Fluoride Distribution in the Groundwater of Peddavagu basin, Adilabad District, Telangana, India

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Abstract **- This study was carried out to assess the fluoride concentration in groundwater of Peddavagu basin, Adilabad District. Where groundwater is the main source of drinking water. Water samples collected from bore wells were analyzed for pH, Electrical Conductivity (EC), Nitrate (NO_3^-) and Fluoride (F-) content. Fluoride concentration of groundwater ranges from 0 to 4.54 mg/l. Out of 31 water samples studied 20 samples have fluoride concentration below 1 mg/l and 11 water samples have fluoride concentration above 1 mg/l. As per the desirable and maximum permissible limit for fluoride in drinking water (1.5 mg/l) prescribed by WHO (2004) and Bureau of Indian Standards (2009), 35.4% groundwater sources in the study area is unfit for drinking purposes. Due to the higher fluoride levels in drinking water several cases of dental and skeletal fluorosis have appeared at alarming rate in the investigated area. The wells in the investigated area have been demarcated into safe and unsafe wells for consumption of water with respect to fluoride concentration.**

Index Terms **- Groundwater, Distribution, Fluoride, Fluorosis, Peddavagu basin, Adilabad District.**

INTRODUCTION

Nearly 12 million of the 85 million tons of fluoride deposits on the earth's crust are found in India. It is not surprising; therefore, the fluorosis is endemic in 17 states of India (UNICEF 1999). The most seriously affected areas are Telangana, Andhra Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Tamil Nadu and Utter Pradesh (Kumaran et al. 1971; Teotia et al. 1984). Fluoride is a key aspect of water quality in rural water supply system, which potentially affects the sustainability of water if it exceeds its prescribed limit.. Approximately 62 million people including 6 million children suffer from fluorosis because of consumption of water with high fluoride concentrations (Susheela, 1999).

The amount of fluoride occurring naturally in groundwater is governed by climate, composition of the host rock, and hydrogeology (Gupta et al., 2006). The major sources of fluoride in groundwater are due to fluoride bearing minerals such as fluorspar, cryolite, fluor-apitite and Hydroxylapatite. The fluoride content is a function of many factors such as availability and solubility of fluoride minerals, velocity of flowing water, temperature, pH, concentration of calcium and bicarbonate ions in water, etc. (Meenakshi et al., 2004). In Indian continent, the higher concentration of fluoride in groundwater is associated with igneous and metamorphic rocks.

Fluorine is the most electronegative of all chemical elements and is therefore never found in nature in elemental form. Combined chemically in the form of fluorides, it ranks 17th in abundance of elements in the earth's crust representing about 0.06–0.09% of the earth's crust (WHO, 1994). Fluoride is one of important life elements to human health. It is essential for normal mineralization of bones and formation of dental enamel with presence in small quantity (Chouhan and Flora, 2010). When fluoride is taken up more than permissible limit, it become toxic and causes clinical and metabolic disturbance in animals and human being such as dental and skeletal Fluorosis (Hussain et al., 2012; Singh et al., 2007).

The selected part for this study is situated in western part of the state where groundwater is a major source of drinking water. Detailed hydrogeochemical investigations have been carried out to know the geochemical behavior and to assess the quality of groundwater in the study area. with reference to fluoride and fluorosis problem. The objective of this study is to investigate the quality of drinking water (underground water) with special reference to the concentration of Peddavagu basin, Adilabad District, Telangana, India. The present study brings out

distribution of fluoride in the groundwater in the area underlain mostly by granites.

LOCATION OF THE STUDY AREA

The study area, covering about 151.1sq.km, falls in Adilabad District, Telangana,india. Study area covers the Boath, Dhanur buzurg, Dhanur khurd, Mandhaguda and Vagulapalli major villages. Geographical location North Lat. of 19^0 15′ - 19^0 23′ East Long. of 78^0 15′ - 78^0 26′ and falls in SOI Toposheet No.56I/7. The annual rainfall of the district is 1153 mm, About 75 percent of the annual rain is received during the south west monsoon (Source= IMD, India).

GEOLOGY

The study area is mostly covered by 60% of basaltic lava flows i.e., Deccan traps. The remaining 40% of the area comprises Archean granites. In the southeasternpart of the study area Pedda vagu basin is totally covered by basaltic terrain. The main litho - units are Decacan traps, Pink and grey Granites with quartz & pegmatite veins.

Era	Period	Formation	Lithology
Mesozoic lower tertiary	Upper cretaceous to Lower Eocene	Deccan traps	Basaltic lava flows
----------**Unconformity**----------			
INFRATRAPPENS			
Lower to middle proterozoic	Archaeans	Archaeans	Granite (Pink and Gray) Gneisses Pegmatites, Quartz Vein and Aplites

MATERIALS AND METHODS

In order to assess the groundwater quality, 31 groundwater samples have been collected from hand-pumps, bore wells, open wells in Peddavagu basin, Adilabad District, Telangana,. The samples were collected in clean two liter polythene bottles and analyzed for pH, Electrical Conductivity (Ec), Nitrate (NO_3^-) and Fluoride (F-) as per standard methods (APHA, 1985). The results were evaluated in accordance with the drinking water quality standards given by the World Health Organization (2004) and Bureau of Indian Standards (2009). The pH was measured with Digital pH Meter (Model 802 Systronics), EC was measured with Conductivity Meter (Model 304 Systronics), Fluoride concentration was measured with Orion ion analyzer with fluoride ion selective electrode.

The concentration of EC is expressed in microsiemens/cm at 25ºC, Nitrate (N^-) and Fluoride(F^-) are expressed in mg /l. Location map of the water sample is shown in the (Fig.1), the analytical results are presented in the (Tables 1), the concentrations are compared with the standards (WHO, 2004. BIS, 2009) and the statistical parameters of the variables such as minimum, maximum, mean, median, standard deviation of different chemical parameters of groundwater are given in Table 2. Distribution maps are generated for Fluoride with the help of GIS software to know the spatial distribution of the concentrations Figure (3).

RESULTS AND DISCUSSION

pH:

The pH of water is a very important indication of its quality and provides important information in many types of geochemical equilibrium or solubility calculation (Hem, 1985). The present investigation area of pH is varying between 6.28to 7.78 with an aver age value is 7.41 respectively. The pH of groundwater in the study area is moderately alkaline (pH more than 7) in nature. Higher alkalinity of groundwater activates leaching of fluoride and thus increases concentration of fluoride ions in groundwater (Wodeyar and Sreenivasan, 1996; Subba Rao, 2003; Jacks et aI., 2005; Kodata et aI., 2007 and Tiwari et aI., 2008). There is no general trend in the pH distribution.

Electrical Conductivity (EC):

Electrical conductivity of the groundwater varies from 167 to 1370 micromhos/ cm at 25^0C (average 653.32 micromhos/ cm). The acceptable limit of EC in drinking water is less than 1500 micromhos/cm (WHO, 2004; BIS, 2009). 4% of samples show concentrations higher than the prescribed limit. Higher concentrations indicate that the ionic concentrations are more in the groundwater. The conductivity measurement provides an indication of ionic concentration. It depends upon temperature, concentration and types of ions present (Hem, 1985). High conductance is attributed to high concentration of salts in groundwater (Davies and Dewiest, 1966). From the (fig. 4) high concentration of salts is observed in southern part of the study area.

Fluoride (F^-):

Fluorosis is a disease caused by excessive fluoride concentration in drinking water. Concentration above 1.0 mg/l give rise to mottling of enamel of teeth a condition known as “dental fluorosis”, still higher amounts in excess of 3.0 mg/l cause abnormalities in bone structure. These symptoms are known as ‘Skeletal fluorosis. Another symptom of fluorosis is ‘Knock Knees’ often observed in high fluoride areas. Fluoride concentration in the groundwater of study area varies from 0 mg/l to 4.54 mg/l with an average of 0.78

After evaluating the data it is suggested that groundwater of some villages Boath, Dhanur buzurg, Dhanur khurd, Mandhaguda and Vagulapalli major is not suitable for drinking purposes. As per the desirable and maximum permissible limit for fluoride in drinking water determined by WHO (2004) or by Bureau of Indian Standards (2009), 35.4% of groundwater shows excess of fluoride prescribed for drinking purpose. Fluoride content is shown in distribution map (Fig. 3). South-western parts seem to be having groundwater with highest fluoride concentration.

However, in plasma, fluoride is transported as ionic fluoride and non-ionic fluoride. Ionic fluoride does not bind to plasma proteins, and is easily excreted with the urine. However, in the form of HF, about 35–45% is reabsorbed and returned to the systemic circulation. pH of tubular fluid and urinary flow are the main factors which influence reabsorption (Whiteford et al. 1976). The amount of urinary fluoride excreted from the body reflects the amount of fluoride ingested. Brouwer et al. (1988) stated that fluoride (F-) is attracted by positively charged calcium ions, due to its strong electronegative charges, in teeth and bones and therefore excessive intake of fluoride cause pathological changes in teeth and bones.

CONCLUSIONS

Hydrogeochemical investigations carried out in the Peddavagu basin, Adilabad District, revealed that the groundwater is alkaline in nature. Nearly 5 % of groundwater of the study area shows concentrations higher than the prescribed limit of 1500 micromhos/cm for drinking purpose. The higher values indicate that ionic concentrations are more in the groundwater. While 35.4% of groundwater shows excess fluoride prescribed for drinking purpose. It is observed that the people living in high fluoride concentration areas are suffering from mottled teeths and also knee joint pains especially in younger people. Moreover, dental and skeletal fluorosis is at alarming stage in local resident of these areas.

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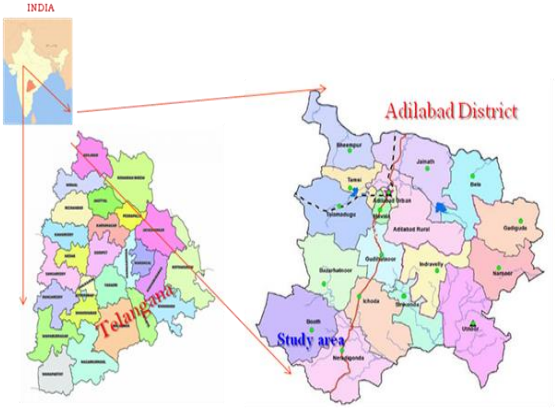
Table 1: Analytical Data of the Groundwater in the Study Area

well no	TDS	F	well no	TDS	F
p1	830	0	p17	320	0.5
p2	650	0.8	p18	292	0.6
p3	333	1.4	p19	520	0.7
p4	910	0.4	p20	339	1
p5	474	0.4	p21	490	4.3
p6	560	0.9	p22	620	2.3
p7	339	1.1	p23	499	0.5
p8	750	1.4	p24	491	0.7
p9	690	0.5	p25	590	2.5
p10	1100	0.9	p26	1180	0.7
p11	580	1.4	p27	610	0.7
p12	560	0.9	p28	488	0.8
p13	680	1.1	p29	395	1.1
p14	1110	1.1	p30	530	0.4
p15	1130	1.1	p31	397	0.6
p16	186	0.8			

Table 2: Groundwater samples of the study area exceeding the permissible limits prescribed by WHO (2004) and BIS (2009) for drinking purpose (in mg/l)

Parameters in mg/l, except pH	Min	Max	Mean	St Dev	WHO value(1984)
pH	6.28	7.78	7.41	277.7	500
TDS	167	1370	653.32	42.2	200
F	0	4.54	0.78	224.4	100



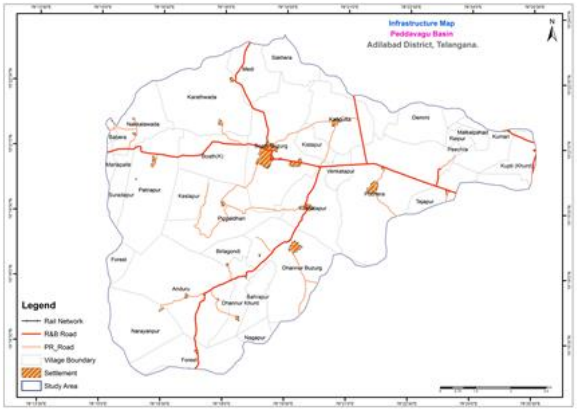


Fig 1. Location Map of the Study Area

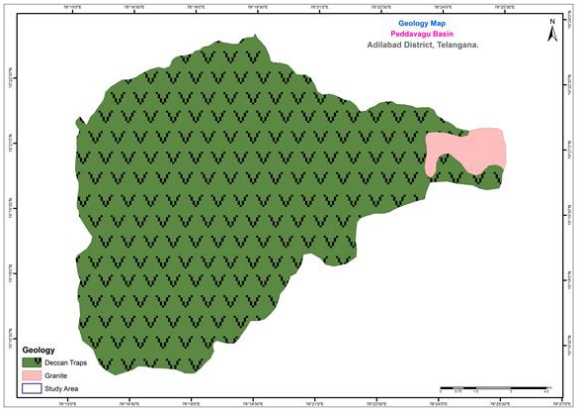


Figure 2: Geological map of the study area

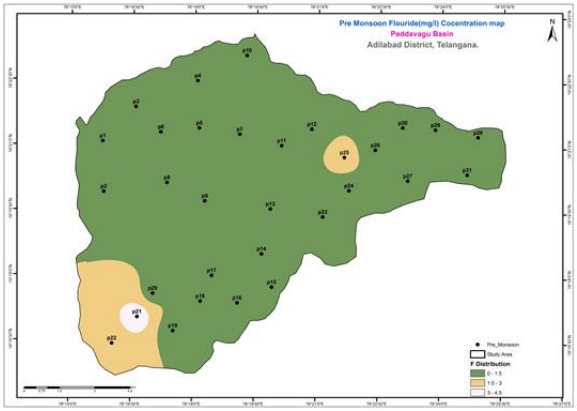


Figure 3: Distribution of Fluoride (F-)

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