.6	7.9	8.4
DO	4.9	5.3	5.8	6.6	5.2
TDS	1166	133.4	1183.6	868.3	759
TH	520	308	768	568	648
Chloride	456	52	312	270	268
Sulphur	42.5	38.6	154.2	133.1	105.6
Fluoride	0.8	1.0	1.7	1.3	1.6
Nitrate	48.8	37.8	47.4	3.5	8.8
T.Alkalinity	480	300	272	548	460
Sulphates	18.5	64	77.5	16.5	18.5
Magnesium	44	32.5	56	40	42.5
Phosphate	0.2	0.3	0.2	0.3	0.3
Potassium	4.5	2.9	2.7	5.2	3.9
Calcium	176	76.8	184	164.8	222.4
Total Iron	ND	ND	ND	ND	ND

Note: *NTU ; # µS/cm

Calcium which is found as alkaline in nature is an important element for proper bone growth. Calcium, magnesium and total hardness in the ground water are interrelated. Calcium is found alkaline in nature. Presence of silicate mineral group, like pyroxene and amphibole in igneous rocks results in the formation of calcium in ground water [8, 1]. Concentration of Ca^{+2} ion ranged from a minimum of 76.8 ppm for BW7 to a maximum of 222.4 ppm for BW10, with an average value of 149.6 ppm. Figure 4 shows the variation of calcium in the bore-wells selected. Increased concentration of calcium may be attributed to the type of water-bearing strata in which calcite; dolomite, gypsum and anhydrite are the reasons for enriching the ground water with calcium ions [10]. Calcium and magnesium content is very common in ground water, due to their abundant availability in most of the rocks and high solubility. However, the solubility of calcium carbonate and sulphate governs the available range of calcium [4].

Dissolved oxygen concentration for the samples analysed ranged from 4.9 ppm to 6.9 ppm, with BW6 recording near to the minimum concentration as per WHO guidelines. Other samples recorded DO values within the range as per WHO guidelines, as in Figure 3. Lower DO values are generally due to lack of natural aeration or due to organic deposits. In the present study, lower DO values may be attributed to deposit of human materials, oxidation of pyrites or biodegradation of organic matter from waste or petroleum, and the presence of any source of organic carbon [6]. However, as DO values recorded in all bore wells are more than the minimum required, there was no indication of any adverse effect that could lower the oxygen content of ground water.

Total dissolved solids recorded higher concentration for all bore well samples, as suggested by the WHO limit which is 500 ppm. TDS varied from a minimum of 133.38 ppm for BW7 to a maximum of 1305.15 ppm for BW4, with an average of 873.93 ppm, as presented in Figure 2. TDS is valuable indicator for the presence of total dissolved salts in water, and very high EC and TDS recorded in the present study suggest the contamination of ground water by the transfer of leachate, intrusion of sewage or due to the excess application of agricultural fertilizers [10]. High concentration of TDS decreases the palatability of water and may also cause gastro-intestinal irritation in humans, particularly those suffering from kidney problems, and laxative and constipation effect.

Chloride concentration for the samples analyzed recorded higher values exceeding the EPA limit for most of the bore wells as is evident from Figure 4. However, higher concentrations of chloride recorded in BW2 and BW4 exceed the maximum limit as per WHO guidelines. Recorded values for chloride ranged from a minimum of 52 ppm for BW7 to a maximum of 684 ppm for BW4, with an average of 348.8 ppm. Major sources of chloride in ground water include the constituents of igneous and metamorphic rocks, like chlorapatite [6, 1]. Further, due to sewage intrusion, fertilizers, human and animal wastes and leaching of saline residue in the soil, high chloride concentrations may occur in the ground water. Chloride is soluble in water and moves freely with water through soil and rocks in the form of sodium chloride increasing its concentrations in ground water. Chloride salts in excess of 100 ppm imparts salty taste to water. Further, chloride is widely available in the form of NaCl, KCl and $CaCl_2$ salts [7]. Chloride is also discharged through effluents of chemical industries, oil well operations, sewage discharge and irrigation leachates. In the present study, high chloride concentrations were recorded in BW1, BW2, BW4, BW5, BW6 and BW8. Although, there is no immediate health disorder due to human consumption of high chloride content water, it imparts salty taste and has laxative effect for those who are not accustomed to such water.

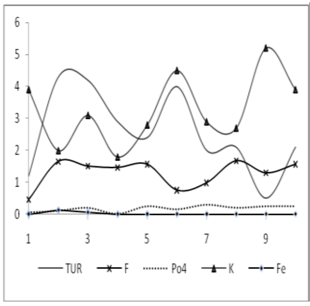

Fig. 2

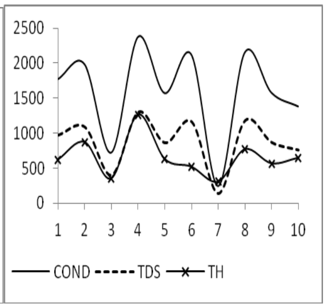

Fig. 3

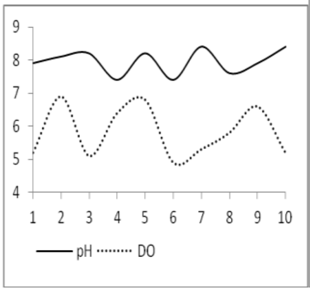

Fig. 4

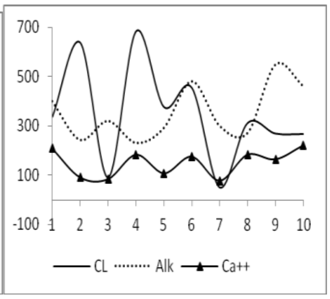

Fig. 5

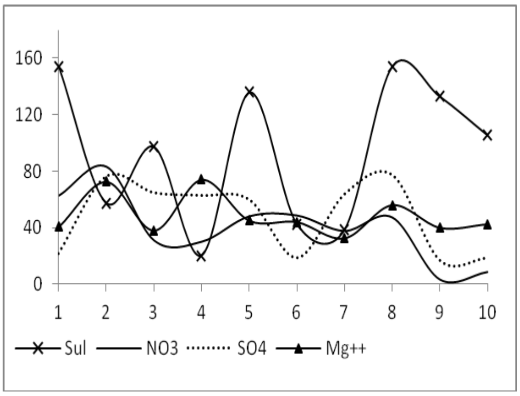

Fig. 6

Turbidity: Turbidity values range from 1.2 NTU for BW1 to a maximum of 4.3 NTU for BW2. All the bore-well samples recorded the turbidity concentration much less than the maximum limit of 5 NTU as per WHO guidelines. These less turbidity concentrations for the water may be attributed to the fact that natural filtration through the ground strata arrested the suspended particles and no muddy water. Turbidity to the water is imparted mainly due to the presence of suspended particles and due to undesirable substances. It is an important parameter of water for coagulation treatment process and provides an estimate of undissolved substances. The study revealed that 62.5% of the total selected bore-wells recorded very less turbidity and the remaining close to the maximum limit of WHO guidelines. Turbid water is aesthetically not accepted by the consumer, and no adverse effect on the human health is reported due to consumption of high turbid water.

Sulphates: Analyzed values for the bore-well samples recorded sulphates concentration ranging between 18.5 ppm to 77.5 ppm. Maximum value of sulphates was 77.5 ppm recorded for the BW8 and the minimum 18.5 ppm was recorded for BW6, with an average value of 55.75 ppm for all the 10 bore-well samples collected for the study purpose. However, sulphates concentrations found in all the samples were much less than the maximum permissible limit as per WHO guidelines. Variation of sulphates is presented in Figure 5. Sulphates concentrations in ground water generally increases due to the nature of aquifer, where presence of minerals, like gypsum are found. Although, higher concentration of sulphates in drinking water has no adverse health effect, SO_4^{-2} with more than 200 ppm may cause gastro-intestinal irritation and bowel discharge [6].

Nutrients: Concentration of NO_3 in the study area ranged from 30.22ppm for BW4 to a maximum of 83.02 ppm for BW2, with an average of 48.69 ppm as shown in Figure 5. Recorded concentrations for nitrates showed much higher values than the maximum limit of 10 ppm as per EPA standards. Only BW3, BW4 and BW7 recorded NO_3 values less than 45 ppm, which is the maximum limit as per WHO guidelines. Addition of nitrogen to ground water is through certain plants - legumes which fix atmospheric nitrogen and transfer to soil, from where surplus nitrogen is added to the ground water by percolation [11]. Other sources are decomposing plant debris, animal waste, household solid waste and nitrogen fertilizers. Nitrogen may also enter in to the ground water due to sewage discharge on-land. Natural nitrate concentrations in ground water vary from 0.1 ppm to 10 ppm [9]. Excess nitrate, more than 45 ppm is undesirable for drinking water as it causes methemoglobinemia in infants. Excess nitrate cannot be removed by boiling- needs distillation [8].

Conclusion: Ground water quality for the outskirts of Belgaum city was analyzed in the present study. Ground water is alkaline in nature and total hardness recorded indicates that ground water under the study area falls under hard to very hard category. Further, total dissolved solids also recorded higher values along with conductivity making water unsuitable for irrigation purpose. Except for BW1, other water samples have higher values of fluoride which may have adverse health hazard on the consumer in the long run. However, total iron and color recorded lesser concentrations and in some case, below detectable limit. Results recorded for all 18 parameters analyzed for the water samples were compared with standard limits of BIS and WHO specifications. Based on these results and comparison, it can be stated that the study area falls under moderately contaminated category making the water unfit for human consumption as well as for irrigation purpose. Negligence of concerned authorities permitting sewage to flow through nearby nallha in an unscientific manner together with semiarid climate, other anthropogenic activities and increased human interventions has adversely affected the ground water quality in the region.

ACKNOWLEDGMENT: AUTHORS THANK THE COOPERATION AND ASSISTANCE EXTENDED BY THE MANAGEMENT AND THE PRINCIPALS OF INDUR INSTITUTE OF ENGINEERING & TECHNOLOGY, SIDDIPET, TELANGANA STATE, AND BAPUJI INSTITUTE OF ENGINEERING & TECHNOLOGY, DAVANAGERE, KARNATAKA STATE, INDIA.

REFERENCES

[1] Afzali A., Shahedi K., Roshan M. H., and Solaimani K.(2014). Groundwater Quality Assessment in Haraz Alluvial Fan, Iran. International Journal of Scientific Research in Environmental Sciences. 2(11), 410-420.

[2] Ananthakrishnan S., Loganathan K. and Ahamed J.(2014). A Comparative Study of Water Quality Index (Wqi) of Vagamon and Peermade Sub-Water sheds of Meenachil and Pamba River Basins of Western Ghats, Keral, South India. International Journal of Applied Science Research. 8 (1), 53-58.

[3] Behera B, Das M. and Rana G. S.(2012). Studies on ground water pollution due to iron content and water quality in and around, Jagdalpur, Bastar district, Chattisgarh, India, Journal of Chemical and Pharmaceutical Research. 4(8), 3803-3807.

[4] Joan B. G. Marla C., Pum Song and Lee-Hyung Kim.(2010). The Water Quality of the Pasig River in the City of Manila, Philippines: Current Status, Management and Future Recovery, Journal of Environmental Engineering Research. 15(3), 173-179.

[5] Kumar M. A. and Raju B.S.N.(2012). A Comparative Study of Water Quality Indices of River Godavari. International Journal of Engineering Research and Development. 2, 29-34.

[6] Ramesh K., Bhuvana J. P.(2012). Contamination of Groundwater due to Solid Waste Disposal and Textile Effluent in and Around Erode City, Tamil Nadu, International Journal of Research in Chemistry and Environment. 3, 262-271.

[7] Ramesh.C and Vennila (2012). Hydrochemical Analysis and Evaluation of Groundwater Quality in and around Hosur, Krishnagiri District, Tamil Nadu, India, International Journal of Research in Chemistry and Environment. 1(2), 113-122.

[8] Sarala C, and Ravi. P (2012). Assessment of Groundwater Quality Parameters in Hadpsar area, Pune, Maharashtra, International Journal of Scientific and Technology. 2(1), 1-6.

[9] Satyanarayana P., Raju A.N., Harikrishna K. and Viswanath K.(2013). Urban Ground Water Quality Assessment: A Case Study of Greater Vishakhapatnam Muncipal Corporation Area (Gvmc), Andhra Pradesh, India. International Journal of Engineering Science Invention.2 (5), 20-31.

I. [10] SHARAKY, A. M., ATTA A.S., HASSANEIN EL AND KHALLAF, K. M. A.(2007). GROUND WATER QUALITY USING WATER QUALITY INDEX AND ARC GIS: CASE STUDY: WESTERN NILE DELTA AQUIFER, EGYPT, 2ND INTERNATIONAL CONFERENCE ON THE GEOLOGY OF TETHYS, CAIRO UNIVERSITY, 2(1), 1-23.

[11] Shivakumar D. (2014). Ground Water Quality Assessment around Nagalkarni Tannery Industrial Belt. International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering. 8(3), 322-325.