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Physico-chemical characteristics of Groundwater in Byramangala and Harobele command areas of Arkavathi sub-basin of River Cauvery, Karnataka

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ABSTRACT

Arkavathi, a tributary of Cauvery, is facing a threat from urbanisation and industrialization from the last few decades. The Physico-chemical parameters for both Harobele and Byrmangala command areas coming in Arkavathi river were analysed to investigate the suitability of the groundwater for drinking and agricultural practices. The groundwater samples were collected from bore wells in 5 villages each in both command areas, located within 5 km buffer on either sides of the Arkavathi River in Harobele and Byrmangala command areas. The parameters such as pH, EC, Turbidity, TDS, Chloride, Magnesium, Fluoride, Nitrate, Boron, Sulphate, Phosphate in both areas were found within the permissible limit. The Phosphate concentrations in Byrmangala groundwater were negligible when compared to Harobele groundwater.The mean Sodium Absorption Ratio (SAR) of both the reservoir was falling under excellent category (0-10) as per standard classification which represents that the samples are suitable for agricultural purposes. Samples are falling under a good category (<1.25) in case of Residual Sodium Carbonate. The samples analysed for Sodium concentration found within good to an excellent category in both Byrmangala and Harobele command area. This indicates that groundwater samples were suitable for agriculture purposes. The discharge of partially treated water is not yet polluting groundwater of the peri-urban region of Bangalore. However, sewage could be treated before discharging to these reservoirs to keep groundwater in good condition for the future generations.

Key words : *Physico-chemical characteristics, Groundwater*

Introduction

The United Nations predicted that by 2050, 64.1% and 85.9% of the developing and developed world will be urban areas (2008). Urbanization leads to unorganized horizontal or vertical growth of urban areas. The consequences of urbanization vary across different regions of the globe. The increase in urban population results in a rapid change in land use land cover and simultaneously with the change in people's lifestyle resulted in poor management of sewage and industrial effluents, which leads to the immense demand for freshwater (Intizar *et al.*, 2001). The use of domestic sewage in farming is becoming inevitable as the demand for water is increasing in the peri-urban areas of India (Najam and Kaur, 2016). Irrigation with sewage became a prevalent practice in arid and semiarid regions, where it was readily available (Mekki *et al.*, 2013).

Rapid urbanization in India, has affected the availability and quality of groundwater due to its overexploitation and improper waste disposal, especially in urban areas. The urban expansion around Bangalore has put enormous pressure on

groundwater extraction for agriculture, drinking and construction purposes. Due to increasing water consumption in Bangalore, the level of groundwater keeps declining. The change in land use of the catchment area of a river determines the characteristics of both quantity as well as the quality of inflowing water. Quite a number of seasonal rivers have been converted to perennial rivers due to the continuous influx of sewage and effluents in the urban fringe. The quality of the surface water influences the surrounding groundwater quality and intern soils. Hence the present study aims at assessing physico-chemical characteristics of groundwater inperi-urban region of Arkavathi sub-basin of the Cauvery River of Bangalore city.

Materials and Methodology

Study area

The study area includes the Byramangala and the Harobele command areas of the Arkavathi sub-basin of River Cauvery. River Arkavathi besides receiving freshwater also receives untreated or partially treated sewage from Bangalore city. The industrial clusters such as Bidadi, Kumbalagodu and Harohalli areas lie within the Arkavathi catchment area also discharge partially treated effluents. To assess the water quality of groundwater, the borewells coming within 5 km buffer on either side of the river were identified and collected in these two command areas.

Water sample collection and analysis

A total of ten groundwater samples was collected from the Byramangala and Harobele command area of the Arkavathi sub-basin of the Cauvery River. The sample villages are Abbanakuppe, Banadur, Ittamadu, Chowkahalli, S. Dhoddi coming in upstream Byramangala command area of Vrishabavathi tributary, while Bendagudu, Mulhalli, Igolhalli, Chikkakoppa and Harobele villages coming in downstream in Harobele command area in Arkavathi basin. The samples was collected in plastic bottles in the early morning were analysed using APHA (2012).

Results and Discussion

Physico-chemical Characteristics

The Physico-chemical parameters of both command areas were given in Tables 1 and 2. The parameters

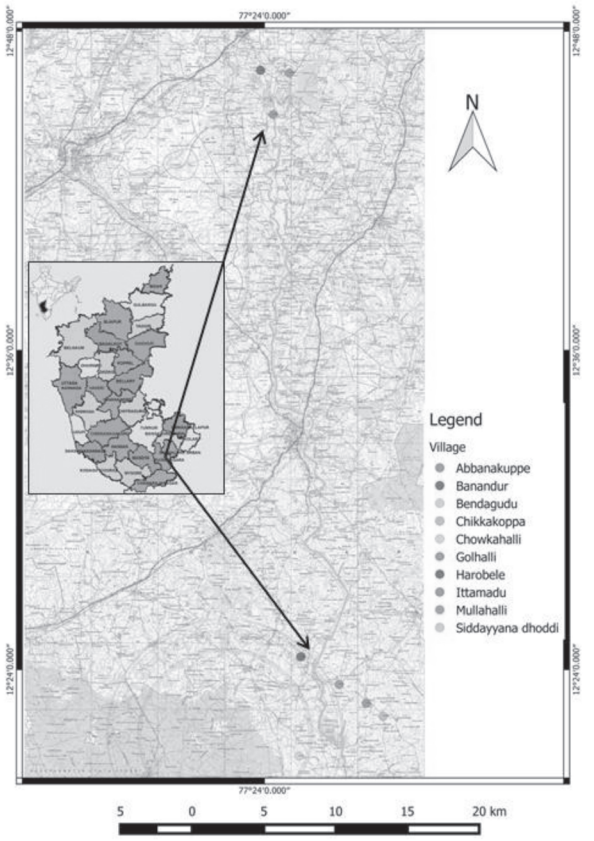

Fig. 1. Groundwater locations in Byrmangala and Harobele command areas of Arkavathi Sub-basin of River Cauvery.

such as pH, EC, Turbidity, TDS, Chloride, Magnesium, Fluoride, Nitrate, Boron, Sulphate, Phosphate in both areas are within the permissible limit. Only Phosphate, Nitrate and Fluoride were shown differences for both the command areas.

Natural sources of phosphorus in groundwater include atmospheric deposition, natural decomposition of rocks and minerals, weathering of soluble inorganic materials, decaying biomass, runoff, and sedimentation. Anthropogenic sources include; fertilizers, wastewater and septic system, animal wastes, detergents, industrial discharge, phosphate mining, drinking water treatment, forest fires and synthetic material development surface. Lower concentrations were not much harmful, however, extremely high levels of phosphates can cause digestive problems. Further excessive concentration of phosphate increases it leads to lake eutrophication resulting in reduced stability of the ecosystem (Fadiran *et al.*, 2007). The Phosphate concentrations in the Byrmangala command area were negligible

Table 1. The Physico-chemical Characteristics of groundwater in five villages coming in Byramangala command area.

Sl. No.	Characteristics	Villages				
		Abbanakuppe	Banadur	Ittamadu	Chowkahalli	S.Doddi
1	pH	7.35	7.63	7.74	7.2	7.61
2	Conductivity (μS/Cm)	1218	1600	1436	1708	1486
3	Turbidity (NTU)	0	0	0.1	0	0
4	Alkalinity (mg/L/)	152	208.12	188	228	200
5	TDS (mg/L)	500	643	588	701	593
6	Total Hardness (mg/L)	232.2	276.24	260.23	320.28	264.23
7	Chloride (mg/L)	97.96	119.96	104.09	129.95	107.96
8	Magnesium (mg/L)	52.04	56.05	55.82	64.05	60.05
9	Fluoride (mg/L)	0	0	0	0	0
10	Nitrate (mg/L)	0.569	4.7052	4.9005	7.912	0.96
11	Boron (mg/L)	0.5779	0.422	0.3577	0.477	0.055
12	Sulphate (mg/L)	0.588	0.624	0.4438	0.6761	0.699
13	Phosphate (mg/L)	0	0	0	0	0

Table 2. The Physico-chemical Characteristics of groundwater in five villages coming in Harobele command area.

Sl. No.	Characteristics	Villages				
		Bendagodu	Mulahalli	Golhalli	Chikkakoppa	Harobele
1	pH	7.11	7.4	7.29	7.23	7.64
2	Conductivity (μS/cm)	1700	1382	1382	1309	1489
3	Turbidity (NTU)	0	0	0	0	0
4	Alkalinity (mg/L/)	240	160	180	160	184
5	TDS (mg/L)	700	516	606	489	556
6	Total Hardness (mg/L)	332	240.2	280.2	228.2	260.2
7	Chloride (mg/L)	97.96	83.97	109.96	71.97	87.97
8	Magnesium (mg/L)	67.8	48.03	56.05	36.03	48.04
9	Fluoride (mg/L)	0	0.0374	0	0	0.061
10	Nitrate (mg/L)	12.09	6.072	5.47	2.23	11.49
11	Boron (mg/L)	0	0.1559	0.0642	0	0
12	Sulphate (mg/L)	0.5847	0.3923	0.6	0.3714	0.6057
13	Phosphate (mg/L)	0.225	0	0.602	0	1.05

when compared to Harobele groundwater.

Nitrate in groundwater originates primarily from fertilizers, septic systems, and manure storage or spreading operations. Nitrate is one of the most common groundwater contaminants in rural areas. It is regulated in drinking water primarily can cause methemoglobinemia, or "blue baby" disease (McCasland *et al.*, 1985). The nitrate concentrations of both the sampling location results are within the prescribed limit of 45 mg/L. When we compare the samples within two command areas, groundwater samples in Harobele are found to be more compared to the Byrmangala command area.

The fluoride concentration of atleast 0.6 mg/L is required for human consumption as it will help to have stronger teeth and bones. Consumption of water with fluoride concentration above 1.5 mg/L results in acute to chronic dental fluorosis where the tooth becomes colored from yellow to brown (Brindha and Elango, 2011). Here the limits are within the permissible limits. However, Mulhalli and Harobele villages coming in the Harobele command area have recorded fluoride content.

Apart from soil quality, water is also an important component for plant growth. When poor quality of water is used for agricultural purposes that may have an impact on crop productivity (Tak *et al.*, 2012). The conventional practices of agriculture, which include the use of synthetic chemical fertilizers, pesticides, herbicides, and insecticides, have a significant effect on groundwater quality.

Irrigation Water Quality

Sodium adsorption ratio (SAR) is the measure of the relative concentration of sodium to calcium and magnesium in groundwater. Based on SAR ground-

Table 3. Irrigation water quality of groundwater samples near Byrmangala and Harobele command areas.

Sl. No.	Parameters	Villages in Byrmangala Command area				
		Abbanakuppe	Banadur	Ittamadu	Chowkahalli	S. Dhoddi
1	Percent Sodium	5.64	6.07	5.77	5.305	5.6
2	Residual Sodium Carbonate	-80.2	-68.12	-72.23	-92.28	-64.23
3	Sodium Absorption Ratio	1.299	1.53	1.4	1.44	1.39
		Villages in Harobele Command area				
1	Percent Sodium	2.63	3.62	3.44	3.37	3.34
2	Residual Sodium Carbonate	-92	-80.2	-100.25	-68.2	-76.23
3	Sodium Absorption Ratio	0.69	0.82	0.844	0.74	0.78

water can be classified as excellent (0-10), good (10-18), permissible (18-26) and unsuitable (>26) for agricultural purposes (Sridharan and Nathan, 2017). The present result shows that the mean value of Byrmangala and Harobele which fall under excellent group as based on the classification and samples, are suitable for agricultural purposes.

The suitability of groundwater is affected by the excess concentration of bicarbonates. The excess bicarbonate concentration is harmful to the physical properties of soil. Groundwater can be classified on the basis of Residual sodium carbonate as good (<1.25), doubtful (1.25-2.5) and unsuitable (>2.5) for agricultural purposes. The results showed that the samples fall within the prescribed limits. Sodium concentration in excess reduces the permeability of the soil, destroys the soil structure, which eventually leads to the reduction of crop production and plant growth (Sridharan and Nathan, 2017). Based on the %Na groundwater can be grouped as Excellent (<20), good (20-40), permissible (40-60), Doubtful(60-80) and unsuitable (>80) for irrigation purposes. The study showed that the analyzed samples fall under excellent category and hence the groundwater can be used for irrigation purposes.

Conclusion

The results indicated that the physicochemical parameters of groundwater samples coming in the Byramgala and Harobele command areas were found to be within the prescribed limit. This indicates that groundwater samples were suitable for agriculture purposes. The discharge of partially treated water is not yet polluting groundwater of the peri-urban region of Bangalore. However, sewage could be treated before discharging to these reservoirs to keep groundwater in good condition for the future generations.

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