Assessment of Hydrogeochemistry of Groundwater in Pratap Nagar, Sanganer Tehsil, Jaipur District, Rajasthan

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***Abstract*– Groundwater is a highly useful and the most widely distributed natural resource known to us. It is paramount for municipal, industrial and agricultural purposes. Therefore, clean and uncontaminated groundwater is pivotal for the region. When compared to surface water, groundwater is generally cheaper, more convenient and less vulnerable to pollution. Butan thropogenic activities of human beings have beset the use of groundwater around the world. Use of groundwater over time can lead to perceptible lowering of the water table beyond the reach of existing wells. Consequently, lowered water table may cause problems such as saltwater intrusion and groundwater-related subsidence. Primary objective of this research paper is to test the groundwater samples for their physico- chemical parameters such as Total Dissolved Solids, fluoride, nitrate and chloride content. The tested values were then compared with the standard permissible limits as prescribed in IS10500: 2012.Taken together, the findings of hydrochemical parameters indicated that most of the samples were within the maximum permissible limits for drinking water. Most of the groundwater samples were found to be saline in nature and also affected by fluoride contamination. Computation of groundwater quality is indispensable to assure its safe and stable use. Hence quality evolution of the available groundwater has been carried out.**

***Key word*–Water Table, Salt Water Intrusion, Groundwater-Related Subsidence, Physico- Chemical Parameters, Total Dissolved Solids, Fluoride, Nitrate, Chloride.**

I. INTRODUCTION

India is a tropical country and vast diversity is observed in climate, topography, geology and vegetation of the country giving rise to divergent groundwater situations in different parts of the country. Though the country witness fairly high annual rainfall, it is not uniformly distributed over the entire country. While the north-eastern part of the country has ample groundwater resource, the western region witnesses scarcity of groundwater.

Rajasthan lying in the western part of the country is the driest part of India. Western part of Rajasthan receives least rainfall among the entire state and consequently experiences an arid climatic condition or hot desert climate. The state may be divided into three hydrogeological units i.e. consolidated rocks, semi-consolidated sediments and unconsolidated sediments. Being the driest region, groundwater plays a decisive role in the wellbeing of the state. Aravali mountain range stretching across the state from south- west to north- east separates the desert and semi desert area of west from humid area of eastern part of the state. As a result, population density is higher in eastern part of the state.

Jaipur, the semi-arid district received 527mm annual rainfall during the period 2001 to 2010.Groundwater in the district occurs both in unconsolidated Quaternary formations and consolidated formations of Bhilwara and Delhi Super Groups and also Post Delhi Granites.

The quality of groundwater is affected by its quantitative and qualitative composition of suspended solids and dissolved minerals. Also, variations in natural and human activities are reflected in the hydrochemical parameters of the groundwater. The groundwater quality is degrading due to discharge of sewage, effluents from industries, precipitation, irrigation and soil type.

Hence, there is an urgent need for the qualitative study and management of groundwater quality.

I. STUDY AREA

The study area i.e. Pratap Nagar lies in Sanganer Tehsil, Jaipur, Rajasthan. It is a semi-arid region and is geographically situated between 26.8072^{o} N latitude and 75.8219^{o} E longitude. The average annual rainfall received by study area during the period of 2001- 2010 is 513.26mm.The average temperature of the study area rises to 30 ^{o}C. The city experiences monsoon showers in the months of August and September with frequent thunderstorms. Depth of ground water table varies from 15m to 40 m with seasonal variation of 1m to 3m.

There are total of 120 tube wells in the area and the average size of each tube well is 200m. Present average yield of the tube wells is 8374, head of tube well is 112m and average discharge is 10,000 LPM.

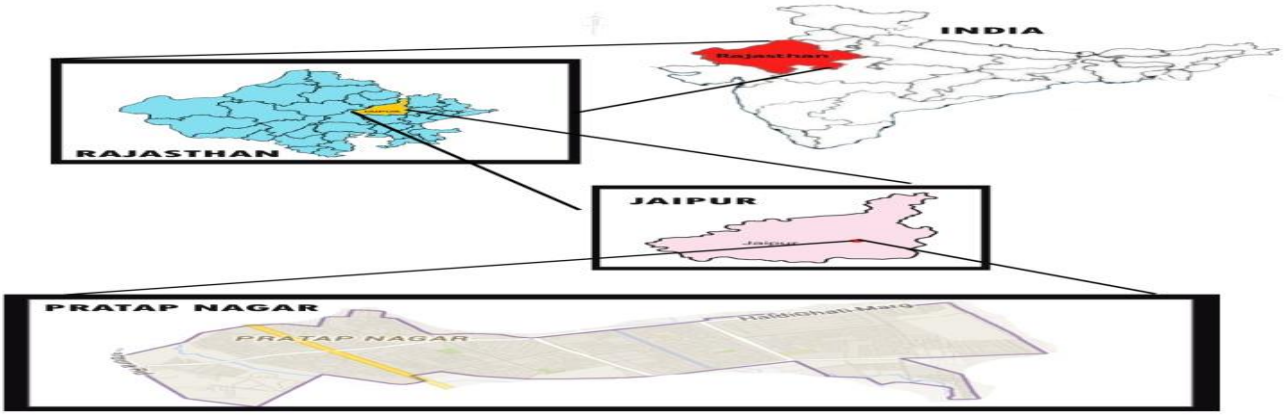

Fig I. Map showing Pratap Nagar (study area)

I. METHDOLOGY

A total of 60 groundwater samples were collected during the post monsoon period i.e. during September 2015 from 60 different tube wells located in the Pratap Nagar, Jaipur.All the samples were then analysed for parameters like Total Dissolved Solids, fluoride, nitrate and chloride content by following the standard guidelines prescribed in Bureau of Indian Standards and the results were then compared with the standard values given in IS 10500:2012, as shown in table 1.The geographical location (longitude and latitude) of the tube wells was determined with help of GPS device.[4]

TABLE I. WATER QUALITY PARAMETERS AS PER BIS

S. No.	Characteristics	Acceptable limit	Permissible limit
1.	Fluoride	1	1.5
2.	Chloride	250	1000
3.	Nitrate	45	0.002
4.	Total Dissolved Solids	500	2000

I. RESULTS AND HYDROCHEMISTRY OF GROUNDWATER

After the computation of groundwater quality parameters it can be easily stated that the water quality in the study area is poor as the study area is contaminated by high concentration of fluoride, nitrate and Total Dissolved Solids while the average chloride concentration in the area is within permissible limit. The spatial distribution of various groundwater quality parameters is given in maps below.

A. FLOURIDE

Rajasthan is the most badly affected state by high concentration of fluoride in groundwater. High fluoride ion concentration in groundwater is due to bed rocks rich in fluoride such as fluorspar, rock phosphate, cryolite, apatite and a wide variety of minerals. At low concentrations, fluoride is beneficial for teeth but in excessive amounts it can give rise to a number of adverse effects such as mild dental fluorosis, crippling skeletal fluorosis and muscular fluorosis. According to UNESCO specifications, water containing more than 1.5 mg/l of fluoride cause mottled tooth enamel in children and is unsafe for human consumption.As per Bureau of Indian Standards, the permissible limit of fluoride in drinking water is 1.2 mg/l and maximum safe daily consumption of fluoride is 10 mg for an adult.Average fluoride concentration in the study area is found to be 1.2 mg/l, which is equal to the maximum permissible limit as per BIS. Minimum fluoride level (0.4 mg/l) was found in New Ganesh Colony and the maximum fluoride concentration (3.7mg/l) was found in sector 17. Fluoride concentration was below 1.2 mg/l in 47% of the studied area while the remaining area had fluoride above 1.2 mg/l.[2, 3]

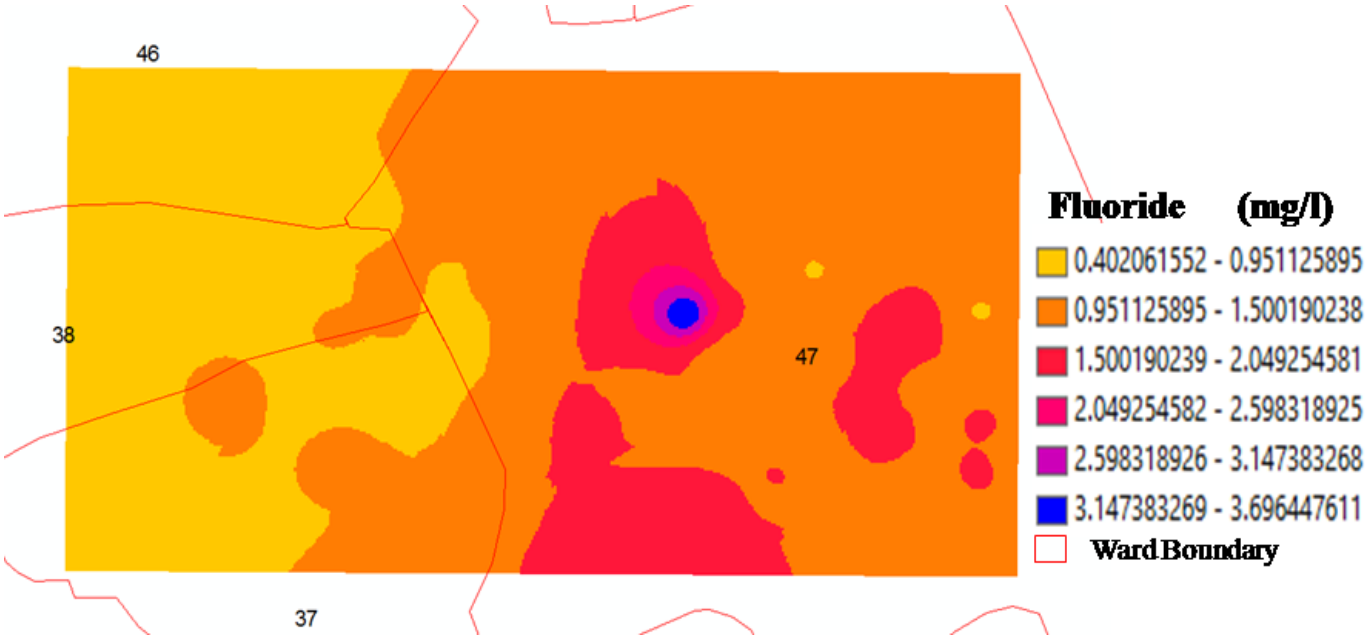

Fig II. Spatial distribution map of fluoride in the study area

B. NITRATE

Nitrate can reach both surface water and groundwater but it occurs in high quantities in groundwater compared to surface water. Some of the major sources of groundwater nitrate are inorganic nitrogenous fertilizers, livestock facilities, sewage disposal systems and oxidation of nitrogenous waste products in human and animal excreta. If consumed in high concentration, it contributes to the illness known as Blue Body Syndrome in infants. Nitrates are known to react with amines, amides in body to form nitrosamine which causes stomach and gastrointestinal cancer.

As per Bureau Of Indian Standards (IS: 10500), the permissible limit of nitrate is 45 mg/l. Average nitrate concentration in the groundwater of the study area is found to be 47 mg/l, which is above the permissible limit of Nitrate as per IS: 10500. Minimum nitrate concentration (22 mg/l) was found in sector 26 while the maximum nitrate concentration (79 mg/l) was found in sector 18. 48% of the total study area has nitrate level less than 45 mg/l and the rest of the region has nitrate level above 45 mg/l. [2, 3, 5]

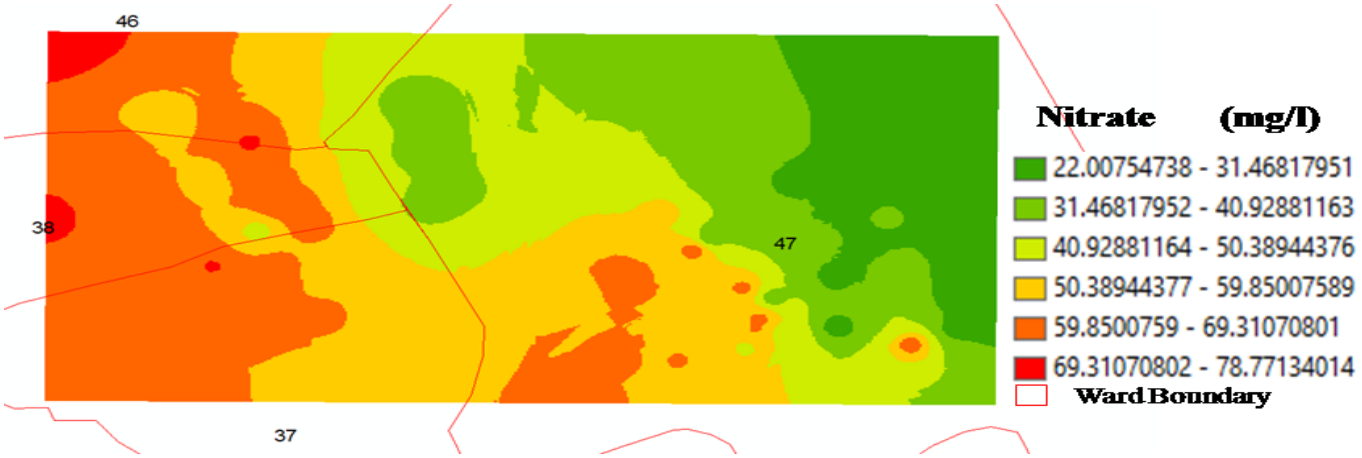

Fig III. Spatial distribution map of nitrate in the study area

C. CHLORIDE

Chlorides are present in nature as salts of potassium (KCl), sodium (NaCl), and calcium ($CaCl_2$). As per WHO, desirable limit of chloride in drinking water is 250 mg/l and permissible limit is 1000 mg/l. Chloride in water is responsible for salty taste. Chloride plays an important role in balancing level of electrolyte in blood plasma and is not toxic to human health below 250 mg/l but high levels may cause odour issues. High intake of chloride causes risk of stroke, left ventricular hypertension, osteoporosis, renal stones and asthma in human beings. Chloride may get into groundwater due to solid waste dumping, agriculture runoff, rocks containing chloride and geochemical activities in the area.

Average chloride level of the study area is found to be 75 mg/l which is well within desirable limit set by WHO. Highest level of chloride i.e. 180 mg/l was found in sector 26, while the lowest level i.e. 20 mg/l was found in sector 18. The chloride concentration was found below 125 mg/l in 87% of study area and remaining 13% area had chloride above 125 mg/l. [2,3]

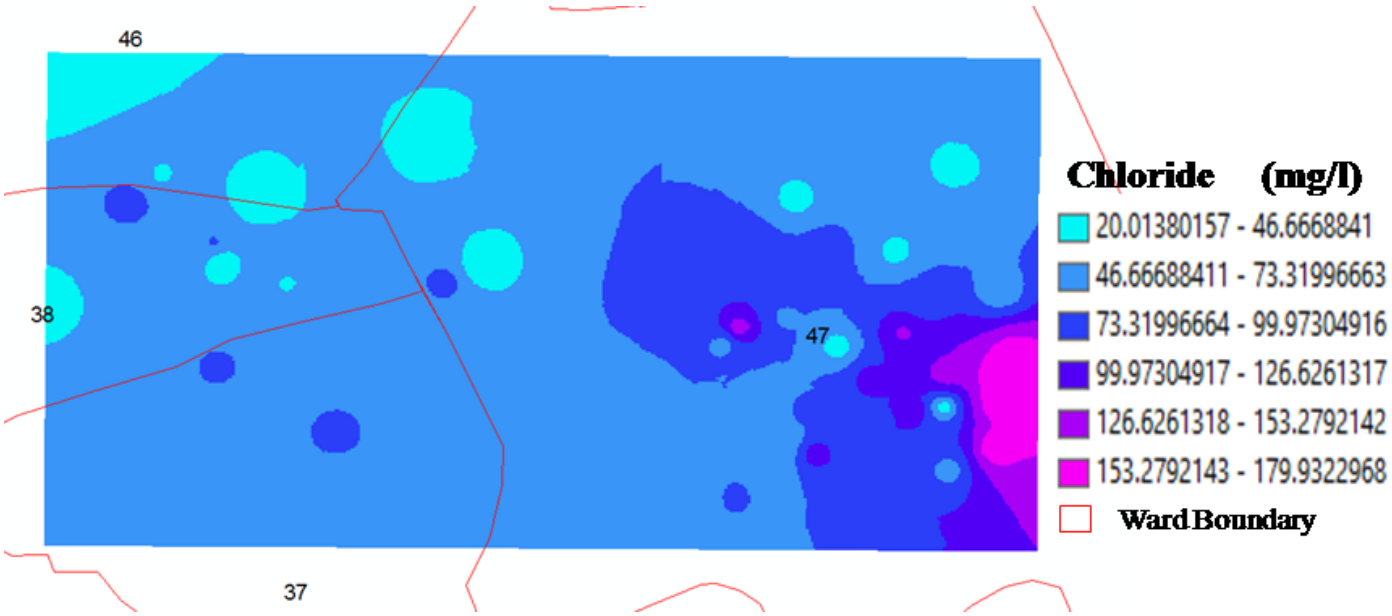

Fig IV. Spatial distribution map of chloride in the study area

D. TOTAL DISSOLVED SOLIDS

TDS is a measure of inorganic salts and organic matter present in water in molecular ionized, micro granular suspended form. The principal constituents are inorganic salts of calcium, magnesium, sodium, and potassium cations and carbonate, hydrogencarbonate, chloride, sulphate, and nitrate anions. Main source of TDS are sewage, urban runoff, industrial waste water and natural sources.As per Bureau of Indian Standard (IS 10500: 2012) guidelines, 500mg/l is the desirable limit and 2000 mg/l is the permissible limit but high levels of TDS may be unpleasant to consumers because dissolved ions may cause water to be corrosive and of salty, brackish taste, may also cause excessive scaling in water pipes, boilers and household appliances. Therefore, according to WHO, Water containing TDS concentrations below 1000 mg/litre is usually acceptable to consumers.Maximum concentration of TDS i.e. 2560 mg/l was observed in sector 26 and the minimum concentration of TDS i.e. 720 mg/l was observed in Raghunathpuri. The average TDS level of the study area is 1576 mg/l which is well above desirable limit set by WHO. Levels of TDS were below 1000 mg/l in 19% area, between 1000mg/l and 1500 mg/l in 24% area and 57% area contains TDS higher than the permissible limit. The findings indicate organic pollution of water.[2,3,5]

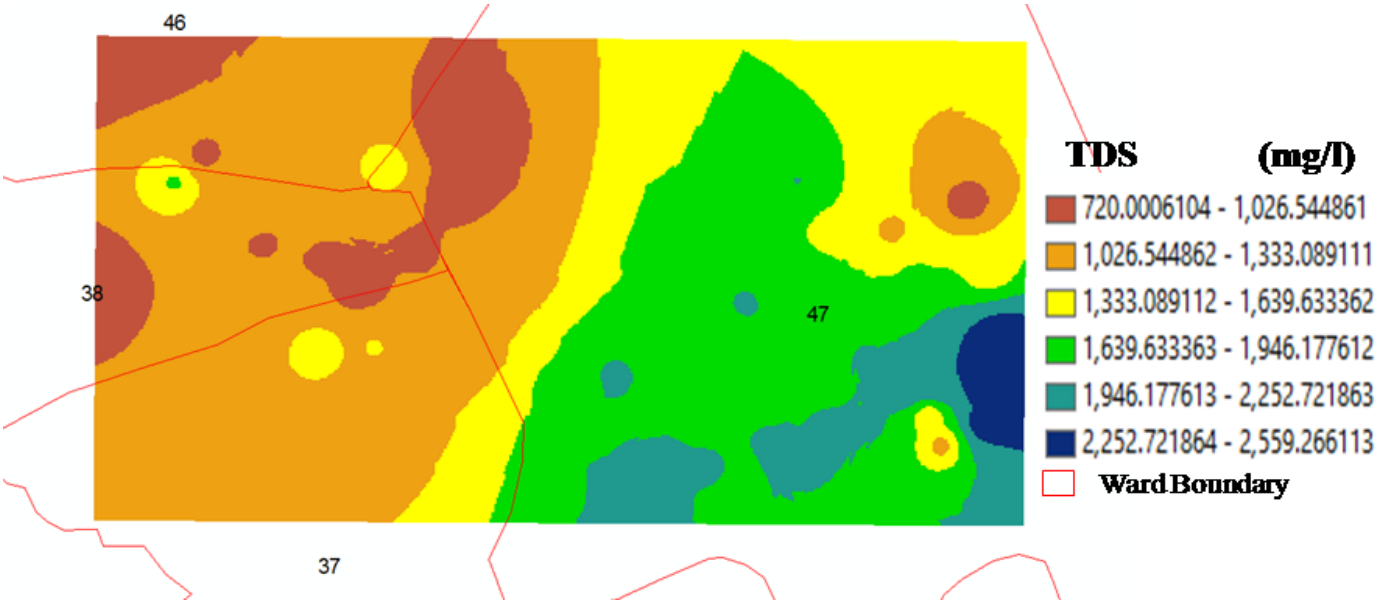

Fig V. Spatial distribution map of total dissolved solids in the study area

V. CONCLUSION

The groundwater quality in Pratap Nagar has been studied and most of the physico-chemical parameters measured for groundwater samples were near the maximum permissible limits set by the World Health Organization. Taken together, these findings indicate that the fluoride content in the groundwater is alarming in the area and 52% of area exceeds the permissible limit of nitrate set by BIS (IS 10500: 2012). Similar case is with TDS as 57% of area has TDS above permissible limit. Though some locations have high chloride content but the study area has average chloride concentration within the permissible limit set by World Health Organization. Hence, groundwater must be used for drinking only after treatment such as water softening and defluoridation.[1]

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