Seasonal Fluctuations In Quality Of Drinking Water Supply Reservoirs Of Dungarpur In South Rajasthan, India

Yogita Ninama, G. V. Mishra

Abstract: Access to safe drinking-water is essential to health, a basic human right and a component of effective policy for health protection as per the published guidelines of WHO. The contamination of drinking water leads to major health burden, particularly in areas which are considered on lower side of human development index. The water-borne diseases owing to quality deterioration and fouling are major community health concern among rural and underdeveloped regions in developing nations. The study related to this problem was conducted in Dungarpur, located in southern Rajasthan of India. This hilly region constitutes 80% of rural populace which are largely tribal and the district on the whole is classed among least developed in country. Drinking water is either accessed from ground water or provided through supply line by government department, for which some water bodies are used as the supply sources. These water bodies are rainfall dependent and fed through some limited catchment area. Hence, water level exhibits fluctuations through different seasons of the year and so the quality profile of water there. Major water bodies used as the source of drinking water in district headquarter city Dungarpur and adjoining areas are- Adward samand and Demia Dam. Other related water bodies are Gaip Sagar and Sabela Talab. The objective of this study was to ascertain the pattern of physic-chemical and microbial changes in different seasons of the year and analyze its probable health hazards.

Index Terms: Drinking water, seasonal fluctuation, physicochemical, microbial, Dungarpur, human health, waterborne-disease.

1 INTRODUCTION

Water quality impacts every one of us, and investing in water and sanitation is imperative for community health and maintaining related human development index parameters. United Nations (UN) General Assembly declared in 2010 that safe and clean drinking-water and sanitation is a human right, essential to the full enjoyment of life and all other human rights. These commitments build on a long history of support including the UN General Assembly adopting the Millennium Development Goals in 2000 and declaring the period 2005–2015 as the International Decade for Action, "Water for Life" (WHO, 2017). Unsafe drinking water, inadequate availability of water for hygiene, and lack of access to sanitation together contribute to about 88% of deaths from diarrheal diseases (Prüss-Üstün et al. 2004). As in the study area excess fluoride content in drinking water is a menace already, causing perceptible counts of skeletal and dental fluorosis cases in the population (Choubisa, 2001), provision of safe drinking water is already an issue. This study relates to already existing concern of availability and drinkability of available water. The study was conducted in area at and around Dungarpur. This is the district headquarter located in southern Rajasthan state of India latitude 23°21′:24°01′ and longitude 73°21′:74°23′. Dungarpur is one the district in Rajasthan where the average rate of depletion in ground water has been rated to be critical.

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Though, this district may usually record a good rainfall but geological (dissolve mineral content) properties of ground water is alarming. Earlier publications related to the drinking water available in southern Rajasthan have indicated the excess of Fluoride content the drinking water in the district and water survey mapping conducted by PHED accounts that along with Fluoride the TDS, chloride and Nitrate content is also over the stipulated limits in some pockets. According to GIS based survey conducted by Keshari and Dhiman (2001), the geological structure of the district belongs to the Pre-Cambrian Aravalli system and the degree of fluoride contamination corresponds to hydro-geo-chemical process mobilizing the fluoride. It is the phenomena with other parameters also. Mapping for the study area reveal that there exists a high positive correlation between fluoride and ultrabasic rock. Major quality criterion of safe drinking water is its physico-chemical properties and microbial load. In any water supply system and resources those parameters are ought to be monitored regularly. This study was undertaken to establish a pattern of seasonal alteration in those parameters, as the variation in physical and chemical property or microbial contamination is crucial for the general health of populace drinking that water.

2 MATERIALS AND METHODS

There are some water bodies which are utilized for supply of drinking water in and around district headquarter town Dungarpur. The water bodies that were surveyed and sampled for water analysis were Adward Samand (Patri dam), Dimia Talab (also called Vijay Sagar), Gaip Sagar and Sabela Talab. Adward Samand and Dimia pond is used exclusively for drinking water supply whereas later two are used for other purposes also. The water samples were collected in the month of February, May and October. For physico-chemical examination of water samples methodology suggested by APHA (1998) was adapted. All relevant quality indicators were investigated. To ascertain the microbiological attributes total coliform/ 100 ml and E. coli organism/ 100 ml was analyzed using

the standard protocol for this purpose. Method proposed in WHO (1996) for water quality monitoring was followed.

3 RESULTS and DISCUSSION

Altogether 14 parameters were tested for water samples collected in rainy, winter and summer season. The recorded pH varied from 7.6 to 9.00 and variation was not only observed in different water bodies rather seasonal changes were also apparent. In one water body the pH was 9.0 in summer season that is above the safe limit as per BIS (2012). The turbidity value exhibited a greater variation ranging from 0.5 to 19.2 and in rainy season this indicator was much higher than prescribed limit, though the water is treated before being supplied for drinking purpose. Temperature variation was according to the season. Total alkalinity ranged from 130 to 400, and maximum values were observed in summer season. Calcium, magnesium hardness, and chloride, nitrate and fluoride content also showed similar phenomena. Calcium hardness was found to be in prescribed range but magnesium hardness was higher indicating high content of the metal in geological bed. Significant variation in the value of calcium and magnesium hardness was observed between the studied water bodies which are located in the range of 35-40 kilometer distance. Kumar et al. (2006) studied the water from 24 different locations in Punjab and noted that there was a large variation in mineral contents in the well water, with a range of 8–343 mg/l for calcium and 5–235.6 mg/l for magnesium. This study suggests that even for groundwater from similar geographical locations, the mineral contents can vary markedly. Total hardness varied with the collection sites and level was significantly elevated in summer month. Total hardness was beyond the acceptable level of 200, but in permissible limit (less than 600) in absence of any alternative source as per BIS (2012) guideline. Results were similar in the case of TDS (Total dissolved solids). Maximum TDS was recorded in summer month on all sites and in one water body Sabela pond it ranged from 1130 to 1700. Chloride and Nitrates were lowest in rainy season and highest in summer. Both the parameters were recorded to be within permissible limits. Our main curiosity was the regarding fluoride level as this district falls in endemic zone of fluoride toxicity and the ground water in some of the blocks in district exhibits high concentration of fluoride owing to hydro-geo-chemical mobilization process as mentioned earlier. The symptoms of high fluoride in ground water like dental and skeletal fluorosis are prevalent in district (Choubisa, 2012). But, may be because the water bodies are rain fed and located away from fluorotic rocks the concentration of fluoride was well under permissible limit. The microbial load of water was found to be higher rainy season. The highest MPN value of Coliform was recorded in Sabela pond and Adward Samand. But, the later was found to be less burdened in terms of faecal E. coli. Sabela was definitely the most polluted pond may be due to inflow of drainage and other sources of contamination (in rainy season the overflow of Gaip sagar is also drained in Sabela). The faecal E. coli level was highest in this pond. In Dungarpur a related study was reported by Rathore et. al. (2016), in which water quality was recorded in one of the water body investigated by us (Adward samand). But, it was not the study of seasonal variation, and in the period of their study the values of pH was similar but TDS, hardness and nitrate were found to be higher in our study. Sharma et. al. (2011) conducted similar study of seasonal variation in another water body Picchola at Udaipur. The range of

parameters like pH, temperature, TDS, hardness alkalinity and chloride were similar to our results and exhibited same pattern of seasonal variation. As Udaipur and Dungarpur shares the similar rock bed formation of Aravali range, so this was expected. Mahajan and Billore (2014) assessed the seasonal variation in physicochemical parameters of water in Nagchoon pond of Khandwa district (Madhya Pradesh). The range of values was different but patterns of monthly variation matched the results of our study. Garg et al. (2010) conducted a similar study in Ramsagar reservoir of Datia district, Madhya Pradesh and though the parameter values varied, the trend of seasonal variation in values was analogous to our results.

4 CONCLUSION

In this study it was observed that the physicochemical parameters are mostly in the prescribed range of BIS (2012). But, microbial load is exceptionally high especially in the months of rainy season. The water treatment plant of PHED at Dungarpur employs coagulation, flocculation, sedimentation and filtration. These treatment measures are sufficient to remove or adjust turbidity and hardness etc. For removal of microbial contamination chlorine and ammonia are added that forms chloramine compounds. The chloramine is stable and favored disinfectant. But, such a high magnitude of contamination warrants high doses of Chloramine. Therefore, there is always a chance of residual chloramine and its bye products generated at different pH which may pose some health risks (Krassner, 2009; Miranda et al. 2007). The microbial contamination of drinking water has been found to be correlated with upsurge in the hospital cases of waterborne diseases in an earlier study conducted on its ground water resources in this district (Mishra, 2011). Such implications cannot be ruled out if such a heavy load of microbial contamination is not treated properly before supply of water.

5 TABLES

ADWARD SAMAND SAMPLES

S. No.	Parameter	Rainy season 05/10/2015	Winter season 02/02/2016	Summer season 07/05/2016
1.	pH	7.70	7.80	8.10
2.	Turbidity (NTU)	15	1.5	1.9
3.	Temperature (˚C)	28.5	26.5	36.50
4.	Total Alkalinity(as $CaCO_3$) (mg/L)	130	170	210
5.	Total Hardness(as $CaCO_3$) (mg/L)	180	250	240
6.	Calcium Hardness	100	100	100
7.	Magnesium Hardness	80	150	140
8.	Chloride (as Cl^-) (mg/L)	60	80	120
9.	Nitrates (as NO_3^-) (mg/L)	3.00	4.00	7.00
10.	Fluoride (as F^-) (mg/L)	0.22	0.18	0.30
11.	Total Dissolved Solids (mg/L)	380	480	590
12.	Residual Chlorine (mg/L)	0.0	0.0	0.0
13.	Total Coliform Organism/100ml	>1600	500	900
14.	E-coli Organism/100 ml.	170	40	60

DIMIA TALAB SAMPLES

S. No.	Parameter	Rainy season 05/10/2015	Winter season02/02/2016	Summer season 07/05/2016
1.	pH	7.40	7.60	8.10
2.	Turbidity (NTU)	10	1.8	1.9
3.	Temperature(˚C)	29.0	27.00	37.00
4.	Total Alkalinity(as $CaCO_3$) (mg/L)	210	250	280
5.	Total Hardness(as $CaCO_3$) (mg/L)	240	260	250
6.	Calcium Hardness	130	130	130
7.	Magnesium Hardness	110	130	120
8.	Chloride (as Cl^-) (mg/L)	50	70	90
9.	Nitrates(as NO_3^-) (mg/L)	3.00	5.00	6.00
10.	Fluoride(as F^-) (mg/L)	0.42	0.30	0.40
11.	Total Dissolved Solids (mg/L)	600	630	680
12.	Residual Chlorine(mg/L)	0.0	0.0	0.0
13.	Total Coliform Orga./100ml	900	280	300
14.	E-coli Organism/100 ml.	70	17	26

GAIP SAGAR SAMPLES

S. No.	Parameter	Rainy season 05/10/2015	Winter season - 02/02/2016	Summer season 07/05/2016
1.	pH	7.80	8.0	8.40
2.	Turbidity(NTU)	19.2	2.6	3.7
3.	Temperature (˚C)	29.8	26.8	36.50
4.	Total Alkalinity(as $CaCO_3$) (mg/L)	100	220	250
5.	Total Hardness(as $CaCO_3$) (mg/L)	180	220	200
6.	Calcium Hardness	100	110	80
7.	Magnesium Hardness	80	110	120
8.	Chloride (as Cl^-) (mg/L)	120	140	200
9.	Nitrates(as NO_3^-) (mg/L)	5.00	7.00	18.00
10.	Fluoride(as F^-) (mg/L)	0.45	0.39	0.50
11.	Total Dissolved Solids (mg/L)	510	580	940
12.	Residual Chlorine (mg/L)	0.0	0.0	0.0
13.	Total Coliform Orga./100ml	1600	900	900
14.	E-coli Organism/100 ml.	110	70	90

SABELA TALAB SAMPLES

S. No.	Parameter	Rainy season 05/10/2015	Winter season 02/02/2016	Summer season 07/05/2016
1.	pH	7.60	8.40	9.00
2.	Turbidity (NTU)	15.0	2.4	2.9
3.	Temperature (˚C)	29.4	26.5	36.50
4.	Total Alkalinity (as $CaCO_3$) (mg/L)	270	350	400
5.	Total Hardness(as $CaCO_3$) (mg/L)	340	350	380
6.	Calcium Hardness	200	140	70
7.	Magnesium Hardness	140	210	310
8.	Chloride (as Cl^-) (mg/L)	320	370	700
9.	Nitrates(as NO_3^-) (mg/L)	11.00	17.00	38.00
10.	Fluoride(as F^-) (mg/L)	0.38	0.30	0.45
11.	Total Dissolved Solids (mg/L)	1130	1220	1700
12.	Residual Chlorine (mg/L)	0.0	0.0	0.0
13.	Total Coliform Orga./100ml	>1600	900	1600
14.	E-coli Organism/100 ml.	500	240	300

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