

# **Fluoride Contamination Assessment in Ground Water: Case Study from Chityala Mandal, Nalgonda District, Telangana.**

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**ABSTRACT:** Groundwater quality problems have emerged in many geographical areas due to natural environmental processes and human intervention in the geosystems. Groundwater is the major resource for drinking and domestic purpose in most parts of the world as it is available inexpensively near to door step and free from pathogenic germs. Chemical contamination of drinking water especially fluoride is a major concern in drinking water supply. Good quality of drinking water is essential for human life. The spatio-temporal variations in rainfall, local distribution in geological and geomorphic composition of various units have led to uneven occurrence and distribution of groundwater resources. Telangana state has been improved occurrence of fluorosis day by day, due to moderate concentration of fluoride in ground water. The fluoride is occurring predominantly in the younger granitic terrain like Alkali Feldspar Granite and Grey Biotite Granite.

The Remote Sensing imagery with its synoptic coverage, acts as a tool for finding suitable solution when combined with conventional data. Fluoride concentration maps were using Remote Sensing & GIS techniques. An integrated Remote Sensing & GIS study has been taken up for chityala mandal for studying the hydro geomorphic unit wise ground water quality evaluation and its impacts. The district is underlain by different rock types like granites (85%) and gneisses (8%); and rest of the area is underlain by intrusive. The ranges of fluoride in the district are varying from 1.25 to 3.10 ppm. The maximum permissible limit for fluoride in drinking is 1.50 ppm as per Indian Drinking Water Standards (BIS Guideline-IS: 10500: 1991). Most of the quality affected sources are having marginally high concentration of fluoride (1.50-3.00 ppm). It is observed that the fluoride contamination is more on the north and eastern parts. Remedial measures like supply of safe drinking water and construction of rain water harvesting structures to minimize the moderately high concentration of fluoride are proposed.

**KEYWORDS:** Fluoride, groundwater, chityala mandal, Hydrogeology, Remote sensing.

## **1. INTRODUCTION**

Occurrence of fluoride (F) in groundwater has drawn global attention as ingestion of water with fluoride concentration above 1.5 mg L may result in dental or skeletal fluorosis. The maximum tolerance limit of fluoride in drinking water specified by the World Health Organization (WHO, 1984) is 1.5 mg L. High fluoride concentration in the groundwater has been reported in many parts of Indian subcontinent and is becoming a serious concern or the drinking water supply (Jackset al., 2000, 2005; Keshari & Dhiman, 2001). Studies reveal that infants, children and adults in the study area of chityala mandal are exposed to high doses of fluoride from groundwater (Chinoyet al., 1992; Dhiman & Keshari, 2003). Normally, fluorine, because of its high reactivity, exists in the form of fluoride in natural waters (Leung & Hruday, 1985).

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The main natural sources of fluoride in soil are fragments of minerals, such as apatite, cryolite, fluorite or fluorspar and topaz (Al silicates containing F), fluormica (phlogopite), epidote, phosphorite, tremolite and villuanite. These can be supplemented by anthropogenic input from industrial sources. Industries which use raw materials containing even small amounts of fluorine can release enough gaseous (HF, SiF<sub>4</sub>) and/or particulate fluorides (AlF<sub>3</sub> Na<sub>3</sub>AlF<sub>6</sub>, CaF<sub>2</sub>) to enhance elemental levels in the surrounding areas. Pollutant sources include: manufacturers of bricks, iron-based fertilizers and glass; coal-fired power stations; and aluminiumsmelters (Handa, 1975; Wedepohl, 1978; Matthes & Harvey, 1982; Deeret al., 1983; Pickering, 1985; Hem, 1986; Handa, 1988; Gaumatet al., 1992; Gaciri & Davies, 1993, Rao, 1997).

In this study, hydro geochemical evaluation of high-fluoride groundwater in chityala mandal, Nalgonda district is carried out (a) to characterize fluoride contamination in the groundwater; and (b) to identify possible geochemical reactions under the prevailing hydrogeological conditions, as well as their role in mobilizing fluoride concentration.

## II. STUDY AREA

**Location & Accessibility:** Chityala Mandal is located in northern part of the district of Nalgonda, Telangana State, India. The Chityala is around 25 km from Nalgonda in North-West direction. Chityala mandal covered villages are Chityala, Peddakaparth, Veliminedu, Gundrampalli, Sunkenapalli, Aipoor, Pittampalle, Perapalle, Chinnakaparth, Talla vellemla, Yelikatte, Urmadla, Nerada, Vattimarathi, Vanipakala and Sivaneni gudem. The extent of the Chityala stretches from between 17°11'26" and 17°13'83" North Latitudes, and 78°57'38" and 79°11'3" East Longitudes. Elevation is between 420(High) Meters to 300(Low) Meters and is covered in the Survey of India. Topo sheet number 56O/4. Of NE, NW direction on the scale of 1:25,000 and covers an area of 26000 hectares, (260 sq kilometers) The study area is a part of Nalgonda district. Can approached National highway road 9, which is passing through the study area and is also connecting the three stats Maharashtra, Telangana and Andhrapradesh. This national high way is connecting in major cities they are Vijayawada, Hyderabad. The study area distance measured from Hyderabad is 70 km. the study area is located 25 km NW of the Nalgonda.

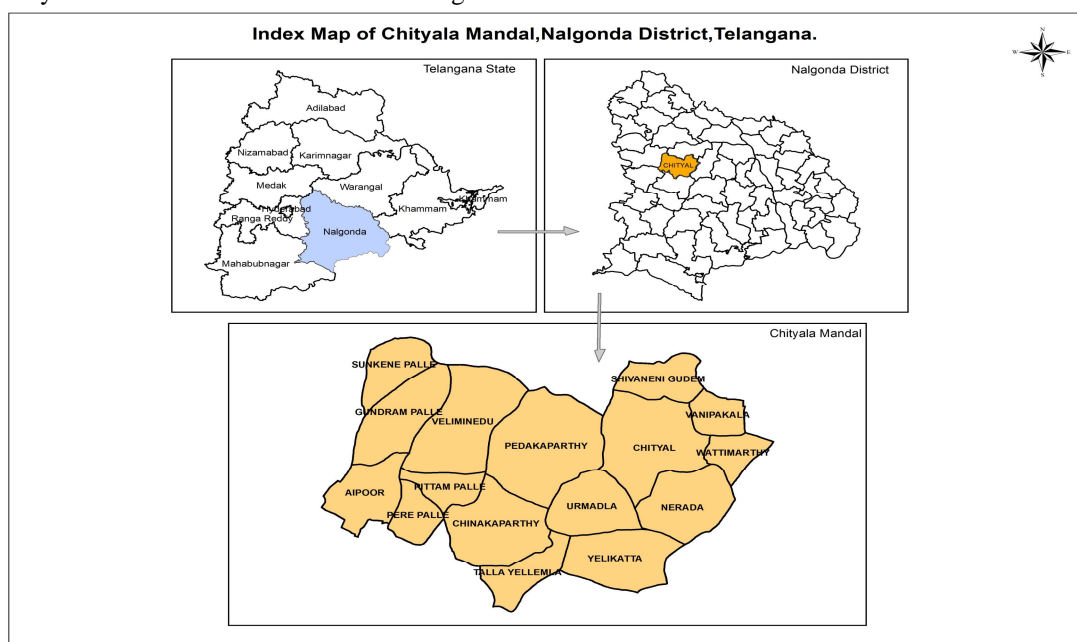


Fig.1 Location map of the study area.

**Physiography & Drainage & Rainfall:** Based on the Cartosat dem (15m) and Satellite image the elevation varies from 280 to 480m MSL. The study area exhibits Plains, Pediments, the middle part of the study area is exhibits dykes and small hills. The area has general slope towards South and Southeast. The Maine stream is Peddavagu passing

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through Gundrampalli, Epuru towards Southeast. Apart from this, many minor streams are present in this area and have their general trend towards South and Southeast. The drainage is mostly controlled by the geology and structural pattern that exists in the area. Higher part of the study area is northern part and Lower part of the study area is stouter part. This area drainage pattern is mainly dendritic drainage. They are characterized by irregular branching of tributary stream in many directions and at almost any angle. Dolerite dyke is present in between Peddakaparthi and chityala which has got the highest elevation (420m) in this area. The area receives rainfall during the southwest monsoon during June to September. The average normal rainfall for the past 10 years of the study area is about 719 mm.

**Methodology:** The satellite data has been used for updating of drainage and surface water bodies. The IRS P6 LISS-IV is a multi-spectral high resolution camera with a spatial resolution of 5.8m at nadir. Satellite image of the Chityala mandal is shown in map. The area around the chityala mandal has been cover for ground water sampling approximately covered 24 samples have been collected. Each bottle was collected in 1 liter polythene bottles. Samples were analyzed in laboratory for the major ions chemistry using standard methods APHA1995.

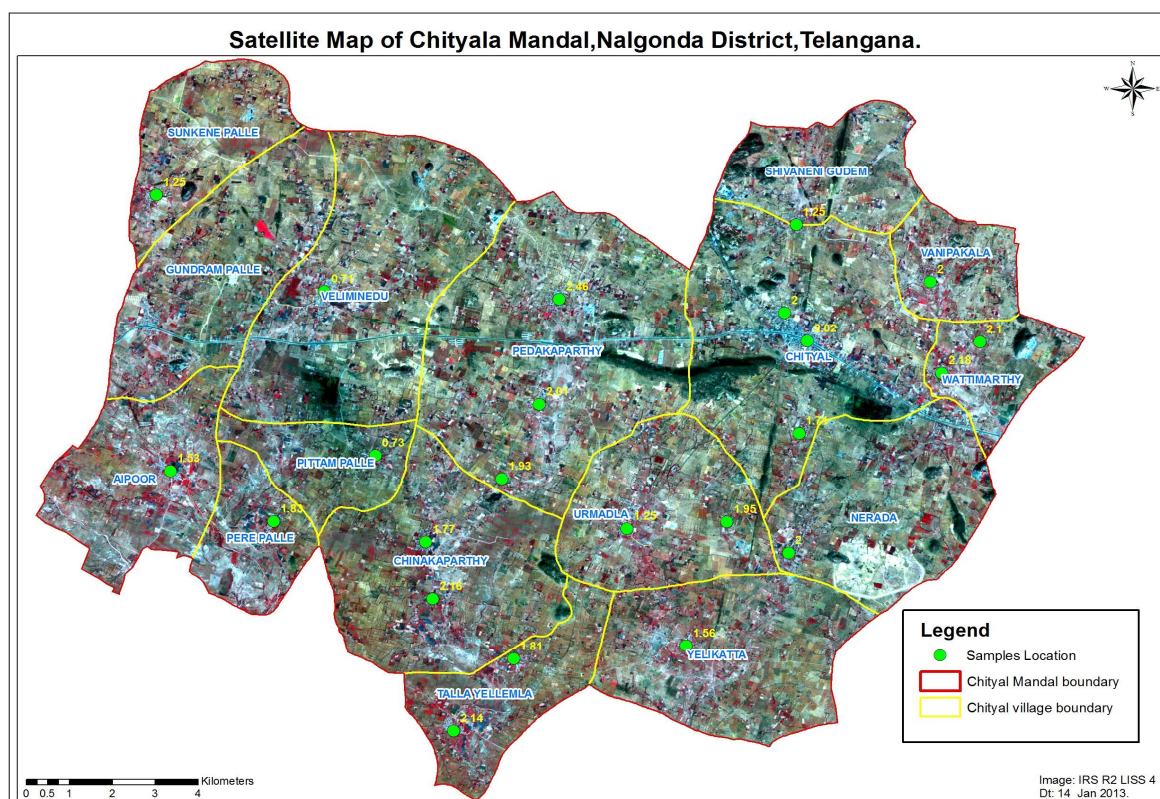


Fig.2 Satellite map with sample collection locations.

**Geology:** Chityala mandal is underlain by the formation of South Indian Peninsular shield consisting of older Metamorphics, Peninsular Gneissic Complex. in the age of Achaean. The Peninsular Gneissic Complex are intruded by younger Granite, basic intrusive (dolerite dykes), Quartz & Pegmatite veins. And they are younger than the Achaean. Quartz veins and Dolerite/Gabbro intrusives are Lower Proterozoic age. Geologically Study area is stable and consisting of hard rock terrain of granite gneiss. Have a bearing on the capacity of the rocks to hold and transmit groundwater. The area is marked by numerous fractures and the drainage is mainly controlled by these fractures/lineaments. A number of lineaments running in SE directions are identified. The SE-NW lineaments are more prominent. That study area dolerite dykes are structurally 2 directions one is NE-SW, and second one is NW-SE.

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**Hydrogeology:** In the district granite/gneisses, basalts, dolerite dykes at various places. However majority of the area is occupied by hard rock formations like gneissic complex. Only less amount of the area is occupied by other formations. In hard rock formations there is lack of primary porosity. However the aquifer system is developed because of secondary porosity due to various tectonic disturbances and weathering activity. The deeper aquifer system is developed due to major faults, joints, fractures, crevices, shear zones etc. It is observed that the ground water prospects in Moderately weathered Granite gneiss rocks and valleys is in the order of 100-200 lpm, whereas it is 50-100 lpm in Shallow weathered Granite gneiss rocks and valleys. In the pediment zones of granitic rocks, the expected yield of the wells is in the order of 10-50 lpm. In highly dissected hills, the prospects are low to poor (0 to 10 lpm).

**Fluoride distribution:** Habitation wise ground water quality data for the fluoride element during the year 2014 is collected. The data belongs essentially to drinking water sources like Hand Pumps / Bore wells. The data is segregated in to pre monsoon seasons based on date of collection of samples.

As there are many sources in a habitation, average value of fluoride for all the sources is calculated for each habitation. The fluoride map is prepared by using Spatial Analyst tools using Inverse Distance Weightage (IDW) method. The final map is re-classified in to 3 classes like Desirable (<1.00 mg/L); Permissible (1.50-3.00 mg/L) and Non Potable (>3.00 mg/L) as per Bureau of Indian standards. The final classified map pertaining to pre monsoon seasons is as given in Figures. 3. This may be because of dilution of fluoride with recharged rain water. The concentration of fluoride is out of range in most parts of Peddakaparthly, Wattimarthly, and Chinnakaparthly villages.

Table.1 Water analysis parameters.

SampleNO	Hab_NAME	SourceType	PH	TDS	TH	TA	F	Cl	Fe	NO3	SO4
1	CHITYAL	HP	7.81	1535	785	667	3.02	535	0.18	30	140
2	CHITYAL	BW	8.14	1417	644	520	2.75	573	0.21	29	139
3	VENKATAPUR	HP	7.14	741	390	347	1.71	200	0.18	24	116
4	VANIPAKALA	HP	7.24	692	460	428	2.75	192	0.06	24	100
5	VANIPAKALA	BW	8.18	1470	690	745	3.10	610	0.14	19	99
6	SHIVANENIGUDEM	HP	7.12	878	301	296	1.25	214	0.14	30	138
7	VATTIMARTHY	HP	6.95	982	514	512	2.18	388	0.04	16	96
8	NEREDA	HP	7.08	1280	350	358	3.00	400	0.29	26	69
9	NEREDA	BW	7.32	3620	632	870	2.75	648	0.20	29	110
10	URUMADLA	HP	7.08	489	187	167	1.25	214	0.06	23	62
11	URUMADLA	BW	6.72	344	124	276	1.50	164	0.11	38	103
12	SUNKENPALLY	HP	7.22	847	124	342	1.25	146	0.22	26	78
13	AIPOOR	HP	7.32	2542	548	765	1.53	891	0.16	22	137
14	PERAPALLY	HP	7.08	941	388	350	1.83	370	0.20	28	140
15	PITTAMPALLY	HP	7.13	1821	389	417	0.73	256	0.10	28	118
16	VELIMINEDU	HP	7.02	648	118	372	0.71	160	0.08	19	67
17	PEDAKAPARTHY	BW	7.12	683	244	214	2.98	216	0.16	20	128
18	PEDAKAPARTHY	HP	7.19	816	314	267	3.01	227	0.09	18	144
19	CHINNAKAPARTHY	BW	7.60	1859	763	630	2.77	666	0.19	22	144
20	CHINNAKAPARTHY	HP	7.19	1041	401	345	3.16	285	0.28	19	126
21	MORSUGUEDEM	HP	7.18	1227	321	412	2.93	526	0.30	20	67
22	T.VELLEMLA	BW	7.09	1200	467	341	2.78	134	0.20	28	148
23	T.VELLEMLA	HP	7.34	632	208	326	2.81	402	0.08	26	132
24	ELLIKATTE	HP	8.09	1651	712	734	2.56	590	0.09	27	140

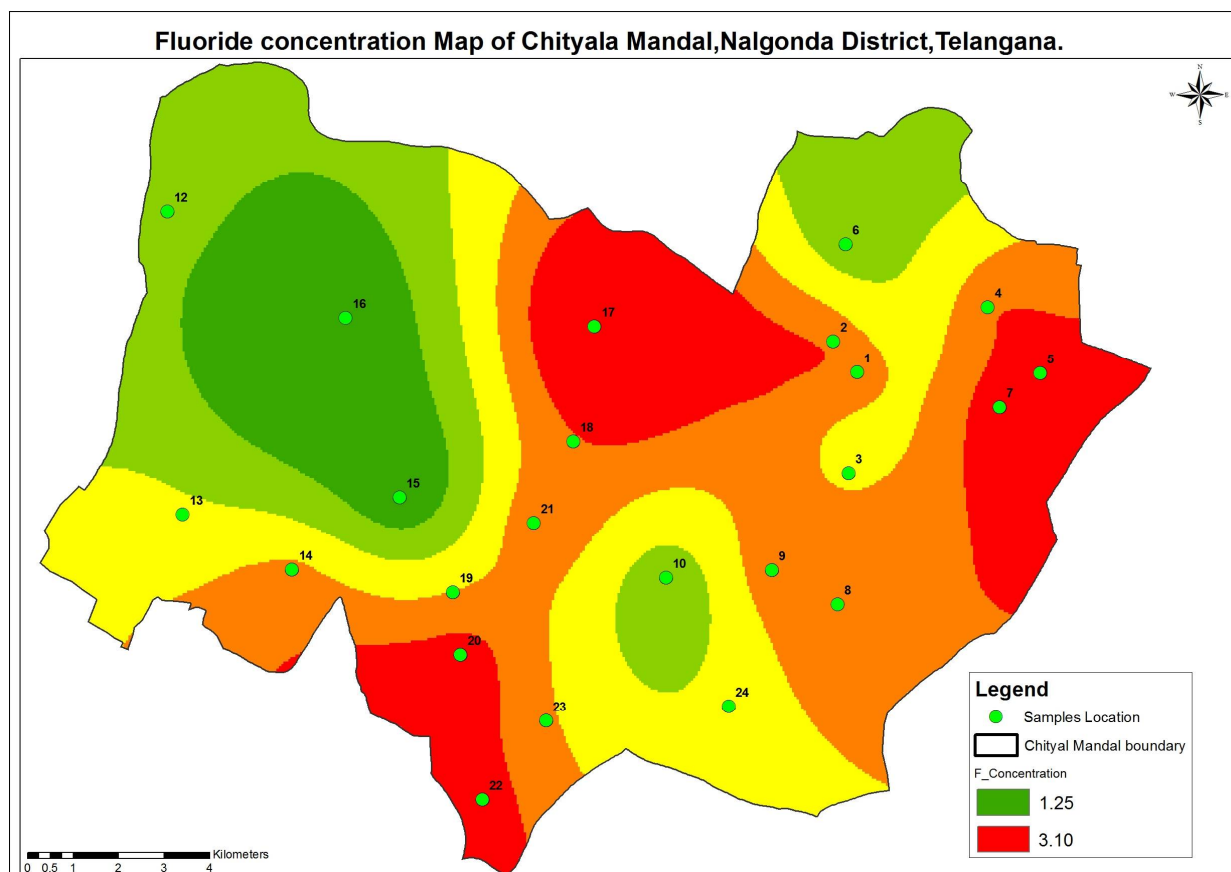


Fig.3 Fluoride concentration map of study area.

### III. RESULTS AND DISCUSSION

The habitation-wise chemical analysis data is subjected to detailed analysis and the following observations are made. Among all the villages, the average fluoride concentration (>1.5ppm) is highest in Wanipakala, Peddakaparthi and Chityala villages. It is observed that the fluoride concentration is more in shallow and moderately weathered Pediplains and valleys in granitic rocks like Alkali Feldspar Granite and Grey Biotite Granite situated in the study area. High concentration of fluoride is observed at isolated places in younger granite. Most of the quality affected sources are having marginally high concentration of fluoride (1.50-3.00 ppm) who is at risk for dental fluorosis. In some of the habitations/villages like peddakaparthi, chityala, Wanipakala and Chinnakaparthi majority of sources are showing the fluoride concentration of more than 3 mg/L and up to 3.10 mg/L which are at risk for dental/skeletal fluorosis in the long run.

The high concentration of fluoride rich ground water can be diluted surface water downstream of a surface water body by the result of augmented infiltration. In view of this, rainwater harvesting structures are suggested upstream of moderately high fluoride zones so that the impounded water would not only recharge ground water but also helps in diluting fluoride rich ground water, thus serves for dual purpose of both quality and quantity.

Bhagavan and Raghu (2005) stated that the concentration of fluoride in drinking water is directly proportional to the fluoride concentration in blood serum and urine of the villagers. Further, they have also attributed the variations in the concentration of fluoride in ground water to the Lithology, amount and duration of rainfall, and the level of exploitation of ground water of the area. Fluoride in the exogenic cycle of this fluorosis belt is almost wholly contributed by the granitic and pegmatitic rocks. A major part of the mandal is occupied by the granites and gneisses.

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The principal fluoride bearing minerals of these rocks are the acid soluble minerals such as fluorite, fluorapatite, hornblende, mica, epidote etc. These are the minerals that are responsible for high concentration of fluoride in natural waters, as they release fluoride under normal temperature pressure conditions.

These minerals are abundant in granite and gneiss rocks present in the study area. Hence, the concentration of fluoride in ground water is highest in those villages present on the northern parts and in isolated patches of the mandal. The factors that govern the distribution of fluoride in natural waters is dependent on the amount of fluoride in the source rocks, soils, duration of contact of water with rocks and soils, temperature, rainfall, vegetation and oxidation and reduction reaction. Under conditions of heavy rainfall, the percolating waters dissolve the salts from soils and as such the concentration of ground waters may be in no way less but may be more than that during dry periods. The other factors that control the amount of fluoride in waters is dependent on the degree of weathering to which the granitic rocks of the area were subjected.

## IV. CONCLUSIONS

It is revealed that the utility of remotesensing and GIS technique helps in delineating groundwater prospects zones represented with various hydro-geomorphic units. The other observations are as follows:

- As the non-command area is more there is tremendous pressure on ground water for agriculture and industrial uses which results in pollution of ground water resources and in future these limited resources will not be able to meet out the water demand qualitatively and quantitatively in the same ratio as today.
- The occurrence and quality of groundwater in an area is largely controlled by rainfall, and the characteristics of the terrain features like landforms, geology, soil, drainage, topography, etc. The information provided in the groundwater prospect zones helps in identifying areas suitable for artificial recharge to ensure sustainable groundwater draft.
- Groundwater conservation and artificial recharge structures are needed to be taken up watershed wise on war foot basis, with scientific lines, for enhancing the groundwater storage so as to make the existing bore wells sustainable.
- The intake of fluoride above the permissible limit in drinking water is the major reason for fluorosis disease in some parts of the study area.
- For fluoride mitigation preventive measures like taking safe drinking water with sufficient dietary food needs to be encouraged.
- Health education with focus on fluoride toxicity and the necessity to avoid fluoride consumption to be encouraged to each and every citizen.
- Scientific mapping of resources needs to be taken for preventing quality problem with remedial measures. It is important to look for holistic and people-centred approaches for water management.
- For De fluorination purpose use Nalgonda techniqs and tamarind planting in high fluoride villages.

## V. ACKNOWLEDGMENT

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