International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 10, Issue 10 (October 2014), PP.01-08

Study of Fluoride Distribution and Spatial variation in Huvinhalla Watershed, Karnataka, India

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Abstract:- The Huvinhalla watershed is found in Koppal Taluka of North Karnataka. Arid to semi arid climatic conditions prevail over the watershed. Closepet granites of pink and grey varieties are the major litho units in the area. These granities along with essential minerals do contain the accessory minerals like hornblende, muscovite, tourmaline, sphene, apatite, biotite etc. These minerals contain fluoride. The weathering of granites has enabled to leach out fluoride from the fluoride bearing minerals. Thus, leached fluoride has contaminated or mixed with the ground water in the aquifer. The fluoride content varies from traces to 3.20 mg/l in the watershed. There is depletion in the fluoride content from the place of recharge to the place of discharge. There is variation in the content of fluoride in pre and post monsoon groundwater samples. In pre monsoon groundwater samples, fluoride varies from traces to 2.5 mg/l with an average of 1.30 mg/l. In post monsoon groundwater samples fluoride varies from traces to 3.20 mg/l with an average of 1.40 mg/l. Dispersion of fluoride in the watershed is described in the paper.

Keywords:- Huvinhalla basin, Watershed, Flouride, Leaching, Aquifer

I. INTRODUCTION

The incidence of fluoride in groundwater is from the rock formations containing fluoride bearing minerals. Normally, granites and granitic gneisses contain accessory minerals like muscovite, biotite, apatite, tourmaline, sphene and hornblende. Rigorous weathering of these rocks in the semi arid and arid regions, promote leaching of flouride into groundwater. Since 1960's the presence of fluoride in groundwater is reported and the diseases like skeletal and dental fluorosis are reported. The fluoride content more than 1.5 mg/l is considered as harmful to human consumption (ISI, 2003 and WHO, 2004). The effect of flouride in human body is possible when there is consumption of fluoride bearing water for long period of time or for many years.

The Huvinhalla watershed in Koppal District of Karnataka (Fig 1) is one of such areas where closepet granites are the litho units. The watershed is about 281 sq Km. The watershed experiences hot summer, moderate rain and cold winter climatic conditions. These granites are highly fractured/jointed and weathered. Highly fractured and weathered granites create a passage to the water table which enhances the leached fluoride to reach groundwater substantially.

II. PRESENT WORK

Groundwater samples are collected throughout the watershed from the available regularly used bore wells. 53 number of groundwater samples are collected and subjected for routine chemical analysis for determination of cat ions and an ion. The estimated ions are Ca,Mg,Na,K,Fe,HCO_3,CO_3,Cl,SO_4,F and TDS,TH,pH,EC etc. In this research article the dispersion of fluoride content in the watershed is discussed in detail. To study the distribution of fluoride in the watershed, the watershed is divided into 3 blocks and variations along stream course are explained utilizing fluoride values.

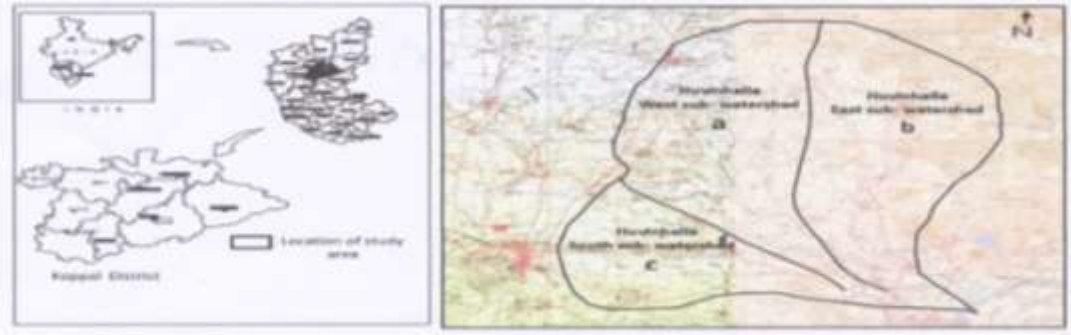

Fig.1: Location map of study area.

III. DISTRIBUTION OF FLOURIDE IN THE WATERSHED

A. Variation in fluoride as per different blocks

Huvinhalla watershed falls between15°17' N to 15°30' N latitude and longitude between 76°10'E to 76°23' E . Three blocks are demarcated in the watershed namely **a, b** and **c**. The fluoride content of these blocks are tabulated in Tables I, II, III. These tables represent number of bore wells in the respective areas along with names of villages, fluoride content of each well and average fluoride value. Such classification is performed for both pre and post-monsoon seasons. The data of Table I, II, III is presented in Fig 2 (pre and post-monsoon data). The pre-monsoon season samples show that there is variation in fluoride content in all the three blocks. The post-monsoon seasons samples show that there is increase in the content of fluoride from northern part to the southern part. In the northern part the average value of fluoride is 0.96 mg/l, in the central part it is 1.30 mg/l and in the southern part it is 1.69 mg/l.

Table I: Northern block of watershed (Block a)

Sl No	Villages	Pre-monsoon Fluoride Values			Average	Post-monsoon Fluoride Values			Average
		Location 1	Location 2	Location 3		Location 1	Location 2	Location 3	
1	Jinnapur	1.20			1.20	0.90			0.90
2	Hoshalli	2.30			2.30	1.5			1.5
3	Bellary	0.00	0.30		0.15	0.70	0.80		0.75
4	B-Kamanur	1.70			1.70	1.00			1.00
5	Abbigeri	2.00			2.00	1.10			1.10
6	Indaragi	0.20	0.40		0.30	1.10	1.90		1.50
7	Chick	1.70			1.70	1.10			1.10
8	Abbigeri	2.00	2.00	0.30	1.43	0.90	0.90	1.20	1.00
9	Kukanpalli	0.10	1.40		0.10	0.70	0.00		0.35
				Average	1.21			Average	1.02

Table II: Central block of watershed (Block b)

Sl No	Villages	Pre-monsoon Fluoride Values		Average	Post-monsoon Fluoride Values		Average
		Location 1	Location 2		Location 1	Location 2	
1	Libageri	1.30		1.30	0.90		0.90
2	Libageri-Sangapura	0.30		0.30	1.40		1.40
3	Kamanur -Bheemanur	0.80		0.80	1.00		1.00
4	Tavargera	0.10		0.10	1.10		1.10
5	Dankandoddi	1.70		1.70	1.10		1.10
6	Tenakanakallu	1.80	1.90	1.85	2.20	3.20	2.70
7	Hanumanhalli	1.70		1.70	2.40		2.40
8	Sangapura	0.80		0.80	1.50		1.50
9	Bheemanur	1.6		1.6	1.10		1.10
10	Hoshalli	0.30		0.30	0.60		0.60
11	Budagumpa	0.90	0.70	0.80	0.90	1.10	1.00
12	Nageshanhalli	1.00		1.00	0.80		0.80
			Average	1.02		Average	1.30

Table III: Southern block of watershed (Block c)

Sl No	Villages	Pre-monsoon Fluoride Values			Average	Post-monsoon Fluoride Values			Average
		Location 1	Location 2	Location 3		Location 1	Location 2	Location 3	
1	Kotakkanhalli	2.20	1.70		1.95	3.00	2.30		2.65
2	Gingera Tank	2.10			2.10	2.40			2.40
3	Gabbur	1.80	0.30		1.05	1.40	0.70		1.05
4	Seed Farm	1.70			1.70	1.40			1.40
5	Guladhalli	1.70			1.70	0.80			0.80
6	Kerahalli	0.90			0.90	1.10			1.10
7	Cannal-Road Junction	1.50	0.70	1.80	1.33	1.50	0.80	0.70	1.00
8	Shapur	1.70			1.70	1.40			1.40
9	Bevanhal	0.70			0.70	0.80			0.80
10	Lingadhalli	1.60			1.60	1.80			1.80
11	Kankapur	0.30			0.30	1.80			1.80
12	Hosa Kankapur	2.50			2.50	2.40			2.40
13	Allanagar	0.90			0.90	2.40			2.40
14	Industry	1.00			1.00	1.90			1.90
15	Ginagera	1.90			1.90	2.60			2.60
16	Basapur	1.70			1.70	1.70			1.70
17	Kidadhala-	1.40			1.40	1.50			1.50
18	Kidadhala	1.20			1.20	2.00			2.00
19	Belanlu	2.50	2.50		2.50	0.90	2.40		1.65
20	Koppal DC	2.00			2.00	1.50			1.50
				Average	1.51			Average	1.69

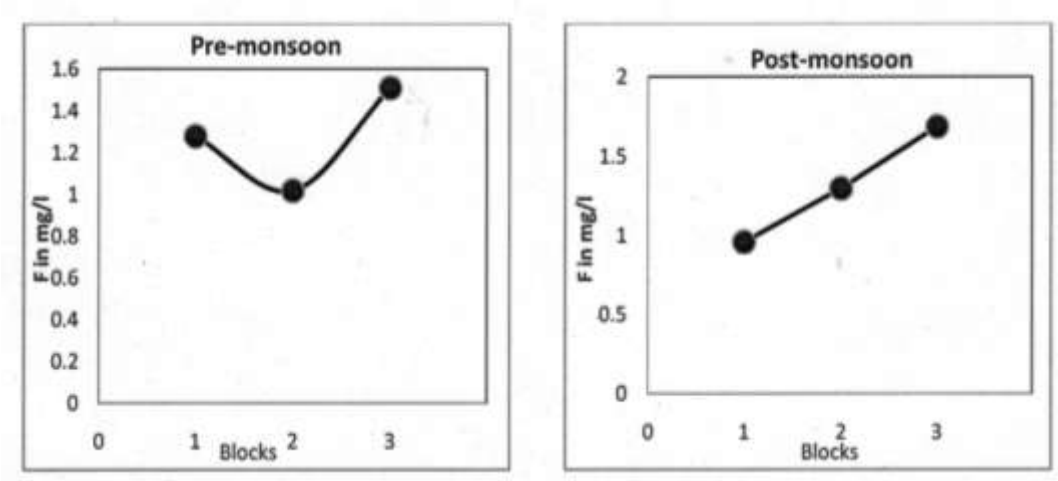

Fig. 2: Block wise variation of average fluoride in pre and post-monsoon.

B. Variation of fluoride as per stream directions

Further, the variation of fluoride content is studied along the stream flow direction. For this study the watershed is divided into 3 sub-watersheds viz, (Fig 1).

1) Huvinhalla West sub watershed (Block a): Flowing from north to south.
2) Huvinhalla East sub watershed (Block b): Flowing from north to south
3) Huvinhalla South sub watershed (Block c): Flowing from west to east

The data of fluoride content in the samples collected in borewells along or adjacent to these streams are presented in table IV, V, VI. The tables 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. This data is represented in Fig 3, Fig 4, Fig 5. The Fig 3 of Huvinhalla East Sub Watershed and Fig 4 Huvinhalla West Sub Watershed exhibit the increase in fluoride values along downstream direction. It is interesting to record that in case of Fig. 5 of Huvinhalla South Sub Watershed there is decrease in the content of fluoride from west to east.N-S flowing stream, the groundwater show increase in fluoride content from the areas of recharge to the area of discharge. But the west to east flowing stream, the groundwater show that there is decrease in the fluoride content from the area of recharge to the area of discharge.

Table IV: Huvinhalla East Sub Watershed

Sl No	Villages	Pre-monsoon Fluoride Values			Average	Post-monsoon Fluoride Values			Average
		Location 1	Location 2	Location 3		Location 1	Location 2	Location 3	
1	Bellary	0.00	0.30		0.15	0.70	0.80		0.75
2	Indaragi	0.20	0.40		0.30	1.10	1.90		1.50
3	Nageshanhalli	1.00			1.00	0.80			0.80
4	Kukanpalli	0.10	1.40		0.75	0.70	0.00		0.35
5	Dankandoddi	1.70			1.70	1.10			1.10
6	Budagumpa	0.90	0.70		0.80	0.90	1.10		1.00
7	Guladhalli	1.70			1.70	0.80			0.80
8	Kerahalli	0.90			0.90	1.10			1.10
9	Cannal-Road	1.50	0.70	1.80	1.33	1.50	0.80	0.70	1.00

Table V: Huvinhalla West Sub Watershed

Sl No	Villages	Pre-monsoon Fluoride Values			Average	Post-monsoon Fluoride Values			Average
		Location 1	Location 2	Location 3		Location 1	Location 2	Location 3	
1	Jinnapur Tanda	1.20			1.20	0.90			0.90
2	Hoshalli	2.30			2.30	1.50			1.50
3	Abbigeri Tanda	2.00			2.00	1.10			1.10
4	Abbigeri	2.00	2.00	0.30	1.43	0.90	0.90	1.20	1.00
5	Tavargera	0.10			0.10	1.10			1.10
6	Hoshalli	0.30			0.30	0.60			0.60
7	B-Kamanur	1.70			1.70	1.00			1.00
8	Chick Kamanur	1.70			1.70	1.10			1.10
9	Kamanur -Bheemanur	0.80			0.80	1.00			1.00
10	Libageri	1.30			1.30	0.90			0.90
11	Libageri-Sangapura	0.30			0.30	1.40			1.40
12	Sangapura	0.80			0.80	1.50			1.50
13	Bheemanur	1.6			1.6	1.10			1.10
14	Gabbur	1.80	0.30		1.05	1.40	0.70		1.05
15	Seed Farm	1.70			1.70	1.40			1.40
16	Shapur	1.70			1.70	1.40			1.40

Table VI: Huvinhalla South Sub Watershed

Sl No	Villages	Pre-monsoon Fluoride Values		Average	Post-monsoon Fluoride Values		Average
		Location 1	Location 2		Location 1	Location 2	
1	Tenakanakallu	1.80	1.90	1.85	2.20	3.20	2.70
2	Hanumanhalli	1.70		1.70	2.40		2.40
3	Kotakkanhalli	2.20	1.70	1.95	3.00	2.30	2.65
4	Gingera Tank	2.10		2.10	2.40		2.40
5	Koppal DC	2.00		2.00	1.50		1.50
6	Kidadhala	1.20		1.20	2.00		2.00
7	Belanlu	2.50	2.50	2.50	0.90	2.40	1.65
8	Kidadhala-	1.40		1.40	1.50		1.50
9	Basapur	1.70		1.70	1.70		1.70
10	Allanagar	0.90		0.90	2.40		2.40
11	Industry	1.00		1.00	1.90		1.90
12	Ginagera	1.90		1.90	2.60		2.60
13	Hosa Kankapur	2.50		2.50	2.40		2.40
14	Kankapur	0.30		0.30	1.80		1.80
15	Lingadhalli	1.60		1.60	1.80		1.80
16	Bevanhal	0.70		0.70	0.80		0.80

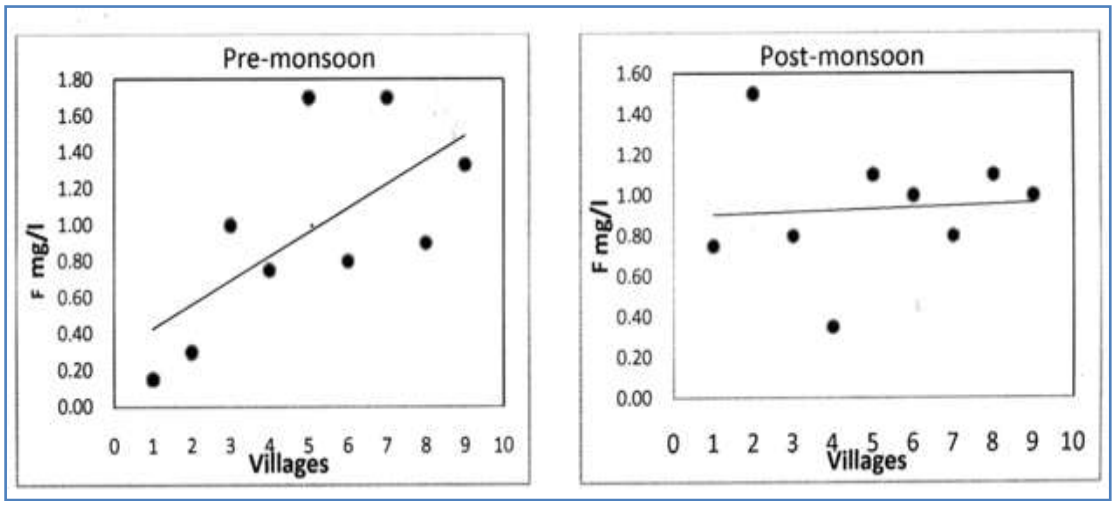

Fig 3: Variation of fluoride along Huvinhalla East Sub Watershed

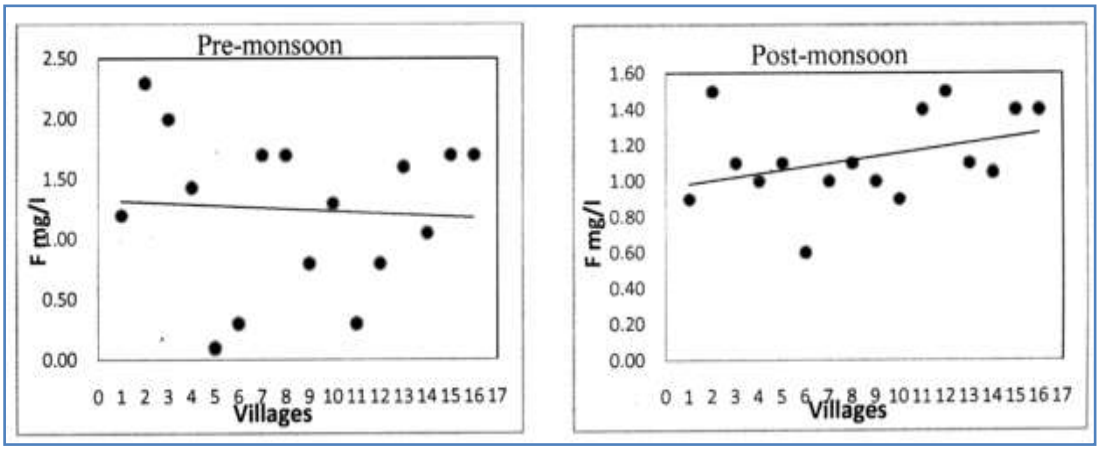

Fig 4: Variation of fluoride along Huvinhalla West Sub Watershed

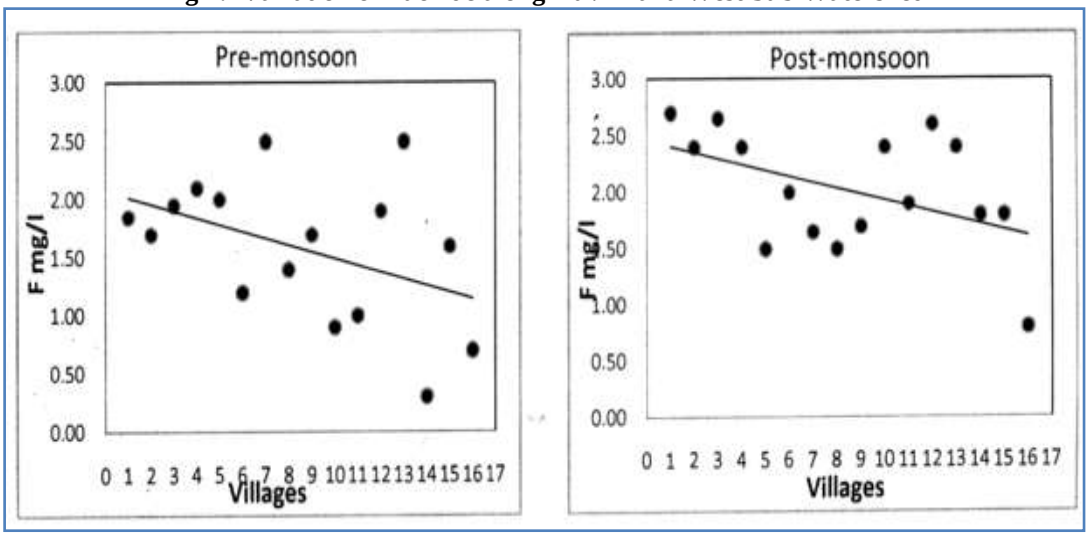

Fig 5: Variation of fluoride along Huvinhalla South Sub Watershed

C. Spatial Variation of fluoride content

The spatial variation maps of fluoride in given Fig 6 and Fig. 7.

The pre-monsoon variation (Fig.6) shows that in the northern part fluoride content varies from 0.3 to 2.1 mg/l, in the western part it varies from 0.7 to 1.7 mg/l, in the central part it varies from 1.5 to 2.3 mg/l, while in the eastern part it varies from 0.3 to 1.1 mg/l. The figure shows variation of fluoride content more towards the central parts of northern and southern watersheds. This variation is less in the eastern and south western part.

The post-monsoon variation (Fig.7) shows that the fluoride content variation is 0.4 to 0.8 mg/l in the northern part. In the central part it is 1 to 1.6 mg/l. In the western part it is 1 to 2.6 mg/l. In the southern part it is 0.8 to 2.4 mg/l. The figure shows variation in fluoride content is more in the western part and less in the northern and eastern part.

The variation in fluoride content is more in the post-monsoon season, when compared to the pre-monsoon season.

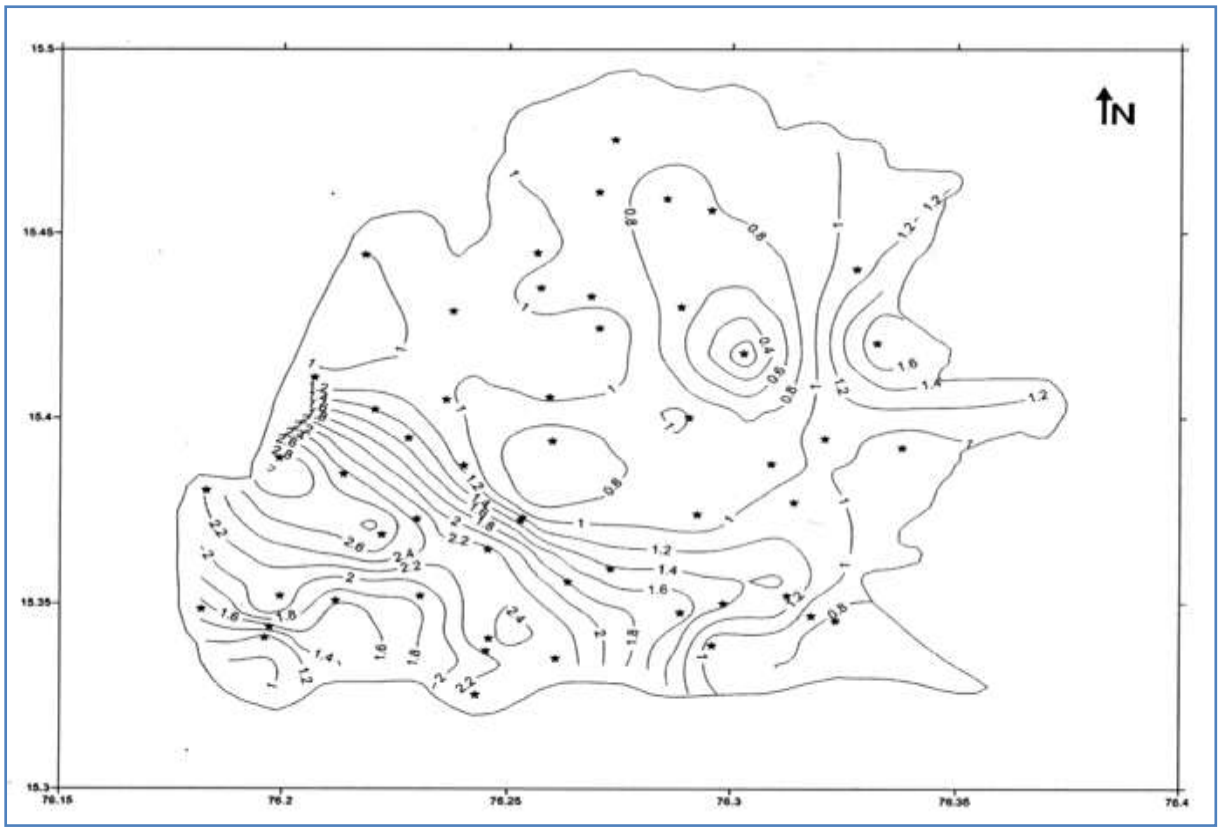

Fig. 6: Pre-monsoon spatial variation of fluoride content

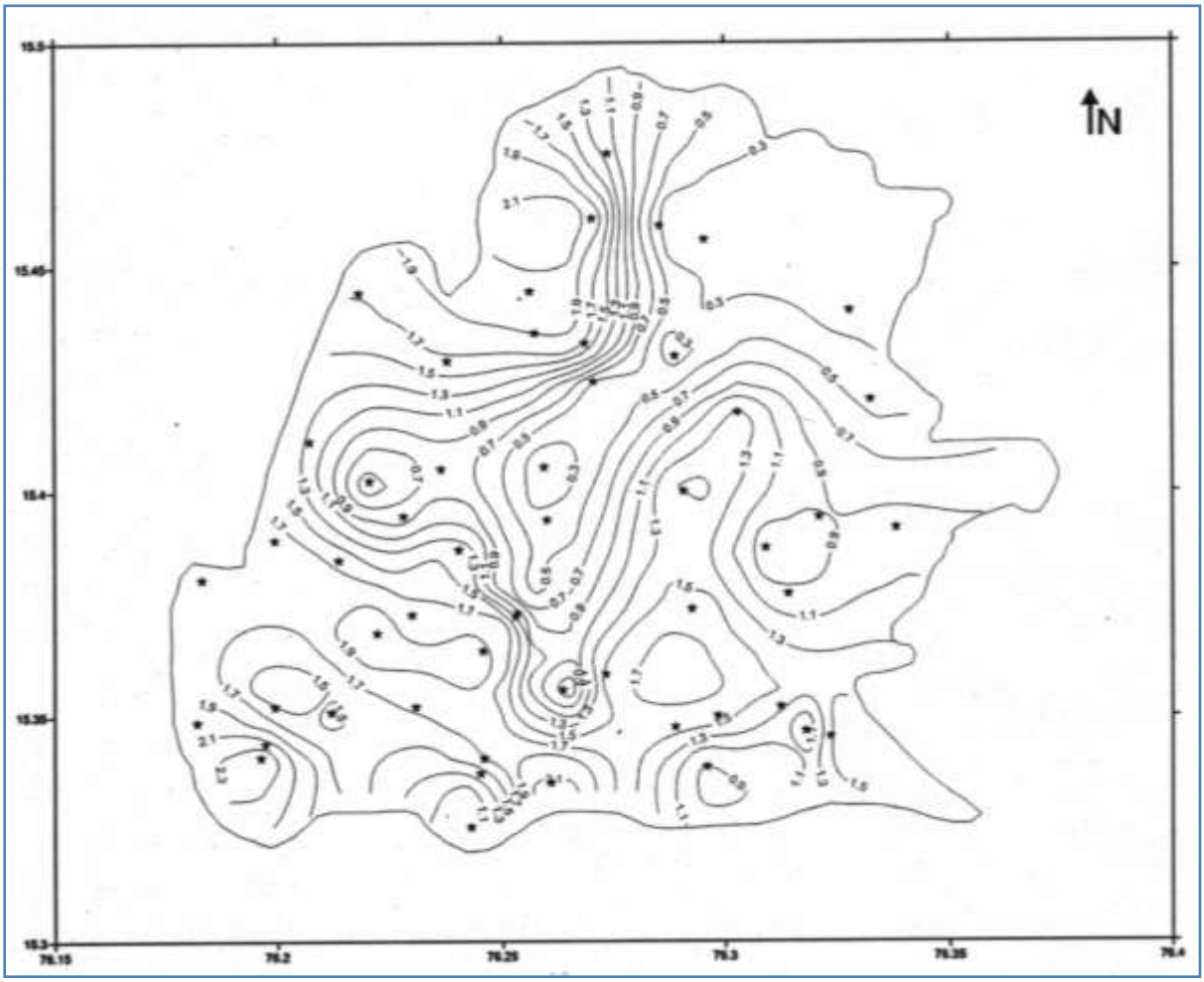

Fig. 7: Post-monsoon spatial variation of fluoride content

IV. CONCLUSIONS

The study of dispersion of fluoride content in the Huvinhalla watershed reveals that there is increase fluoride content from north to south in the two watersheds flowing from north to south. This is to say that the recharge area is having less of fluoride content when compared to the discharge area. The fluoride in groundwater is due to weathering of fluoride bearing minerals in the granitic rocks. The hydraulic gradient played a role in transporting fluoride from the place of recharge to the place of discharge. It is pertinent to note here that there is another sub-watershed in the Huvinhalla watershed itself. This sub-watershed is flowing from west to east in the southern part of the watershed. It is interesting to note that in this sub-watershed the fluoride content is decreasing from the place of recharge to the place of discharge.

Though the content of fluoride in this watershed is not alarming today, The process of dissolution of fluoride into groundwater is in progress since time immemorial. This process of dissolution may lead to higher concentration of fluoride leading to more health related complications in years to come.

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