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# Fluoride and Nitrate Contamination in the Groundwater of Kalwakurthy Area, Mahabubnagar District, Telangana State, India

KEYWORDS: Groundwater, Contamination, Fluoride, Fluorosis, Nitrate, Kalwakurthy, Mahabubnagar, India.


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**ABSTRACT** *This study was carried out to assess the fluoride and Nitrate concentration in groundwater of Kalwakurthy area, Mahabubnagar District, where groundwater is the main source of drinking water. Water samples collected from bore wells were analyzed for pH, Electrical Conductivity (EC), Nitrate (NO3-) and Fluoride (F-) content. Fluoride concentration of groundwater ranges from 0.16 to 3.4 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), 46% 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 study revealed that 43% of the samples were found to be unsuitable for drinking purposes due to excess nitrate (>45 mg/l) content in the groundwater. High Nitrate concentration may cause blue baby syndrome or methemoglobinemia.*

## INTRODUCTION

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 17$^{th}$ 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).

Nitrogen, an element considered to be the most abundant in the atmosphere, composing nearly 80% (Berner,1987), can be found in many forms, the major ones being $N_2$, $N_2O$, NO, $NO_2$, $NH_3$[2]. Nitrate is part of the nitrogen cycle in nature and it represents the most oxidized chemical form of nitrogen found in the natural systems. All living systems need nitrogen for their existence since it is used to build many essential components such as proteins, DNA, RNA, vitamins, and as well as hormones and enzymes. Nitrates, though very essential for the very existence of life, is also one of the most widespread pollutants of groundwater in many parts of the world and in several instances this is due to the intensification of agriculture (Goldberg, 1989).

### Location of the Study Area

The study area, covering about 237 sq.km, falls in Mahabubnagar district of Andhra Pradesh, India. It is located 80 km from Hyderabad. Kalwakurthy lies in between North Latitudes 16° 34′ 30″ to 16° 42′ 00″ and East longitudes 78° 24′ 00″ to 78° 28′ 48″ (figure 1) and falls in the Toposheet No. 56 L/6 and 56 L/10. The climate of the study area is generally hot. Average Temperature in summer is 40.9$^0$C, in winter is 25$^0$C and rainfall is 604 mm.

### Geology

The study area forms a part of the stable Dharwar craton of south Indian shield. Grey granite occupies dominant portion of the area (Fig.1) these rocks are composed of quartz, feldspars, and biotite. These are medium to course grained and equigranular in texture. The typical grey colour is due to the presence of the plagioclase feldspars and quartz. The potash feldspars that are present in the rock are orthoclase and microcline but in less abundance. Biotite is the most predominant mineral in these rocks. (Geological Survey of India, G. S. I, 1995).

### Materials and Methods:

In order to assess the groundwater quality, 56 groundwater samples have been collected from hand-pumps, bore wells, open wells in Kalwakurthy area, Mahabubnagar District. 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), Nitrate was determined by spectrophotometer and Fluoride concentration was measured with Orion ion analyzer with fluoride ion selective electrode. The concentrations are compared with the standards (WHO, 2004; BIS, 2009) and the statistical

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parameters of the variables such as minimum, maximum mean of different chemical parameters of groundwater are given in Table 1.

## 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 7.42 to 8.8 with an average value is 8.04 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). There is no general trend in the pH distribution (Fig. 3).

### Electrical Conductivity (EC):

Electrical conductivity of the groundwater varies from 78.44 to 1568.8 micromhos/ cm at 25$^0$C (average 402.86 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.

### Nitrate ($NO_3^-$):

Nitrate concentration in the groundwater of the area varies from 1.1 mg/l to 112 mg/l. Average $NO_3^-$ concentration in the groundwater is 57.35mg/l. Acceptable limit of $NO_3^-$ content in drinking water is 45 mg/l (WHO, 2004; BIS, 2009). While 43% of the groundwater from the study area exceeds the permissible limit. North-central part of the area has highest nitrate concentration in the groundwater (Fig. 5). It is observed that the concentration of nitrate in the groundwater is high in the study area, which is attributed to the migration of nitrates from different anthropogenic sources during rainy season. The reason for high concentration of nitrate in groundwater is attributed to anthropogenic activities like the use of synthetic N-fertilizers like urea, calcium ammonium nitrate, ammonium phosphate, ammonium sulphate is on the increase in the agricultural sector, which is the major source for nitrates in the groundwater.

### 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 0.16 mg/l to 3.4 mg/l with an average of 1.86.

After evaluating the data it is suggested that groundwater of some villages namely Panjagul Thanda (3.4 mg/l), Sub Station Kalwakurthy (2.56 mg/l), Rachalapally (2.52 mg/l),Ram Nagar tanda(1.7 mg/l), Elikal Thanda(1.7 mg/l), Sanjapuram(1.81 mg/l), Kurimidda Thanda (1.83 mg/l), 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), 45% of groundwater shows excess of fluoride prescribed for drinking purpose. Fluoride content is shown in distribution map (Fig. 5). North-western parts seem to be having groundwater with highest fluoride concentration. 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.

### Conclusions:

Hydrogeochemical investigations carried out in the Kalwakurthy, area of Mahabubnagar 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. Nitrate concentration in the groundwater of the area varies from 1.1mg/l to 112 mg/l, while 43% of the groundwater contains more than 45 mg/l of nitrate which is the prescribed limit for drinking purpose and is attributed to the migration of nitrates from anthropogenic sources during rainy season. While 46% 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.

### Acknowledgements:

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**Table 1: Groundwater samples of the study area exceeding the permissible limits prescribed by WHO (2004) and BIS (2009) for drinking purpose (in mg/l)**

| Parameter | Min. | Max. | Mean | Median | Std. Dev | Acceptable Limit WHO(2004) BIS (2009) | %of samples exceeding the limit |
|---|---|---|---|---|---|---|---|
| pH | 7.42 | 8.8 | 8.04 | 8.1 | 0.29 | 6.5-8.5 | 5 |
| EC | 78.44 | 1568.8 | 387.88 | 314 | 272.86 | 1500 | 4 |
| $NO_3^-$ | 1.1 | 112 | 39.63 | 28 | 31.84 | 45 | 43 |
| $F^-$ | 0.17 | 3.4 | 1.13 | 0.94 | 0.66 | 1.0 | 45 |

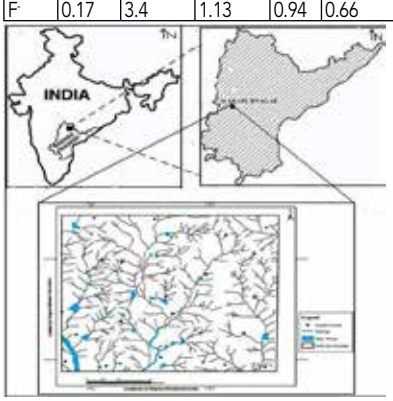


**Fig.1. Location Map of the Study Area with Water Sample Points, Drainage and Tanks.**

Volume : 5 | Issue : 1 | Jan 2015 | ISSN - 2249-555X

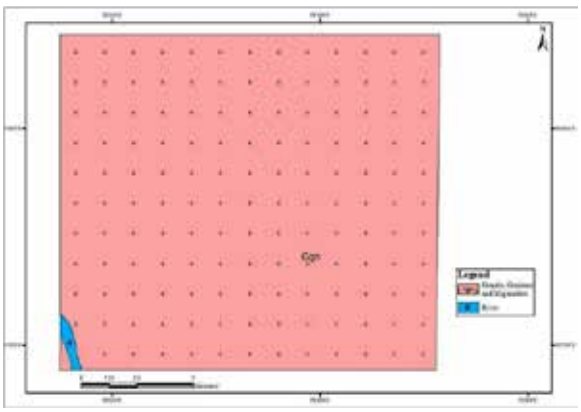

Fig. 2. Geological Map of the Study Area

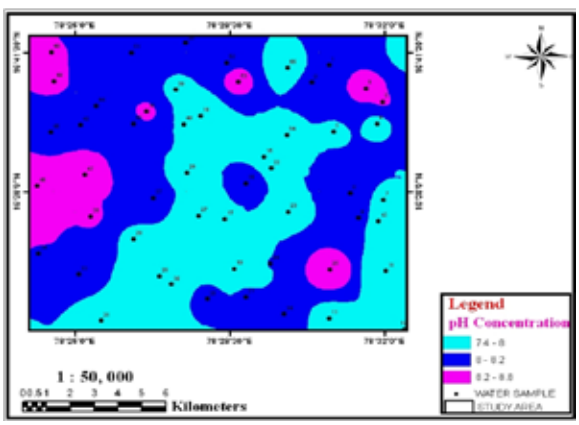


Figure 3: Concentration of pH

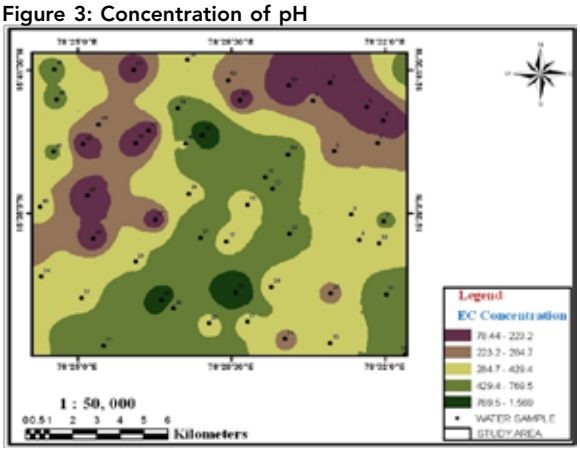


Figure 4: Concentration of Electrical Conductivity (EC)

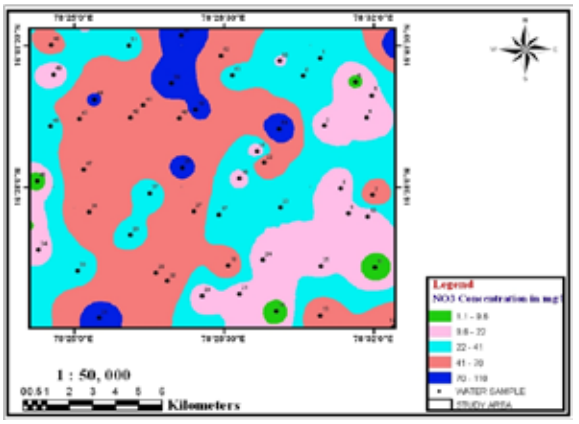


Figure 5: Concentration of Nitrate (NO3-)

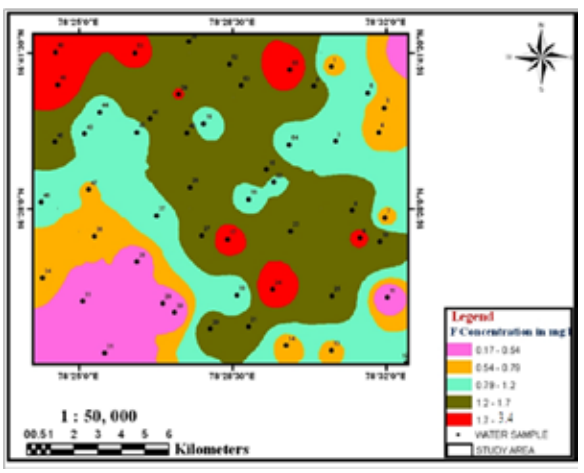


Figure 6: Concentration of Fluoride (F-)

**REFERENCE**

American Public Health Association (APHA), Standard methods for Examination of water and | wastewater. Sixteenth edition, A.P.H.A Washington (1995). | | Berner E., and Berner R., The global water cycle (pp. 102–119). New Jersey: Prentice Hall | (1987). | Chouhan, S. & Flora, S. J. S. (2010). Arsenic and Fluoride: Two Major Groundwater Pollutants, Indian J Experimental Biology, 48:666-678. | | Davis A, Kempton JH, Nicholson A (1994) Groundwater transport of arsenic and chromium at a historical tannery, Woburn, Massachusetts, USA. Appl. Geochem 9:569–582. | Gupta, S., S. Banerjee, R. Saha, J.K. Datta and N. Mondal, 2006. Fluoride geochemistry of groundwater in Birbhum, West Bengal, India. Fluoride, 39: pp 318– 320. | | Geological Survey of India., Geology and minerals map of Mahabubnagar district, Andhra | Pradesh, India (1995). | | Goldberg V. M., Groundwater pollution by nitrates from livestock wastes. Environ Health | Perspect, 83, 25– 29 (1989). | | Hem, John D, (1985) Study and interpretation of the chemical characters of natural water USGS water supply paper 2254, pp. 117-120. | | Meenakshi, V.K. Garg, Kavita, Renuka, and Anju Malik, 2004. Groundwater quality in some villages of Haryana, India: focus on fluoride and fluorosis. Jour. Hazard. Mater, 106B: pp 85–97. | | WHO (2004) Guidelines to drinking water quality. World Health Organization, Geneva | | Wodeyar, B.K. and Sreenivasan, G., (1996). Occurrence of fluoride in the groundwater and its impact in Peddavankahalla Basin, Bellary District, Karnataka, India-A preliminary study. Current Science, v. 70, pp. 71-74. |