

Fluoride Contamination in Groundwater in Some Villages of Banda District, Uttar Pradesh, India

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Abstract

In India most of the people in rural areas depend on groundwater for drinking water. Serious problems are faced in several parts of the world due to the presence of high concentration of fluoride in drinking water which causes dental and skeletal fluorosis to humans. The aim of this present investigation is to study the level of fluoride in the groundwater of some villages in Banda district of Uttar Pradesh state and its comparison with the water of bore wells, hand pump and surface water by collecting ten samples of the water from five different villages during August 2014 to February 2015. The fluoride level in the underground water of villages of Banda district was exceeding the permissible limit (>1.5 mg/L). Fluoride concentrations in the water samples vary between 0.32 mg/L to 3.5 mg/L with highest concentration in Mavai village making these village prone to dental and skeletal fluorosis. It was found that all the five villages of Banda district was under serious fluoride contamination than bore well and hand pump water which causes adverse effect like dental and skeletal fluorosis. Potable water available in schools and in public hand pumps recorded the highest fluoride concentration as compared to minimum in surface indicating need of awareness among masses about ill effects of use of fluoride contaminated water. The spatial distribution pattern of fluoride concentration varies from place to place and most of the fluoride contaminated. Removal of excess fluoride and supply of potable water is urgently required in the rural areas of Banda district.

Keywords: Fluoride concentration, Groundwater, dental and skeletal fluorosis, Banda, Uttar Pradesh

I. INTRODUCTION

The Potable Water is of vital concern for mankind, since it is directly linked to human beings. Fresh water occurs as surface water and ground water. In this, groundwater contributes only 0.6 % of total water resources on earth [8]. Water is an essential natural resource for sustaining life and environment that we have always thought to be available in abundance and free gift of nature however chemical composition of surface or subsurface water is one of the prime factors on which the suitability of water for domestic, industrial and agriculture purpose depends. Fresh water occurs as surface water and ground water in this groundwater contributes only 0.6% of the total water resources on earth. It is major and preferred source of drinking water in rural and urban areas particularly in India. Water content many minerals like calcium, magnesium and fluoride etc. in this fluoride essential in minute quantity for normal mineralization of bone and teeth (for formation of dental enamel) fluoride stimulate growth of many plant species but on other hand when fluoride is taken up in excessive amount may prove toxic to plant and on feeding may toxic to animal and human as fluorosis [2] 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. High fluoride concentration in the ground water and surface water in many parts of the world is a cause of great concern. The main source of fluoride in ground water is fluoride-bearing rocks such as fluorspar, fluorite, cryolite, fluorapatite and hydroxylapatite. 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. High fluoride in drinking water was reported from different geographical regions [1, 3]. In India, the problem of excessive fluoride in ground water was first reported in 1937 in the state of U.P. Nineteen states in India have been identified, as endemic for fluorosis and Uttar Pradesh state is one of them. Though fluoride enters the body through water, food, industrial exposure, drugs, cosmetics, etc., drinking water is the major source (75%) of daily intake. Due to its strong electro negativity, fluoride is attracted to positively charged calcium in teeth and bones. Major health problems caused by fluoride are dental fluorosis, teeth mottling, skeletal fluorosis and deformation of bones in children as well as adults. Excess fluoride affects plants and animals also. The effect on agriculture was also evident due to inhibition on plant metabolism leading to necrosis, needle scratch and tip burn diseases. In animals also prominent symptoms of fluorosis were observed. In human beings, effects on dental and skeletal tissues can occur in adolescents and young adults and even in children under 10 years of age among communities exposed to high levels of fluoride [11].

Fluoride is a common constituent of groundwater. Fluoride is an ion of the chemical element fluorine which belongs to the halogen group of minerals and is natural constituents of the environment. Fluorine is the 13th most abundant element of the earth's crust and represents about 0.3 g/kg of earth's crust [19]. It occurs mainly in the form of chemical compounds such as sodium

fluoride or hydrogen fluoride which are present in minerals like fluor spar, fluorapatite, topaz and cryolite. The high concentration of fluoride is caused by excess alkalinity and low calcium content [7]. India is also confronting the same problem and about 25 million people in 8700 villages are consuming water having high fluoride.[12]. Fluoride at lower concentration (0.6- 1.5mg/L) is essential element for the development of teeth and bones in growth, fertility, prevention of anemia in pregnancy and infancy [18]. Excess intake of fluoride taken over a long period of time exerts negative effects on the course of metabolic processes and an individual may suffer from skeletal fluorosis, dental fluorosis, non skeletal manifestation or combination of the above [16,15]. This can cause joint pain, restriction of mobility, bending of vertebral column, deformation of knee joints, bone fracture and even paralysis. It can interfere with carbohydrates, lipids, protein, vitamins, enzymes and mineral metabolism when the dosage is high. Skeletal deformation and weakening of joints are typical forms of fluoride at high levels of fluoride intake. Fluoride is primarily excreted in urine. The severity of injury is determined by duration of fluoride exposure and concentration. Fluoride concentrations in ground water in India vary significantly. In some parts of India, fluoride levels are below 0.5 mg/L, while in other places, fluoride levels are as high as 30 mg/l. According to WHO [17], permissible limit for fluoride in drinking waters is 1.5 mg/l. WHO 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 [4]. In this paper, the data interpreting to fluoride concentrations in the ground water of some villages of Banda district in Uttar Pradesh state of India has been presented.

II. MATERIALS & METHODS:

A. STUDY AREA:

Banda District is one among 71 Districts of Uttar Pradesh State, India. Banda District Administrative head quarter is Banda. It is located 192 KM North towards State capital Lucknow. Banda District population is 1799541. It is 53rd Largest District in the State by population. It is located at Latitude-25.4, Longitude-80.3. Banda District is sharing border with Fatehpur District to the North. Banda District occupies an area of approximately 4413 square kilometres. Its elevation ranges from 141 meters to 122 meters. This District belongs to Hindi Belt India. In Banda district loose sediments as well as black cotton soil is found. Black cotton soil is prominent in the central part. Four major types of soil a) Rakar, b) Mar, c) Kabar and d) Padua are dominant in the district.

Physiographically the area can be divided into three physiographic units— (1) Alluvial Plain (2) Marginal Alluvial (3) High Land (Hard rock) area.

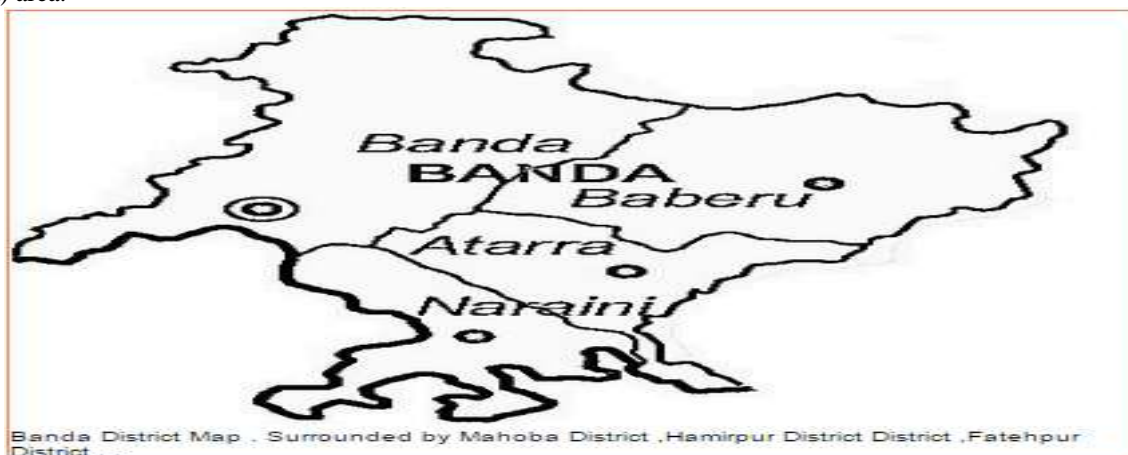


Fig. 1:

B. Climate:

It is too hot in summer. Banda District summer highest day temperature is in between 27 ° C to 48° C . Average temperatures of January is 15 ° C , February is 19 ° C , March is 27 ° C , April is 34 ° C , May is 39 ° C .. The average annual rainfall is 902.00 mm.

C. Sampling:

The study was carried out in five villages of Banda district because the people of this region use ground water and surface water for drinking and also for irrigation fields. The water samples were collected from hand pumps, bore wells, open wells and supply water (surface water) at Monsoon season and Winter season during the study year from Aug.2014 to Feb.2015 from ten (10) different sampling stations of villages Mavai (S1 & S2), Kanvara (S3 & S4), Badokhar (S5 & S6), Tindvari (S7 & S8), and Duredi (S9 & S10). The water samples were collected in clean polyethylene plastic bottles of 200 ml capacity and before filling, bottles were rinsed with water under study. They were labeled, coded and brought to the laboratory for fluoride determination on the same day.

Many methods have been suggested for the determination of fluoride ion in water given by agencies. The calorimetric & electrode method are the most satisfactory at the present time.[13].

III. FLUORIDE ION-SELECTIVE ELECTRODE METHOD:

A. Apparatus:

Ion-Selective Meter, Fluoride Electrode, Magnetic Stirrer

B. Reagent:

Fluoride Standards of various ranges (0.2-20ppm) Fluoride Buffer (TISAB-Total ionic strength adjustment buffer)

C. Procedure:

Calibrate the instrument take 10ml sample in a beaker at 10ml buffer solution. Put stirring bar into the beaker immerse electrode and start the magnetic stirrer and wait until reading is constant withdrawal electrode rinse with distilled water.

IV. RESULTS AND DISCUSSION:

In the study area fluoride contamination is mainly a natural process, i.e. leaching of fluorine-bearing minerals, since no man-made pollution has been noticed. Since fluorite, apatite, mica and various other minerals take part during rock-water interaction and liberate fluoride in to the groundwater. In general, it is found that the fluoride concentration in groundwater increases along the groundwater flow direction and also with increasing depth.

| Sl.no. | Sampling station | Source | Experimental Results (F in Mg/l) | |
|--------|------------------------------|---------------|-------------------------------------|---------------|
| | | | Monsoon season | Winter season |
| 1 | Village Mavai (S1) & S2 | Tube well | 3.5 | 2.8 |
| | | Hand pump | 2.1 | 1.8 |
| 2 | Village Kanvara (S3) & (S4) | Hand pump | 1.4 | 1.1 |
| | | Tube wells | 1.8 | 1.5 |
| 3 | Village Badokhar (S5) & (S6) | Surface Water | 0.4 | 0.32 |
| | | Open well | 0.6 | 0.4 |
| 4 | Village Tindvari (S7) & (S8) | Tube well | 0.9 | 0.7 |
| | | Hand pump | 0.7 | 0.5 |
| 5 | Village Duredi (S9) & (S10) | Hand pump | 1.2 | 1.0 |
| | | Tube well | 1.9 | 1.7 |

Fig. 2:

Fluoride in groundwater of this region is mainly due to dissolution from fluoride bearing minerals like Fluorspar, Fluorite etc. The fluoride concentration in groundwater in this study varied between 0.32 to 3.5 mg/l. The desirable range of fluoride concentration in drinking water is from 0.6 to 1.2 mg/l according to the Indian standard specifications (BIS) [5,6]. Thus, if the concentration of fluoride is below 0.6 and above 1.2 mg/l, the water is not suitable for drinking purposes. However, it is suggested that the maximum limit can be extended up to 1.5 mg/l (BIS) [6].

The fluoride concentration values were variable during the study period (Figure-2). The higher concentration was found in the groundwater of Mavai Village with highest fluoride level in monsoon season and lowest in Winter season. Out of total 10 (ten) samples of 5 (five) villages, most of the water samples analysed for fluoride had higher concentrations of fluoride compared to the prescribed permissible values (>1.5 mg/L) while all the samples of bore wells, hand pump and open wells analyzed had fluoride concentration above the permissible limit (< 1.5 mg/L). It was found that all these different villages were under very serious fluoride contamination. This paper also investigates the health risks involved with higher concentrations of fluoride in drinking water. Deformations of bones in children as well as in adults, weakening of joints and knees in adults, teeth molting in inhabitants were observed in the study area indicating the consequences of excess fluoride concentration, time to time local news paper also indicating in regard of this problem in this area.

Removal of excess fluoride and supply of potable water is urgently required in the rural areas of Banda district.

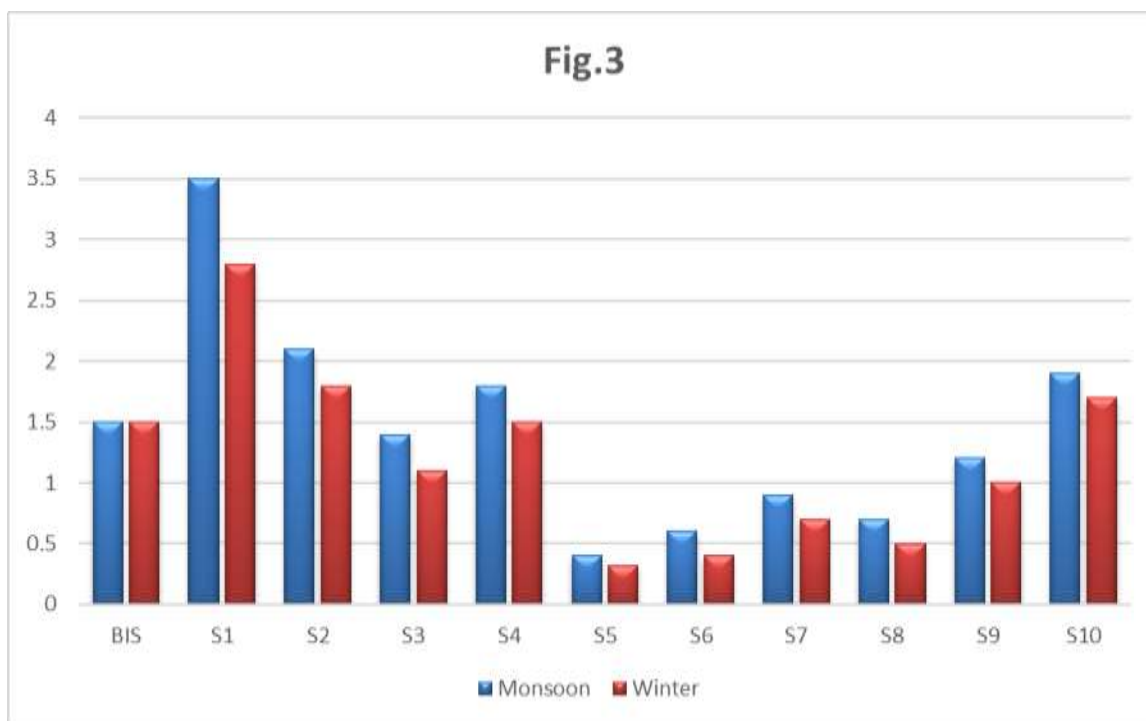


Fig. 3:

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