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Fluoride Distribution in the Groundwater of Gangadhara Area, Karimnagar District, Telangana, India

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Abstract: Hydrogeochemical investigations have been carried out in parts of Karimnagar district of Telangana to study the distribution of fluoride in groundwater of Gangadhara area. Eighty five groundwater samples were analyzed in January, 2013 (post-monsoon) and also in June, 2013 (pre-monsoon) for pH, Ec and Fluoride. It is observed that the groundwater in both the seasons is alkaline in nature. 39% of groundwater in post- monsoon and 23.52% of groundwater in pre-monsoon has higher concentration of Electrical conductivity than the prescribed limit. The higher values indicate that ionic concentrations are more in the groundwater. Nearly 65% of groundwater has more than the permissible limits of fluoride prescribed for drinking purpose in both post-monsoon and pre-monsoon seasons in the study area.

Keywords: *Pre-monsoon, post-monsoon, groundwater, granitic terrain, Fluoride distribution, Electrical Conductivity, Karimnagar district, Telangana*

1. Introduction

Occurrence of excessive fluoride in drinking water is the major concern in many parts of the globe, especially in arid and semi-arid regions. Human beings as well as livestock are seriously affected and even crippled by the dreaded fluorosis (excess fluoride resultant disease). WHO prescribes 1.5 mg/L fluoride concentration in drinking water as the upper limit [1, 2, 3, 4]. The fluorosis is endemic in 17 states of India. The most seriously affected areas are Andhra Pradesh, Telangana, Punjab, Haryana, Rajasthan, Gujarat, Tamil Nadu and Utter Pradesh [5, 6, 7]. In India, about 62 million people including 6 million children suffer from fluorosis because of consumption of water, milk and food products with high fluoride concentrations [8 & 20]. Most parts of Andhra Pradesh and Telangana have highly endemic fluorosis zones [9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19]. The fluoride is beneficial to certain extent when present in the concentration of 0.8 to 1.0 mg/L for calcification of dental enamel, especially for children below 8 years. Whereas, if fluoride contaminated water is consumed for 6 months to several years, it causes dental fluorosis (if present in excess of 1.5 mg/L) and skeletal fluorosis, if present beyond 3.0 mg/L. Most F^- accumulation in the human body occurs through F^- contaminated drinking water, substantial amounts of F^- can also be ingested through crops and vegetables irrigated with F^- contaminated water [20].

Hydrogeochemical investigations have been carried out in the granitic terrain of Gangadhara area of Karimnagar district, Telangana with an aim to identify and delineate high fluoride bearing groundwater zones.

2. The study area Characteristics

It is located in the central eastern part of Karimnagar district and forms a part of the Survey of India toposheets 56N/2, 56J/14 (Fig.1) and lies between longitudes N 78°94′-79°06′ and E 18°51′-18°62′latitudes. The major rock types occurring in the study area are granites and gneisses of Achaean age. The crystalline rocks like granite and gneisses lack primary porosity. They develop secondary porosity through fracturing and weathering over ages and thus become water bearing. The movement of groundwater is controlled by the degree of inter-connection of these secondary pores/voids. Consequently the prospects of groundwater are rather limited. Groundwater occurs under unconfined conditions in weathered zone and under semi confined conditions in the fractures and fissures.

3. Materials and Methods

Eighty five groundwater samples during post-monsoon season (January, 2013) and pre- monsoon season (June, 2013) were collected from the bore wells and dug wells in Gangadhara area (Fig. 2) in clean two liter polyethylene bottles. The samples have been analysed for pH, Electrical conductivity (Ec) and fluoride (F^-) as per the standard methods [21]. The pH and conductivity were measured with pH meter and Elico conductivity meter (CM-180). Fluoride concentrations were measured with Orion ion analyser (model EA^{TM} 940).

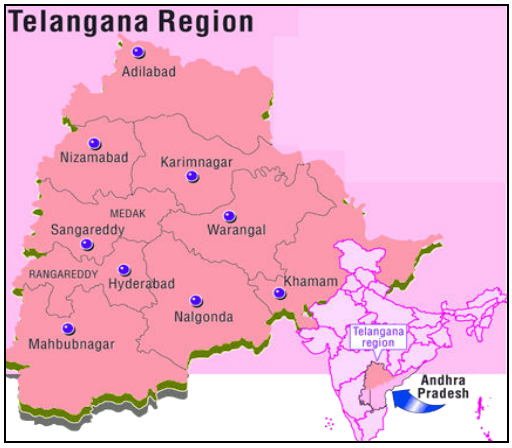

Figure 1 *Location map of the study area*

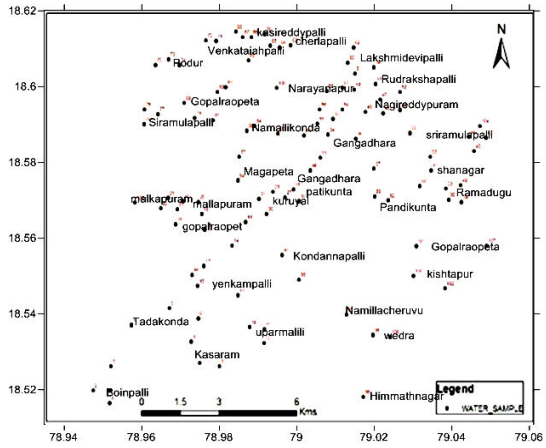

Figure 2: *Location of the groundwater samples collected in the study area*

Table .1: *Results of the Chemical Analysis of Groundwater samples Collected from Gangadhara Area of Karimnagar district, Andhra Pradesh in Post-monsoon (January, 2013) and Pre-Monsoon (June, 2013)*

S.No.	pH post-monsoon	pH pre-monsoon	EC µS/CM post-monsoon	EC µS/CM pre-monsoon	F^- mg/L post-monsoon	F^- mg/L pre-monsoon
W1	8.03	7.15	4332	1260	2	2
W2	7.75	7.75	1412	1170	2	2
W3	7.89	7.6	1520	1710	3	3
W4	7.9	7.87	1629	1350	2	3
W5	7.73	7.45	1520	990	1	2
W6	7.83	7.57	652	1260	2	3
W7	7.92	7.48	760	1260	2	2
W8	7.61	7.45	1303	900	2	1
W9	7.9	7.3	869	1440	3	2
W10	7.77	7.37	1629	1620	2	1
W11	7.7	7.2	1195	2160	2	2
W12	7.86	7.93	1303	1440	2	5
W13	8.06	7.66	1411	1890	3	3
W14	7.68	7.22	1738	810	1	1
W15	8.14	7.18	130	1440	3	2
W16	7.93	7.21	1195	990	2	3
W17	7.7	7.25	2063	900	3	3
W18	8.08	7.29	1520	1440	4	2
W19	8.03	7.58	1846	1710	5	2
W20	8.06	7.29	730	1260	2	2
W21	8.05	7.58	869	900	3	2
W22	8.1	7.34	1303	1440	3	1
W23	7.97	7.23	2172	1800	3	2
W24	7.77	7.32	1520	1710	3	2
W25	7.88	7.44	4127	1710	2	2
W26	8.16	7.51	1086	1080	2	2
W27	7.99	7.5	1086	900	2	2
W28	7.69	7.61	1629	1350	2	1
W29	7.7	7.44	1303	1170	2	1
W30	7.65	7.31	1303	810	2	3
W31	7.9	7.03	730	1620	2	3
W32	7.9	7.37	1086	1710	1	4
W33	7.69	7.23	1195	1350	1	2
W34	7.77	7.7	869	1800	1	3
W35	7.63	7.67	1195	1890	2	5
W36	7.62	7.6	2063	3060	1	4
W37	7.85	7.82	2063	1620	1	3
W38	8.1	7.68	543	1620	1	4
W39	8.12	7.75	1629	1260	1	3
W40	8.07	7.71	730	1170	1	3
W41	7.89	7.33	651	1170	1	2

W42	7.58	7.45	1411	1350	1	1
W43	7.69	7.45	730	810	1	3
W44	7.7	7.45	1411	720	2	4
W45	7.89	6.93	1520	2340	1	1
W46	7.7	7.45	2063	1080	0.7	2
W47	7.69	7.24	1520	1440	0.8	4
W48	7.81	7.18	977	1530	0.9	1
W49	7.57	7.52	1086	900	0.9	2
W50	7.55	7.26	1411	1260	0.7	1
W51	7.7	7.25	869	900	0.7	0.9
W52	7.59	7.12	1411	1260	2	1
W53	7.86	7.41	1629	1080	0.9	3
W54	7.73	7.19	1738	1350	1.9	1
W55	7.67	7.29	1846	1800	1.1	1
W56	7.99	7.32	1411	1440	5	4
W57	7.7	7.44	3367	1260	3	3
W58	7.5	7.51	2715	1350	2	2
W59	7.78	7.33	1195	1530	4	1
W60	7.7	7.45	1195	1440	2	1
W61	7.77	7.54	651	1620	1.9	2
W62	7.57	7.39	1629	990	2	1
W63	7.46	7.22	1629	1080	1.9	1
W64	7.53	7.87	1846	900	2	1
W65	7.54	7.36	2063	1260	2	1
W66	7.93	7.5	869	990	2	2
W67	7.81	7.25	1303	1080	3	2
W68	7.84	7.41	730	1080	3.9	2
W69	8.02	7.59	1738	990	4	2
W70	7.94	7.23	1738	1080	4	1
W71	8.01	7.2	1303	900	3	1
W72	8.36	7.45	3041	900	4	0.8
W73	8.21	7.15	1629	450	4	0.9
W74	8.2	7.15	1955	990	4	1
W75	8.25	7.1	1629	450	3.9	0.9
W76	8.01	7.45	869	1080	2	1
W77	8.17	7.43	1195	1260	3	1
W78	7.97	7.43	1738	1080	3	1
W79	7.67	7.41	1738	1080	2.8	0.8
W80	7.7	7.27	1411	1170	3	0.8
W81	7.56	7.37	977	1170	2	1
W82	7.55	7.36	1520	1080	0.9	0.9
W83	7.7	7.45	730	1440	1	2
W84	8.13	7.77	1846	1350	2	3
W85	8.56	7.18	1303	2200	1	2

Table 2. *Statistical parameters for pH, Ec and F^-*

Parameter		Min	Max	Average	Acceptable limit	% of samples exceeding limit
pH	Post-monsoon	7.46	8.56	7.85	7.0-8.5	6.5
	Pre-monsoon	6.93	7.93	7.41	7.0-8.5	-
Ec	Post-monsoon	130	4332	1465	1500	39.25
	Pre-monsoon	450	3060	1302	1500	23.52
F^-	Post-monsoon	0.7	5	2.15	1.0-1.5	64.74
	Pre-monsoon	0.8	5	2.0	1.0-1.5	65.17

4. Results and Discussion

The analytical results of post and pre- monsoon seasons carried out on groundwater of the study area are presented in Table-1. Statistical parameters are presented in Table-2 and the fluoride distribution in the study area is presented in Table-3.

pH: The pH of the groundwater is varying between 7.46 to 8.56 with an average of 7.85 and 6.93 – 7.93 with an average of 7.41 for post and pre-monsoon seasons, respectively. Groundwater in both the seasons is alkaline in nature. There is no general trend in the pH distribution (Fig. 3a&3b).

Ec: Electrical conductivity of the groundwater varies

from 130 to 4332 micromhos/ cm at 25 °C (average 1465 micromhos/cm) in the post monsoon and 450 to 3060 micromhos/cm (average 1302 micromhos/cm) during pre-monsoon season. The acceptable limit of Ec in drinking water is less than 1500 micromhos/cm (23). 40% of groundwater in post- monsoon and 23.52% of groundwater in pre-monsoon has higher concentration than the prescribed limit. The higher values indicate that ionic concentrations are more in the groundwater (Fig. 4a&4b).

Fluoride: Fluoride concentration in the groundwater varies from 0.7 mg/L to 5 mg/L with an average of 2.15 mg/L in post-monsoon and 0.8 mg/L to 5 mg/L with an average of 2.0 mg/L in the pre-monsoon seasons. The distribution of fluoride in the groundwater is shown in Fig.5a&5b. Nearly 65% of groundwater has more than the permissible limits of fluoride prescribed for drinking purpose in both post-monsoon and pre-monsoon seasons. It is observed that nearly 35% of groundwater has less than 1.5mg/L of fluoride and 53% of groundwater has fluoride concentration between 1.5 to 3.0 mg/l. 12% of groundwater has more than 3.0 mg/l of fluoride (Table.4). The principal fluorine-bearing minerals in the granites of the study area are fluorite, apatite and biotite. These minerals are major source for the fluoride in the groundwater. The amount of fluoride occurring naturally in groundwater is governed by climate, composition of the host rock, and hydrogeology. The fluoride content is a function of many factors such as availability and solubility of fluorine bearing minerals, velocity of flowing water, temperature, pH, concentration of calcium and bicarbonate ions in water, etc. [22, 23].

Table 3. *Fluoride distribution in the groundwater of the study area*

F^- concentration	% of groundwater	villages
Up to 1.5 mg/L	36%	Kasaram, Gopalraopalli, Malkapuram, Shanagar, Ramadug, Rudrkshapalli, Anepally, Namilagudu, Narayanpur, Patikunta, venkatagiri, Kistaper.
1.5 to 3.0 mg/L	53%	Uparmalli,Yenkampilli, Gopalraopalli, Mllapurm, Sriramulapalli, Gangadhara X road, Nagireddypalli, Lakshmidevipalli, Kasireddypalli, Cherlapally, Islampur, Gangadhara, Kondannapalli.
3.0 to 5.0 mg/L	12%	Uparmalli, Yenkampilli, Lakshmidevipalli, Kasireddypalli, Venkataipalli, Gangadhara.

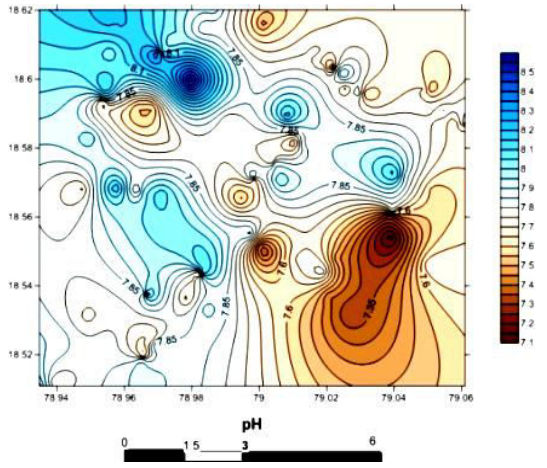

Figure 3a *Distribution of pH in the groundwater (Post-monsoon)*

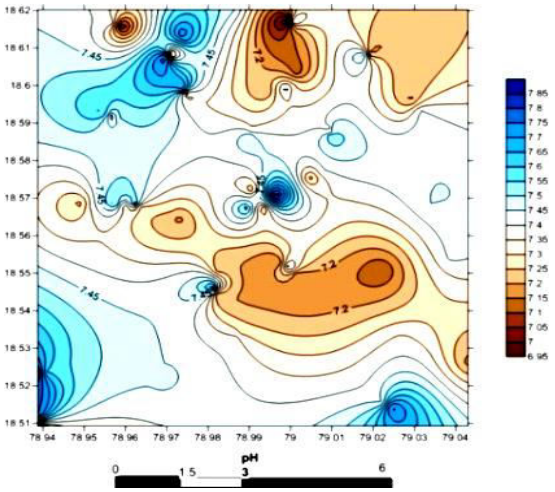

Figure 3b *Distribution of pH in the groundwater (Pre-monsoon)*

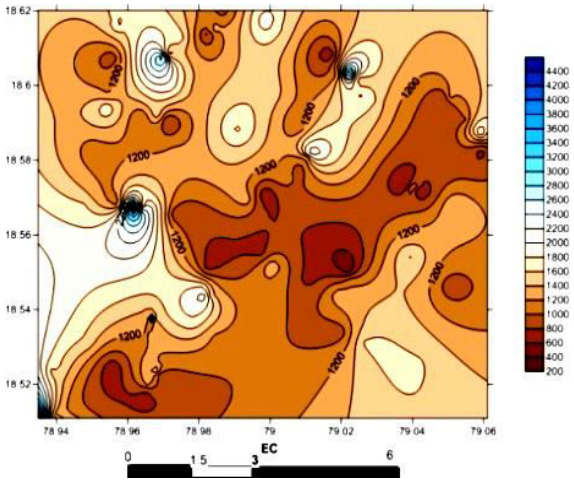

Figure 4a *Distribution of Ec in the groundwater (Post-monsoon)*

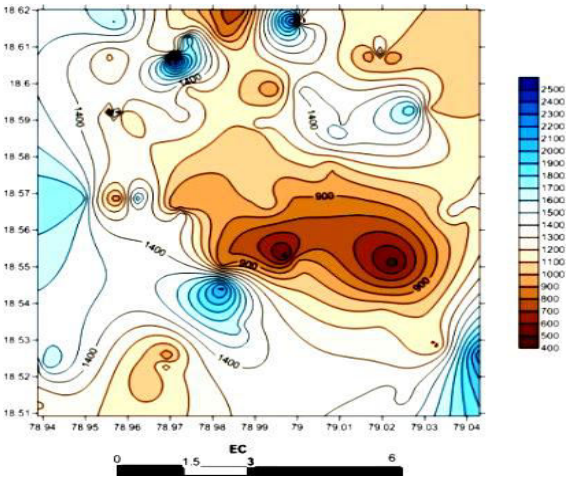

Figure 4b *Distribution of Ec in the groundwater (Pre-monsoon)*

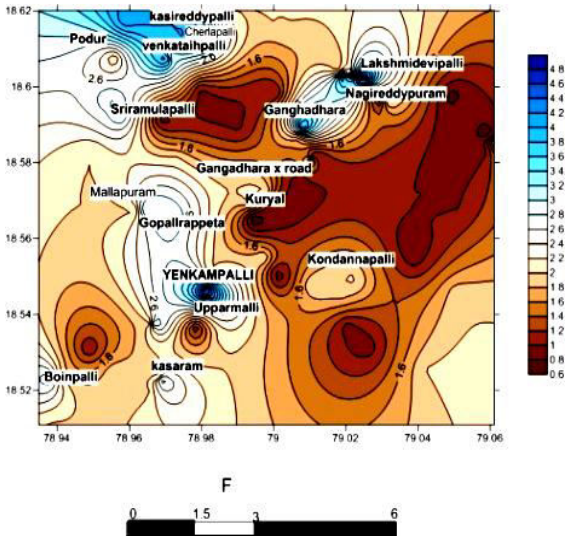

Figure 5a *Distribution of F⁻ in the groundwater (Post-monsoon)*

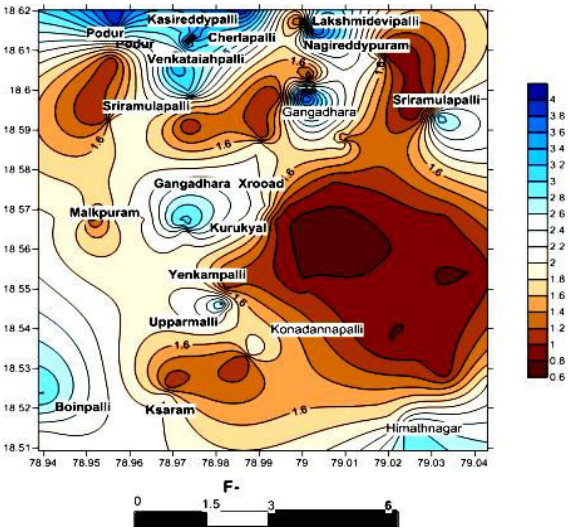

Figure 5b *Distribution of F⁻ in the groundwater (Pre-monsoon)*

5. Conclusions

Hydrogeochemical investigations carried out in Gangadhara area of Karimnagar district, Telangana revealed that nearly 65% of groundwater has more than the permissible limits of fluoride prescribed for drinking purpose in both post-monsoon and pre-monsoon seasons in the study area, thus making the groundwater unsuitable for drinking purpose.

Since the problem has become a severe chronic problem and as monsoon vagaries are not allowing proper storage of water in surface water bodies present in the region it is essential to take up an integrated water conservation and usage mechanism, by developing surface and sub surface water storage facilities to ensure orderly dilution of ground waters with the stored rain waters. This could be included as part of presently implemented Mission Kakatiya.

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