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FOOTPRINT OF GROUND WATER QUALITY IN BANGARPET TALUK OF SOUTH-EASTERN KARNATAKA, INDIA

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ABSTRACT: A total of 30 ground water samples were collected from Bangarpet taluk of Kolar district and analyzed for water quality. It was found from the analysis that water is safe for drinking purposes that the water is potable except for the high hardness. The groundwater samples were alkaline in nature, having TDS values observed well below the standard limit. Total alkalinity was less than total hardness in the study area, indicating the prevalence of permanent or non-carbonate hardness as it cannot be removed or precipitated by boiling and this type is associated with sulfate, chloride and nitrate ions. Calcium was the dominant cation (viz., Ca^{2+}> Na^{+}> Mg^{2+}> K^{+}) and bicarbonate, the dominant anion (viz., HCO_3^- > Cl^-> SO_4^{2-} > NO_3^- > F^- >PO_4^{3-}). Fluoride concentration in few samples was close to standard limit of 1.5 mg/L, which may require attention in near future. Therefore, it is suggested to carry out a detailed investigation on ground water quality from time to time on routine basis in order to protect ground water quality and also from point view of public health.

KEYWORDS: Ground water, Public health, Footprint of water quality, Dissolved salts.

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1.INTRODUCTION

Water is the essential source of life, a precious gift of nature to mankind in addition to millions of other species living on the earth. From the past few decades, it is fast becoming a scarce commodity in most part of the world. Water resources comprising of surface water (major water bodies such as rivers and lakes), ground water, and marine and coastal waters support all living things including human beings. The total water resource available in India is 1850 km^3, which is roughly 4% of the world's fresh water resources. Though water is available in the universe in huge quantity in the order of 1400 x106km^3, only 3% of the waters in the universe are fresh water. Among the fresh waters, only about 5% of them or 0.15% of the total world waters are readily available for beneficial uses [1].Water resources are fast dwindling due to increased utilization of water for the fast growing demands of economic activities. Water demanding activities agriculture, industrial production, power generation, mining operations and navigation, and recreational activities has increased significantly day by day, secondly, water supply has declined due to water distress of scarcity and poor ground water source and its management is the major challenge for the policy makers [2].Groundwater is one important natural resource necessary for human consumption, domestic services, agriculture, industry, manufacturing and other sectors [3]. Although underground water is said to be clean and free from contamination, the change in quality of groundwater is response to variation in physical, chemical and biological environment through which it passes [4] and depends upon quality / composition and quantity of materials dispersed and dissolved in it, regulating seasonal variation in water quality [5, 6]. Quality of groundwater is deteriorating at a faster pace and is influenced by pollution of soil / air, septic tanks, domestic sewage, agricultural runoff/agricultural fields and industrial waste disposal, organic components, pathogenic microorganisms, application of fertilizers and pesticides in agriculture, etc.besides contamination and pollution of water in the surroundings and in the storage [5, 7, 8, 9]. Contamination of groundwater also depends on the geology, soil types and it is rapid in hard rock areas especially in lime stone regions where extensive cavern system are below the water table. Water quality is now being recognized in India as a major crisis and becomes global problem; the water supplied through groundwater is beset with problems of quality. Assessment of safe drinking water remains an urgent necessity, as 30% of the urban and 90% of the rural households still depend completely on untreated surface or ground water [10]. Drinking water needs to be protected from pollution and biological contamination [5]. Groundwater quality assessment plays an important role in groundwater protection and quality conservation as the quality of groundwater summarizes physical, chemical and biological characteristics of water as a suitability measure. Several researchers have conducted a study on groundwater quality in different parts across the country by employing standards methods of analysis and different ways of water quality data interpretation to substantiate the variation of groundwater quality [14, 15, 16, 17, 18, 19, 20, 21]. Thus, it is very important to assess and protect the groundwater quality not only for its present use but also from the viewpoint of a potential source of water for future consumption [5, 6, 13]. In Kolar district, groundwater contributes to about 80% of the drinking water requirements in the rural areas, 50% of the urban water requirements and more than 50% of the irrigation requirements of the nation. Groundwater resource in Kolar district was widely exploited for irrigation and other domestic purposes in addition drinking purpose, which provides water for 10 taluks including Bangarpet. One of the major problem regarding groundwater in Kolar District is quality (high concentration of fluorides, nitrates and chloride) and drying of wells (due to over exploitation, the water level is being lowered resulting in the drying of wells). Shallow hand pumps draw water from the topmost bearing structure, which is most liable to contamination by various natural as well as anthropogenic sources percolating in the vicinity and taking with it minerals [22]. The present study is aimed at assessing the physico-chemical characteristics as a measure of groundwater quality.

2. MATERIALS AND METHODS

Study area

Kolar district lies between North latitude 12° 45’ 54” to 13° 35’ 47” and East Longitude 77° 50’ 29” to 78° 35’ 18”. It is bounded by Bangalore and Tumkur districts on the west, Chickballapur district on north-west, Ananthpur district of Andhra Pradesh on the north, Chittoor district on the east and on the south by North Arcot and Dharmapuri districts of Tamil Nadu. The district is famous for gold exploitation at Kolar Gold Fields. Administratively the district is divided into 5 taluks, 27 hoblies, 156 gram- panchayats and 1797 villages. The population as per the 2001census is 1387062 and the density of population is 348 per sq.km. Total geographical area of the district is 3639 sq.km .The district is divided into 5 taluks i.e., Kolar, Bangarpet , Malur, Mulbagal and Srinivaspur. There are no perennial rivers in Kolar district. The district is drained by three river basins namely Palar, Ponnaiar, North Pennar (North pinakani), and South Pennar (South Pinakani). All these rivers and their tributaries are small and carry water only during rainy season. Kolar district falls in the Eastern dry agro climatic Zone. It experiences a semi-arid climate, characterized by typical monsoon tropical weather with hot summers and mild winters. The year is normally divided into four seasons. They are a) dry season during Jan-Feb, b) Pre-monsoon season during Mar-May, c) Southwest Monsoon season during Jun-Sep and d) Post or Northeast monsoon season during Oct-Dec (Fig 1).Bangarpet is the headquarters of the taluk of Bangarpet. Bangarpet was originally called Bowringpet, named after an officer working in the Kolar Gold Fields. This town came into existence as the connecting point of traffic between the gold fields and Bangalore. Bangarpet city is divided into 23 wards for which elections are held every 5 years. The Bangarpet Town Municipal Council has population of 44,849 of which 22,628 are males while 22,221 are females as per report released by Census India 2011 [22].

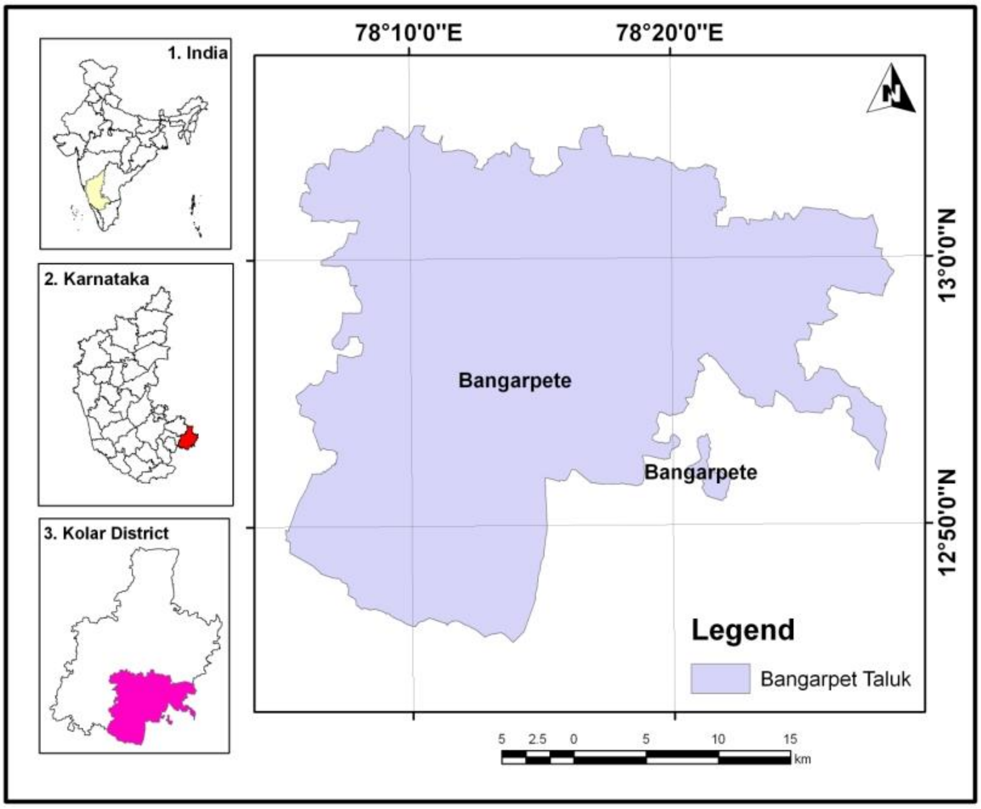

Fig 1. Map showing study area of Bangarpet taluk

Experimental

A total of 30 groundwater samples were collected during the month of March and April, 2016, knowing its depth and ground water table. Samples were collected in acid pre-washed, polythene bottles/containers of 2 litres capacity, where pH, colour, and temperature were noted soon after collection in the study area. Water quality parameters like temperature, pH, colour, conductivity, total dissolved solids, turbidity, hardness, calcium, magnesium, chloride, sulphate, fluoride, alkalinity, and nitrate were analyzed as per standard methods. The analytical results were compared with Bureau of Indian Standards [23] as well APHA [24] standards for drinking water specification.

3. RESULTS AND DISCUSSION

pH, Electrical Conductivity and TDS

The pH value of water is largely governed by carbon dioxide, carbonates and bicarbonates equilibrium. pH of water may be altered to many reasons like acid rain, acid mine drainage, discharge of acidic and alkaline effluents from industries etc. In the present study, the pH values ranged between 7.32 and 8.20 with a mean value of 7.75 **(Fig 2).** pH values were below the BIS standard limit of 6.5-8.5 and all the samples were alkaline in nature.

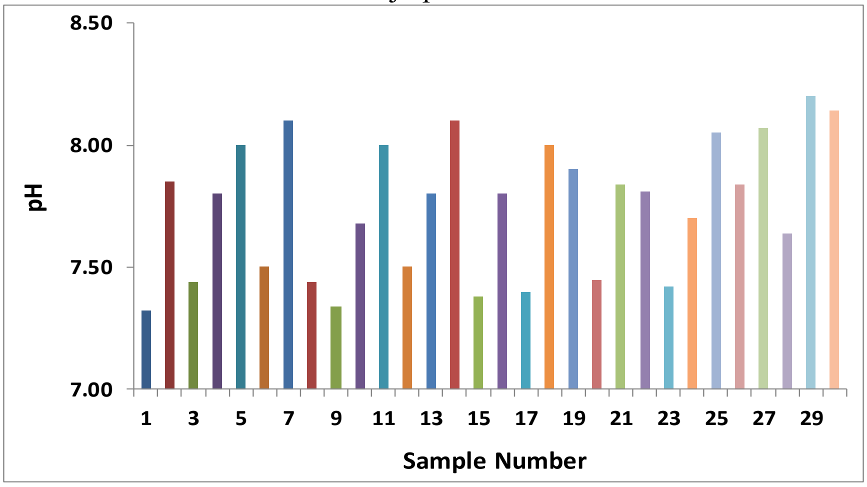

Fig 2. Spatial distribution of pH value of ground water samples

Conductivity is the capacity of water to carry an electrical and varies with number and types of ions the solution contains which in term is related to the concentration of the ionized substance in water. Most dissolved substances is in the ionized form, contributes to conductance. With a mean value of 1155 µS/cm, the EC values varied from 600 to 1600 µS/cm **(Fig 3).** The high value of conductance of samples can be attributed to the fact that the ground water has a high concentration of dissolved inorganic substance. The EC values were below the BIS standard limit of 2000 µS/cm. Similarly, the dissolved solids in natural waters consist of bicarbonates, carbonates, sulphates, chlorides and any other salts which are inorganic in nature. At levels above 500 mg/L, excessive hardness, unpalatability, mineral deposition and corrosion may occur while at lower levels, however, TDS contributes to turn better the water palatability [25]. In the present study, water samples analyzed show a TDS value to range from 384 to 1024 mg/L, with an average value of 739.2 mg/L. In general, water with total dissolved contents of 500 mg/L is desirable. Nearly 80% of the samples were having TDS value above the desirable limit, but well within the BIS permissible limit of 2000 mg/L **(Fig 3).** Similar trend distribution / variation pattern of EC and TDS is clearly visible from Fig 3, which could be attributed to direct relationship between the electrical conductance and the concentration of dissolved ionized solids in the water.

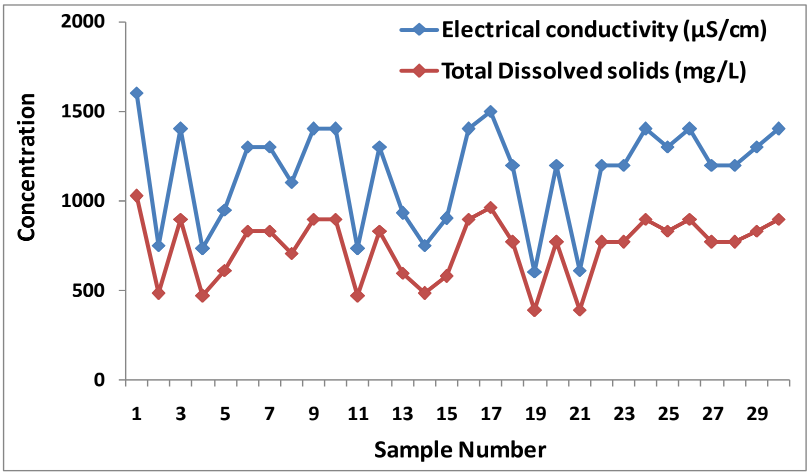

Fig 3. Spatial distribution of Electrical Conductivity and TDS values

Total hardness and Total alkalinity

Hardness in natural water is due to the presence of bicarbonates of calcium and magnesium dissolved in water, beside sulphate, chloride and nitrates of calcium and magnesium. Hardness in water prevents sufficient lather formation with soaps they causes loss of tenderness of vegetables and meal cooked. On the other hand, alkalinity of water is measure of its capacity to neutralize acids and it may be the salts of carbonates, bicarbonates, borates, silicates and phosphates along with the hydroxyl ions in the free State. However, the major contributors to alkalinity are the hydroxides carbonates and bicarbonates which may result in order to their association with high pH values.

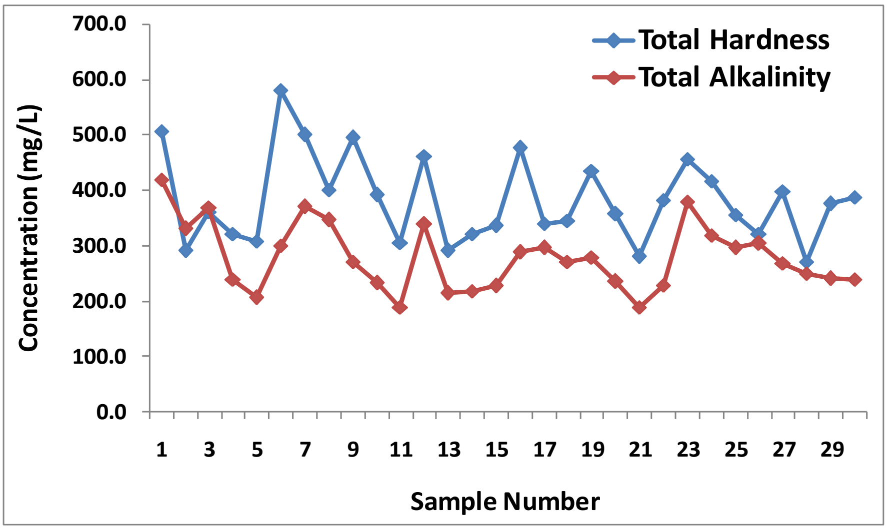

Fig 4. Spatial distribution of Total hardness and Total Alkalinity values

In the present study, total hardness ranged from 270 to 580 mg/L (mean: 381.8 mg/L) while total alkalinity varied from 188 to 418 mg/L (mean: 277.9 mg/L). All the ground water samples analyzed were hard in nature as their hardness values was above the 75 mg/L, meant for soft water [26]. Further, the total hardness values were below the BIS permissible limit of 600 mg/L. The total alkalinity values in analyzed groundwater samples were below their standard limit of 600 mg/L **(Fig 4).** Also, it is evident from Fig 4 that total alkalinity was less than total hardness, indicating the prevalence of permanent or non-carbonate hardness in the study area as it cannot be removed or precipitated by boiling and this type is associated with sulfate, chloride and nitrate ions.

Cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+})

From the diagram (**Fig 5**), it is evident that calcium was the dominant cation followed by sodium, magnesium and potassium (viz., Ca^{2+}> Na^{+}> Mg^{2+}> K^{+}). Calcium and magnesium concentration ranged from 52 to 120 mg/L (mean: 82.8 mg/L) and 22.0 to 80.52 mg/L (mean: 42.7 mg/L) respectively. While, sodium and potassium concentration varied from 23.8 to 90 mg/L (mean: 61.0 mg/L) and 1.4 to 8.7 mg/L (mean: 3.5 mg/L) respectively. It is evident that alkaline earth metal **(Ca^{2+}, Mg^{2+})** concentrations were higher than alkali metal (**Na^{+}, K^{+}**) concentrations. Concentration of Ca^{2+}, Mg^{2+}, Na^{+} and K^{+} were below their respective BIS permissible standard limits of 200, 100, 200 and 10 mg/L.

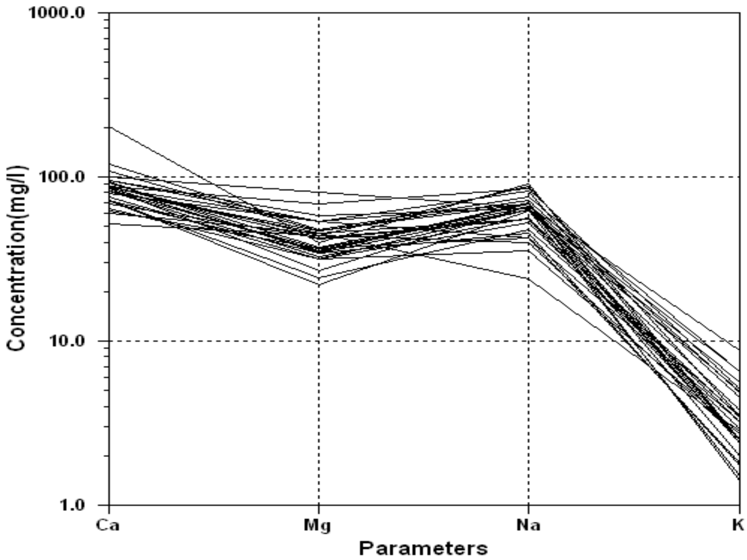

Fig 5. Schoeller diagram showing cationic distribution in the study area

Anions (HCO_3^-, SO_4^{2-}, Cl^-, NO_3^-, F^-, PO_4^{3-})

From thediagram (**Fig 6)and Fig 7,** it is evident that bicarbonate was the dominant anionfollowed by chloride and sulphate (viz., **(HCO_3^- > Cl^-> SO_4^{2-} > NO_3^- > F^- >PO_4^{3-})**. It is also apparent from the results that weak acidic anions (HCO_3^-, CO_3^{2-}) concentrations were higher than strong acidic anions (SO_4^{2-}, Cl^-) concentrations. High pH in water samples is attributed to presence of high content of carbonate and bicarbonates ions while Chlorides are widely distributed in nature as salts of sodium (NaCl), potassium (KCl), and calcium ($CaCl_2$) besides leaching from various rocks into soil and water by weathering. The chloride ion is highly mobile and is transported to closed basins or oceans. In the present study, bicarbonate concentration ranged from 229.4 to 510 mg/L (mean: 339.1 mg/L) while chloride concentration ranged from 70.3 to 249.8 mg/L (mean: 146.7 mg/L) respectively. The Chloride concentrations in the ground water samples from the study area were below the BIS desirable limit of 250 mg/L.

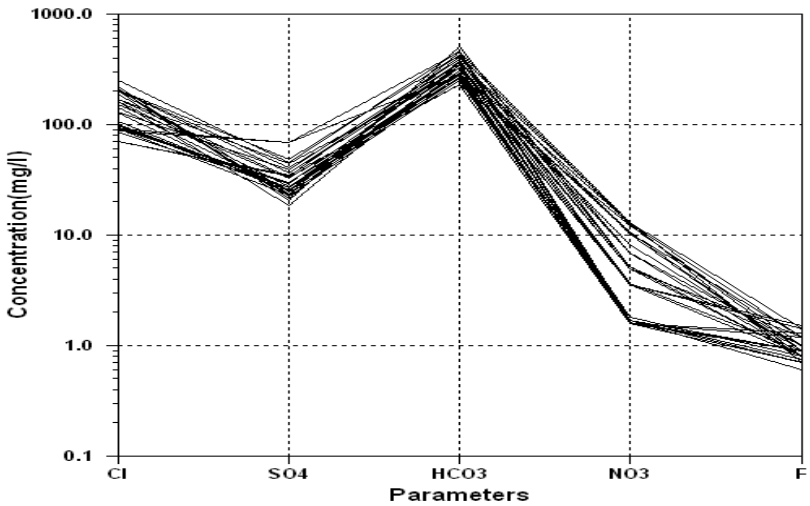

Fig 6. Schoellerdiagram showing Anionic distribution in the study area

Sulphates ions originate in natural waters oxidation of sulphate ores solution of gypsum and anhydride. Sulphates contribute to the total solid contents and they are readily soluble in water. High amounts can also more bitter taste of water. Sulphates cause a problem of scaling in industrial water supplies and problems of odour and corrosion in waste water treatment due to its reduction to hydrogen sulphides. Nitrates are believed to occur in a ground water mainly due to the leaching losses from soil organic matter, leaching of fertilizers applied to soil, leachates from refuse dumps and industrial discharge also contribute to presence of nitrate. A nitrate present in high concentration in drinking water is considered unsafe for infants because they get reduced to nitrates in their intestinal track and this causes methemoglobinemia, and blue baby diseases [28]. In the present study, sulphate and nitrate concentrations respectively varied from 18.5 to 69.0 mg/L (mean: 32.7 mg/L) and 1.59 to 13.1 mg/L (mean: 5.6 mg/L). All the samples showed sulphate and nitrate concentration below their respective BIS desirable standard limit of 200 and 45 mg/L.

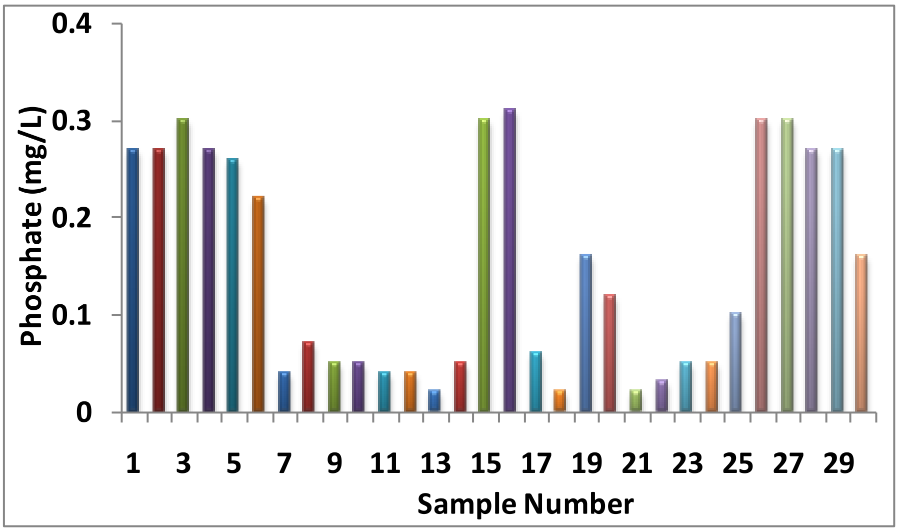

Fig 7. Spatial distribution of Phosphate value of ground water samples

Phosphates may occur in surface or ground water as a result of leaching from minerals or ores, from agriculture run off and as a major element of municipal sewage due to utilization of synthetic detergents. The concentration of phosphates is not so important for drinking water compared to their significance in water and waste water treatment. On the other hand, the presence of fluoride ions has dual significance in water supplies high concentration of fluoride causes dental and skeletal fluorosis while concentration less than the 1.0 mg/l results in dental caries, which has a serious socioeconomic implication [29]. Hence it is essential to maintain fluoride concentration between 0.8 to 1.0 mg/l, daily absorption of 20 to 80 mg or more fluoride in the body in the eventual development of above stated severely clipping disease fluorosis. In the study area, phosphate concentration (**Fig 7)** ranged from 0.02 to 0.31 mg/L (mean: 0.1 mg/L) while Fluoride values ranged from 0.6 to 1.5 mg/L (mean: 1.0 mg/L). It is clear from the results that phosphate concentration in few samples was within the prescribed BIS standard limit of 0.3 mg/L except for one sample. On the other hand, despite within the BIS permissible limit of 1.5 mg/L level, the fluoride concentration in some of the samples were close to standard limit (**Fig 8)**, which may draw attention on the health impacts of fluoride in near future, in case those samples were continuously used for drinking purpose [27,30, 31] and hence water quality assessment and monitoring plays an important role in protection and conservation of water resources [32].

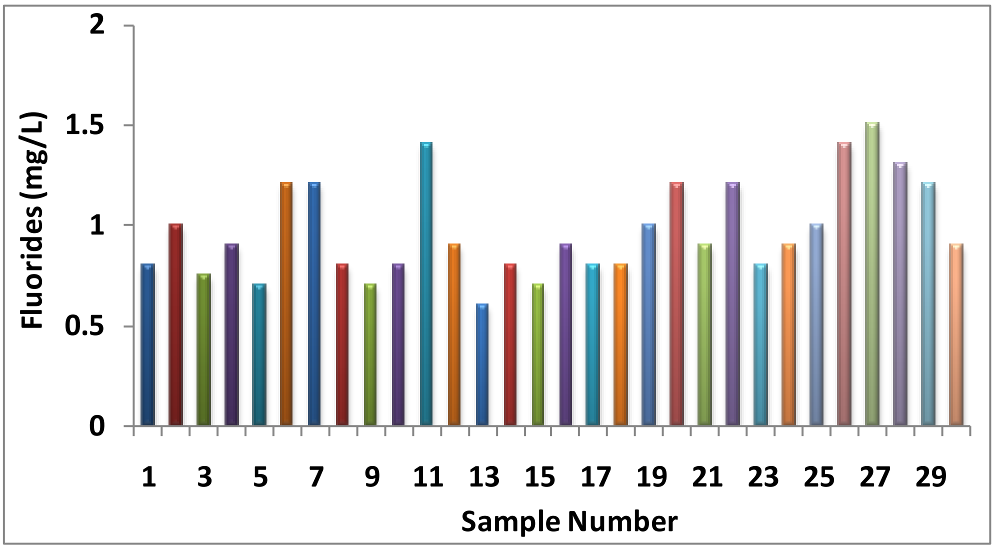

Fig 8. Spatial distribution of Fluoride value of ground water samples

4. CONCLUSION

The overall quality of ground water analyzed revealed that the water samples are safe for drinking purpose. Hardness estimation indicated that the groundwater samples are very hard in nature and is of permanent or non-carbonate type. Although hardness not having significant deleterious ill effect on humans, it is advised to take adequate steps to remove hardness before supply water at consumer level. Hard water can form scale, which leads to various problems like water spots when water is left to dry on plumbing fixtures, glassware, metal ware and other materials. Scaling in valves, pumps, water meters and other materials can cause corrosion, especially on movable parts. High total hardness can result in abnormal cloudiness and the formation of scale in utensils while storing. However, levels of hardness that are too low could make the water corrosive and more aggressive. Further, Water with a high level of hardness could cause serious problems in industrial equipment and machinery settings wherein water hardness is typically monitored to prevent costly failures in components like cooling towers, boilers and other equipment that contains or processes water. Further, for the precautionary measure, it is advisable to carry out a detailed investigation on ground water quality from time to time on routine basis in order to protect ground water quality and also from point view of public health.

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CONFLICT OF INTEREST

Authors have no any conflict of interest.

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