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Spatial Distribution of Fluoride in Groundwaters, Hirehalla Watershed, Karnataka

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Abstract- The Hirehalla watershed is found in Gadag and Koppal talukas, of North Karnataka. The Hirehalla Watershed experiences semi arid climatic conditions. The granitic gneisses are the litho units in the watershed. These rocks are highly weathered and altered. The minerals viz, muscovite, biotite, apatite, tourmaline, sphene, hornblende are very common accessory minerals in these rocks containing fluorine mineral. The fluorine has been leached from these minerals into groundwater. There is increase in fluoride content from the place of recharge to the place of discharge. The post-monsoon samples show high content of fluoride when compared to the pre-monsoon samples. In pre- monsoon groundwater samples 'Fluoride' varies from 0.6 to 2.1 mg/l with an average of 1.29 mg/l. In post monsoon groundwater samples 'Fluoride' varies from 0.8 to 10 mg/l with an average of 3.37 mg/l. Spatial distribution of fluoride throughout the watershed is described in the paper.

Index Terms-Hirehallawatershed, Fluoride, leaching, Groundwater. Spatial distribution**.**

INTRODUCTION

The presence of fluoride in groundwater is studied since 1960s. The fluoride content in drinking water is harmful to human health is well known. The fluoride content more than 1.5 mg/l is considered as harmful for drinking (ISI, 2003 and WHO, 2004).The diseases like dental and skeletal fluorosis are reported in the people who consume such water for long period of time.

In the present work the authors have discussed the dissemination of fluoride and distribution of fluoride content in the Hirehalla watershed of Gadag and Koppal district, Karnataka (Fig1).The Basin covers an area 393 sq km. The area experiences semi arid climatic conditions with scanty rainfall and hot summer. The Archean granitic gneisses are the litho units in the watershed; these rocks are highly weathered and fractured. The groundwater occurs in the unconfined conditions. The presences of fluoride bearing minerals like Apatite, Sphene, Tourmaline, Hornblende, Muscovite and Biotite, in granitic gneisses are the sources of fluoride content in groundwater. These granitic gneisses are highly weathered and fractured. The groundwater occurs under phreatic condition.

PRESENT WORK

In the present study groundwater samples are collected throughout the watershed from the available regularly used bore wells. Due to drying of wells in summer season some of the bore wells in the northern part of the watershed the samples could not collected. In this process 61 number of groundwater samples are collected in pre-monsoon and 68 are collected in post-monsoon seasons. All the samples are subjected for determination of cations viz Ca, Mg, Na, K, Fe, and an ions viz alkalies, SO_4, Cl, F, NO3 along with TDS, TH, pH, EC etc. In this paper distribution of Fluoride content in the watershed is described. This distribution study is performed by dividing the watershed into different blocks and variation in fluoride content along stream course.

DISTRIBUTION OF FLUORIDE IN THE WATERSHED

The watershed is divided into 3 parts viz northern, central and southern. The area north of latitude 15^0 20' is considered as 'northern part' (area 1) and the area between latitude 15^0 0' and $15^0$15' is considered as 'southern part' (area 3). The area between latitudes $15^0$15' and 15^0 20' is as 'central part' (area 2). The distributions of fluoride content in groundwater samples in these three areas are studied. The fluoride content values in the groundwater samples in these three areas are tabulated in table 1 a, b, c. The table 1 represents number of bore wells in the respective areas along with village names, fluoride content of each wells average fluoride value. Such classification is performed for both pre and post-monsoon seasons.
The table 1 a, b and c data reveals that during pre-monsoon season the variation fluoride content is in the northern part is 0.80 – 1.48 mg/l. In the central part it is 1.20 mg/l to 1.93 mg/l, while in southern part it is 1 mg/l to 1.70 mg/l. During post-monsoon season the variation is in the northern part is 2.10 to 8.20

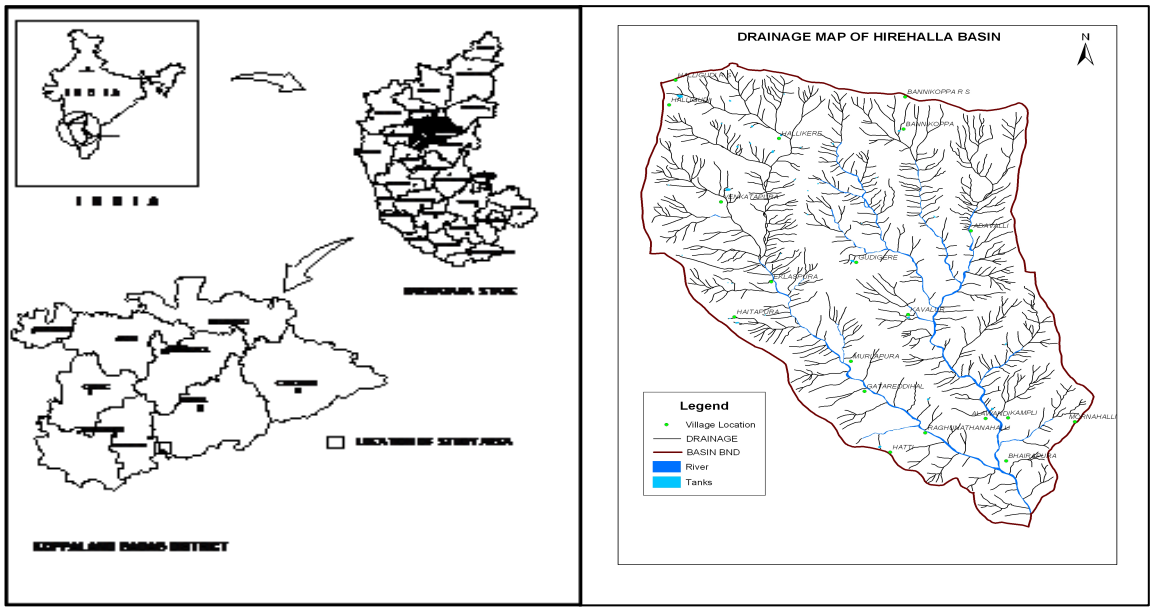

Fig. 1. Location map of study area.

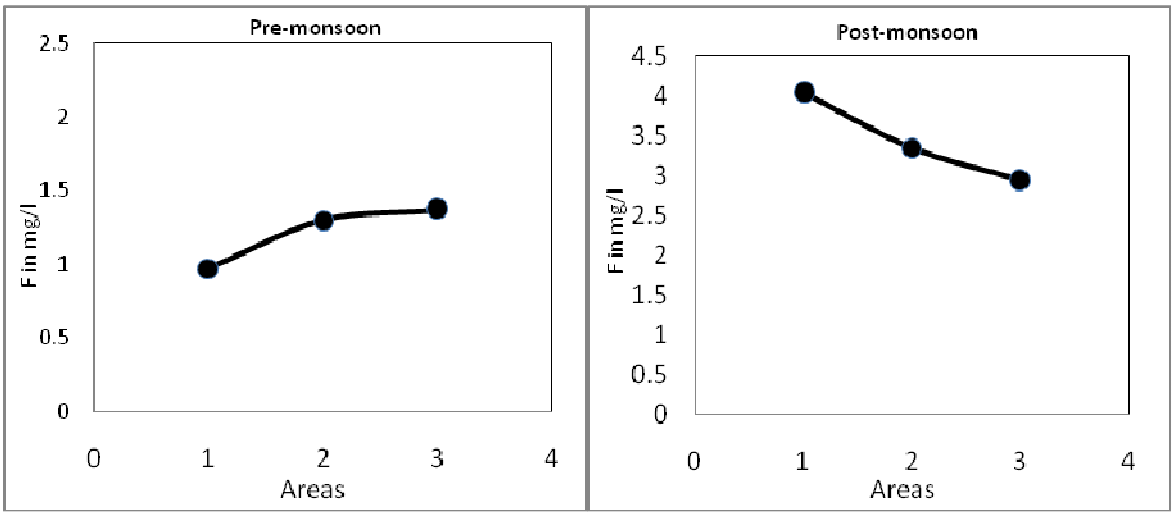

Fig. 2. Area wise fluoride variation

mg/l, in the central part it is 2.36 to 4.0 mg/l, while in the southern part it is 2.33-3.80 mg/l.

Average fluoride values are of each part are used to prepare the variation graph (fig 2) for pre and post-monsoon season. The pre-monsoon graph represents increase fluoride content from northern part to southern part. The post-monsoon graph represents decrease in fluoride content from northern part to southern part. Further, the distribution of fluoride is studied with respect to flow of streams. The groundwater samples are collected from the available bore wells along or adjacent to these two watersheds. The details of these are presented in Table 2(a and b).The Table 2 represents number of bore wells, names of villages, fluoride content of each wells and average fluoride content. Such classification is performed for both pre and post-monsoon seasons.

The table 2(a and b) data is represented in fig 3 and 4. All these figures show that there is increase in the fluoride, content from north to south i.e., the place of recharge to the place of discharge. These two interpretations clearly reveal that the fluoride content is less in the area of recharge and is more in the area of discharge.

Table 1a Northern part of watershed

S. No	Village	Pre-monsoon Fluoride Values in mg/l				Avg	Post-monsoon Fluoride Values in mg/l				Avg
1	Halligudi	0.8				0.80	4.8				4.80
2	Hallikeri	0.8	0.8			0.80	3.2	2.4			2.80
3	Bannikoppa	1.0	0.6			0.80	2.6	2.2			2.40
4	Venkatapur	1.4	1.7	1.4	1.4	1.48	10	10	4.4	8.4	8.20
5	Adavalli						1.2	3.0			2.10
Average						0.97	Average				4.06

Table 1b Central part of watershed

S. No	Village	Pre-monsoon Fluoride Values in mg/l					Avg	Post-monsoon Fluoride Values in mg/l						Avg
1	Eklasapur	1.2					1.20	4.4	1.6	3.6				3.20
2	Haithapur	1.3	1.2	0.9	1.0	0.7	1.02	2.0	2.8	2.8	2.0	3.4	1.2	2.36
3	Kavalur	1.1	0.7	1.0			0.93	3.2	4.0	4.2				3.80
4	Gattireddihal	2.0	2.0	2.0	1.7		1.93	4.2	1.6	5.4	4.8	4.0	4.0	4.00
5	Murlapura	1.4					1.40	3.4						3.40
Average							1.30	Average						3.35

Table 1c Southern part of watershed

S. No	Village	Pre-monsoon Fluoride Values in mg/l						Avg	Post-monsoon Fluoride Values in mg/l							Avg
1	Hatti	2.1	1.7	1.7	1.2	1.6			1.6	6	2.8	1.8	4.2	1.8	3.6	2.83
2	Ragunathhal	1.7	2.0	1.1	1.1	1.1			1.4	2.8	3.2	3.6	2.0			2.90
3	Kolihalli	2.0	1.7	1.4					1.7	2.8	2.4	1.8				2.33
4	Alavandi	1.3	1.1	1.1	1.0	1.3	1.3		1.2	4.0	4.0	4.4	3.6	4.0	2.8	3.80
5	Kampli	1.1	1.2	1.3	0.8	1.4	1.1	1.30	1.2	4.0	3.8	4.4	2.4	2.6	3.6	3.40
6	Moranhalli	1.2							1.2	2.4						2.40
7	Bhiarpur	1.3							1.3	3.2	3.6					3.40
8	Kampli	1.0							1.0	2.4						2.40
9	Confluence point	1.7							1.7	3.2	2.8					3.00
Average								1.37	Average							2.94

Table 2a West Hirehalla sub- watershed

S. No	Village	Pre-monsoon Fluoride Values in mg/l					Avg	Post-monsoon Fluoride Values in mg/l						Avg
1	Hallikeri	0.8	0.8				0.80	3.2	2.4					3.2
2	Eklasapura	1.4	1.7	1.4	1.4		1.48	4.4	1.6	3.6				4.4
3	Haitapura	1.3	1.2	0.9	1	0.7	1.02	2	2.8	2.8	2	3.4	1.2	2
4	Murlapura	1.4					1.40	3.4						3.4
5	Gattireddihal	2	2	2	1.7		1.93	4.2	1.6	5.4	4.8	4	4	4.2
6	Ragunathhalli	1.7	2	1.1	1.1	1.1	1.40	2.8	3.2	3.6	2			2.8
7	Hatti	2.1	1.7	1.7	1.2	1.6	1.66	2.8	2.8	1.8	4.2	1.8	3.6	2.8
8	Kolihalli	2	1.7	1.4			1.70	2.8	2.4	1.8				2.8
9	Confluence point	1.7					1.70	3.2	2.8					3.2

Table 2b East Hirehalla sub watershed

S. No	Village	Pre-monsoon Fluoride Values in mg/l							Avg	Post-monsoon Fluoride Values in mg/l						Avg
1	Bannikoppa	1.0	0.6						0.80	2.6	2.2					2.40
2	Adavalli									1.2	3.0					2.10
3	Gudageri	0.7							0.70	4.0						4.00
4	Moranhalli	1.2							1.20	2.2						2.20
5	Kavalur	1.1	0.7	1.0					0.93	3.2	4.0	4.2				3.80
6	Kavalur - Alavandi	1.8	0.8	0.9	1.2				1.18	2.8	3.2					3.00
7	Alavandi	1.3	1.1	1.1	1.0	1.3	1.3		1.18	4.0	4.0	4.4	3.6	4.0	2.8	3.80
8	Kampli	1.1	1.2	1.3	0.8	1.4	1.1	1.3	1.17	4.0	3.8	4.4	2.4	2.6	3.6	3.40
9	Bhiarpur	1.3							1.30	3.2	3.6					3.40
10	Confluence point	1.7							1.70	3.2	2.8					3.00

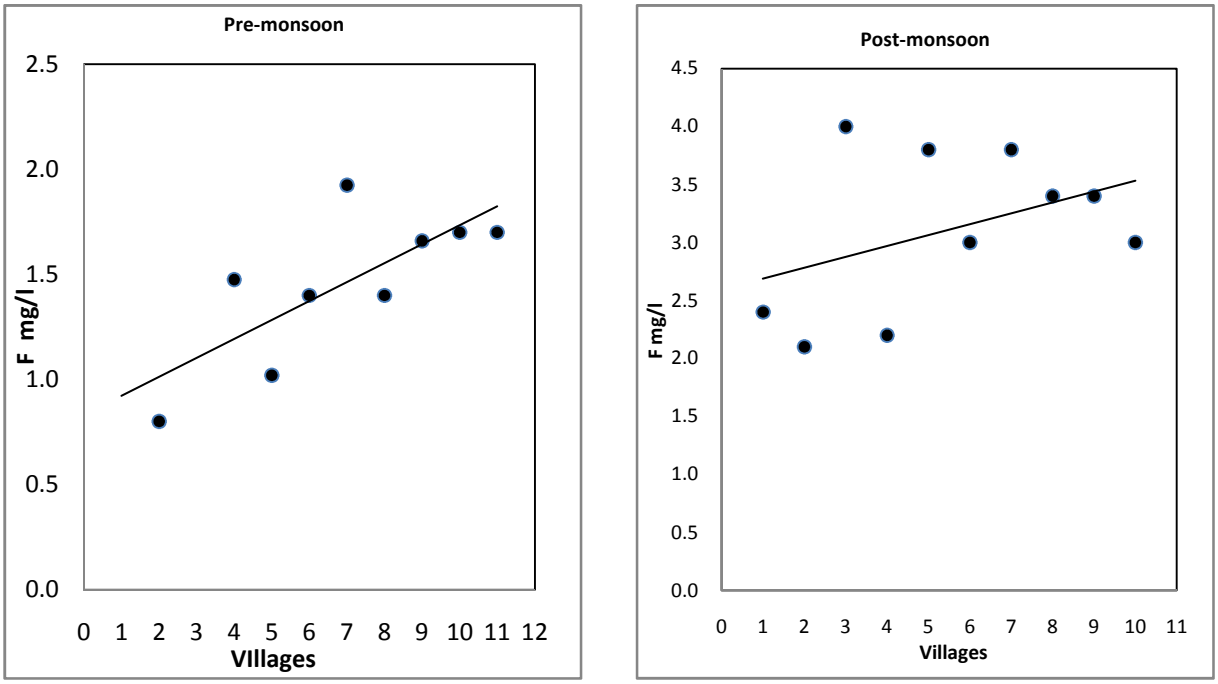

Fig.3. Variation of fluoride along East Hirehalla, sub-watershed

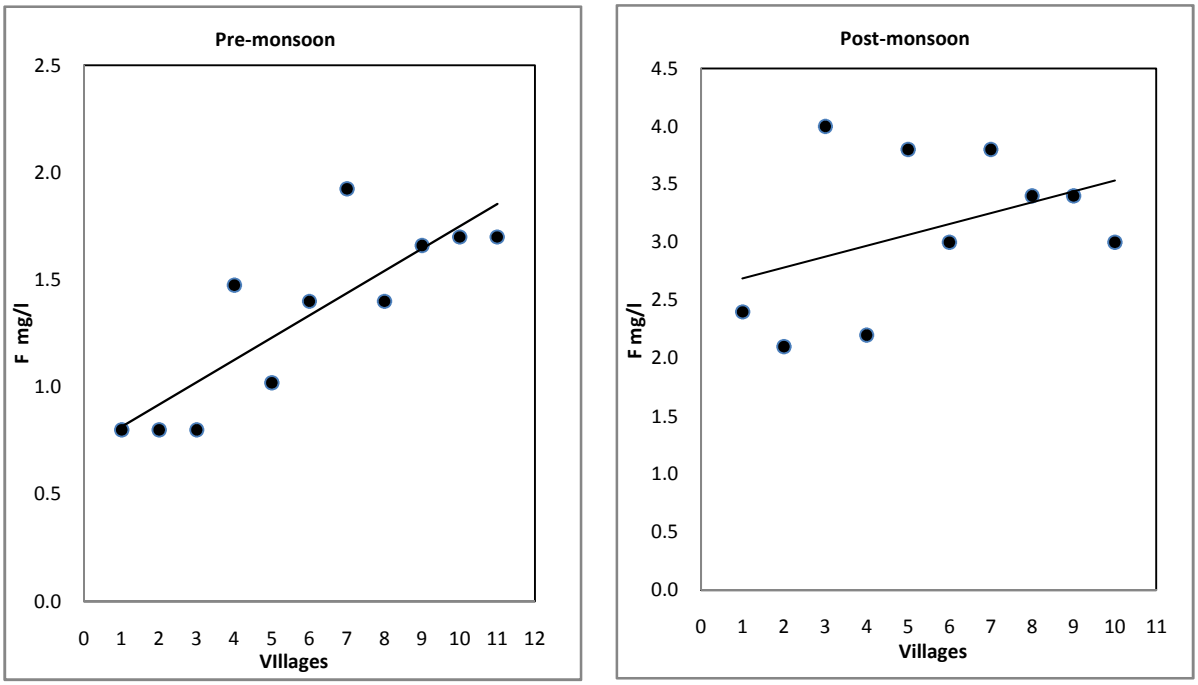

Fig. 4. Variation of fluoride along West Hirehalla, sub-watershed.

SPATIAL VARIATION OF FLUORIDE CONTENT

The spatial variation of fluoride over the watershed is studied by preparing counter maps considering fluoride values in groundwater for the samples collected during pre and post-monsoon samples (fig 5 and 6).

The pre-monsoon spatial variation map (fig.5) exhibits that the northern and eastern parts of watershed the concentration of fluoride is 0.7 to 0.8 mg/l. In the western part it is 1.1 to 1.6 mg/l. In the central part it is 0.8 to 1.1 mg/l., while in the southern part it is 1.1 to 1.9 mg/l. The variation in fluoride concentration is less in the eastern and northern part, where as its variation is more in the southern part.

The post-monsoon spatial variation map (fig.6) exhibits that the northern and eastern part of watershed the concentration of fluoride is 1.5 to 3.3 mg/l. In the western part it is 2.1 to 4.2 mg/l. In the central part it is 3 to 3.6 mg/l, while in the southern part it is 2.1 to 3.6 mg/l. The variation in fluoride concentration is less in the eastern and northern part, where as its variation is more southern part.

These two spatial variation diagrams reveal that the fluoride concentration is more in the southern part of the basin i.e. in the area of discharge.

CONCLUSIONS

The detailed study of distribution of fluoride content in the Hirehalla watershed reveals that in the recharge area the F content is less when compared to the discharge area. The topographic slope, surface and groundwater flow in this watershed is from north to south. Thus, the recharge area is in the northern part of the watershed and the discharge area is southern part of the watershed. The presence fluoride in groundwater is due to weathering of fluoride bearing minerals in granitic gneissic rocks. The dissolved fluoride in groundwater is transported with respect to hydraulic gradient northern part to southern part and hence fluoride content is more in the southern part i.e, discharge area.

Though the content of fluoride in this watershed is not very alarming today but in the process of dissolution fluoride concentration in future years may lead to higher concentration of fluoride.

Fig 5 Pre-monsoon spatial variation of fluoride content

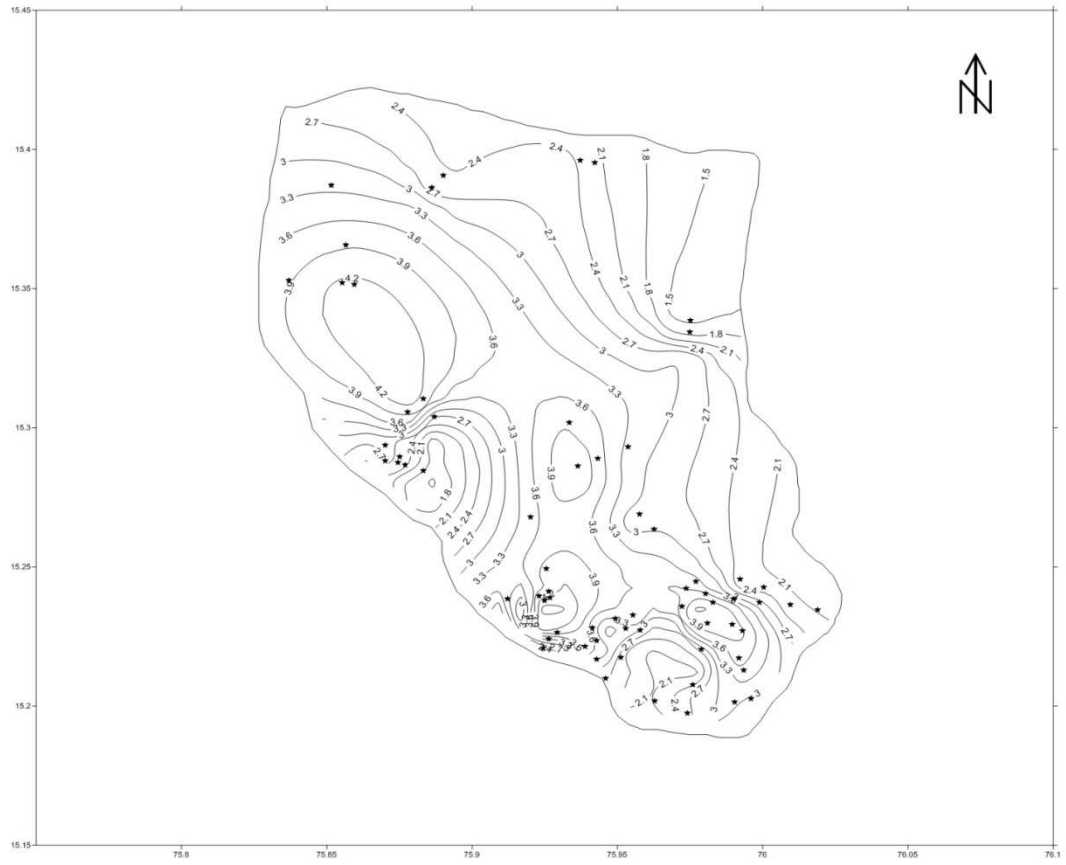

Fig. 6. Post-monsoon spatial variation of Fluoride content

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