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GEO-ENVIRONMENTAL ISSUES IN PARTS OF AMRAVATI, AKOLA AND YAVATMAL DISTRICTS, MAHARASHTRA WITH REFERENCE TO FLUORIDE CONCENTRATION IN GROUNDWATER

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Abstract

In this study an attempt has been made to examine and evaluate the current environmental condition of the various parts of Amravati, Akola and Yavatmal districts as result of interactions of natural and economical (technogenous) systems. Hydro geochemical investigations were carried out in various parts of Amravati, Akola and Yavatmal districts from where soil, sediment and water samples were collected for geo-environmental investigations. Depth wise soil samples were collected (0-20 cms and a subsoil sample from 20-50cm) and were analyzed for SiO_2, Al_2O_3, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, TiO_2, P_2O_5, Ba, Co, Cr, Mo, Ni, Pb, Rb, Sr, V, Y and Zn). The generated data and the distribution maps of different elements are directly relevant to economic and environmental decisions involving groundwater exploration, many aspects of human and animal health, waste disposal and land use planning. Environment protection from pollution has been suggested to evaluate the geo environmental condition in these territories using modern and precise technology in order to determine types and causes of pollution as well as their control. To achieve these objectives, hydro geochemical, geomorphologic and terrain evaluation techniques were interpreted which were taken in different years in order to identify the most polluted areas which are difficult to be distinguished by the traditional methods. Physico-chemical condition like decomposition, dissociation and subsequent dissolution along with long residence time might be responsible for leaching fluoride in to the ground water. Fluoride concentration in groundwater was estimated from places in and around Amravati, Akola and Yavatmal districts, occurrence found within permissible limit in 85% of the samples and 15 % places showed a higher degree exceeding the normal levels. The results of the present study form the bases of a geoinformation system databank for environmental monitoring. In this study an attempt has been made to compute the environmental assessment analysis for the sustainable development of the region.

Introduction:

The groundwater contamination occurring due to either natural causes or anthropogenic activities need regular monitoring of water quality to device ways and means to protect it. It involves identification of major pollutants and confirmation of suitability of groundwater for human consumption (drinking purposes, etc.). As per government information, a survey was conducted in 9,798 villages in Maharashtra having fluoride, iron or nitrates or all of them as contaminants. It was noticed that 1,758 villages were fluoride affected in the state. Of these, 1011 were in Vidarbha alone. People in as many as 454 villages in Yavatmal district are being forced to consume fluoride affected water for years. Approximately 30-40 villages each in Yavatmal, Umarkhed, Kelapur, Wani, Zari, Ghatanji, Arni, Digras, Darwah and Ralegaon talukas are suffering from various forms of fluorosis due to regular consumption of fluoride rich water. The cross-sectional study was conducted at Pimpalgeon village, near Yavatmal Vidarbha region of Maharashtra. The main source of drinking water in this area is tube well. The concentration of fluoride in drinking water was measured using ion selective electrode method using an orion-ptt meter.The present investigations indicate the presence of fluoride contamination in certain parts of Amravati, Akola and Yavatmal districts which need to be further investigated.

Presence of low or high concentration of certain ions is a major issue as they make the groundwater unsuitable for various purposes. Fluoride is one such ion that causes health problems in people living in more than 25 nations around the world. Fluoride concentration of at least 0.6 mg/l is required for human consumption as it will help to have stronger teeth and bones. Consumption of water with fluoride concentration above 1.5 mg/l results in acute to chronic dental fluorosis where the tooth become coloured from yellow to brown. Skeletal fluorosis which causes weakness and bending of the bones also results due to long term consumption of water containing high fluoride. Presence of low or high concentration of fluoride in groundwater is because of natural or anthropogenic causes or a combination of both. Natural sources are associated to the geological conditions of an area. Several rocks have fluoride bearing minerals like apatite, fluorite, biotite and hornblende. The weathering of these rocks and infiltration of rainfall through it increases fluoride concentration in groundwater. Fluoride which is present in high concentration in volcanic ash is readily soluble in water and forms another natural source. Anthropogenic sources of fluoride include agricultural fertilizers and combustion of coal. Phosphate fertilizers contribute to fluoride in irrigation lands. Coal which is a potential source of fluoride is used for combustion in various industries and in brick kilns. The aerial emission of fluoride in gaseous form during these activities reaches the surface by fall out of particulate fluorides and during rainfall they percolate with the rainwater thus reaching the groundwater table. Also the improper disposal of fly ash on ground surface contributes to fluoride in groundwater. Since ingestion of high fluoride has a long term effect on human health it is essential to monitor its concentration in groundwater used for drinking periodically and take steps to bring them within the permissible range of 0.6 to 1.5 mg/l. There are several methods available for the removal of fluoride from groundwater which is in situ or ex situ. To dilute the groundwater contaminated with fluoride, artificial recharging structures can be built in suitable places which will decrease its concentration. Rainwater harvesting through existing wells also will prove effective to reduce the groundwater fluoride concentration. Ex situ methods which are conventional treatment methods like adsorption, ion exchange, reverse osmosis, electro dialysis, coagulation and precipitation etc can be practiced at community level or at households to reduce fluoride concentration before ingestion. But the choice of each method depends on the local conditions of the region such as the quality of groundwater and the source of contamination whether it is natural or anthropogenic. Fluoride contamination being a prominent and widespread problem in several parts of the world and as causes for this are mostly natural and unpreventable, educating the people and defluorinating the groundwater before consumption are essential for a healthy world.

In human nutrition, fluorine plays a dual role; to prevent dental caries at a certain level of intake and can cause serious damages in bony and dental tissues. Skeletal changes and mottled enamel may result when drinking water content of fluoride exceeds 2 ppm. Clinical studies have shown that fluoride intake rapidly enters mineralized tissues like bone and developing teeth. The estimated range of safe and adequate intake of fluorides for adults is 1.5 to 4.0 mg per day and it is less for children and those with renal disease. The daily intake of fluoride in endemic regions varies from 10 to 35 mg and can be even higher in summer months. The adverse effects of fluoride include dental fluorosis, skeletal fluorosis and it also affects R.B.C. cell wall. In skeletal fluorosis, the patients often complain of a vague discomfort and paresthesiae in the limbs and the trunk, pain and stiffness in the back appear next, especially in the lumbar region, followed by dorsal and cervical spines. Restriction of the spine movements is the earliest clinical sign of skeletal fluorosis. The stage at which skeletal fluorosis becomes crippling usually occurs between 30 and 50 years of age in the endemic regions (Rawlani et al, 2010)

Study area

The study area forms a part of Amravati, Akola and Yavatmal districts of Maharashtra wherein samples from selected open dug wells and bore wells were collected in pre-monsoon and post monsoon periods (Fig.1). The climate of these regions is mostly tropical. Summer months are mostly hot and humid while winter season is moderate and pleasant.

Regional Geology

Regional geology includes Deccan trap basalts with the occasional presence of Purna alluvium. The visually interpreted geological frame work of the area comprises of Achaean gneisses, Gondwana sequence and basaltic flows (Table 1).

Fig.1 Location map of the study area

Table1 Generalized stratigraphic succession of the study area

Age	Group	Formation	Lithology
Quaternary			Alluvium
Cretaceous to Paleocene	Deccan Basalts	Karanja Fm	2 to 5 flows (160m thick)
		Buldhana Fm	Aa flows (50m thick)
		Chikhli Fm	11 aa and 1 compound flows(90m thick)
		Ajanta Fm	5 aa and 9 pahoehoe flows (154m thick)
Archean		Granitic Gneiss	Archean basement

Materials and Methods

Thirty eight groundwater samples were collected from selected dug well and bore well locations in Amravati, Akola and Yavatmal districts of Maharashtra which are extensively used for drinking and domestic purposes. The samples were collected in clean polythene bottles, which were first rinsed with distilled water and then two to three times by the sample water before collecting the sample for analysis. The collected groundwater samples were analyzed for pH, electrical conductivity (EC), TDS using water analysis kit. Total alkalinity as $CaCO_3$ and bicarbonate, HCO3 were estimated by titration with HCl. Total hardness as CaCO3 was analyzed titrimetrically Initial Fluoride concentration in water samples were determined using parameters prescribed in standard methods for the examination of water and waste water, APHA, 1995 using ion selective electrode (ISE) method.

Results and Discussion

Fluoride contamination in groundwater

Ground water analysis has been carried out in parts of Amravati, Akola and Yavatmal districts, Maharashtra with reference to fluoride concentration in groundwater such as Konghara and Dharana regions using hydrogeological analysis aspects in a systematic way by utilizing various computer aided programs and statistical techniques. This study will also provide first hand information on fluorosis problem and geology of the study area. This study will also provide the knowledge about the hydrogeology of the area. Fluorosis disease comes from the increasing percentage of fluoride minerals present in the rocks.

People use the water to the drinking purposes trough the drinking percentage of fluoride increases into the body and results into the fluorosis. For knowing the origin or source of the fluorosis problem it is very important to know about the geology and hydrological properties of the rocks. Fluoride belongs to halogen family represented as 'F' with atomic weight 18.998 and atomic number 9. It occurs as a diatomic gas in its elemental form and has a valence number 1. It is the most electronegative and the most reactive when compared to all chemical elements in the periodic table. It has an oxidation state of -1 and occurs as both organic and inorganic compounds. It is the 13th most abundant element in the earth's crust. Its natural abundance in the earth's crust is0.06 to 0.09% and the average crustal abundance is 300 mg/kg (Tebutt, 1983). Fluoride does not exhibit any colour, taste or smell when dissolved in water. Hence, it is not easy to determine it through physical examination. Only chemical analysis of the groundwater samples can determine the concentration of this ion. The widely used method for the estimation of fluoride in groundwater sample is colorimetric SPANDNS (sodium 2-(parasul fophenylazo)-l,8-dihydroxy-3,6-naphthalene disulfonate) method. The other colorimetric method extensively used is the complex one method. Fluoride concentration can also be quantified using sophisticated instruments like ion chromatograph. Ion selective electrodes are available to measure fluoride concentration in water, which can be used both in the field and in laboratory. Fluoride is one of the important micronutrient in humans which is required for strong teeth and bones. In humans, about 95% of the total body fluoride is found in bones and teeth. WHO (World Health Organization) (1984) has prescribed the range of fluoride from 0.6 to 1.5mg/l in drinking water as suitable for human consumption. BIS (Bureau of Indian Standards).

Groundwater is the major source for various purposes in most parts of the world. The Presence of low or high concentration of certain ions is a major issue as they make the groundwater unsuitable for various purposes. Fluoride is one such ion that causes health problems in people living in more than 25 nations around the world.

Fluoride concentration of at least 0.6 mg/l is required for human consumption as it will help to have stronger teeth and bones. Consumption of water with fluoride concentration above 1.5 mg/l results in acute to chronic dental fluorosis where the tooth become coloured from yellow to brown. Skeletal fluorosis which causes weakness and bending of the bones also results due to long term consumption of water containing high fluoride.

Presence of low or high concentration of fluoride in groundwater is because of natural or anthropogenic causes or a combination of both. Natural sources are associated to the geological conditions of an area. Several rocks have fluoride bearing minerals like apatite, fluorite, biotite and hornblende. The weathering of these rocks and infiltration of rainfall through it increases fluoride concentration in groundwater. Fluoride which is present in high concentration in volcanic ash is readily soluble in water and forms another natural source. Anthropogenic sources of fluoride include agricultural fertilizers and combustion of coal. Phosphate fertilizers contribute to fluoride in irrigation lands. Coal which is a potential source of fluoride is used for combustion in various industries and in brick kilns. The aerial emission of fluoride in gaseous form during these activities reaches the surface by fall out of particulate fluorides and during rainfall they percolate with the rainwater thus reaching the groundwater table. Also the improper disposal of fly ash on ground surface contributes to fluoride in groundwater. Since ingestion of high fluoride has a long term effect on human health it is essential to monitor its concentration in groundwater used for drinking periodically and take steps to bring them within the permissible range of 0.6 to 1.5 mg/l. There are several methods available for the removal of fluoride from groundwater which is in situ or ex situ. To dilute the groundwater contaminated with fluoride, artificial recharging structures can be built in suitable places which will decrease its concentration. Rainwater harvesting through existing wells also will prove effective to reduce the groundwater fluoride concentration. Ex situ methods which are conventional treatment methods like adsorption, ion exchange, reverse osmosis, electro dialysis, coagulation and precipitation etc can be practiced at community level or at households to reduce fluoride concentration before ingestion. But the choice of each method depends on the local conditions of the region such as the quality of groundwater and the source of contamination whether it is natural or anthropogenic. Fluoride contamination being a prominent and widespread problem in several parts of the world and as causes for this are mostly natural and unpreventable, educating the people and defluorinating the groundwater before consumption are essential for a healthy world.(Brindha and Elango,2011)

Ground water Pollution studies

In Amravati, Akola and Yavatmal districts of Maharashtra, incidences of fluorosis has been raising in recent years alongside the mindless extraction of groundwater (Table 2). Lack of rainfall has meant parts of these districts to be largely dependent on groundwater, both for irrigation and drinking water requirements. Indiscriminant digging of bore wells has given rise to sharp rise in the fluoride concentration in the ground water. Fluorides and other dissolved salts in drinking water have exceeded the safe limit in the past two decades. A high intake of fluoride (>1.5 mg/l) in drinking water over a prolonged period is known to cause damage to the enamel of the teeth, and eventually results in skeletal complications leading to fluorosis. Low pH is one of the common problems of ground water. The primary cause of a low pH is the addition of acidic rain water. Other ions found in ground water such as nitrates and sulfates may result in lower pH. The negative effects of acidic water are many. Highly acidic water may result in pipe corrosion, causing the possible release of iron, lead, or copper into the tap water. A low pH may discolor the water and give it a bitter taste.Total dissolved solids (TDS), is defined as the concentration of all dissolved minerals in the water. TDS are a direct measurement of the interaction between ground water and subsurface minerals. High values of TDS could be due to dense residential area and intensive irrigation. Sources for TDS include agricultural run-off, urban run-off, industrial wastewater, sewage, and natural sources such as leaves, silt, plankton, and rocks. Piping or plumbing may also release metals into the water. A higher concentration of TDS usually serves as no health threat to humans until the values exceed 10,000 mg/L. At this level the water is considered brine and defined as undrinkable. A high TDS (levels above 1,000 mg/L) may cause corrosion of pipes and plumbing systems. To remove TDS to acceptable levels, a water softener with a reverse osmosis (R/O) system is usually effective.

The hardness of water is related to presence of Ca and Mg in water basically depending on soil type of that area. Water hardness in most groundwater is naturally occurring from weathering of limestone, sedimentary rock and calcium bearing minerals. Hardness can also occur locally in groundwater from chemical and mining industry effluent or excessive application of lime to the soil in agricultural areas. Sulphate can be found in almost all natural water. The origin of most Sulphate compounds is the oxidation of sulfite ores, the presence of shales, or the industrial wastes. Excess sulphate in the water could be due to the soil type as some soils contain sulphite minerals. As groundwater moves through these, some of the sulphate is dissolved into the water. Some minerals that contain Sulphate are Sodium Sulphate (Glauber's salt), Magnesium Sulphate (Epsom salt), and Calcium Sulphate (gypsum).Fluoride is a common constituent of groundwater. Natural sources are connected to various types of rocks and to volcanic activity. Agricultural (use of phosphatic fertilizers) and industrial activities (clays used in ceramic industries or burning of coals) also contribute to high fluoride concentrations in groundwater (Rammohan Rao et al, 1993). During weathering and circulation of water in rocks and soils, fluorine can be reached out and dissolved in groundwater and thermal gases. The fluoride content of groundwater varies greatly depending on the geological settings and type of rocks. The most common fluorine-bearing minerals are fluorite, apatite and micas. Therefore fluoride problems tend to occur in places where these minerals are abundant in the host rocks.

Nitrogen typically is present in ground water in three forms: ammonia, nitrate, and nitrite. Of the three, nitrite is the most toxic, yet usually occurs in the lowest concentrations. Most nitrogen compounds found in the ground water are partially derived from the atmosphere. Specific plants can "fix" nitrogen from the atmosphere onto their roots. Nitrogen not used by the plant is released into the soil. (Saxena and Ahmad 2003). In the soil, free reactions with water, minerals, and bacteria take place. Secondary sources of nitrogen compounds include fertilizers, manure and urine from feedlots and pastures, sewage, and landfills. Excessive nitrate in the water could be due to the over-application of fertilizers or improper operation and maintenance of septic systems or improper manure management system. Nitrates are especially toxic to children less than six months of age. Children who ingest nitrate may not have developed an immune system that can ward off the compound. The condition known as "blue-baby syndrome" may occur. The concentration of Chlorine is high in the regions of high temp and less rainfall. Soil porosity and permeability can build up chloride ions in water 6-3 (Ram Mohan Rao et al, 1993).Microorganisms, more specifically bacteria, can be found virtually in any water sample. Most microorganisms contained within normal well water supplies do not pose a threat to human health. Bacteria are generally introduced into a well by foreign means. Foreign methods can range from contaminated drilling tools to an improperly sealed well casing. Bacteria thrive in environments which contain iron, nitrogen, or sulfur compounds. Sources of these compounds may be derived from sewage, animal manure, and leaky septic systems. Well water serves as excellent living environments for bacteria. Wells high in nitrate (>10 mg/L) and sulfate levels should be bacteriological tested. Bacteria can convert nitrate in water to the more dangerous nitrite. Water rich in sulfur could contain bacteria which may convert sulfate ions to potentially toxic sulfide ions. (Andezhath et al 1999).

Table2. Fluoride contamination (mg/l) in groundwater observed in the study area

S. No	Village	District	Fluoride Concentration
1	Chandur Railway	Amravati	0.64

2	Morshi	Amravati	0.54
3	Nandgaon	Amravati	0.98
4	Khandeshwar	Amravati	0.86
5	Tiwasa	Amravati	1.02
6	Achalpur	Amravati	1.03
7	Bhatkuli	Amravati	1.75
8	Daryapur	Amravati	1.98
9	Digras	Amravati	2.25
10	Kelapur,	Amravati	2.42
11	Maregaon,	Amravati	2.21
12	Ner	Amravati	2.63
13	Wani	Amravati	2.14
14	Lamkani	Akola	1.26
15	Agar	Akola	1.68
16	Palso Budruk	Akola	2.01
17	Patsul	Akola	2.61
18	Devarda,	Akola	1.53
19	Lohara.	Akola	1.48
20	Hilaldad,	Akola	2.06
21	Kinkhed,	Akola	2.46
22	Wadegaon,	Akola	2.89
23	Parala	Akola	2.23
24	Rahit	Akola	2.03
25	Rasulpur	Akola	2.86
26	Dapura	Akola	2.21
27	Panhagavan	Akola	2.25
28	Konghara	Yavatmal	2.36
29	Konghara	Yavatmal	2.21
30	Konghara	Yavatmal	2.08
31	Konghara	Yavatmal	1.96
32	Konghara	Yavatmal	2.12
33	Dharana	Yavatmal	2.22
34	Dharana	Yavatmal	2.11
35	Dharana	Yavatmal	1.86
36	Dharana	Yavatmal	1.94
37	Dharana	Yavatmal	2.42
38	Konghara	Yavatmal	2.36

Hydro-geochemical investigations carried out during pre and post monsoon periods have demonstrated the groundwater regime of the study area through ground water quality analysis. The results indicates good to permissible groundwater quality in certain regions like Barshi Takli and Patur however, in certain villages namely Wanirambhapur, Akolkhed, Popatkhed, Ruikhed, Shahanpur, Madhapuri, Chatari, Sawarkhed and Thar had showed excellent water quality. The other villages where the water quality was unsuitable for drinking are namely Agar, Palso budruk, Patsul, Devarda, Hilaldad, Parala, Kinkhed, Wadegaon, Rahit, Rasulpur, Dapura, Panhagavan and Lohara. Amravati District is one of the eleven districts of Vidarbha region of Maharashtra. Wardha River forms the eastern boundary of the district. The district can be broadly divided into two physiographic units viz., Melghat Hill range made up of Gawilgarh hills, which are a part of the Satpuda hill ranges and plain area of the Paynghat The eastern part of the district falls under Godavari basin and consists of 20 watersheds, whereas the western and north western parts fall in Tapi basin and consists of 23 watersheds. It is situated in the northern part of the State. The total area of the district is 12210 sq. km. The major part of the district comes under Purna-Tapi and Wardha River basins. The important rivers flowing through the district are Tapi, Purna, Wardha, Pedhi and Chandrabhaga. From three years water quality of Amravati district, it was found that water quality located in Anjangaon taluk was excellent with Fe values, whereas villages without Fe concentration showed good WQI. Similarly talukas namely Chandur Bazar, Chikhaldara, Dharni, Amravati and Warud had good water quality. Apart from these remaining villages in respective talukas such as Chandur Railway, Morshi, Nandgaon Khandeshwar, Tiwasa, Achalpur, Bhatkuli and Daryapur showed poor water quality which needs a special attention to improve the ground water quality of these locations. Arni, Darwha, Mahagaon, Ralegaon, Umarkhed had a good water quality, when WQI calculated without considering Fe concentration, but when Fe weightage was considered the WQI found to be good for talukas Babhulgaon, Ghatanji, Maregaon, Ner, Pusad, Yavatmal and Zari Jamni. In some of the talukas viz. Ghatanji, Kalamb, Pusad, water quality varied between good to poor depending upon their Fe weightage in monitored data. Based on WQI calculation and BIS standard comparison showed that talukas namely Digras, Kelapur, Maregaon, Ner and Wani had a poor water quality, where the significant contamination of nitrate and fluoride was observed.

Possible causes of Fluoride Contamination

Presence of low or high concentration of fluoride in groundwater is because of natural or anthropogenic causes or a combination of both. Natural sources are associated to the geological conditions of an area. Several rocks have fluoride bearing minerals like apatite, fluorite, biotite and hornblende. The weathering of these rocks and infiltration of rainfall through it increases fluoride concentration in groundwater. Fluoride which is present in high concentration in volcanic ash is readily soluble in water and forms another natural source. Anthropogenic sources of fluoride include agricultural fertilizers and combustion of coal. Phosphate fertilizers contribute to fluoride in irrigation lands (Fig.2). Coal which is a potential source of fluoride is used for combustion in various industries and in brick kilns. The aerial emission of fluoride in gaseous form during these activities reaches the surface by fall out of particulate fluorides and during rainfall they percolate with the rainwater thus reaching the groundwater table. Also the improper disposal of fly ash on ground surface contributes to fluoride in groundwater. Since ingestion of high fluoride has a long term effect on human health it is essential to monitor its concentration in groundwater used for drinking periodically and take steps to bring them within the permissible range of 0.6 to 1.5 mg/l. There are several methods available for the removal of fluoride from groundwater which is in situ or ex situ. To dilute the groundwater contaminated with fluoride, artificial recharging structures can be built in suitable places which will decrease its concentration. Rainwater harvesting through existing wells also will prove effective to reduce the groundwater fluoride concentration. Ex situ methods which are conventional treatment methods like adsorption, ion exchange, reverse osmosis, electro dialysis, coagulation and precipitation etc can be practiced at community level or at households to reduce fluoride concentration before ingestion. But the choice of each method depends on the local conditions of the region such as the quality of groundwater and the source of contamination whether it is natural or anthropogenic. Fluoride contamination being a prominent and widespread problem in several parts of the world and as causes for this are mostly natural and unpreventable, educating the people and defluorinating the groundwater before consumption are essential for a healthy world

But when they are present above the recommended limit of WHO and BIS i.e. 1.5 mg/l it results in mild dental fluorosis to crippling skeletal fluorosis as the quantity and period of exposure increases. Dental fluorosis is more prevalent in children than in adults. Skeletal fluorosis occurs when an individual is exposed to fluoride of above 10 mg almost every day over a period of one or two decades. Apart from fluorosis there are also several health disorders due to ingestion of drinking water with high fluoride. To remediate the groundwater with high fluoride, defluorination techniques are adopted. They include adsorption, ion exchange, coagulation and precipitation, reverse osmosis and electro dialysis. Of these, reverse osmosis has been considered as the best available technology. Onsite treatment includes artificial recharge methods such as rain water harvesting, constructing check dams, percolation ponds, facilitating recharge of rain water through existing wells etc. Adopting a particular method depends on the initial fluoride concentration, source and cost effectiveness in an area (Brindha and Elango, 2011). Simplified micro-watershed methodology along with recharge techniques will reduce the fluoride concentration to a reasonable extent (Fig.3).

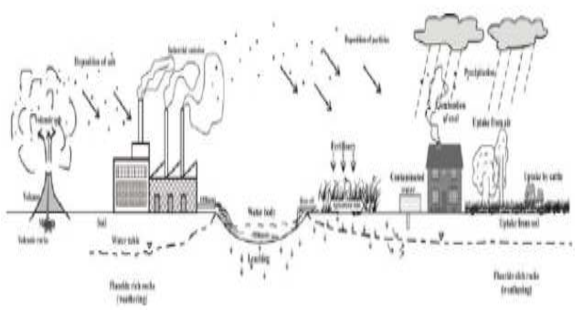

Fig.2 Possible causes of Fluoride contamination in study area (After Brindha and Elango, 2011)

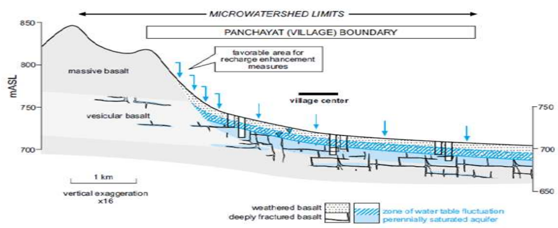

Fig.3 Simplified hydrogeological section of study area using micro-watershed methodology

Summary and Conclusions:

Water is the most essential natural resource for suatainable management of the environment. Groundwater is the main source of drinking water in rural and urban areas in the study area. More than 85% of people in the rural areas and urban regions uses groundwater for domestic purposes. Occurrence of fluorine in groundwater has drawn worldwide attention due to its considerable impact on human physiology. In this view fluoride contamination studies have been carriedout in parts of Amravati, Akola and Yavatmal districts of Vidharbha region. In addition, various other water quality perameters have also been analysed for monitering the water quality of the region. The results of the study indicate the fluoride concentration varies from 0.85 to 2.86 mgl. The alluvial regionds associated with the presence of secondary vein filling minerals in the Basaltic terrain might be the possible source for the presence of fluoride in the groundwater of the region. In addition, semi arid climate of the region and long residence time of the groundwater in aquifer might also be responsible for the concentration of the fluoride in the groundwater. In this study an attempt has also been made to correlate the fluoride concentration with various physicochemical characters. The results indicate that the fluoride concentration can be strongly correlated with pH, EC, TH, Na, HCO_3 and negatively correlated with Ca^{2+} and Mg^{2+}.

Fluoride is present in surface water as well as in subsurface water in the study area. Fluoride is reported due to the fluoride content in minerals occurring in soil and rocks of the area. Fluorite (CaF_2) a common fluoride bearing mineral which is present in the Precambrian crystalline and sedimentary rocks of the area. The apatite (Ca_3 P_2O_3 CaF_2) Occurs in the form of crystals grain in basic igneous rocks such as basalts. Sometimes fluoride concentrates in pegmatite metallic vein and magmatic intrusion in the Precambrian basement. It also occurs in metamorphic rock i.e. schist and gneisses. The study area is covered by lava flows belonging to Deccan traps with the shallow Precambrian basement. It is speculated that the circulating groundwater from the basement into the shallow aquifer is responsible for the concentration of fluorite in the groundwater sources of the area. Dental fluorosis is occurring due to increasing percentage of fluoride in water. pH value of water sample is higher in

Konghara is 7.8mg/lit found in study area. Alkalinity value of water sample is higher in Dharana i.e., 50mg/lit found in study area which is located near Konghara. Ca value of water sample is higher in Dharana 60mg/lit where as the Chloride value of water sample is higher in Konghara, 240mg/lit. Fluoride value of water sample is higher in Dharana, 2.4mg/lit found in study area.

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