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Assesment of Hydro-Geochemical Parameter of Ground Water at Rawatsar Tehsil, Hanumangarh District, Rajasthan (India)

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Abstract **- The ground water samples were collected from Rawatsar tehsil at Hanumangarh district. These samples were evaluated during pre and post-monsoon 2003 for its hydro-geochemical parameters regularly in three months. A systematic study of water quality parameters has been carried out. A separate base map had been prepared with the help of satellite imagery using GIS. The base map was prepared with the help of SOI topsheet No. 44K on 1:50,000 scale. This map have been used to plot and represent various ions and other hydrochemical variations. The parameters studied were pH, Conductivity, TDS, Hardness, Ca, Mg, Na, K, Fe, Alkalinity, CO3, HCO3, Cl, F, NO3 and SO4. The chemical data obtained were subjected to graphical presentation using standard discrimination diagrams for the assessment of groundwater quality for domestic and agriculture purpose. Seasonal variations in the parameters were discussed here. All parameters were found to be within permissible limit.**

Keywords : Rawatsar, physico-chemical parameters, electrical conductivity.

I. INTRODUCTION

Hydrogeochemistry is a sub-discipline of hydrogeology which is referred to as Chemical hydrogeology in some references and Groundwater geochemistry in some others (e.g. Merkel and Planer-Friedrich, 2005). One may also points to "Contaminant hydrogeology" used by Fetter (1998) as another term that carries the same syllabus as Hydrogeochemistry. In all fields of science and engineering, sub-disciplines are developed to accomplish some missions, fulfill some requirements and supplement the base subject. The same is true with hydrogeochemistry. This sub-discipline has been developed to deal with quality, contamination, chemistry, chemical processes and reactions that take place in various groundwater systems. Due to the importance of water quality issues, this sub-discipline has gradually changed into a well established field of research. For instance, Prasanna et al. (2011) clearly demonstrates that the study of quantity of water alone is not sufficient to solve the water management problems because its uses for various purposes depend on its quality. In addition, a number of other researchers show that the hydrogeochemical characteristics of groundwater and groundwater quality in different aquifers over space and time are important parameters in solving the groundwater management issues (Panigrahy et al., 1996; Atwia et al., 1997; Ballukraya and Ravi, 1999; Ramappa and Suresh, 2000). At the start, it should be pointed out that the quality of groundwater depends on the chemical composition of recharge water, the interaction between water and soil, soil–gas interaction, the types of rock with which it comes into contact in the unsaturated zone, the residence time of groundwater in the subsurface environment and the reactions that take place within the aquifer (Freeze and Cherry, 1979; Hem, 1989; Appelo and Postma, 2005). Hydrogeochemical processes such as dissolution, precipitation, absorption and desorption, ion exchange reactions and the residence time along the flow path which controls the chemical composition of groundwater, constitutes the other issues that are dealt with in hydrogeochemistry.

Groundwater sampling for chemical analysis are proposed and meticulously planned. Depending on the financial constraints and the level of precision required to solve the problem in hand, the number of samples varies. Sometime, it might be needed to drill new piezometers for this purpose. Before any sampling campaign, necessary equipments such as bottles, additives including acids and reagents, field probes, filter papers, pumps and bailers, various size hoses, isolating box or car fridge and a variety of other stuff- depending on the specific aim of the study- should be prepared. Field vehicle, maps, food and proper shoe and clothing are also needed as is the case with any geological field investigations. Collected groundwater samples are then transported to the relevant laboratory in due time, where they are analyzed using methods specified for different types of chemical elements, anthropogenic constituents,
microbes and bacteria. The quality control techniques (duplicated samples, comparing the results which were produced by different laboratories analyzing the same samples, etc) should be undertaken to ensure reliable data. Working with various computer codes to interpret the data and graphically illustrate the results, is the program of work for the next step. At the final stage of the study, hydrogeochemical findings should be compared with the other geological, hydrogeological and field observations results and either revised accordingly or further filed investigation and water sampling be planned.

II. MATERIALS AND METHODS

The study area is located between the latitudes 29°14’ to 29°10’ N and longitudes 73°48’ to 74°20’ E in the Rawatsar

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tehsil of Hanumangarh district which is situated in the northern most part of the state and forms a part of Indo-Gangetic plains. The study area comprises part of the Survey of India toposheet No. 44K on 1:50,000 scale. The study area is irrigated by Rawatsar distributary in the south and southeast and Naurangdesar distributary in north and northwest. Climate of the area is hot and arid with extremes of temperature, erratic and scanty rainfall and high evapotranspiration. Water samples were collected in polythene bags of tube wells from Rawatsar tehsil during pre and post-monsoon 2003. The temperature was recorded at the Spot. The chemicals used for analysis were A.R. Grade and the solutions were prepared in double distilled water.

A total 78 groundwater samples were collected from bore wells of study area. Using pre-cleaned sterilized poly propylene plastic bottles with necessary precautions. The samples were chemically analysed in order to determine the major cations and anions. The chemical analysis were carried out for ph, Electrical Conductivity (EC), total dissolved salts (TDS), total hardness (TH) as well as sodium (Na^+), potassium (K^+), chloride (Cl^-), sulphate ($SO4^{-2}$), nitrate ($NO3^-$), and fluoride (F^-), carbonate, bicarbonate, sodium, potassium etc. according to the standard method (APHA, AWWA and WPCF, (1985)). The ph was measured using ph meter. The Ca^{+2}, Mg^{+2} were determined together volumetrically by titration.

III. RESULTS AND DISCUSSIONS

pH – It is the measure of the hydrogen ion activity. For pure water it is associated to a slight extent into positively charged hydrogen ion (H^+) and negatively charged hydroxyl ion (OH^-). For pure water at 25°C, it is 7.00 (Hem, 1959). The values less than or greater than 7.00 indicates acidic or alkaline nature respectively. In the present study area, groundwater has the Ph ranging from 6.70 (12 AG) to 10.05 (13 BPM) which indicates that the water is alkaline in nature owing possibly due to hydrolysis of carbonates present in water. Most of the brackish waters on other hand show ph between 7.58 to 7.95 indicating normal to slightly alkaline character.

Electrical Conductivity (EC) – Amount of total dissolved salts is expressed as electrical conductivity (EC) and it is considered as measure of salinity. In the study area, the EC in pre-monsoon varies from as low as 350 µs/cm in the well water of RD 3.5 KKM to as high as 38700 µs/cm in the well water of Naurangdesar. Parts of the study area except some patches in the north, west and southeast part around Naurangdesar, Modunagar, Kanwani, Dassuwali etc. where EC value reaches up to 30,000 µs/cm. The groundwater having moderate salinity ranging from 2000 to 4000 µs/cm are normally encountered adjoining to Dhani Luna, Dabli Kallan, Rampura, Ghaggar Head, Rawatsar, 7 KM and Hardeswali-A etc.

TOTAL DISSOLVED SOLIDS (TDS) – Water with high dissolved solids may induce an unfavourable physiological reaction in the transient consumer and generally are of inferior palatability. The Indian Council of Medical Research (ICMR) has recommended 500 mg/l as acceptable and 1500 mg/l as maximum permissible limit of TDS. Looking to the requirement and available water resources for drinking water in the study area, the limit has been further relaxed to 3000 mg/l for TDS where alternate groundwater sources of better quality are not available. Such water should not contain other toxic constituents above potability limits. Potable groundwater having TDS more than 4000 mg/l are encountered in 30 well waters in patches around Dabli Khurd, Naurangdesar, 12 AG, Khodan etc. Groundwater around 10 MZW, RD 3.5 KKM, 2 KKSM having 500 mg/l TDS are considered as excellent.

TOTAL HARDNESS (TH) – Hardness of the water is the property attributable to the presence of alkaline earths. Hardness may be of two types (1) Temporary (2) Permanent. Hardness is always expressed in terms of $CaCO_3$. The total hardness varies from 50 mg/l in the well water of Kalalonwali, RD 77 RWD to as high as 6975 mg/l in highly saline groundwater of 7 DWD.

CHLORIDE – The presence of chlorides in natural waters can mainly be attributed to dissolution of salt deposits in the form of ions (Cl^-). It is the major form of inorganic anions in water for aquatic life. In the present study area, the lowest concentration of Cl^- is of 1 mg/l (RD 3.5 KKM, Naulkhi) and maximum concentration is in 370 mg/l (Dassuwali).

FLOURIDE - Fluoride is a minor constituent in most igneous and sedimentary rocks. CaF2 is slightly soluble in pure water. Fluoride is easily absorbed by sediments. Due to above factors as well as low availability, the concentration of fluoride remains within potable limits in most part of the study area. Slightly saline to moderately saline groundwater are recorded in well water of Thalarka, Budhwalia, Kanwani, RD 97 RWD, 11 DWD, RD 17 KKM, Naulkhi, Hardeswali-A, Hanuman Temple and RD 107 IGMN where the value of fluoride is more than 2 mg/l. The high fluoride contents in groundwater (> 2 mg/l) are normally associated with high salinity and found in southwest, south and southeast part of the study area. Flouride less than 1 mg/l is dominant in the study area.

NITRATE – Nitrates are the most oxidized forms of nitrogen and the end product of the aerobic decomposition of organic nitrogenous matter. The groundwater contamination is due to the leaching of nitrate present on the surface with percolating water. In the study area, the maximum value of nitrate is registered in the well water of Naulakhi (124 mg/l). Nitrate content in groundwater varies from nil to 124 mg/l. It is reported in the study area that dissolved nitrate above 20 mg/l in drinking may cause cyanosis in infants. Southern parts of the study area are characterized by high nitrates (> 100 mg/l).

SULPHATE – Sulphate ions usually occur in natural waters. Sulphates are found appreciably in all natural waters, particularly those with high salt content. Besides industrial pollution and domestic sewage, biological oxidations of

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reduced sulphur species also add to sulphate content. The sources of sulphates are minerals of igneous sedimentary rocks. The oxidation of sulphide minerals in the dark clays, silts and gypsum (hard pan) available in the Tertiary and Quaternary deposits may be the sources of sulphates in the groundwater of the study area. In the study area, Sulphate content ranges from nil at Masitawali Head, Meharwala, Khetawali, 10 KWD, Chaiya, Kanwani, Kesardesar and as high as 1777.2 mg/l in the well water of Bhompura.

SODIUM AND POTASSIUM – The major source of sodium and potassium is weathering of rocks besides the sewage and industrial effluents. Na vary widely between 1.35 to 365 mg/l in fresh water in the study area. The two coordinate fields depicting the relationship between TDS and Na content in water samples of the study area confirms the tendency of most natural waters to approach the composition of NaCl and TDS increase. Na is a dominant cation and varies from 1.35 mg/l in the well water of 10 MZW to 365 mg/l in Modunagar. K in natural water comes from potash feldspars,

micas and feldspathoids and evaporates. K in natural water comes from potash feldspars, micas, feldspathoids and evaporates. K ranges between 0.10 mg/l (Hardeswali A, RD 77 RWD) to 10 mg/l (Naurangdesar) in study area. The study shows that Na and K are the dominant cation in the region.

BICARBONATES AND CARBONATES – Most of the groundwater derive their carbonates and bicarbonates ions through interaction with CO2 of the air, soil and also with the solution of carbonate rocks. ph of the system plays an important role in deciding whether carbonate or bicarbonate would be the dominant ion. In the groundwater of the study area, the bicarbonate concentration is usually high and is found in the range from 0.5 mg/l (10 KWD) to 18.5 mg/l (Dhani Luna), while the carbonate is found in the range of 1 mg/l (Meharwala, 2/3 MZW, 22 AG, Lakhuwali Head, Modunagar, 10 KWD, Chaiya, 29 DWD and Thalarka).

CALCIUM AND MAGNESIUM – Ca occurs in most natural waters as the most dominant cation, while Mg is commonly present in amounts much less than both Ca and Na. In the study area, the major part of Ca is come from limestones, shales and quaternary sediments in the form of CaCO3. The observations of the analysis shows that both Ca and Mg ions are not dominated cations in the area. The variation of the Ca content is minimum (0.5 mg/l) in 1 DWSM, 1 DWM, Hardeswali-B, RD 107 IGMN, 19 AG, RD 77RWD, RD 106 RWD and 34 RWD to maximum (63 mg/l) in Ramka while the Mg content is minimum (0.5 mg/l) in 11 DWD, Bhagirath ki Dhani, Mirzawali, Ghaggar Head, Rawatsar, 7 KM, Khannasar and RD 77 RWD to maximum (87 mg/l) in 7 DWD.

CHLORIDE – As per Fairbridge (1972), many workers now agree that chloride in natural water, has been derived largely from the cyclic salts, i.e. the salts dissolved in sea water are transferred to the atmosphere in spray and bubbles, which are carried to land by clouds and precipitated on the land surface as rain or snow. Once the chloride is dissolved in water, it is very difficult to be removed through natural processes owing to its high solubility. In the study area, the lowest concentration of chloride in groundwater is 1 mg/l (RD 3.5 KKM, Naulkhi) and the maximum concentration is 370 mg/l (Dassuwali).

IV. CONCLUSION

1. The results of chemical analysis data indicate that ph range fom 6.5 to 10.55 indicating that the water is alkaline in nature.
2. EC of groundwater depends upon the total dissolved solids. The major part of IGNP area has value of EC more than 4000 microsimens/cm at 25°C which shows that the shallow groundwater is not suitable for irrigation.
3. The analysis of water samples of bore wells of different areas show that the deep groundwater have EC value between 20,000 to 40,000 µs/cm at 25°C. 38.46% groundwater samples are of poor quality according to distribution of TDS in the study area.
4. Only 4 water samples (TDS 0-500 mg/l) are excellent as per ICMR Norms.
5. The values of Na, Ca, Mg vary between 8 to 2100, 12 to 500 and 1 to 814 ppm respectively.
6. Ca and Mg in most part of the study area fall within safe limits of use of household purposes and it has been generally observed that Mg is more abundant in all types of water than Ca, indicating a strong climatic control on the quality of groundwater prevailing in the study area.
7. 71.79% of water samples have Cl^{-} less than 100 mg/l while 28.21% have Cl^{-} above 100 mg/l indicating that there is no scarcity of potable water.
8. F^{-} in the study area is in the range of less than 1 mg/l which is of good for drinking. 39.58% samples of nitrate is good for drinking purposes.
9. 38 water samples of $SO4^{-2}$ is in the range of < 250. It is evident from the chemical data that a fresh water cushion has developed over the native saline groundwater mainly due to seepage from canal system, return flow from surface water application for irrigation purposes, seepage from depressions of Ghaggar Flood Diversion Channel and presence of poorly permeable layer at shallow depths.

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