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CONTOUR CHARECTERISATION AND GROUNDWATER QUALITY STUDIES IN HEBBAL VALLEY, KARNATAKA, INDIA

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ABSTRACT

Groundwater is one of the most important natural resource. This natural resource of late is becoming scarce due to various reasons Viz., over exploitation, pollution, reduced recharge, mismanagement of existing available water resource etc. Groundwater crisis to some extent is due to natural factors but mainly due to human interaction with the environment. Pollution of groundwater resources has become a major problem today. In addition, leachates from agricultural practices, industrial waste and municipal solid wastes are also polluting groundwater. As a result quality of groundwater in some parts of the country, particularly shallow groundwater is deteriorating. Along with human activities, water quality is also affected due to natural processes particularity the water-rock interaction in the aquifers. In context to the above issues an attempt has been made to study the geochemistry of groundwater available in Hebbal valley. The water samples have been analysed for both cation and anions. The anomalies are highlighted by the Isogram maps and the same has been interpreted. In general the overall quality of the groundwater in the study area is suitable for both domestic and agricultural activity as of now.

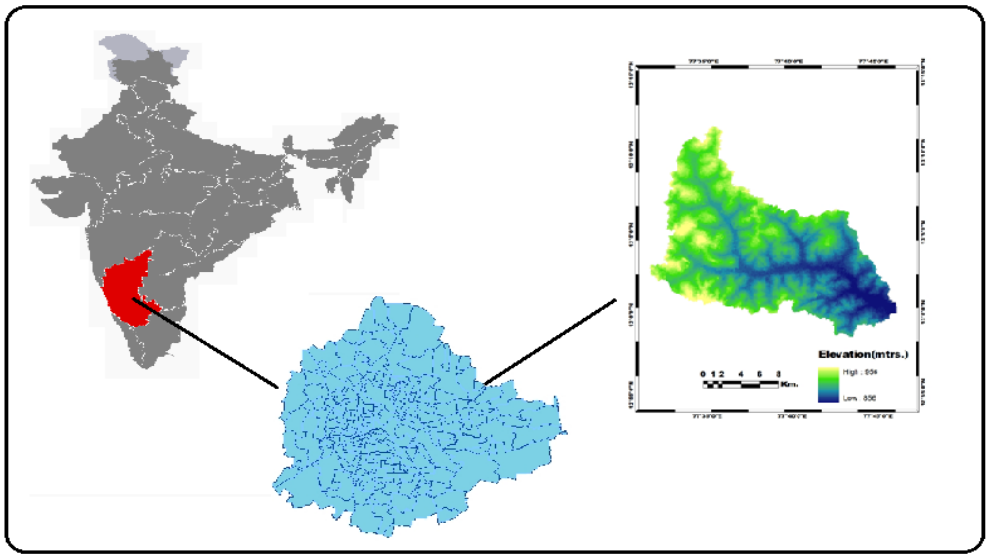
Keywords: Hebbal valley, Groundwater Quality, Leachates, Aquifers, Isograms.

INTRODUCTION

Groundwater is most important and critical natural resource. Groundwater is the major source for drinking water. Besides, it is an important source of water for the agricultural and industrial sectors. The water quality is of vital concern for mankind as it is directly linked with human welfare. The groundwater is believed to be comparatively much clean and free from pollution than surface water. The chemical composition of natural waters is influenced by the soluble products due to rock weathering and decomposition in the aquifer. Thus the main factors that control the quality of water are the associated lithology, soil and to some extent landuse.

The quality of groundwater particularly at shallow depth is changing. The situation is leading to the problem of water pollution. The fresh water crisis is mainly due to improper management of water resources and environmental degradation, which has lead to a lack of access to safe water supply. The modern civilization, industrialization, urbanization and increase in population have lead to rapid degradation of groundwater quality. However, the growing demand for groundwater resources has caused concerns about the sustainability of both agriculture and the economy. The available water resource has to be evaluated both for quantity and quality alike. Monitoring of groundwater quality is an effort to obtain information on chemical quality through representative sampling in different hydrogeological environment. The resources can be utilized for the benefit of the society when needed.

STUDY AREA



Map 1 - Study area

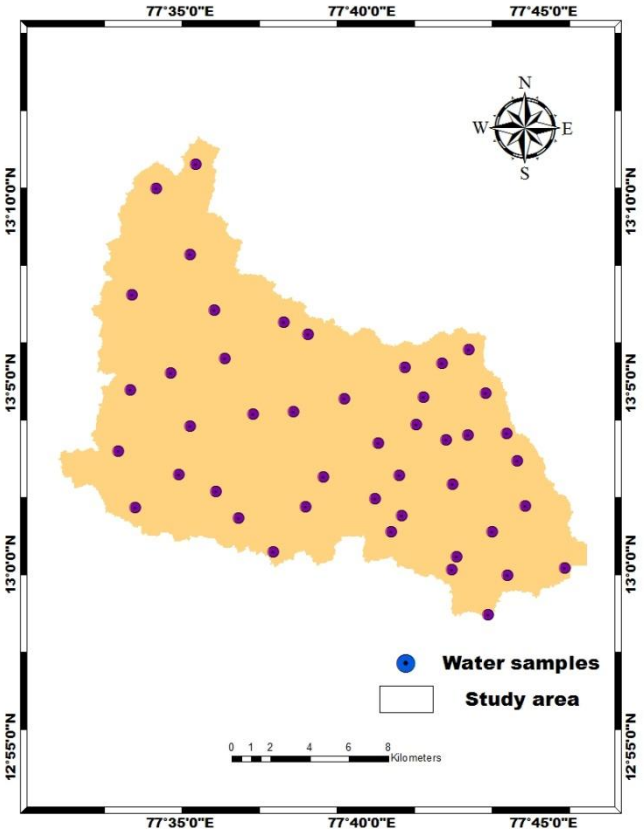
The study area is located between 12º 50’ to 13º 5’N Latitudes and 77º 30’ to 77º 40’E Longitudes forming a part of Cauvery river basin (Map-1). The study area covers an area of 310.24 km^2 and drains into river Pinakini in Bangalore district of Karnataka. Physiographically the area is characterized by undulating topography with plains and shallow valleys. The area is covered by peninusular gneissic complx and soils includes red sandy, gravely,loamy and clay soils. The study area is located at the north eastern parts of Bangalore. Bangalore is the capital of Karnataka state. However the district does not have any major river flowing. The district falls in Cauvery river basin. The study area attains maximum elevation of 940 mtrs. and a minimum of 880 mtrs. above mean sea level. The study area is well connected by highways and main roads. The average annual rainfall in the study area is 820 mm.

METHODOLOGY

In the study area 45 groundwater samples have been collected from various locations for two different seasons *Viz*., pre monsoon and post monsoon (Map-2). The sampling points were located in areas where there was no treated water supply. The samples so collected were analysed for various physico-chemical parameters by adopting standard analytical procedures. The samples were analysed for pH, electrical conductivity (EC), major cations and anions. The pH was measured with pH meter and EC with Conductivity meter. Calcium, magnesium, bicarbonate and chlorides were estimated by titrimetric method. Sodium and Potassium were determined by flame photometer. Fluoride concentration was measured with Spectrophotometric technique. Geographical information system has been used to generate iso-concentration maps to depict the anomalies in the study area.

RESULT AND DISCUSSION

The groundwater samples are analyzed and statistical parameters of the chemical variables are tabulated in Table 2. Distribution pattern of the ionic concentration over the study area is shown by generating Iso-contour maps (Map - 3&4).



Map 2: Groundwater Sample locations

Calcium (Ca^{2+})

The Calcium value in the study area in pre monsoon period ranges from 27.15 mg/l to 188.5 mg/l with an average of 77.13 mg/l and 28.4 mg/l to 177.6 mg/l with an average of 77.8 mg/l in post monsoon period (Map - 3&4). The permissible range of Calcium for drinking water is specified as 75 to 200 mg/l (WHO). Iso concentration maps have been prepared to depict the chemical variations for both the seasons and the maps reveals that all the groundwater samples of the study area are well within the permissible range. However, few samples are found to exceed the permissible limit. Weathering of gneissic and granitic rock contributes Calcium to the groundwater.

Magnesium (Mg^{2+})

The Magnesium value in the study area ranges from 15 mg/l to 86 mg/l (Map - 3&4) with an average of 32.3 mg/l in pre monsoon period and 15.54 mg/l to 68.5 mg/l with an average of 34.5 mg/l in post monsoon season. The desirable limit specified for Magnesium concentration for drinking water is 30 mg/l (WHO). The Variation of the Magnesium over

the study area is as shown in the isogram map. Contribution of Magnesium in the study area is mainly due to the lithounits of the area. Weathering of schists and gneisses enrich the Magnesium content in groundwater.

Sodium (Na^+)

The average Sodium content for the study area is 80.11 and 65.9 mg/l in pre and post monsoon seasons. (Map - 3&4). There is no permissible limit for Sodium, thus it is not used in classifying drinking water but crucial from agricultural point of view. Application of animal waste and increased use of chemical fertilizers and weathering of clay minerals, pyroxenes and amphiboles contributes significant amount of Sodium to groundwater.

Potassium (K^+)

Potassium concentration varies from traces to 37.1 mg/l, with an average of 12.83 mg/l in pre monsoon and 2.32 to 71.8 mg/l with an average of 16.91 mg/l in post monsoon season. The main source of Potassium is due to weathering of lithology rich in minerals such as orthoclase, microcline, biotite. Apart from this excess usage of organic fertilizers and plant and animal waste used as manure also contributes to the enrichment of Potassium in groundwater. The variation of Potassium is shown in the isogram map (Map - 3&4).

Chloride (Cl^-)

Generally the concentration of Chloride is high in groundwater as it is highly soluble. Its presence in drinking water doesn't harm but excess of its concentration affects the taste. Chloride concentration in the study area range from 28 mg/l to 179 mg/l (Map-8 with an average of 90.24 mg/l in pre monsoon and 51 mg/l to 167 mg/l (Map - 3&4) with an average of 89.05 mg/l in post monsoon season. The permissible limit of Chloride in drinking water is 200 mg/l (WHO). Improper agricultural practices and domestic sewage adds most of the Chloride to groundwater.

Sulphate (SO_4^-)

Sulphur is readily soluble and chemically stable compound. The recommended upper limit of Sulphate in drinking water is 250 mg/l (WHO). Sulphate concentration in the study area varies from 15 mg/l to 307 mg/l with an average of 51.35 mg/l in pre monsoon and 19 mg/l to 203 mg/l with an average of 51.80 mg/l in post monsoon period. The sulphate concentration in groundwater samples of the study area is within the permissible limit except in some isolated cases. Sulphide minerals, application of sulphatic soil conditioners and excess use of organic fertilizers contributes Sulphates to the groundwater. The distribution of Sulphate over the study area is as shown in the map - 3&4.

Nitrate (No_3^-)

The main source of Nitrate comes due to human activity. Excessive usage of chemical fertilizers in agricultural activities and the cultivation of nitrogen fixing nodule plants like peas, beans, soybeans, and groundnut. Nitrate concentration in the study area varies from 6 mg/l to 52 mg/l with an average of 23 mg/l in pre monsoon and 13 mg/l to 46 mg/l with an average of 26 mg/l in post monsoon period. The prescribed limit for Nitrate in the drinking water is 45 mg/l (WHO). Few groundwater samples of the study area are above the permissible limit. The anomalies are shown in the isogram map (Map - 3&4).

Bicarbonate (HCO_3^-)

The primary source of bicarbonate in groundwater is the dissolved CO_2 in rain. Normally the bicarbonate in groundwater ranges from 100 to 800 mg/ltr. The mean value of bicarbonate in the study area is 281 mg/ltr., with a range of 131 to 563 mg/ltr in pre monsoon and 147 mg/l to 417 mg/l with an average of 268 mg/l in post monsoon period. The anomalous zones are noticed are due to alkaline nature of soils and carbonate bearing litho units.

pH

The pH of water indicates its quality and provides information on geochemical equilibrium or Solubility calculation (Hem,1985). pH values of the study area varies from 6.7 to 8.6 with an average pH of 7.6 in pre monsoon and 6.8 to 8.3 with an average pH of 7.6 in

post monsoon. The desirable limit of pH for drinking water is 7 to 8.5. pH of the groundwater samples in the study area are within the permissible limit.

Electrical Conductivity (EC)

The conductivity indicates the ionic concentration. The conductivity depends on temperature, concentration and type of ions present (Hem,1985). EC of the groundwater varies from 239 to 3949 microsiemens/cm at 25^{o}C with an average of 907 in pre monsoon and 419 to 1705 microsiemens/cm at 25^{o}C with an average of 911 in post monsoon.

Total Dissolved Solids (TDS)

TDS describes the inorganic salts and small amounts of organic matter present in water (WHO, 1989). High TDS concentration is due to the presence of bicarbonates, carbonates, sulphates and chlorides of calcium. High value of TDS influences the taste, hardness and corrosive property of the water. The calculated values of TDS in the study area varies from 167 mg/l to 940 mg/l with an average of 479.7mg/l in pre monsoon and 227 mg/l to 719 mg/l with an average of 472.7mg/l in post monsoon period. The permissible limit of TDS is 2000 mg/l(BIS). Groundwater classification based on TDS shows that all the samples are permissible for drinking and all the groundwater samples are desirable for irrigation.

Total Hardness (TH)

Hardness of water refers to the soap neutralizing power of water, while soap is precipitated primarily by calcium and magnesium ions, hardness is defined as the sum of concentration of these ions expressed as mg/l. of $CaCO_3$. The calculated values of TH in the study area vary from 60 mg/l to 790 mg/l with an average of 303.5 mg/l in pre monsoon and 115 mg/l to 621 mg/l with an average of 291 mg/l in post monsoon season. The permissible limit of TH is 600 mg/l (BIS.) Groundwater classification based on TH shows that most of the samples are of soft, few are of hard and rest of samples are of very hard type. The higher values of TH are due to the concentration of Ca and Mg in waters of these regions.

Iron (Fe)

Iron is one of the major constituents in the rock next in abundance to oxygen, silica and aluminium. Iron is mainly derived from iron bearing minerals like pyroxenes, amphiboles and micas. Desirable limit of 'Fe' content in groundwater is 0.3 mg/ltr (BIS). The 'Fe' value ranges from 0.05 to 1.5 mg/ltr. with a mean of 0.35 mg/l in pre monsoon and 0.13 to 0.9 mg/ltr. with a mean of 0.38 mg/l in post monsoon in the study area. The variation of 'Fe' is as shown in map 3&4.

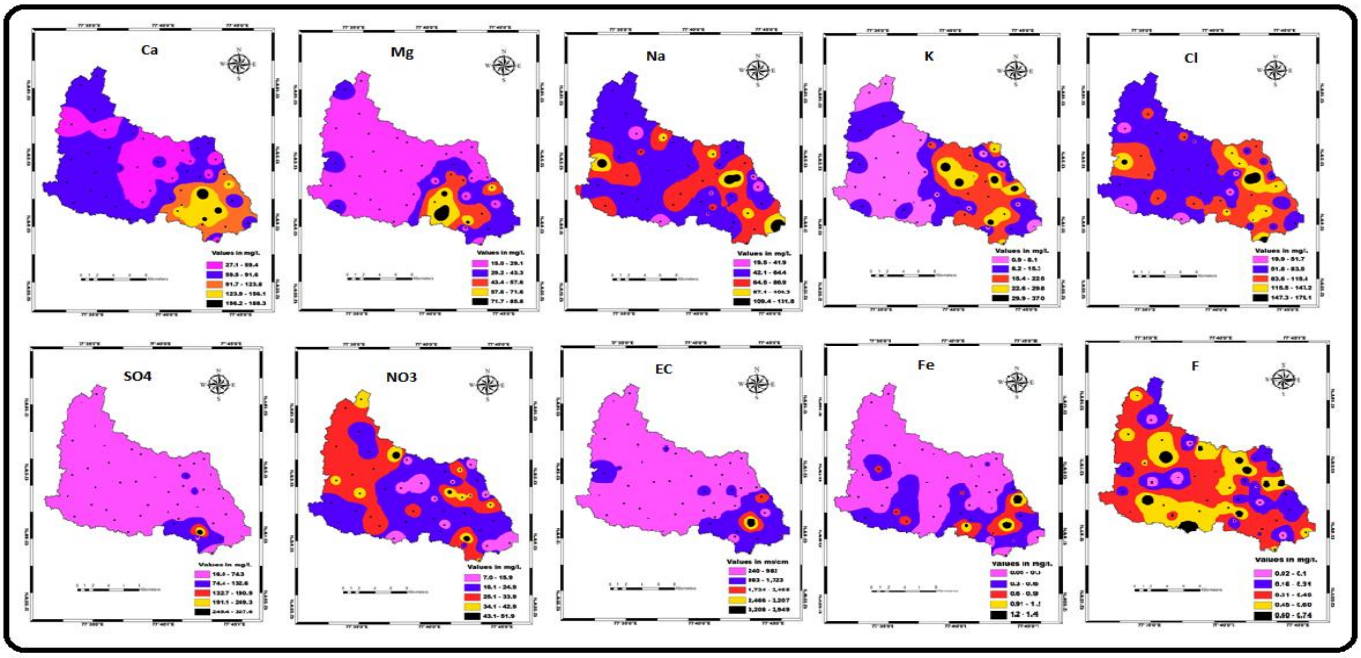
Fluoride (F^-)

The limit of Fluoride concentration in drinking water is specified as 1 mg/l. Fluoride concentration in the study area varies from 0.02 mg/l to 0.75 mg/l with an average of 0.39 mg/l in pre monsoon and 0.07 mg/l to 0.5 mg/l with an average of 0.32 mg/l in post monsoon (Map - 3&4). Fluoride concentration in the groundwater is mainly by the influence of lithology where gneisses and schist covers major portion of the area. Weathering of same has been contributed Fluoride to the groundwater and also due to agricultural runoff containing chemical fertilizers add fluoride to the groundwater to some extent

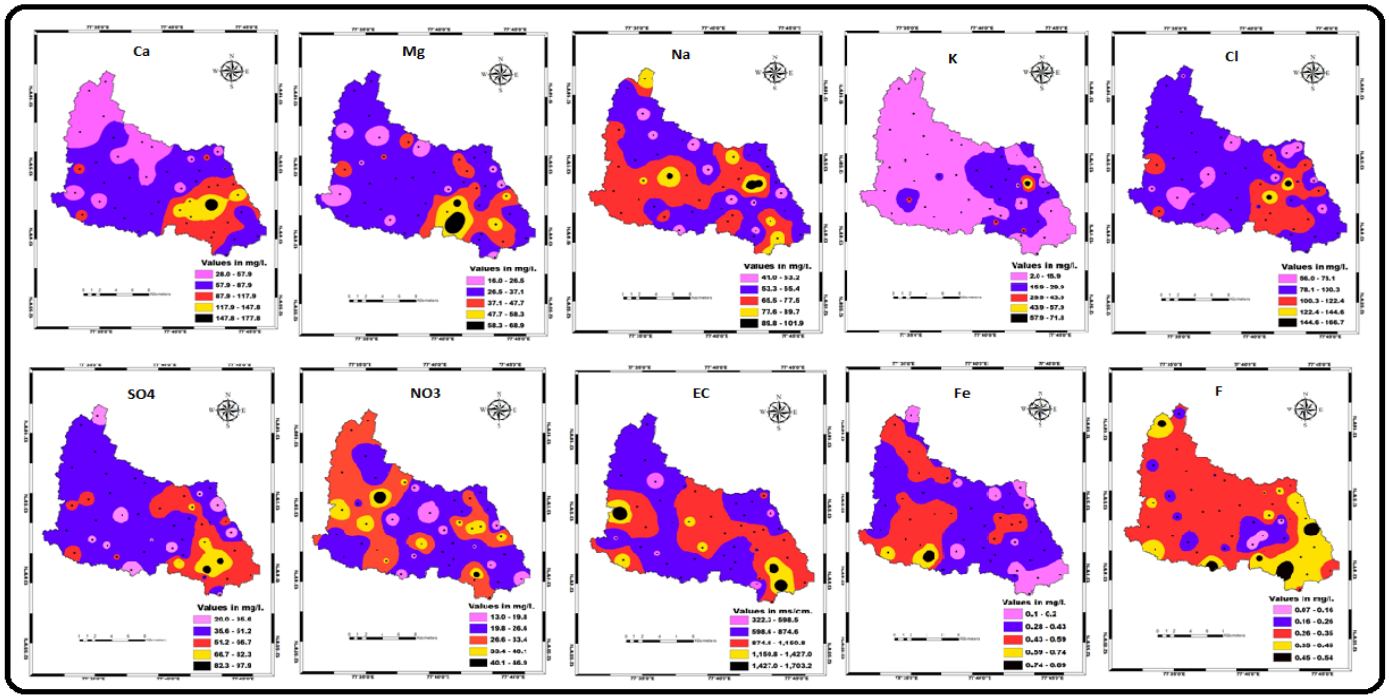
	Pre-monsoon				**Post-monsoon**			
Chemical Constituent	**Min.**	**Max.**	**Mean**	**Standard Deviation**	**Min.**	**Max.**	**Mean**	**Standard Deviation**
Ca	27.15	188.5	77.13	37.1	28.44	177.6	77.8	31.63
Mg	15	86	32.30	19.3	15.54	68.5	34.50	12.7
Na	9.4	753	80.11	106.2	40.9	101.5	65.90	15.2
K	0.95	37.1	12.83	10.9	2.32	71.8	16.91	25.8
Cl	28.55	179	90.24	39.02	51.75	167	89.05	21
SO_4	15.85	307	51.35	45.2	19.85	203	51.80	34.2
NO_3	6.58	52.4	23.91	12.03	13.42	46.5	26.31	8.9
HCO_3	131.25	563	281	95.04	147.1	418.7	268.6	64.54
pH	6.7	8.6	7.6	0.49	6.8	8.3	7.6	0.33
EC	239	3949	907	596.1	419	1705	911	303.3
TDS	167.25	940	479	176.6	227.2	719	472	107.9
TH	60.32	790	303	163.4	115.3	621.2	291	108.2

Fe	0.05	1.5	0.35	0.35	0.13	0.9	0.38	0.15
F	0.02	0.75	0.39	0.22	0.07	0.5	0.32	0.10

Table – 1: Statistical Parameters



Map -3: Iso-concentration maps of chemical parameters for Pre monsoon period



Map 4: Iso-concentration maps of chemical parameters for Post monsoon period

CONCLUSIONS

45 groundwater samples have been collected from various locations of the study area for two different seasons *Viz*., pre monsoon and post monsoon. The samples so collected were analysed for various physico-chemical parameters by adopting standard analytical procedures. The anomalies were identified to draw conclusions. Iso concentration maps have been prepared to depict the chemical variations for both the seasons and the maps reveals that all the groundwater samples in the study area are well within the permissible range. However few groundwater samples are above the permissible limit. This is mainly due to lithology of the area that has contributed to the anomaly. Improper agricultural practices also contributes notable amount of Cl and NO_3 to the groundwater. Although the water quality is mainly controlled by rocks and soils, excessive utilization of agro inputs has also compounded to the problem. However, in general few samples are found to exceed the permissible limit and rest of the samples were well within in the permissible range.

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