GROUNDWATER QUALITY ANALYSIS OF HUNGUNDTALUK WITH EMPHASIS ON FLUORIDE

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Abstract

The uncertainty associated with the availability of surface water both in terms of quantity and quality made people to depend on ground water. But in recent years, depletion of water table and mineral contamination like Fluoride are the causes of concern. Some previous studies show people affected with symptoms of Fluoride contamination in Hungund area. Hence to analyze the fluoride content and other co-relating parameters we selected some bore wells in Amingad and Kamatgi of Hungundtaluk, Bagalkot district of Karnataka.

Our study mainly comprises of determining the mineral parameters present in groundwater with emphasis on fluoride. The water samples from the bore wells of above two places are collected and parameters like Total Hardness, Fluoride, Alkalinity, Acidity, pH, Conductivity, Chloride and Sulphates are analyzed in the laboratory. The obtained fluoride concentration is correlated with other parameters.Along with the parameters, the geological strata surrounding the selected bore well is identified and correlated with fluoride concentration. The fluoride concentration is high (1.58 –11.6 mg/L) in 18 out of 29 groundwater samples analysed. The regression equations were developed by taking Fluoride as dependent variable and other water quality parameters as independent variables. Compared to other parameters total hardness and chloride indicate stronger relation

Keywords: *Fluoride, Fluorosis, pH, dissociation of fluoride, geological strata.*

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1. INTRODUCTION

Air, water and food are the three basic needs for the survival of human beings. It is also very important that the drinking water should be safe and potable. The Government of India, during the International Drinking Water Supply and Sanitation Decade, (1981 -1990),has undertaken to supply safe drinking water for the country's urban and rural population. It is reported that approximately three out of five persons in the developing countries do not have access to safe drinking water. The urban areas are better served. In rural areas 75 per cent of the population having some form of water supply through house connections or stand pipes while only 29 per cent have equivalent water supply.[WHO,1981]Many municipal water supplies are derived solely from groundwater.

2. FLUORIDE

Fluoride is recognized as the thirteenth most common element in the earth's crust. The emissions of volcanoes, marine aerosols, weathering and dissolution of rock minerals release naturally fluorides in the environment. It was found that in sea water fluoride concentration of around 1.2-1.4 mg/L, in ground water it can be up to 67mg/L in some cases and in most surface waters it will be less than 0.1mg/L. (Malik et al., 2010)

In India, fluoride commonly occurs in earth's crust as fluorspar (CaF_2), appetite and rock phosphate and phosphorites. Fluoride occurs significantly in rocks, soils, plants, crops, drugs and industrial processes etc.(Tirumalesh et al., 2005) A large group of minerals containing minor fluorine was made up of the fluorocarbonates, fluorosulphates, fluorophosphates, fluoroarsenate sand fluorocolumbates. Mineral soils also contain fluoride in it. (Rao, 2003)(Abu Rukah and Alksokhny, 2004)

Fluorine (F_2 or F-F) is element #9 in the Periodic Table. It is first element of halogen group with molecular weight 19 and atomic number 9. Fluoride ion has one negative charge which must be accompanied by cations such as sodium (Na^+), as in sodium fluoride (Na^+F^- or NaF). (Kauffman,, 2005)When a fluoride compound is dissolved in water, the element fluorine will be present mainly as fluoride ions. However, depending on the ionic concentrations and pH of the solutions the fluoride is present in solution as HF_2 and un-dissociated HF. Now if it is assumed that the calcium fluoride is representative of the natural fluorides while sodium fluoride that of artificial fluoride, these compounds dissolve in water under the equivalent conditions such that they ionize into as shown in the following equations.(PAtil and Ingole, 2012)(Kauffman,, 2005)

Table 1 Dissociation of fluoride

Calcium fluoride	Sodium fluoride:
$CaF_2 \rightarrow Ca^{++} + 2F^-$	$NaF \rightarrow Na+ + F-$
$F^- + \rightarrow HF$	$F- + H+ \rightarrow HF$
$H + F^+ \rightarrow HF_2$	$HF + F- \rightarrow HF2$

In both these instances, fluoride is yielded as F^-, HF_2 and HF and these will be chemically and physiologically identical with their equivalents irrespective of the two compounds they are delivered from(Patil and Ingole, 2012). The fluoride content is a function of many factors such as availability and solubility of parent fluoride minerals with which this groundwater comes in contact.(Kauffman,, 2005)

Fluoride when consumed in excess (more than 1ppm) can cause several health problems. Fluorosis - a disease caused by ingestion of fluoride in excess through water, food, and air and is a serious health problem. It affects young and old alike. An individual may suffer from Skeletal, Dental and Non-skeletal fluorosis. There will be muscle weakness, stiffness, pain in the muscle and loss of muscle power. It may also cause skin allergies, gastrointestinal problems.(RamGopal and Ghosh, 1985)

3. STUDY AREA

The study area selected shown in Fig.1, is Hungundtaluk, lies in Bagalkot district of Karnataka. The district is drained by the river Krishna and its tributaries Ghataprabha and Malaprabha. All these rivers enter district on the western side and flow in an easterly direction to join the Bay of Bengal. Rainfall as low as 318 mm annually. Canals are the lifelines, providing much needed irrigation and drinking water to the district.The soil found in the area is usually black or red and the soil is very fertile.The HungundTaluk has30 panchayat villages. (Kugali and Yadave 2010)(Varadarajan and Purandara, 2008)

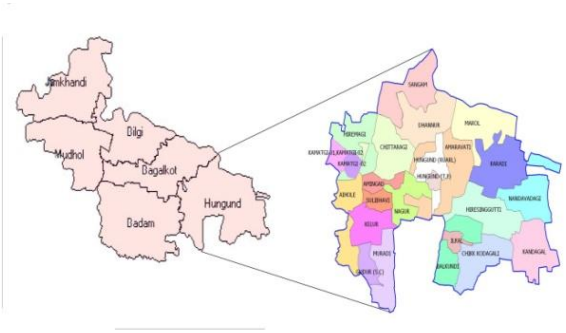

Fig 1 Map of study area

Groundwater quality in Hungundtaluk was studied with special reference to the presence of fluoride(Kalshetty et al., 2013). High fluoride concentrations were found in this area. Hence two villages namely, Kamatagi and Amingad of Hungundtalukwere considered for detail study. Amingadhas a population of about 13593 having 16.0619° north latitude 76.0603° east longitude and Kamatgihas a population of about 14380 having 16.1190° north latitude 75.8482° east longitude. Both the villages are located at an altitude of 530m above sea level. The main occupation is agriculture.Sugarcane, bajra, corn and toor dal cultivated in more quantity and consumption of these is also high.Hungundtaluk is largely covered by alkali granite and meta-sediments with volcanic sequence which contain more fluoride and it increases the fluoride content in the groundwater of area of Hungundtaluk. In study area sugarcane, bajra, corn and toor dal cultivated in more quantity and consumption of these is also high.

4. METHODOLOGY

Some bore wells and open well points were identified in the study area. Samples were collected from these wells and water test analysis was carried out for finding out the concentration of Hardness, Fluoride, Calcium, Magnesium, Acidity, Alkalinity, Chloride and Sulphate. The geological strata and other parameters are correlated with fluoride concentration.

Table 2 Analysis methods used

Sl.No	Parameter	Instrument	Method
1	Total Hardness	Titration	EDTA
2	Calcium & Magnesium	Titration	EDTA
3	Fluoride	Ion Meter	Ion-Electrode
4	Chloride	Titration	Volumetric
5	Acidity	Titration	Volumetric
6	Alkalinity	Titration	Volumetric
7	Conductivity	Cyber Scan Conductivity Meter	
8	pH	Cyber Scan pH Meter	Electrode
9	Sulphate	Nephlometer	Nephlometeric
10	Potassium	Flame Photometer	
11	Sodium	Flame Photometer	

5. RESULTS AND ANALYSIS

The obtained results are depicted in

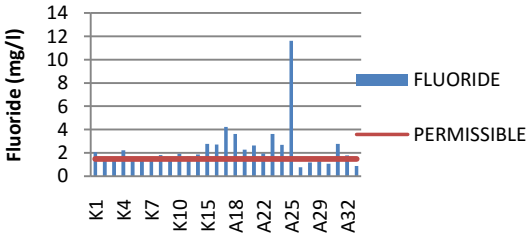

Fig 2 Fluoride concentration in wells

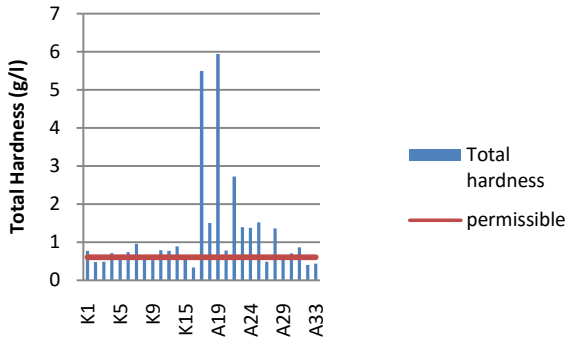

Fig 3 Total Hardness concentration in wells

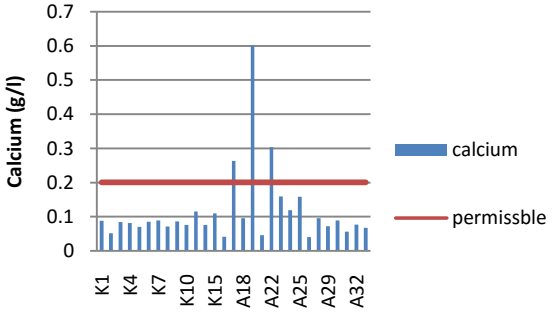

Fig 4 Calcium concentration in wells

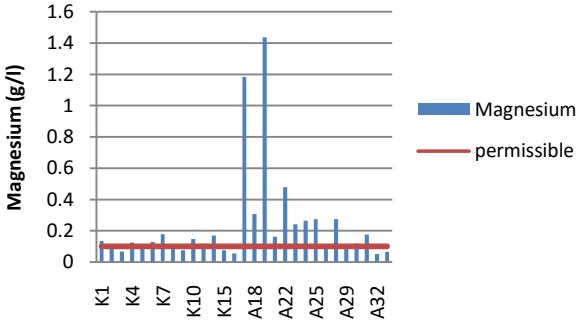

Fig 5 Magnesium concentration in wells

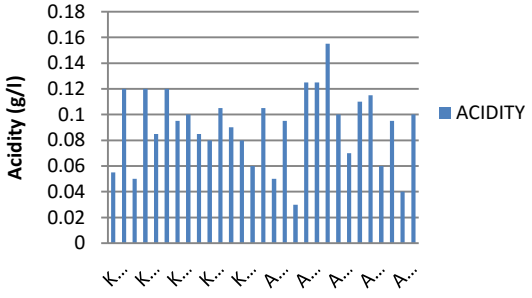

Fig 6 Acidity obtained in the samples

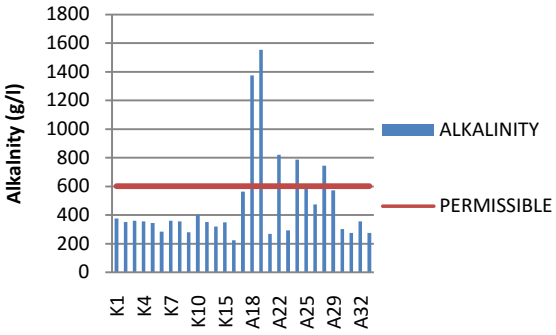

Fig 7 Alkalinity obtained in the samples

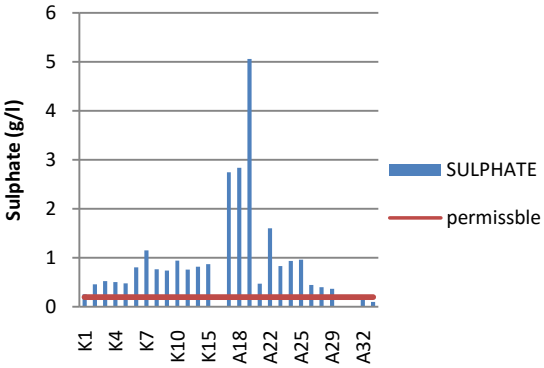

Fig 8 Sulphate obtained in the samples

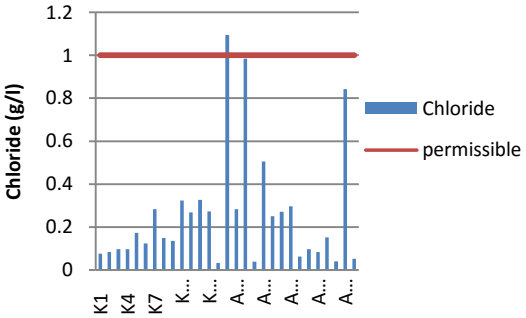

Fig9 Chloride obtained in the samples

Figures 2 to 9 represent the concentration of Fluoride, Total Hardness, Calcium Magnesium, Acidity, Alkalinity, Sulphate and Chloride respectively in the groundwater samples collected. Total 29 samples were collected and out of them 18 samples are above permissible limits in fluoride concentration and total hardness. 3 samples are above permissible limit in calcium concentration. 16 samples are above permissible limit in magnesium concentration. 5 samples are above permissible limit in alkalinity concentration. 23 samples are above permissible limit in sulphate concentration. Other parameters are within range as per Indian standards for drinking water quality.

The regression equations were developed by taking Fluoride as dependent variable and other water quality parameters as independent variables. The higher R^2 values indicate better performance of the relationship and suitability in predicting the dependent variable. (Navneet Kumar, 2011)

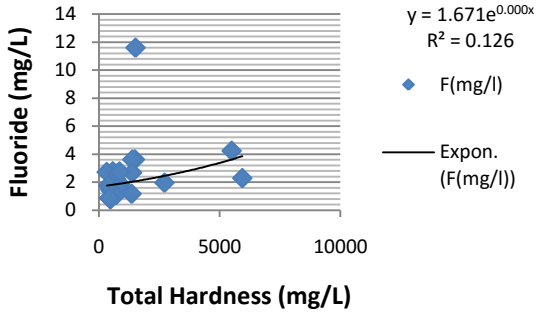

Fig 10 Correlation of Fluoride v/s Hardness

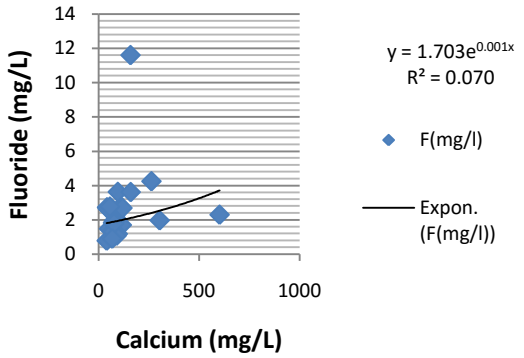

Fig 11 Correlation of Fluoride v/s Calcium

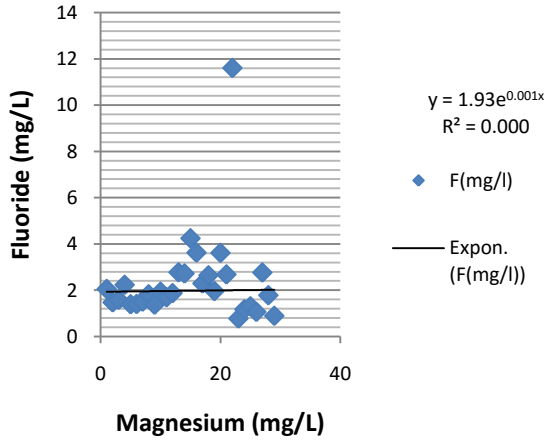

Fig 12. CCorrelation of Fluoride and Magnesium

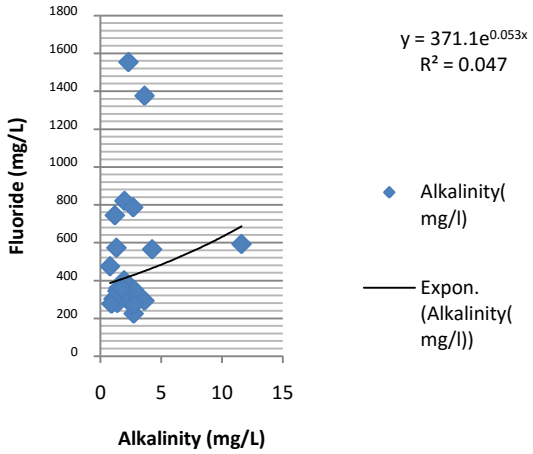

Fig 13 Correlation of Fluoride and Alkalinity

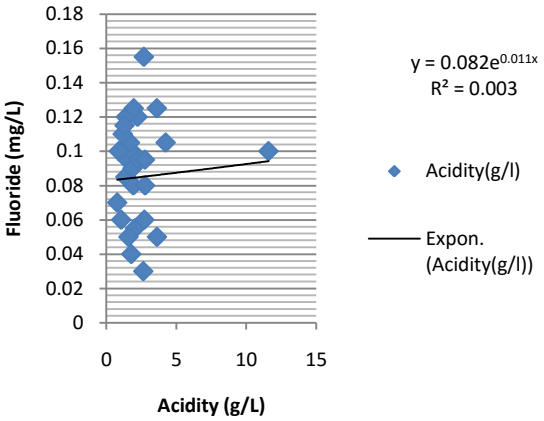

Fig 14 Correlation of Fluoride v/s Acidity

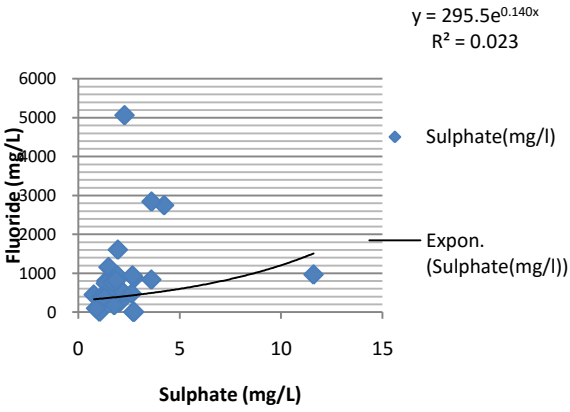

Fig 15. Correlation of Fluoride and Sulphate

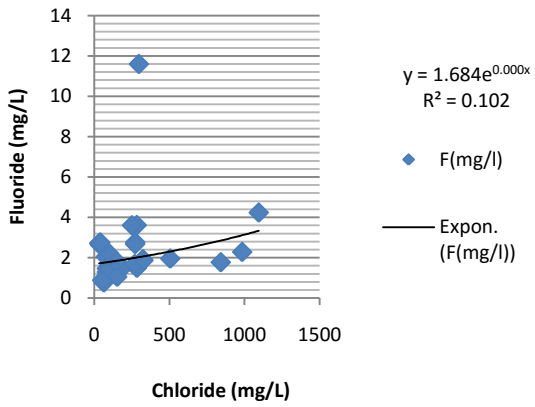

Fig 16. Correlation of Fluoride and Chloride

The Figures 10-16 represent the correlation of Fluoride with Total Hardness, Calcium Magnesium, Acidity, Alkalinity, Sulphate and Chloride respectively. The Fluoride tends to depend more on Hardness, and Chloride compared to any other minerals Analytical analysis of the data was carried out. It was found that about 6.89% of the samples have Fluoride concentrations less than 1 mg/l, 27.6% have concentrations in the range of 1.0-1.50 mg/l, 51.72% have concentrations in the range of 1.50-3.0 mg/l and 13.79% of the samples have concentrations more than 3 mg/l. The minimum and maximum concentrations observed were 0.774 mg/l and 11.6 mg/l respectively.

6. CONCLUSION

The fluoride concentration is high in most of the groundwater samples (18 out of 29 samples) and which ranges from 1.58 – 11.6 mg/L. These values are above permissible limits as prescribed by various standards. So consumption of drinking water from these bore wells lead to various health problems.

During interaction, people of the study area were affected from pain in joints, neck, hip and backbone. This clearly indicates the prevalence of skeletal fluorosis.

Fluoride content of groundwater in the granitic aquifers is mainly due to rock-water interaction. Through weathering of the primary minerals in rocks, fluoride is released into the soil and groundwater, i.e., leaching of fluoride containing minerals will yield fluoride in solution (JanardhanaRaju et al.,2012). As the geological formation of our study area is granite gneiss, it can be concluded that the main cause for the fluoride concentration in our study area is due to the geological formation.

Fluoride bearing water are usually high in the alkalinity (SumaLatha et al., 1999). The ground water samples with high fluoride content are alkaline in nature (7.5-8.4). The alkalinity plays an important part in the mineralisation process (SumaLatha et al., 1999)(Shashishekhar et al., 2006), thus influencing the fluoride concentration.

The regression equations were developed by taking Fluoride as dependent variable and other water quality parameters as independent variables. The higher R^2 values indicate dependency of Fluoride on hardness of water. Compared to other parameters total hardness and chloride indicate stronger relation.

Awareness needs to be created in the villagers regarding the ill effects of fluoride content. The water sources with higher fluoride content should be treated and used.

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