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HYDRO-GEOCHEMISTRY OF SHALLOW GROUNDWATER IN FATEHABAD AND HISAR DISTRICTS OF HARYANA: A TEMPORAL ANALYSIS

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ABSTRACT

Groundwater is one of the most valuable natural resources, which supports human health, socio-economic development, and functioning of ecosystems. Groundwater is acknowledged to be a reliable source for agricultural activities in arid and semi-arid regions. The exploitation of groundwater has increased greatly in the last two to three decades in India, particularly for agriculture purpose, because large parts of the area have little access to the surface water resources. There has been increase in the demand of groundwater due agricultural expansion and growth of the population. Groundwater is largely contaminated by organic and inorganic pollutants in the rural area due the modern agriculture, by way of application of agrochemicals. An assessment of the hydro-geochemistry of shallow groundwater carried out in Fatehabad and Hisar districts, Haryana, where agriculture is the dominant economic activity. Groundwater samples were collected from 48 groundwater observation wells during 1992, and 23 during 2015. The Piper diagram shows that water chemistry of study area was dominated by alkaline earth with strong acid. Na and cl are dominant ions among the cations and anions. Sodium According to Gibbs diagram the predominant sample fall in evaporation dominance.

KEYWORDS: *human health, socio-economic development, and functioning of ecosystems.*

INTRODUCTION :

It is generally conceptualized that natural resource endowment and development are the phenomena that are closely related. But natural resources are not always infinite and their harnessing and development is not sustainable (Costanza and Daly 1992). Groundwater has rapidly emerged to occupy a dominant place in India's agriculture and food security in recent years (Gandhi and Bharariya 2011). There has not been much expansion in canal irrigation in India since 1980s. So the farmers turned to groundwater resources to expand the area under irrigation and take control of the means of irrigation. The cheap and unmetered electricity, slow development and poor management of canal system further encouraged the farmers to use groundwater for irrigation development (Briscoe and Malik 2006). Water extraction increased rapidly under the influence of subsidies on electricity, easy credit availability and commercialization of agriculture. Dhawan (1990) has recognized four factors namely land consolidation, rural electrification, institutional credit and advent of HYV seeds helping in spread of groundwater irrigation in India. During the phase beginning from the mid 1980's, the groundwater extraction technology started changing and submersible pumps and tube-wells went down beyond 400 feet for water extraction in many areas. This led to the rapid decline in water table, deterioration in the quality of water, increase in frequency of well failure and rapid rising cost of well operation.

Contamination of water sources by agriculture, industries and even by domestic use has contributed towards deterioration of groundwater quality. Globally, the sustainability of groundwater is being threatened owing to water overdraft, declining well yields, drying up of springs, stream flow depletion and land subsidence due to over-exploitation (Shah et al. 2000 and Zektser 2000). Saidi et al. (2009) pointed out that the groundwater quality is generally affected by contamination originating from intensive irrigated agriculture. While Vasanthavigar et al. (2010) opined that groundwater quality depends upon the quality of water recharged, precipitation, and inland surface water and sub-surface geochemical processes.

Likewise, groundwater depletion and deterioration of its quality are major environmental issues where groundwater have emerged as dominant source of irrigation. In some of these areas drinking water quality has worsened to the extent of affecting public health. Drinking water quality has posed a major health hazard on account of deterioration in quality of groundwater in various parts of Haryana (Mor et al. 2003, Kaushik et al. 2004, Meenakshi et al. 2004 and Khaiwal and Garg 2006). Increasing threat to groundwater quality due to human activities has become a matter of concern during recent period. An attempt has been made in this study to assess the hydro geochemistry of groundwater in western Haryana (Fatehabad and Hisar Districts)

OBJECTIVE

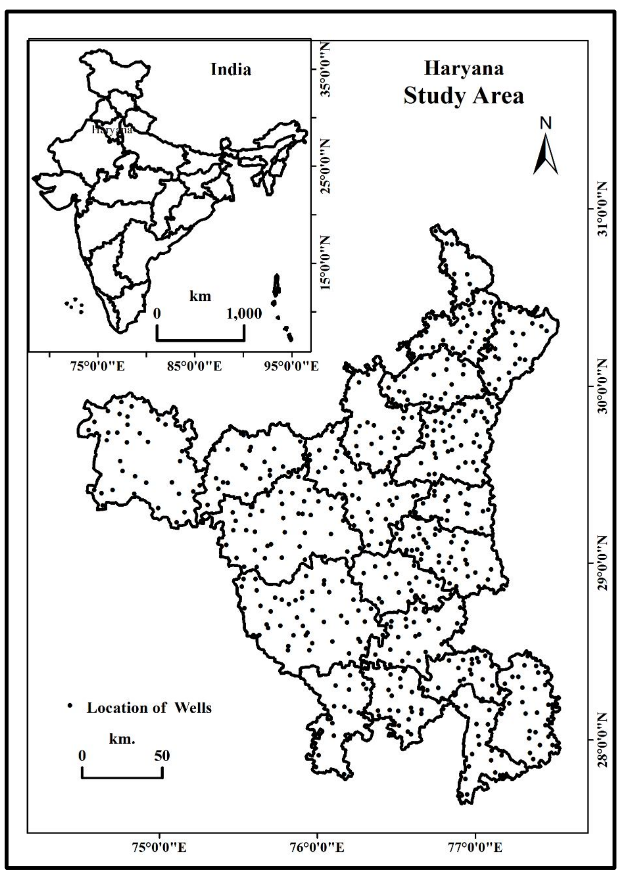
The objective of present study is:-

- To analyse the temporal changes in hydro-chemistry of groundwater in Fatehabad and Hisar districts.

STUDY AREA

The state of Haryana in India is located between 27º39' to 30º56'N latitude and 74º 27' to 77°36'E longitudes, covering an area of 44,212 sq. km. It occupies about 1.40 percent of the total area of the country

Fig.1



At present, the state is divided into four commissionaires and 22 districts. The state has natural geographical boundaries of the Shiwalik hills in the north, the Yamuna River in the east and the Ghaggar River in the north. In the south Aravalli hills define the natural boundary which runs through southern Delhi and Gurgaon district. In the west of the state lies the Thar Desert of Rajasthan. The state is bounded by Uttar Pradesh and Delhi in the east, Punjab in the north, Himachal Pradesh in the northeast and Rajasthan in the south and west.

Fatehabad and Hisar district has been selected for present study. These districts experiences conjunctive use of water where both canals and tubewells supplement each other as a source of irrigation.

DATA BASE AND METHODOLOGY

The present study is based on secondary sources of data collected for the years 1992, and 2015. The data about salts and chemicals dissolved in groundwater of observations wells have been collected from the Annual Reports of Central Groundwater Board, North-western Region, Chandigarh. Details are given below:

Source	Parameters	Data unit	Year
Groundwater Annual Year Book, Haryana, Central Groundwater Board, Northwestern Region, Chandigarh.	Ph, EC, TDS Cation, Anions etc.	Groundwater Observation Wells	1992 2015

Salinity and alkalinity hazards of groundwater have been depicted with the help of US Salinity Hazards Diagram. Piper Diagram has been constructed to plot the parameters of physico chemical data of groundwater and for depicting different hydro-geochemical facies. Quality of water has been classified into categories on the basis of classification scheme given by Back 1961, Hanshow 1965.

Gibbs Diagram has been prepared to depict controlling mechanism of groundwater chemistry.

Hydro-geochemistry of Groundwater

The excessive draft of groundwater in many parts of state the quality of groundwater resulted in alteration in its hydro-geochemistry. In fact the suitability of groundwater for irrigation depend upon the chemical constituents of soil as well as water. Excessive amount of ions in soil and water negatively affect the yield of crops. Excessive salts in irrigation water also increase osmotic pressure in soils and high amount of ions negatively affect growth as well metabolism of plants. There is also negative impact of excessive salt on the soil properties in term of composition, structure, permeability and aeration.

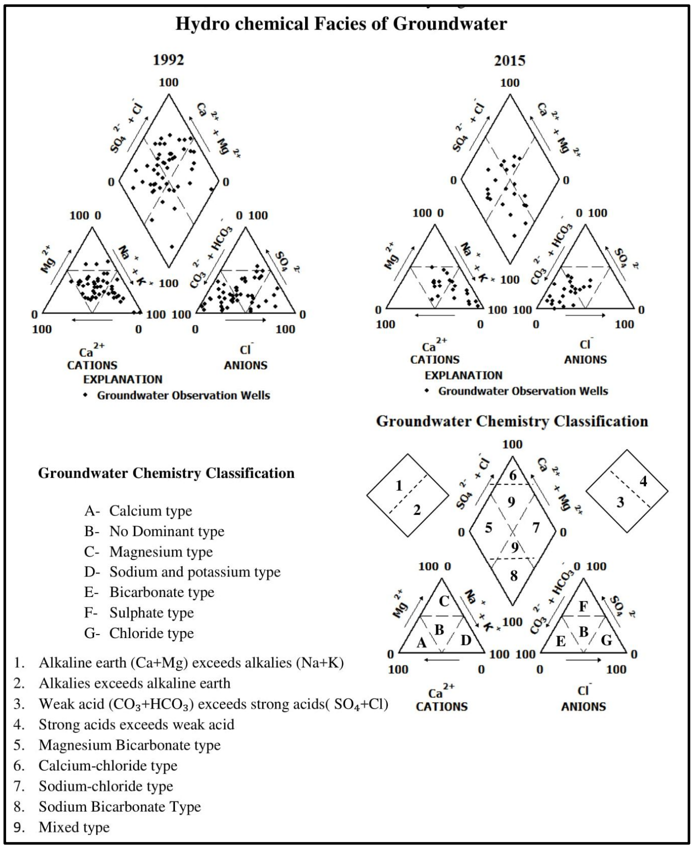


Fig.2

Source: Compiled and computed from 'Groundwater Year Book of Haryana (1992 and 2015)', Central Groundwater Board, North Western Region, Chandigarh.

Piper diagram is a tool for visualizing the chemistry of water. It comprises of three parts, a ternary diagram in the lower left representing the cations, a ternary diagram in the lower right representing the anions and the diamond plot in the middle representing a combination of the two (Fig 2) (Piper 1994).

Cations Characteristics

It is evident from Table 1 that in 1992 there was also dominance of sodium and potassium in 25 percent observation wells respectively.

In 2015 too there was dominance of sodium and potassium cations 39 percent observations wells followed by Magnesium type (26 percent).

It is evident that over the two decades on an average there was 14 percent increase in observation wells which have shown sodium and potassium cations dominance. There is also sharp increase in magnesium concentration in groundwater. But calcium ions have declined very sharply.

Anions Characteristics

Table 2 shows that in 1992 there was dominance of bicarbonate ion in about 47 percent observation wells followed by chloride (16 percent) and sulphate (4 percent).

In 2015 there was equal dominance of bicarbonate, chloride and sulphate 17 percent respectively. It is evident from the analysis that over two decades on an average there has been decline in bicarbonate ions in groundwater but there was slightly increases in sulphate and chloride ions.

Table: 1

Fatehabad and Hisar Districts: Cations Characteristics based on Piper Tri-Linear Diagram

Subdivision	Characteristics of corresponding subdivision of Triangle shaped fields	1992	2015
A	Calcium Type	1(2.08)	0(00)
B	No Dominant Type	32(66.67)	8(34.78)
C	Magnesium Type	3(6.25)	6(26.09)
D	Sodium and Potassium Type	12(25.00)	9(39.13)
Total Observation Wells		**48**	**23**

Source: Fig. 2 (Figures in Parentheses are percentage of wells to total Observation Wells)

Table: 2

Fatehabad and Hisar Districts: Anions Characteristics based on Piper Tri-Linear Diagram

Subdivision	Characteristics of corresponding subdivision of Triangle shaped fields	1992	2015
E	Bicarbonate Type	23(47.92)	4(17.39)
F	Sulphate Type	2(4.17)	4(17.39)
G	Chloride Type	8(16.67)	4(17.39)
B	No Dominant Type	15(31.25)	11(47.83)
Total Observation Wells		**48**	**23**

Source: Fig. 2 (Figures in Parentheses are percentage of wells to total Observation Wells)

Alkalinity Characteristics of Groundwater

It is evident from Table 3 that in 1992 with reference to alkaline earth (Ca^{2+} $+Mg^{2+}$) it is observed that in 73 percent observation wells it has dominance over alkalies (Na^{+}+K^{2+}) (27 percent). In 2015 there was continue to be strong hold of alkaline earth (Ca^{2+} $+Mg^{2+}$)over alkalies (Na^{+}+K^{2+}) (Fig. 2 and Table 3). However the percentage of observations having wells under alkaline earth (Ca^{2+} $+Mg^{2+}$) has declined over two decades.

Acidic Characteristics of Groundwater

Table 4 shows that in 1992 on an average in the groundwater there was strong acid in 60 percent observation wells which dominated over weak acid (40 percent wells). In 2015 too strong acid dominated (83 percent wells) over weak acid (17 percent wells) in the groundwater of Haryana. Over the last two decades it has been observed that there was 23 percent increase in observations of strong acid in groundwater in western part of the state. It indicates increasing dominance of strong acid in the groundwater.

Salinity and Alkalinity of Groundwater

It is evident from Table 5 that in 1992 there was dominance of mix type of water (54 percent observations) followed by magnesium bicarbonate type water (25 percent), sodium chloride type water (17 percent). There is also presence of calcium chloride (2 percent) and sodium bicarbonate (2 percent). In 2015 there was dominance of sodium chloride type water (35 percent observation wells) followed by mix type water (30 percent),calcium chloride type of water (22 percent) and magnesium bicarbonate type water (13percent).

Table: 3
Fatehabad and Hisar Districts: Alkalinity of Groundwater based on Piper Tri-Linear Diagram

Subdivision of the Diamond	Characteristics of corresponding subdivision of diamond shaped fields	1992	2015
1	Alkaline earth (Ca^{2+}+ Mg^{2+}) exceeds alkalies(Na^{+}+K^{2+})	35(72.92)	15(65.22)
2	Alkalies(Na^{+}+K^{2+}) exceeds alkaline earth earth (Ca^{2+}+ Mg^{2+})	13(27.08)	8(34.78)
Total Observation Wells		**26**	**22**

Source: Fig. 2 (Figures in Parentheses are percentage of wells to total Observation Wells)

Table 4
Fatehabad and Hisar Districts: Acidic Characteristics of Groundwater based on Piper Tri-Linear Diagram

Subdivision of the Diamond	Characteristics of corresponding subdivision of diamond shaped fields	1992	2015
3	Weak acid (Co_3^{2-}+ HCO_3-) exceeds strong acids(SO_4^{2-}+Cl^-)	19(39.58)	4(17.39)
4	Strong acids exceeds weak acid	29(60.42)	19(82.61)
Total Observation Wells		**48**	**23**

Source: Fig. 2 (Figures in Parentheses are percentage of wells to total Observation Wells)

Table 5
Fatehabad and Hisar Districts: Salinity/Alkalinity based on Piper Tri-Linear Diagram

Subdivision of the Diamond	Characteristics of corresponding subdivision of diamond shaped fields	1992	2015
5	Magnesium bi- carbonate type	12(25.00)	3(13.04)
6	Calcium-chloride type	1(2.08)	5(21.74)
7	Sodium-chloride type	8(16.67)	8(34.78)
8	Sodium bicarbonate Type	1(2.08)	0(00)
9	Mixed type(No Cation, Anion)	26(54.17)	7(30.43)
Total Observation Wells		**48**	**23**

Source: Fig. 2 (Figures in Parentheses are percentage of wells to total Observation Wells)

It is evident from analysis that overall there is increase in the concentration sodium chloride in the groundwater in the western part of state.

Controlling Mechanism of Groundwater Chemistry

The chemistry of groundwater is influenced by various parameters like chemistry of rocks,

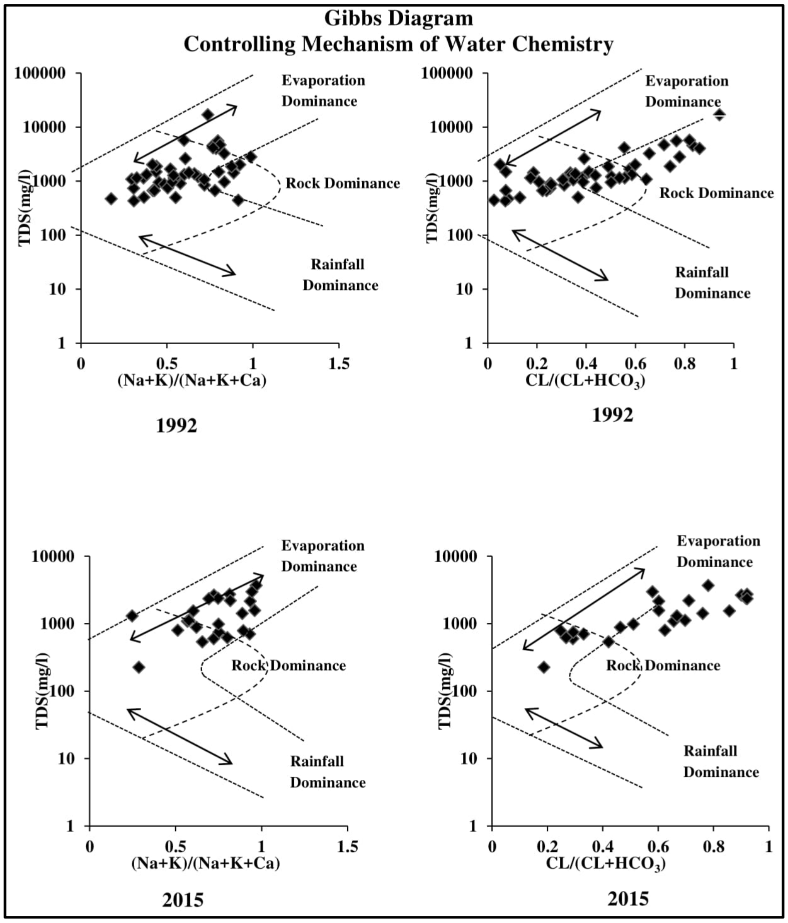


Fig. 3

Source: Compiled and computed from 'Groundwater Year Book of Haryana (1992 and 2015)', Central Groundwater Board, North Western Region, Chandigarh.

chemistry of water and rate of evaporation. In 1970 Gibbs suggested a diagram in which cation and anions were plotted against total dissolved solid (TDS). Gibbs diagram represents the ratio of $Na^{+}+K^{2+}$ / $Na^{+}+$, $K^{2+}+$ Ca^{2+} and Cl^{-} / $(Cl^{-}+HCO_3^{-})$ as a function of total dissolved solid (TDS) which is widely used to assess the functional sources of dissolved chemical constituents i.e., precipitation, rock and evaporation (Gibbs, 1970). Fig. 3 depict controlling mechanisms of water chemistry in the study area.

Fig.3 reveals that in the study area during 1992 majority of observation wells recorded rock dominance which means that chemical weathering of rock leading to minerals release affected the water quality. The dissolution of rock minerals in water was main cause of salinity of groundwater. However in 2015 in this regime majority of observation wells recorded evaporation dominance and hence being major factor in enhancing groundwater salinity.

It is evident from the preceding analysis that groundwater quality is largely controlled by evaporation processes in the study area. It is advised to adopt conjunctive use of surface and groundwater to maintain the quality of groundwater for irrigation.

CONCLUSIONS

Groundwater depletion and deterioration of its quality are the major environmental issues in tubewell irrigated area of the state. The intensification of cropping and expansion of rice-wheat crop combination have led to excessive mining of groundwater and deterioration of groundwater quality. The excessive draft of groundwater in many parts of state has altered hydro-geochemistry. The study brings out that in the western districtsFatehabad and Hiasr over the two decades on an average there was 14 percent increase in observation wells which have shown sodium and potassium cations dominance. There is also sharp increase in magnesium concentration in groundwater. But calcium ions have declined very sharply. Over two decades on an average there has been decline in bicarbonate ions in groundwater but there was slightly increases in sulphate and chloride ions. It has been also observed that there was 23 percent increase in observations of strong acid in groundwater in western part of the state. It indicates increasing dominance of strong acid in the groundwater. It is evident from analysis that overall there is increase in the concentration sodium chloride in the groundwater in the western part of state. Groundwater quality is largely controlled by evaporation processes in the study area. It is advised to adopt conjunctive use of surface and groundwater to maintain the quality of groundwater for irrigation.

REFERENCES

Costanza R and Daly HE (1992). Natural Capital and Sustainable Development. *Conservation Biology*, 6(1): 37-46.

Central Ground Water Board (CGWB) (1993-94). *Groundwater Year Book of Haryana State*. Central Groundwater Board, North Western Region, Chandigarh.

Central Ground Water Board (CGWB) (2015-16). *Groundwater Year Book of Haryana State*. Central Groundwater Board, North Western Region, Chandigarh.

Dhawan BD (1990). How reliable are groundwater estimates? *Economic and Political Weekly,* 1073-1076.

Gibbs RJ (1970). Mechanisms controlling world water chemistry. *Science*, 170: 1088-1090.

Gandhi VP and Bhamoriya V (2011). Groundwater Irrigation in India Growth, Challenges, and Risks. *India Infrastructure Report*, 90-117.

Hanshow BB (1965). Chemical Geohydrology. In Advances in Hydro Science. *Academic Press, New York,* 2: 49-109.

Kaushik A, Kumar K, Sharma IS and Sharma HR (2004). Groundwater quality assessment in different land use areas of Rohtak and Faridabad cities of Haryana using deviation index. *Journal of Environmental Biology,* 25(2):173-180.

Khaiwal R and Garg VK (2006). Distribution of fluoride in groundwater and its suitability assessment for drinking purposes. *International Journal ofEnvironmental Health Research,*16:163-166.

Kumar J and Jaglan MS (2016). Suitability of groundwater for drinking purpose in Bhiwani district Haryana: A spatio temporal analysis. *Punjab Geographer*, 12: 1-20.

Kumar J and Jaglan MS (2018). Dynamics and spatial pattern of groundwater depletion in Haryana. *Indian Groundwater,* 10: 76-92.

Mor S, Bishnoi M and Bishnoi NR (2003). Assessment of groundwater quality of Jind city. *IndianJournal of Environmental Protection,* 23:673-679.

Meenakshi, Garg VK, Kavita, Renuka and Malik A (2004). Groundwater quality in some villages of Haryana, India: focus on fluoride and fluorosis. *Journal of Hazardous Material,* 106 B: 85-97.

Piper AM (1994). A geographic procedure in the geochemical interpretation of water analysis. *Transactionsof the American Geophysical Union, 25*: 914–928.

ShahT, Molden R, Sakthivadivel D and Seckler (2000). The global groundwater situation: overview of opportunities and challenges, Colombo, Sri Lanka. *International Water Management Institute,* 1-8.

Saidi S, Bouri S, Dhia HB, and Anselme B (2009). A GIS-based susceptibility indexing method for irrigation and drinking water management planning: Application to Chebba- Mellouleche aquifer, Tunisia. *Agricultural Water Management*, 96: 1683-1690.

Vasanthavigar M, Srinivasamoorthy K, Vijayaragavan K, Ganthi RR, Chidambaram S, Anandhan P, Manivannan R and Vasudevan S (2010). Application of water quality index for groundwater quality assessment: Thirumanimuttar sub-basin, Tamil Nadu, India. *Environmental Monitoring Assessment,* 171: 595-609.

Zektser IS (2000). Groundwater and the environment: Applications for the global community.*CRC Press, United State*, 83-90.