

EVALUATING FLUORIDE CONTAMINATION IN GROUND WATER OF DHARMAPURI DISTRICT IN TAMILNADU

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ABSTRACT

Water is the one of the most precious resource in the earth. In that groundwater is the major resource of fresh water to all living organism. Most of the rural and urban population uses groundwater for domestic purposes. The people living in rural areas are more exposed since there is no centrally supplied treated water in these areas. Instead, groundwater accessed through dugwells, is their only water supply. Many people are not at all aware of the water borne diseases affecting their health due to high concentration of fluoride in drinking water which causes dental and skeletal fluorosis to humans, Based on (WHO, 2008) Standard Fluoride beyond desirable amounts (0.6 to 1.5 mg/l) in groundwater causes serious health hazards to humans and irreversible damage to plants. This study provide an overview of the fluoride content in drinking water and the extent of human exposure to different level of fluoride contamination in the blocks of Dharmapuri district, Tamilnadu. Most of people in this area suffer from dental & skeletal flurosis such as mottling of teeth, osteosclerosis of pelvis and vertebral column, chronic joint pain.

Keywords: Fluoride Concentration, Groundwater Quality, Physico-Chemical Parameters, Dharmapuri district, GIS Spatial Mapping.

INTRODUCTION

Water is one the most important natural assets and plays a vital role for all living organisms and plants to survive in this world. Safe drinking water is the primary need of every human being. Fresh water has become a scarce commodity due to over exploitation and pollution of water. Major contribution of water is derived from the ground water resources and in many areas groundwater is the only fresh source available and hence protection of the ground water quality has become a critical component for welfare of humankind. There is a necessity of water for purposes like drinking; irrigation for crops and other purposes and therefore extraction of ground water becomes a mandate for policy planners in water budget planning.

The main source of fluoride in ground water is fluoride-bearing rocks, possessing rock bearing minerals that contribute to toxicity of domestic water. Also the content in ground water is a function of many factors such as availability and solubility of fluoride minerals, velocity of flowing water, pH, and temperature, concentrations of calcium and bicarbonate ions in water. Among the water quality parameters, fluoride ion exhibits unique properties as its concentration in optimum dose in drinking water is advantageous to health and if the concentration exceeds the limit, this affects the health (Saravanan et al, 2008). High fluoride concentration in the ground water and surface water in many parts of the world is a cause of great concern. It has been observed that there is a relationship between Calcium, Sodium and Fluoride (Dibal, and Lar, 2005).

The higher the fluoride level, the lower is that of Calcium. This may be as a result of the substitution of Na by Ca during the circulation of water in an aquifer or through carbonate precipitation. However, it is known that fluorites of these ions have low solubility (Smedley et al., 2002; Hounslow, 1995; Hem, 1991). The positive correlation of Ca²⁺ with fluoride explicitly suggests that water hardness increases with depth, affirming the percolation of underground water through a medium rich in Ca. High fluoride in drinking water was reported from different geographical regions of Dharmapuri. WHO, 2008 and BIS, 1991 has set a range of allowable concentration for fluoride in drinking water for a region depending on its climatic conditions, because the amount of water consumed and consequently the amount of fluoride ingested is being influenced primarily by the air temperature. Dharmapuri district in Tamil Nadu. India is one such region where high concentration of fluoride is present in groundwater. Since there are no major studies in the recent past, the present study was carried out to understand the present status of groundwater quality in Dharmapuri district in Tamil Nadu and also to assess the possible causes for high concentration of fluoride in groundwater. Geological mapping in parts of Pappiredditipatti, Dharmapuri, Pennagram Block in district of Dharmapuri to identify lithological units responsible for fluoride concentration.

Table 1. Fluoride Status in India

Region/State	Range of F ⁻ Concentration (mg/l)	Severity of Fluorosis
North-west India	0.4-19	Sever
Central India	0.2-10	Moderate
South Indiaaa	0.2-20	Sever
Deccan Province	0.4-8	Moderate

MATERIALS AND METHOD

Study Area:The study area forms a part of Dharmapuri Taluks, Tamilnadu. Dharmapuri is situated 12.12° N 78.26° E, which is bounded by Tiruvannamalai and Villupuram Districts on the east, Salem District on the South, Krishnagiri District on the north and Kaveri river on the west.. The famous Hogenakkal water falls is in Dharmapuri district. The district also has one of the best quality marble stone reserves in the world. The sub basin area is bounded by Palakodu, Pennagaram, Dharmapuri, Pappireddipatti, Taluks.Dharmapuri district goes through a hot climate during the summer (March-May) with a temperatuereupto 36°C and in winter it varies between 16°C - 12°C. The district has an average annual rainfall of about 895.56 mm.

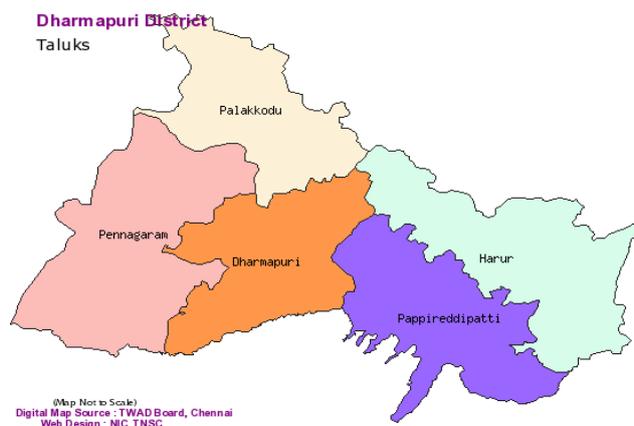


Figure.1.Blocks of Dharmapuri District

Geomorphology: Dharmapuri district forms part of the upland plateau region of Tamil Nadu with many hill ranges and undulating plains. The western part of the district between Pennagaram and Denkanikottai has hill ranges of Mysore Plateau with a chain of undulating hills. The southern boundary of the district is occupied by the Shevaroy hill ranges. The plains occupying the central, eastern and southern parts of the district have an average elevation of 488 m. above Mean Sea Level. The Plateau region along the western boundary and the northwestern part of the district has an average elevation of 914 m. above Mean Sea Level.

Hydrogeology: The district is underlain by Archaean Crystalline formations with recent alluvial deposits of limited areal and vertical extents along major rivers. (Plate-II). The important aquifer systems in the district are constituted by i) unconsolidated & semi consolidated formations and (ii) weathered and fractured crystalline rocks. In the areas underlain by crystalline rocks, occurrence of ground water is essentially limited to zone of weathering and fracturing. Generally the hard rock aquifers are heterogeneous in nature, which is indicated by the variations in lithology, structure and texture. Ground water occurs under phreatic condition in the weathered mantle and semi confined to confined condition in the fracture and fissured zones of these rocks. Thickness of weathered material varied widely from less than 1m bgl to more than 20m bgl.

Preparatory work and collection of information:The preparatory work started at Dharnapuri by literature studies, concerning contaminated groundwater, the chemistry of fluoride in water and geology with fluoride bearing minerals. The work included searching background information about geology, soil type and land use, and also looking for information about previous test results and finding maps over the study areas started at Dharmapuri district.. It was continued with TWAD where more information was available, but since the information gathering is an extensive task, it continued all through the project.

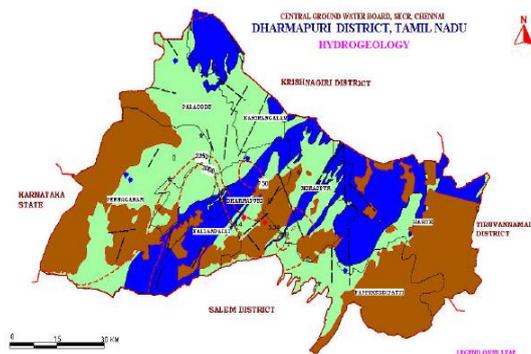


Figure.2. Hydrogeology of Dharmapuri district

METHODOLOGY

Fluoride contamination Where evaluated using two type of method. They are the following

Analysis Method

- i. Survey analysis
- ii. Ground water sample analysis
- Mapping Method (Through GIS)

Survey analysis: Sample survey sheet was framed based on few journals as reference, the same sheet was checked for the data collections with the Department of Statistics, corrected sheet was used for survey . The Survey analysis which is collected in the study area is used to collect the details of people who are affected by Dental fluorosis, Skelton mottling and also its severity in various region of Dharmapuri district. A sample survey Sheet is listed in Fig.3

QUESTIONNAIRE
Title of the Project :
Evaluating Potential Fluoride Contamination in Groundwater And it's Effect on Human Health in some Taluk of Dharamapuri District in Tamil Nadu

Question		Answer			
1. Location:					
2. Name of the Person Age Survey no					
3. Land	Wet (in a cres)	<5	<10	<15	>15
	Dry (in acres)	<5	<10	<15	>15
4. Source of drinking water (a) Tube well (b) Open well					
5. Taste of Water (a) Sweet others (b) Good (c) Fairly Moderate (d) saline					
6. Depth					
7. How long are you using the drinking water source		5 years > 5 years			
8. Past History in the family					
9. Is there any symptoms of		(a) Dental fulorosis - (b) Skeleton mottling -			
10. Who is more affected by the diesase		(a) Children (b) Middle Age (c) Old Age			
11. Need for immediate care and Referral (a) Life-threatening condition (b) Pain or Infection (c) Other Condition (Specify)					
Notes					

Figure.3. Sample Survey Sheet

Collection & Sampling Technique: Water samples were collected in clean Jerri Can bottles of 2 Liters capacity. The sampling bottles were soaked in 1:1 diluted HCl solution for 24 h, washed with distilled water, and were

washed again prior to each sampling with the filtrates of the sample. In the case of bore wells, water samples were collected after pumping the water for 10 min. In the case of open wells, water samples were collected 30 cm below the water level. The sample bottle are closed tightly and labeled. The samples were preserved, cooled and protected from breakage while transporting the bottles to the laboratory. Within 24 hrs the sample is shifted to the Lab for analysis. Fluoride was analyzed using a MERCK SQ118 Photometer. When using this instrument, the sample was firstly mixed with the F1 Reagent and then with the F2 Reagent. The reaction time was approximately five minutes during which the sample turns a bluish-purple color, and it is then poured in to a glass cuvette which is inserted in the Photometer. A light beam passes through the sample and a certain amount of light is absorbed. The absorbed light is proportional to the concentration of fluoride in the sample, which is shown on the display.

RESULTS AND DISCUSSION

The minimum, maximum, mean, and other statistical parameters of groundwater level, pH, fluoride and other hydro-geochemistry of the ground water samples concentration measured during this study is given in Table 2.

Table.2. Summarized hydro-geochemistry of the ground water sample of Dharmapuri Blocks

Parameters	Minimum	Maximum	Mean	SD
pH	7.00	8.21	7.54	0.40
Alkalinity	272.00	612.00	422.93	98.66
Total Hardness as CaCO₃	260.00	680.00	423.60	116.52
Calcium	64.00	168.00	96.67	31.31
Magnesium	24.00	62.00	43.67	10.49
Sodium	64.00	460.00	225.47	125.94
Potassium	4.00	30.00	20.07	10.64
Iron	0.18	0.48	0.30	0.09
Manganese	ND	ND	0.00	0.00
Free Ammonia	0.01	0.10	0.04	0.02
Nitrite (as NO₂)	0.00	2.92	0.24	0.74
Chloride	49.00	544.00	240.00	163.31
Fluoride	0.89	2.10	1.50	0.37
Sulphate	36.00	292.00	152.07	95.87
Phosphate	0.05	1.82	0.31	0.48

The groundwater quality of the Dharmapuri district is evaluated by comparing the range of the value of different geochemical parameter with the drinking water standard both Indian standard and Who standard. Physico-chemical properties of the analysed water sample show concentration variation in the water quality with respect to their chemical composition. The logarithm of the reciprocal of the hydrogen ion concentration (pH) in the water sample varies from 7.00 (Annamalaihalli) to 8.21 (Indur) with a mean value of 7.54. The entire sample is within the recommended limits for consumption. The concentration of Calcium (Ca²⁺) ion concentration in the region shows wide variation from a minimum of 64 mg/l to as high as 164 mg/l. However all the sample are within the maximum permissible limit according to the Indian Standard. The magnesium (Mg²⁺) concentration varies from 24 mg/l to 62 mg/l. This magnesium is coming under the permissible limit of the standards. Sodium (Na⁺) recorded value varies from 64mg/l to 460 mg/l which shows a very high concentration above the permissible limit. The Chloride concentration (Cl⁻) concentration ranges from 49 mg/l to 544 mg/l, while sulphate SO₄²⁻ ranges from 36 mg/l to 292 mg/l, both Cl⁻ and SO₄²⁻ are within the recommended limit. The fluoride concentration shows variation from minimum of 0.89 mg/l to 2.10 mg/l which exceed the permissible level for drinking water which results in causing severe Fluorosis problem to human being mostly Karimangalam, Palakkodu region where affected more by fluoride concentration.

The hydro-geochemistry of the ground water sample of 15 village was compared with the values of Indian Standard. This information was also verified with Socio-Economic survey and Observed that fluoride fluctuation was seen in that many village which is exceeding the permissible limit and hence the people in Dharmapuri district found affected by fluorosis more towards dental mottling. The comparison of the Adagapadi Ground water Sample with Indian Standard for drinking water is shown in the Fig 4.

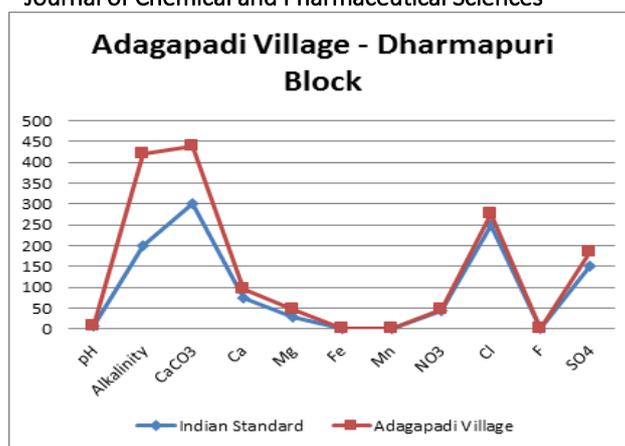


Fig 4. Adagapadi Ground water Sample vs Indian Standard for drinking water

Spatial distribution of geochemical parameters: The spatial distribution of F⁻ and some important geochemical parameters (pH, Na⁺, Ca⁺, Mg⁺, HCO₃⁻, SiO₂) where mapped Fig 5 (a) & (b).

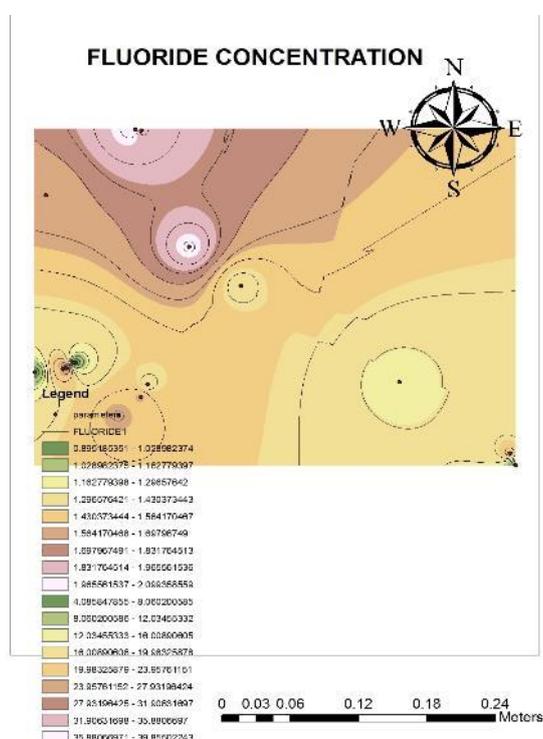




Fig.6.Skeleton mottling

Dental Fluorosis: However, dental mottling could be considered as the alarming signal of impending skeletal deformities with continued exposure to fluoride. Most of the people who exhibited symptoms of fluorosis had been residing in the village from their childhood. Similarly, children who exhibited dental fluorosis were born in the village. Dental fluorosis, in this region where characterized by discolored, blackened, mottled or chalky-white teeth, is a clear indication of overexposure to fluoride during childhood when the teeth were developing. This effects where more severe with the adult above age of 35. Showing fully mottled teeth's (Bano et al., 1987).



Fig.7.Dental Fluorosis

CONCLUSION

The Block like Kariyamangalam, Morappur need to be look or higher concentration of fluoride and related disease, where as Dharmapuri and Pappireddy for lower concentration of fluoride and related diseases. The efforts by organization like UNICEF for demarcating safe and unsafe sources of potable water in the region would provide awareness to masses towards ill effects of using water with fluoride concentration beyond permissible limits. The signs and symptoms exhibited by the villagers indicate clearly that they are suffering from skeletal/dental fluorosis. Hence this paper is done for creating awareness about the fluoride contamination severity in Dharmapuri district and also helps to get the Hogenakkal drinking water Supply which is done through JUNNRM funding to this region at the earliest by the government of Tamilnadu. Geographic Information System (GIS) approach to develop spatial information and knowledge based on the ground water quality of the Blocks of Dharmapuri has been found to be very useful .The Mapping also helps in decision-making process by identifying the most sensitive zones that need immediate attention.

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