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Variation of different parameters in Ground Water of North India: An Overview

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Abstract: Drinking water is associated directly with the health of population. It is important to assess the quality of ground water of Haryana for its suitability for drinking purposes. Well, submersible and hand pump are the major sources of drinking water in Haryana. In this regard, extensive data have been compiled and reviewed in this paper. The majority of the reported articles are about monitoring pH, total dissolved salts, total hardness, and total alkalinity in underground water of Haryana state (India). Also compared the data with Indian as well as WHO standards for quality of ground water for drinking. Hisar district has highest value of TDS while High fluoride concentration in Faridabad, Fatehabad and Sonepat districts,which is serious concern for fluorosis as there are few sites having fluoride ion more than 6mg/L. Ground water of Smalkha is not fit for drinking and domestic purposes due to high value of WQI.

Key words: **Underground water, Drinking water, Total hardness, Water quality standards**

1. INTRODUCTION

Water is a vital resource for human survival. Water is important natural resource and is secondary requirement to sustain the life on the earth after the fresh air. Approximately 60-65 percent of human body is composed of water (Tyagi et al. 2013). It exists in all three states of matter like solid (ice), liquid and gas. The liquid form of water is available for use as surface and groundwater or subsurface water but unfortunately, available drinking water and water table is shrinking across the globe because of imbalance between recharge capacity of aquifers and withdrawal rate of water from the source (Kumari & Rani, 2014). Water covers 78% of the earth's surface, yet water available for human use is limited. Groundwater is the most precious natural resource of the earth and is of great importance in every facet of human life. Because of burgeoning population, urbanization and deforestation, pressure is continuously increasing on this valuable resource of nature (Sitender & Choudhary, 2015). Ground water is the major source of drinking and irrigation water in both urban and rural areas. The industrial waste and domestic sewage are the leading causes of ground water pollution (Sharma & Chaudhary, 2013).

The annual replenishable groundwater resource of the Haryana state is 9,79,833 hectare meter (ha-m) while total annual groundwater draft is 12,42,598 ha-m leaving an annual gap of 2,62,765 ha-m in the availability of groundwater. Rainfall is the major source of groundwater recharge and irrigation is the leading consumer of groundwater resource in the Haryana. Industries consume a large quantity of water and generate a huge amount of wastewater, which are generally discharged into a common effluent drain of industrial area.Toxic pollutants may percolate down via soil profile and reach in ground water, which ultimately cause the health hazards among human being and livestock after consumption as daily drinking requirements (Malik and Bharti, 2010). The waste water without any treatment may cause adverse effect on the health of human, domestic animals, wildlife and environment. Contaminated ground water has deteriorated the drinking water and impacts on soil systems and crop productivity (Bharti et al. 2013). Groundwater quality is highly dependent on the nature of the aquifers and on the ambient climatic conditions (BGS, 2004).

Groundwater is the primary source of drinking water for more than 98% of the populations in Haryana, India. Being a basic need of human development, health and wellbeing, safe drinking water is an internationally accepted human right (WHO, 2001), which has been enlisted as one of the ten targets in the Millennium Development Goals (MDGs). As a decentralized source of drinking water and myriads of other services for millions of rural and urban families, groundwater as a natural resource plays a crucial role, which accounts for nearly 80 per cent of the rural domestic water needs, and 50 per cent of the urban water needs in India (Kumar et al., 2005).
Approximately 75% to 80% population in Haryana state uses groundwater for domestic, irrigational and industrial purposes. Due to high concentration of fluoride, in groundwater, dental fluorosis has become a common disease in the state and symptoms of skeletal fluorosis are prominent among adults in different districts of Haryana state.

Fluoride in groundwater mostly occurs because of the geomorphology of the aquifer below the groundwater. Most of the districts of Haryana have rock bed of quartizites, mica and clay, which is the preliminary case of fluoride existence in groundwater. Besides, it is also observed that at some sites, fluoride concentration varies from one to other. This may be due to the fluctuations in water table at those sites. Therefore, for understanding the cycle of fluoride concentration in groundwater, it is imperative to analyse the aquifer characteristics in detail (Gupta & Misra, 2014).

Total hardness is an important parameter of water for its use in domestic sector. If hard water is used for longer period, it may be one of the main causes of kidney stone formation in human body. At domestic level if hard water is used for washing, cause wastage of soap. In groundwater, hardness is mainly due to carbonates, bicarbonates, sulphates and chlorides of calcium and magnesium (Singh).

In order to assess the ground water quality, different physico-chemical properties, e.g., pH, electrical conductivity (EC), total dissolved solids (TDS), calcium, magnesium, total harness (TH), sodium, potassium, carbonate, bicarbonate, total alkalinity (TA), chloride, fluoride and sulphate concentrations in water has been studied.

II. SUMMARY OF THE STUDIED CONDUCTED IN HARYANA:

The research work concerning measurement of different physico-chemical properties, e.g., pH, electrical conductivity (EC), total dissolved solids (TDS), total harness (TH), total alkalinity (TA) for water quality in Haryana and number of articles appeared in international research journals. Table 1 provide summary of the studies of water quality parameters in Haryana, North India.

III. SUMMARY OF THE RESULTS AND DISCUSSION:

Meenakshi et al. (2004) found fluoride concentrations in the range 0.3–6.9 mg/l in groundwater from Jind district, Haryana and reported that more than 80% of water samples analyzed had unacceptably high fluoride concentrations for drinking purposes. Many of the fluoride occurrences are linked to crystalline basement rocks including granites, although some sedimentary aquifers also appear affected.
Rout and Sharma, 2011 reported water quality parameters of Ambala Cantt. Haryana.
The concentration of fluoride in groundwater samples varied from 0.14 to .90 mg/l. Fluoride (F-) varied from permissible limit for F concentration is 1-1.5 mg/l according to WHO (2003). Fluoride concentration less than 0.8 mg/l leads to dental caries. Hence, it is essential to maintain fluoride concentration between 0.8 to 1.0 mg/l in drinking water. The alkalinity of groundwater is mainly due to carbonates and bicarbonates. The acceptable limit of alkalinity is 200 mg/l and in the absence of alternate water source, alkalinity upto 600 mg/l is acceptable for drinking. the total alkalinity of analyzed water samples varied from 90.83 to 187.70mg/l. The acceptable limit of total hardness is 200 mg/l. The hardness of analyzed water samples varied from 116.6 to 129.4 mg/l.The acceptable range of TDS is 500 mg/l. The range of TDS of analyzed water samples varied between 138.82 to 490.81 mg/l. The permissible limit for electrical conductivity (EC) is 300 µS cm-1. EC of the collected samples ranged from 220 to 770 µS cm-1.pH value in analyzed water samples varied from 6.92 to 8.12. The BIS limit for drinking water is 7.0-8.5. The total hardness varied in between 116.6-129.4 mg/l, which indicates that water in the deep aquifer is moderately hard. So, it is suggested to the cantonment localities to soften the tube well water before consumption.
Singh, 2011 reported water quality parameters of Dabwali area of Sirsa district. The results showed that fluoride concentration in the ground water of

Dabwali ranges from 0.90-34.50 mg/l with a mean of 2.20 ± 18.13 mg/l. The results suggest that the groundwater should be used by the residents only after defluoridation. The ground water was slightly alkaline ranging from 7.20 to 8.10 but these values were within WHO permissible limit. According to WHO, the maximum acceptable concentration of TDS in groundwater for domestic purposes is 500 mg/L and excessive permissible limit is 1500 mg/L.There was a large variation in EC. The EC varied from 0.20 to 4.00 milliSemens (mS). The average value of EC was 1.91 ± 1.09 mS and TDS was 1222.40 ± 16.82 mg/l. Total Hardness varied from 116 to 518 mg/l with a mean of 290.40 ± 11.13 mg/l.The acceptable limit of total alkalinity in drinking water is 200 mg/l (ISI, 1993). Beyond this limit, taste of water becomes unpleasant, whereas in absence of alternate water source, alkalinity up to 600 mg/L is acceptable. In present study total alkalinity (TA) ranged from 300-790 mg/L.

TABLE 1: Summary of the studies of water quality parameters in Haryana, North India

Water Quality Parameters	Study Area	References
Fluoride	Jind District	Meenakshi et al., 2004
Fluoride, TDS, EC, Alkalinity, Hardness	Ambala Cantt.	Rout and Sharma, 2011
Fluoride, TDS, EC, Alkalinity, Hardness	Dabwali, Sirsa	Singh, 2011
Mn, Ni, Cu, Cd and Zn	Panipat	Bharti et al., 2013
TDS, EC, pH value	Yamuna Nagar	Sharma and Chaudhary, 2013
WQI	Smalkha	Kumari and Rani, 2014
Fluoride, TDS, EC, Alkalinity, Hardness	Gurgaon	Manjeet et al. 2014
Fluoride	Some Village of Haryna	Gupta & Misra,2014
Ground water variation	Some location of Haryana	Sitender and Choudhary, 2015
TDS, EC, pH value	Hisar	Rani and Chaudhary, 2015

Bharti et al., 2013 reported the effect of heavy metal in ground water and effect of these metals on water quality in industrial area Panipat. The metals like Mn, Ni, Cu, Cd and Zn were found in ground water as an average of 0.26, 0.07, 0.3, 0.006 and 0.1 mg l-1 respectively.

Result conclude that the textile effluents are deteriorating the ground water and soil quality with special reference to heavy metals in the vicinity of Panipat industrial area.

Sharma and Chaudhary, 2013 reported assessment of water quality in Yamuna Nagar area, Haryana. The mean pH value of all hand pump samples ranged from 7.17 to 8.15 with an average value of 7.66, which indicates that the hand pumps groundwater are slightly alkaline in nature, but well within the limits prescribed by WHO (2004) and BIS (2003) 8.50. The EC values reported higher at Y.R. V and lowest at Y.R IV site 1929 and 223.67 µS/cm respectively with an average value of 847.55µS/cm. Most of the groundwater samples (65%) were above the desirable permissible limit (750 µS/cm) of WHO (2004).

TABLE 2. Fluoride concentration in water samples of Haryana (CGWB,2010).

District	No. of sites Investigated in all three years (2007 to 2009)	Fluoride Concentration More than 1.5 mg/ L**	Fluoride Concentration More than 3 mg/L	Fluoride Concentration More than 6 mg/L and above
Sirsa	33	10	4	1
Rohtak	4	2		
Rewari	20	4	2	
Panipat	33	15	3	
Panchkula	16	1		
Mahendragarh	6	2	1	
Kurukshetra	10	1		
Ambala	30			
Bhiwani	35	14	4	1
Faridabad	35	16	7	2
Fatehabad	22	6	2	2
Gurgaon	42	1		
Hisar	41	11	5	
Jhajjar	32	5	3	
Jind	34	10	3	2
Kaithal	33	9		
Karnal	49	8	1	
Sonepat	48	20	7	3

Yamunan agar	39			

The alkalinity concentration in the groundwater varied from 138mg/L to 658.67 mg/L. They also reported the value of total dissolved solids (TDS) in the ground water varied from 112 to 1062 mg/L with an average value of 486.60 mg/L. About 60% of samples analyzed were found within the desirable limit of 500 mg/L, while about 40% of the samples were found above the desirable limit but well within the maximum permissible limit of 2000 mg/L. The evaluation of groundwater quality for irrigation based on Sodium Absorption Ratio (SAR), Na%, Residual Sodium Carbonate (RSC) and Permeability index (PI) indicates that ground water is good enough for irrigation purpose and after proper disinfection can be used for drinking and domestic purposes.

Kumari and Rani, 2014 has been studied about the quality of water of Smalkha ,Haryana. Water Quality Index (WQI) is defined as the rating that reflects the composite influence of the different parameters. They reported water quality index values from 89.09-146.67.

According to Kumari and Rani, 2014 the high value of WQI has been found in Smalkha due to Magnesium, sulphate and alkalinity in ground water. Results indicate that large area of ground water of Smalkha is not fit for drinking and domestic purposes Manjeet et al. 2014 reported water quality parameters of Gurgaon, Haryana. pH Varies from 5.6 to 8.4.This shows that all samples are existed within the minimum and maximum tolerable limit of WHO and BIS . Total hardness varies form 50.47-2984.2 mg/lit, mostly exceeds the maximum permissible limits of WHO. Alkalinity varies from 102-582 mg/lt. The concentration of fluoride in the studied Water samples varies from 0.02 to 6.4 mg/lt. The analyzed fluoride concentration of the sites shows that around 24% samples have the fluoride levels higher than 1.5 mg/l (BIS, 1991). People in these localities should be advised to adopt some defluoridation technique prior to use of groundwater for drinking purposes. Water at most of the locations is not suitable for drinking purposes as per WHO guidelines WHO, 1997.

Gupta & Misra, 2014 studied about the fluorides in groundwater of Haryana. The districts of Haryana such as Faridabad, Sonepat, Panipat, Bhiwani etc have samples that have high values of fluoride ion. In these districts, 30 to 40% of the investigated sites are having fluoride ion more than permissible limit, which is not safe more human health. In these districts, some of the sites have fluoride even more than 3 mg/L in groundwater, which indicates dental fluorosis. Faridabad, Fatehabad and Sonepat districts have serious concern for fluorosis as there are few sites having fluoride ion more than 6mg/L, which may cause skeletal flurosis.

Groundwater fluoride above the permissible limit that is >1.5 mg/l in drinking water, (BIS, 1991) has become an endemic in 17 States of India.

Sitender and Choudhary, 2015 reported variation ground water level in Haryana. The spatial pattern of the availability of groundwater shows that it varies from 0.08 to 0.55 hectare meter / hectare with highest in the eastern part and lowest in the southwestern part of the state. The per unit draft of groundwater varies from 0.02 to 0.98 hectare meter / hectare with highest in the north and eastern part and lowest along the western boundary of the state. The state is in a disadvantageous position with regard to the quantity of groundwater. The stage of groundwater development of the state is 127 percent. Out of the total 117 blocks, 71 are 'overexploited', 15 are 'critical', 7 are 'semi critical' whereas only 23 are 'safe' from groundwater development point of view. The analysis reveals that a very critical situation with regard to the availability of groundwater exists in Fatehabad, Gurgaon, Kaithal, Karnal, Kurukshetra, Mahendergarh, Panipat, Rewari, Sirsa and Yamuna Nagar districts because all the blocks of these districts are overexploited from groundwater development point of view.

Rani and Chaudhary, 2015 reported quality of water in hisar, Haryana. According to BIS standards and WHO, range EC is 250-750 which is good for drinking purpose. In the study area, only 4.45 km^2 areas is under this category remaining area is not good for drinking purpose. pH value for domestic usable water should be in the range of 6.5 to 8.5 according to BIS standards. The pH values for all observation wells for year 2008 in Hisar District reported between 7.3 - 9.0. As per the map of pH, 90.5% area of the Hisar district had hydrogen ion concentration in desirable range. However, a small area (9.5%) in the northern part of the district was in non-permissible range with pH exceeding 8.5. According to different standards, total dissolved solid (TDS) for drinking water is less than 500 but in the study area, only 5.57 km^2 area is covered under this category. The study concludes that out of the total area of 4174.52 km^2, only 4.48 km^2 is under medium salinity whereas all other area falls either under high, very high or very-very high category of salinity thereby making it unfit for the domestic usage.

Electrical conductivity varies from 520-13820 and TDS varies from 354-8000.

IV. CONCLUSION

Review concludes that there is variation in ground water parameters which depend on geology of the area. Industries and heavy metals in groundwater affected the water quality. Hisar district has highest value of TDS while High fluoride concentration in Faridabad, Fatehabad and Sonepat districts,which is serious concern for fluorosis as there are few sites having fluoride ion more than 6mg/L, which may cause skeletal flurosis risk. Ground water of Smalkha is not fit for drinking and domestic purposes due to high value of WQI. Gurgaon ground water is also not safe for drinking water. Results indicate that ground water of Yamuna Nagar is good enough for irrigation purpose and after proper disinfection can be used for drinking and domestic purposes. Defluoridation is required for the groundwater of Dabwali area of Sirsa District. Result concludes that there is a requirement of treatment of ground water.

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