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Impact of climate change on groundwater quality

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ABSTRACT

Water is an indicator through which climate change is appeared in earth ecosystem. The change in frequency and pattern in rainfall as well as temperature directly affect the movement of water under earth and storage also. Udaipur comes under the semi-arid region of Rajasthan, which receives variable rainfall and temperature pattern. Water samples were collected from 53 locations to evaluate water quality parameters EC, pH, TDS, Ca^{2+}, Nitrate and fluoride. Fluoride is major problem in some areas of Udaipur. Higher rainfall years shows the low concentration of water of fluoride. The investigations indicates that water recharged during an arid time has higher concentration of salt and impacts higher Total dissolves solids (TDS).This study will be helpful to establish a link between climate change and groundwater quality in semi-arid regions of Rajasthan and recommend the required strategic groundwater management policy and planning to improve groundwater quality degradation.

Keywords: Water quality, Rainfall pattern, Climate change, Temperature, TDS

INTRODUCTION

Rajasthan with an area of 3.42 lakh sq.km is the largest but driest state of the country. The state has extreme climate and the geographical conditions. The Aravali range of hills divides the state in two parts. The north -west region has scanty and uncertain rainfall while south-east region has fairly good rainfall. The state has water problem of quantity and quality both. In most of the parts of state, groundwater is either saline or has excess fluoride. Groundwater is the major source of drinking water which covers over 90% demand of the drinking water (Allen *et al.*, 2004).

Rajasthan constitutes a large portion of the total water quality affected habitations of the country. Nearly 2,16,968 habitations of the nation affected with various water quality problems, about 41072 quality affected habitations are in Rajasthan which is 19% of the total quality affected habitations. If iron affected habitations are excluded, the total quality affected habitation in Rajasthan will be about 41 percent. Nearly 75% of the multiple quality and 56% of nitrate affected habitations of the country are in Rajasthan.

METHODOLOGY

Study area

Fateh Sagar Lake is situated in the city of Udaipur, which falls in semi-arid region of Rajasthan bounded by Longitude, 73.6742° E and 24.6014° N Latitude. The Lake is also a prime source drinking water supply for the city of Udaipur. It has catchment area of 54 km^2. The lake water temperature varies from a minimum of 19°C in January to 29.4°C in June at the surface, and correspondingly 16.8 and 28.5°C at the bottom of the lake.

Data Collected

Water quality data of 16 years collected from Ground Water Department, Udaipur. The data of 53 locations of Udaipur district during 1992 to 2008 was collected.

RESULTS AND DISCUSSION

Rainfall and water quality

The groundwater is generally Ca-Mg-HCO_3 type, which is mainly due to the geology of the area

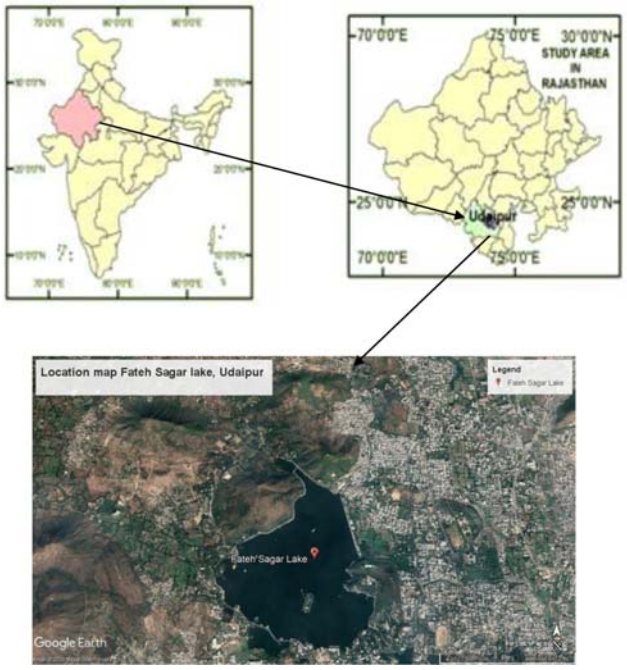

Figure 1. Location of Study Area

which comprises igneous rocks of crystalline nature, in which the major units are gneisses and granites (CGWB, 2002). Groundwater in the study area occurs under water table conditions in the weathered and fractured granite, gneisses. The Fig. 2 clearly indicated the trend that the nitrate concentration increased with increasing rainfall. This may be due to the leaching of nitrogenous fertilizers used for crop production and the other natural nitrates present in the surface soil with rainwater.

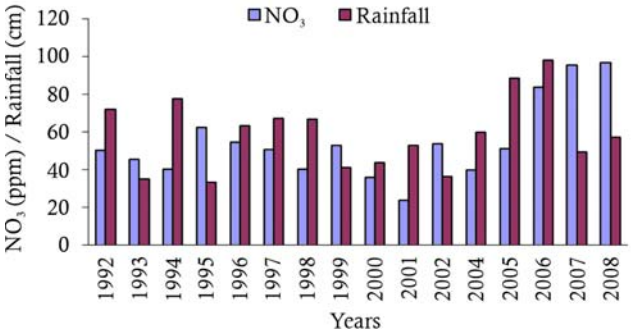

Figure 2. Impact of Rainfall on Nitrate Concentration in Groundwater

The critical observation of the trends of fluoride concentration of the groundwater and the rainfall in Udaipur district during the 1992 to 2008 revealed that in general high rainfall reduces the fluoride

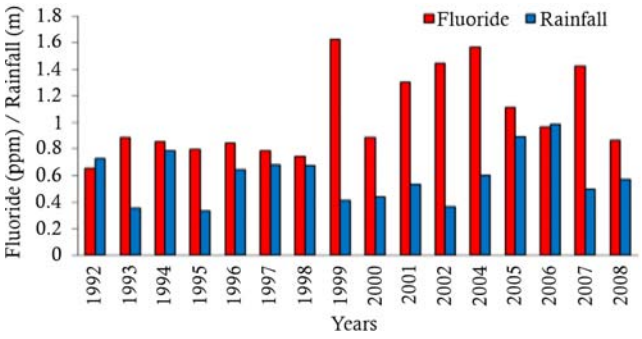

Figure 3. Impact of Rainfall on Fluoride Concentration in Groundwater

concentration in groundwater. Again, the concentration of fluoride in groundwater was found very closer to the safe limits (1.5 ppm) for drinking purpose during 1999 to 2007. The lower concentration of fluoride during high rainfall years may be due to the dilution effect of rainwater because the rainwater generally has no fluoride or very negligible amounts (Fig. 3).

The total dissolved solids (TDS) of the groundwater is very important quality parameter which is highly affected and vulnerable to climate change, especially rainfall and temperature. The trends of the impact of rainfall and the TDS of groundwater shown in the Fig. 4. disclosed that the total dissolved solids increases with the increase in the rainfall during 1992 to 2008 in Udaipur district of Rajasthan. Probably with high rainfall and runoff the dissolved solids present on the surface of the earth are get entered in the groundwater. Similar trends were also observed for the electrical conductivity (EC) and rainfall of the Udaipur district during 1992 to 2008 (Fig. 5).

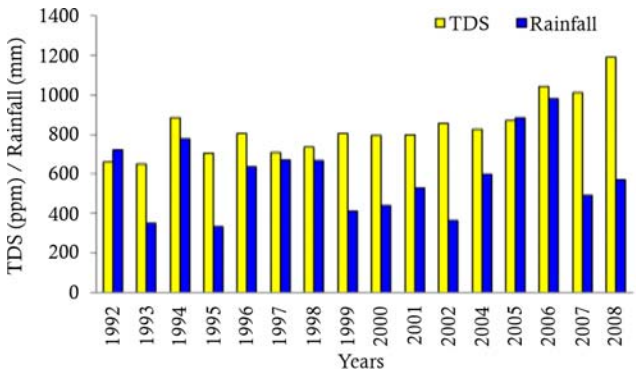

Figure 4. Impact of Rainfall on TDS of Groundwater

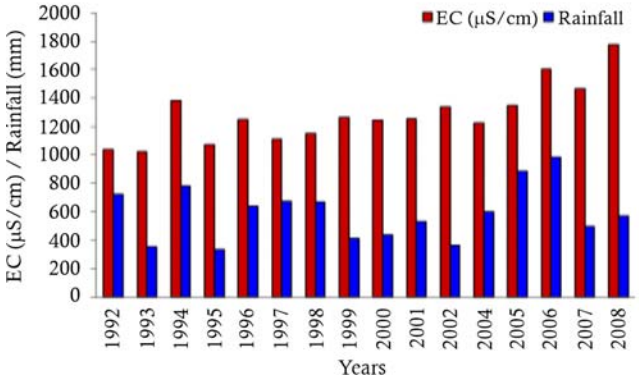

Figure 5. Impact of Rainfall on EC of Groundwater

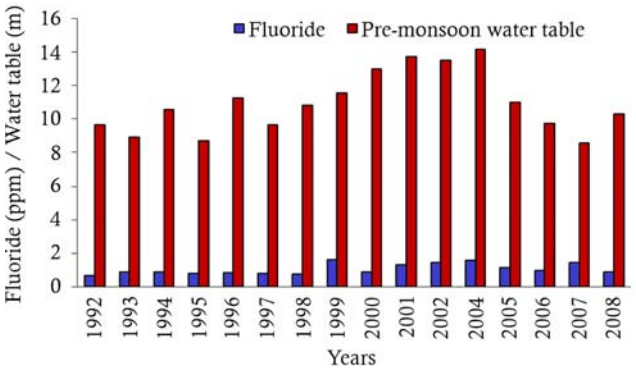

Figure 7. Impact of Pre-Monsoon Water Table on Fluoride Concentration in Groundwater

Groundwater Table and Water Quality

The correlation coefficient between the nitrate content of groundwater and the water table in pre-monsoon season was found to be -0.56 and hence the impact of pre-monsoon groundwater table and the nitrate content of groundwater showed the negative relationship. During the pre-monsoon season the water table goes to deeper strata of the earth and probably the slowly passes of nitrate through the thick layers of earth reduces the concentration of nitrate (Fig. 6).

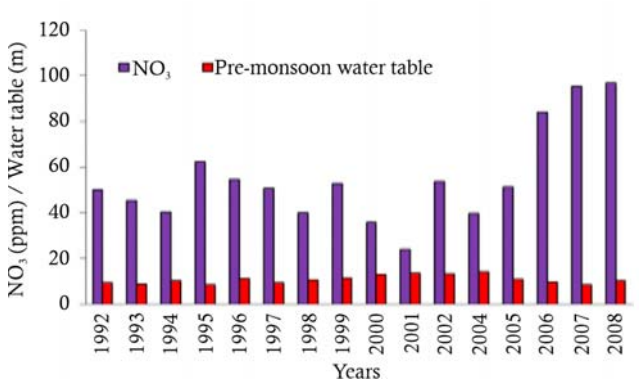

Figure 6. Impact of Pre-Monsoon Water Table on Nitrate Concentration in Groundwater

The impact of pre-monsoon groundwater table and the fluoride content of groundwater showed the positive relationship. The correlation coefficient between the fluoride content of groundwater and the water table in pre-monsoon season was found to be 0.52 and hence it is clear that deeper the water table higher the fluoride content. The increased concentration of fluoride in the groundwater at deeper strata indicated that the fluoride bearing rocks and minerals are present at higher depths and when the water table reaches in the deep strata the fluoride concentration increased to the extent of critical limits or even higher than the safe limits (Fig. 7).

The TDS and the EC also found to increase to some extent with the increasing water table depth. This may be due to high concentration of salt in deeper layers. Further the critical observation of the bars in revealed that these parameters (TDS and EC) were found higher during the drought years (Fig. 8 and 9).

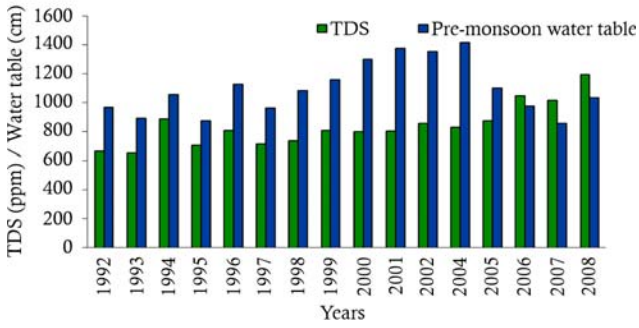

Figure 8. Impact of Pre-Monsoon Water Table on TDS of Groundwater

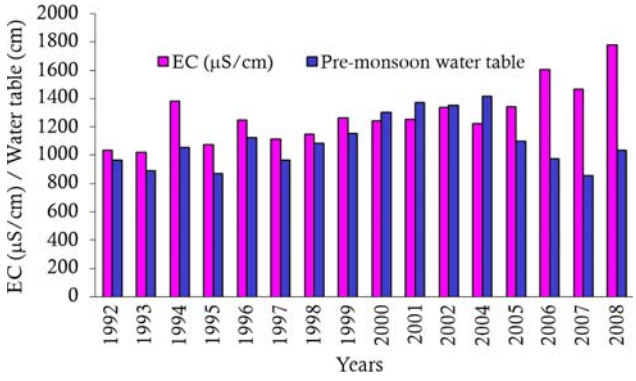

Figure 9. Impact of Pre-Monsoon Water Table on EC of Groundwater

Temperature and water quality

The temperature is affecting the groundwater quality in different ways (Holman, 2006). Among the different water quality parameters taken into consideration in this study, the fluoride, TDS, EC and pH are highly affected by the temperature. The Fig. 10 shows the relationship among the average annual maximum temperature and fluoride content of the groundwater of Udaipur district during 1992 to 2008. The trend in the Fig. 10 clearly indicated that the average annual maximum temperature increased during the study period by nearly 1°C. Further the fluoride content was also found to increase to some extent and in the year 1999 and 2004, the limits of the fluoride content of groundwater was found higher than the maximum permissible limits. The value of the correlation coefficient between the average annual maximum temperature and fluoride content of the groundwater is found good enough (r^2 = 0.63) to explain the trends. The increase in fluoride content of groundwater due to higher temperatures may be attributed to the solubility effects of the higher temperature.

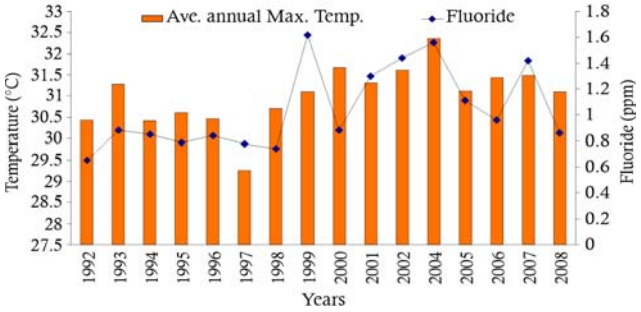

Figure 10. Impact of temperature on Fluoride concentration in groundwater

The TDS and electrical conductivity (EC) of the groundwater is also affected to a great extent with the increase in the average annual maximum temperature. Further it is clear from the trends shown in Fig. 11 and 12 that the temporal variations in the TDS and EC of groundwater is very high. The correlation coefficient between the TDS of groundwater and the average annual maximum temperature is +0.33 and between the EC and average annual maximum temperature is +0.30. This may be due increase in solubility of the salts due increased in temperature.

The Fig. 13 revealed that when the average annual maximum temperature increases the pH of the groundwater decreases. The correlation coefficient between average annual maximum temperature and the pH is found to be -0.45 which clearly indicated that the higher temperatures enhances the solubility of commonly found neutral salts which ultimately reduces the pH of the groundwater.

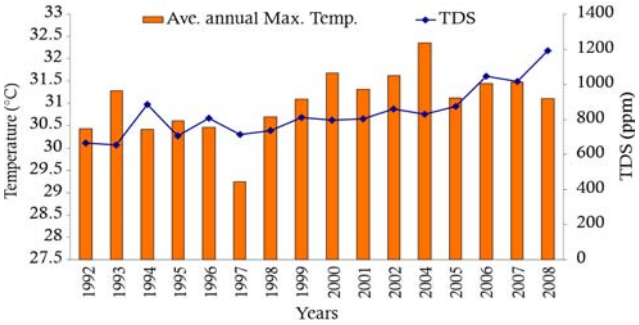

Figure 11. Impact of Temperature on TDS of Groundwater

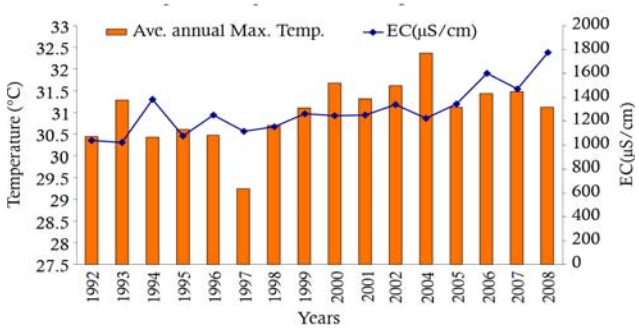

Figure 12. Impact of Temperature on EC of Groundwater

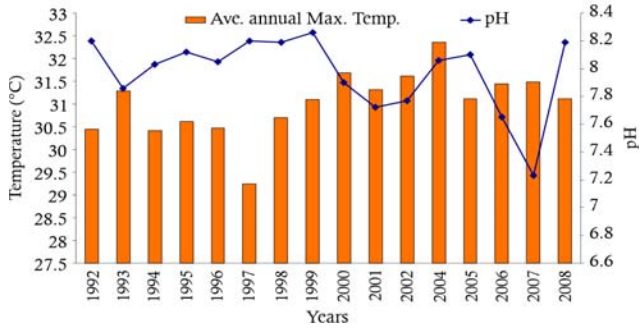

Figure 13. Impact of Temperature on pH of Groundwater

Flood- water quality- water borne diseases

Climate change is expected to increase the severity of weather. This means that some regions may experience an increase in rainfall and flood risk, while regions that are prone to droughts may experience more extreme droughts and even the same area or region may face the extreme drought and heavy flood problems (Mall *et al.*, 2006; Woldeamlak *et al.*, 2007).

Udaipur's famous Lake Pichhola completely dry in May-June 2005

Udaipur's famous Lake Fatehsagar completely dry in May-June 2005

Udaipur's famous Lake Pichhola at fullest level in July 2006

Udaipur's famous Lake Fatehsagar at fullest level in July 2006

Figure 14. Lakes of Udaipur before and during monsoon

Example

In the month of May-June 2005, the main lakes of Udaipur city were completely dried because the rainfall in the catchment areas was negligible to generate sufficient runoff during previous years. But in the monsoon season of the year 2006 the rains changed the scenario (Fig. 14).

CONCLUSIONS

It is revealed that TDS and fluoride are the dominant parameters in groundwater for both pre and post monsoon season. Rainfall and temperature directly affect the TDS and EC of water. Keeping the above experiences in view, it can be concluded that the climate may adversely affect the water quality to a great extent and we have to have strategies to mitigate or to have the set of scales to combat these calamities. This study recommend the policy and management enhancement for proper water quality management to support the sustainable water quality management in Udaipur.

Conflict of Interest

The authors declare that they have no competing interests.

REFERENCES

Allen, D.M., Mackie, D.C. and Wei, M. (2004). Groundwater and climate change: a sensitivity analysis for the Grand Forks aquifer, southern British Columbia, Canada. *Hydrogeology Journal*, **12**: 270-290.

Bates, B.C., Kundzewicz, Z.W. and Wu, S. (2008). Climate Change and Water Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva. 210.

CGWB (2002). Master Plan for Artificial Recharge to Groundwater in India. Central Ground Water Board, New Delhi, 115.

Dragoni, W. and Sukhija, B.S. (2008). *Climate Change and Groundwater: A short Review*. Geological Society, London, Special Publications. 288:1-12.

Holman, I.P. (2006). Climate change impacts on groundwater recharge-uncertainty, shortcomings and the way forward? *Hydrogeology Journal,* **14**: 637-647.

Mall, R.K., Gupta, Akhilesh, Singh, Ranjeet, Singh, R.S. and Rathore, L.S. (2006). Water resources and climate change: An Indian perspective. *Current Science,* **90**: 12.

Woldeamlak, S.T., Batelaan, O. and De Smedt, F. (2007). Effects of climate change on the groundwater system in the Grote-Nete catchment, Belgium. *Hydrogeology Journal*, **15**(5): 891-901.