AN ATTEMPT TO STUDY FLUOROSIS AND ITS IMPECTS IN PARTS OF JHABUA DISTRICT (M.P.)

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ABSTRACT

The Jhabua district is located in the western parts of Madhya Pradesh, it is bounded by latitude 21 55 00 to 23 00 00 North and longitude 74 00 00 to 75 00 00 East. It is bounded by Ratlam and Dhar districts in the north and east; Panchmahal and Vadodara districts of Gujarat in the west and Dhule district of Maharashtra in the south.

The rocks exposed in the district comprises Aravalli Super group of lower Proterozoic age
(2000-2500 m.y.) Godhra Granite of Upper Proterozoic age (900 _1600 m.y.) Bag group of upper Cretaceous age (110 m.y.) and Deccan trap of Upper Cretaceous age (110-60 m.y.)The Aravalli Super group consists of hornblende gneiss, migmatite, marble, chlorite, schist, calc silicate, quartzite, phyllite, dolomite, marble, quartzite, dolomite limestone, quartz mica schist, biotite gneiss, and grey gneissic granite. These are intruded by basic and ultra mafic intrusive. Godhra granite is distinguished as massive granite, porphyroblastic granite and pink granite. Bag beds comprise sand stone and nodular limestone. Deccan Trap are represented by both Aa and pahoehoe flows of various thickness. Bag beds and Deccan Trap are intruded by basic ultra basic carbonate dyke and sills. The gneiss, grey gneissic granite, granite porphyritic granite, pink granite.pegmetite and basic eruptive volcanic rocks contain fluoride as essential and accessory mineral which is main source of Fluorine contamination in the area.

The study of the area indicates that there are incidences of Fluorosis in several villages viz.Tikdimoti, Umariya, Surdiya Kotda, Rambhapur, Behrapada, Thapli, Bawadi Khurd, Behawada Sadli of Jhabua, Rama, Meghnagar, Petlawad, Jobat, Alirajpur, and Jhabua. The value of Fluorine in drinking water varies from 3.66 to 13.86 mg/liters, where as the tolerance limit as per WHO of fluorine is 1.5 mg/liters. The incidence of Fluorosis is also noted from soil in the same area. There is an alarming situation and needs immediate attention and implementation of various awareness program by people participation at cadastral and village level for detailed study and adopting the corrective and mitigating & protective measures. In the area of study systematic water and soil sampling was carried out and about 200 water samples and about 62 soil samples were collected from different water sources and soil profile in 15 villages. Water quality parameters like Fluorine TDS, PH, Alkalinity, Electrical Conductivity (EC), Calcium, bicarbonates were determined .Besides basic data collected from various villages and school children and placed in to different categories. The same were further summarized on the merits of intensity of Fluorosis. The sources of water included open dug wells, concrete dug wells, hand pumps, natural streams, rivers and ponds which are the sole domestic sources of water in the area supply. The results of chemical analysis obtain demonstrate wide spatial variation in the values of all parameters analyzed.

It indicates diversity in the geochemistry in the area. The Parameters like pH, EC, alkalinity, hardness and calcium were found to be within the prescribed limits for most of the water sources, where as Fluoride concentrations were higher than the prescribed limit of 1.5-mg/l. in drinking water sources of ground water and surface water in most of the villages. It is observed that Fluoride and calcium concentration has inverse relation in occurrence in both surface water and sub surface water in the area. The statistical analysis of chemical data revealed that the fluoride concentrations varied between 0.2 –13.5 mg/l in all water sources studied. The concentrations varies place to place with the sources the over all spatial variation of is wide spectrum and diverse. It is significant to note that Fluoride concentrations in ground water sources is quite high as compared to the surface water sources .It appears to due to the dynamic nature of ground water regime which is influenced and controlled by geology and structural set up of the area. The average depth of bore holes in the area is about 250 feet. This indicates that water is being tapped from both shallow and deeper aquifer. The concentration of Fluoride in bore wells water is higher as compared to the other water sources in the area which appears to be due to exposure of to wide verity of crystalline rocks in deeper aquifer which contain fluoride minerals.

The critical analysis of basic data on excessive consumption of fluorides in drinking water indicate that ill effects of human body depend upon several factors like nutrition of the person at risk, the exposure period, preventive measures and awareness. Hence the same level of exposure to fluorides can have different effects on different people. The spatial variation of concentrations of fluoride in drinking water cause different degrees of Fluorosis.The study further reveals that cases of mild dental Fluorosis (discoloration of teeth) occur at fluoride concentrations as low as 2 mg/l.The moderate dental Fluorosis (appearance of striations on teeth) cases are associated with sources containing >3 mg/l. The average fluoride concentration for severe dental Fluorosis (loss of teeth) is about 5 mg/l.

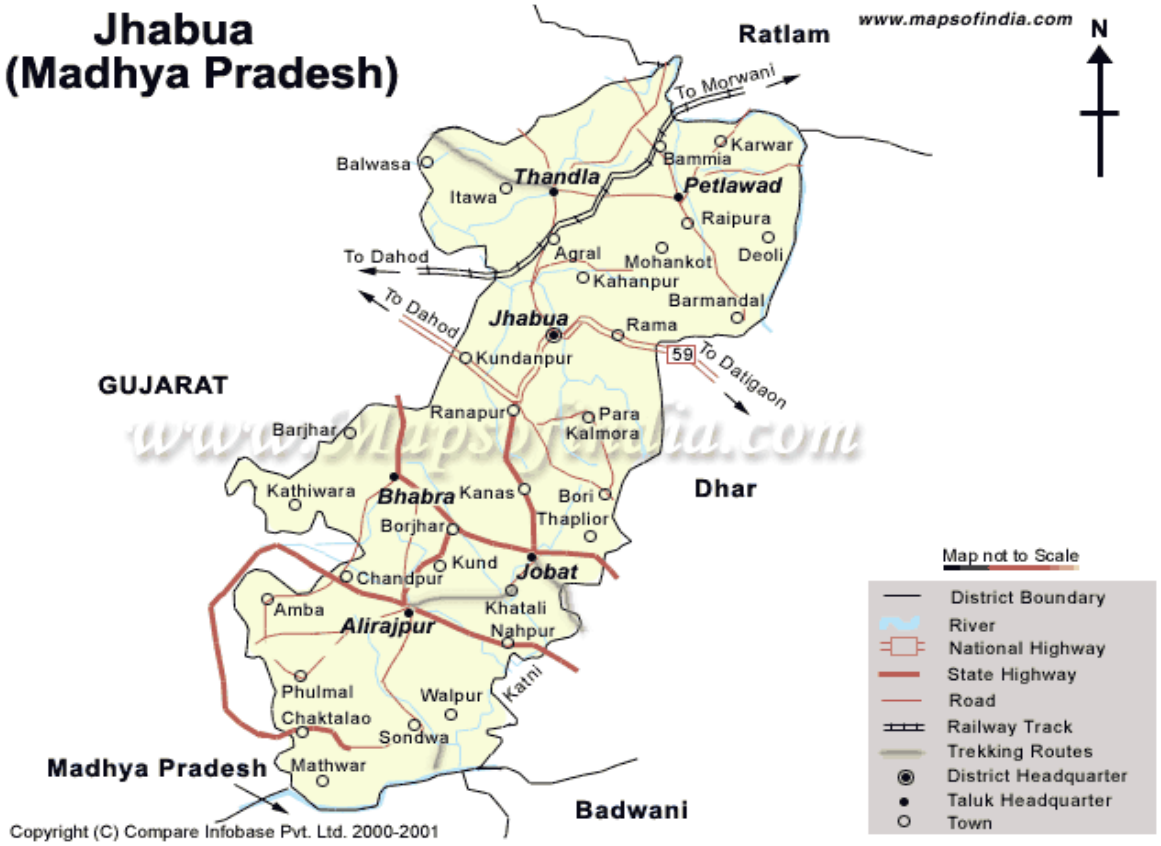
In the area affected Fluorosis a team of social workers, community workers, and scientist and artist scientists through NGO should carry out a rally with different banners and slogan for about as part of awareness programme covering the entire targeted 15 village. They communicated and informed the communities about Fluorosis, it possible sources, its causes, the levels of fluoride contamination in the domestic water sources of their villages and possible measures for mitigation of the problem educating the community about Fluorosis.

KEYWORDS: Fluorosis, fluoride contamination.

INTRODUCTION

In India about 62 million people suffer from dental, skeletal and or non-skeletal Fluorosis. Of these, 6 million are children below the age of 14and are at risk. Fluorosis is caused by excessive concentration in water and soil beyond tolerance limit. Geologically the areas occupied by crystalline rocks comprising of gneisses, granite pegmatite feldspathic granite and eruptive volcanic rocks are the main source of excessive supply of Fluorine to natural water domain ad prone to Fluorosis . The disintegration of these rocks by physical and chemical weathering and consequential formation of soil contain excessive Fluorine. The excessive use and consumption of water and cultivation on such soil caused Fluorosis resulting crippling disease caused by fluoride concentrations above 1.5 mg/L in drinking water. In India about 20 states have been identified with a problem of excess fluoride in groundwater. Rural populations who are mainly dependent on groundwater for drinking

purposes, are the worst affected. Since the late 1980s, government and non-government agencies have launched efforts to control the spread of Fluorosis. Despite these efforts, reports continue to appear indicating an increasing spread of Fluorosis. This can either be due to identification of an existing problem in a new area, or a fresh incidence striking a hitherto unaffected population due to local environmental changes. The Jhabua district in the western Madhya Pradesh is occupied in north by Aravalli Supper Group of rocks comprising of gneisses, granite pegmatite feldspathic granite and by thick sequence of eruptive volcanic rocks consisting of thick pile of basaltic lava flows are the main source of Fluorine to subsurface, subsurface water regimes and to the soil is the geological strata of Jhabua district which comprised of highly folded , faulted and diversified crystalline rock at the basement and overlain by thick sequence of basaltic lava sheets.



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The incidences of Fluorosis in the area reported from several Villages viz.Tikdimoti, Umariya, Surdiya Kotda, Rambhapur, Behrapada, Thapli, Bawadi Khurd, Behawada Sadli of Jhabua, Rama, Meghnagar, Petlawad, Jobat, Alirajpur, Jhabua district. M.P. The value of Fluorine in drinking water varies from 3.66 to 13.86 mg/liters, where as the tolerence limit as per WHO of fluorine is 1.5 mg/liters. The incidence of Fluorosis is also reported from soil in the same area. There is an alarming situation and needs immediate attention and implementation of various awareness programme by people participation at cadastral and village level for detailed study and adopting the corrective, mitigating & protective measures Fluorosis, caused by ingestion of excess fluoride, most commonly through drinking water and food crops irrigated with fluoride contaminated water, affects teeth and bones, as well as many organs in human body and some of the body's critical biological functions. Moderate amounts lead to dental effects, but long term ingestion of large amounts of fluoride can lead to potentially severe skeletal problems. In Chapri village, in also Rama block of Jhabua district, most children have stained teeth. But residents of the village are now attentive to the problem of Fluorosis as the result of the awareness generated by the intervention of UNICEF and allied NGOS.In the adjoining area at Khadaubujrug Dhar district a hand pump contained fluoride in excess of permissible limit which has seriously affected children with teeth and bone deformation problems as such local authorities have capped the hand pump.

Geological set up:

The Jhabua district in the western Madhya Pradesh is occupied by Aravalli Supper Group of rocks comprising of gneisses, granite pegmatite feldspathic granite and by thick sequence of eruptive volcanic rocks consisting of thick pile of basaltic lava flows these rocks contain Fluoride as essential and accessory mineral which are the main source of Fluorine. The Geological succession of these rocks is given in **(Table No.1)**

TABLE – 1

REGIONAL GEOLOGICAL SEQUENCE

Fine to medium grained basaltic, doleritic and carbonate dykes.	Singarchori	DECCAN TRAP *Contain Fluorite as essential mineral and is the main source of Fluorine which contaminate Water and soil in the area of study*	UPPER CRETACEOUS TO PAL. AEOCENE
Three flows mostly moderately to highly porphyritic Pahoehoe Cph flows having vesicular unit at the top.			
Six flows predominantly Pahoehoe Cph flows having megaporphyritic unit containing 2-5 cm phenocrysts of feldspar at the top.	Bargonda Formation		
Four flows moderately to highly porphyritic Pahoehoe Cph flows having megaporphyritic unit containing 2-3 cm size phenocrysts of feldspar at the top.	Indore Formation		
Six flows predominantly moderately to highly vesicular Pahoehoe Cph flows having megacryst unit containing 2-3 cm size phenocrysts of feldspar at the top.	Kankariya – Pirukheri Formation		
Eleven flows mostly highly vesicular Pahoehoe Cph flows having megaporphyritic unit containing megacryst of feldspar of 1 to 2 cm at the top.	Kalisindh Formation		
Seven flows mostly highly vesicular Aa type having megaporphyritic unit containing of phenocrysts of feldspar 0.5 cm to 1.5 cm at the top.	Mandleshwar Formation		
Lameta Group	Lameta Group		UPPER CRETACEOUS
Nimar Sandstone	Bagh Group		
Nodular Limestone, Coralline Limestone			
Quartz vein	Godhra Granite		UPPER

Pink Granite		*Contain Fluorite as essential mineral and is the main source of Fluorine which contaminate Water and soil in the area of study*	PROTEROZOIC
Porphyroblastic Granite			
Grey massive Granite			
Basic intrusives	Champaner Group	ARAVALLI SUPER GROUP	
Dolomite, Phyllite and Slate			
Grey Gneissic Granite / Migmatite	Lunavada Group		
Serpentinites, Pyroxenite and Anorthosite			
Biotite Gneiss			
Feldspathised Quartzite / Gneissose feldspathic rock		*Contain Fluorite as essential mineral and is the main source of Fluorine which contaminate Water and soil in the area of study*	LOWER PROTEROZOIC
Quartz muscovite schist			
Muscovite Quartzite, Quartzite			
Dolomitic limestone (Phosphate bearing)			
Chlorite schist	Udaipur Group		
Chlorite phyllite / Carbonaceous phyllite			
Marble and Calc silicate			
Hornblende Gneiss			

Review of Research and Development in the Subject

International status

The earth crust consist of various rock groups from proterozoic to recent in age which contain fluoride as essential as well accessory mineral in many rock types in its stratigraphic columns. It is the main source of Fluorine in surface water, ground water and soil. The crust strata under the geological exogenetic and endogenetic dynamic process subject to the disintegration and minerals and rocks alter which also cause release of various minerals in to water and soil. In the Global scenario there are about 22 Fluoride endemic countries around the world .The guide line followed for Fluoride contents in drinking water of most of countries is based on WHO norms, the desirable upper limit for Fluoride in drinking water is 1.5 mg /L to 0.6mg/L. The public health aspects of Fluoride and issues of Fluoridation and de fluoridation of drinking water internationally has been debated discussed and recorded since 1935. The status of research and development has at international level been discussed by many scientists. Du Plessis JB. (1995) Schoeman JJ, Steyn (1996) In the second International workshop about 44 scientists have participated and discussed the various aspects of problems of Fluorosis its corrective mitigating and protective measures to be adopted across the Globe. Douw, G. et.al (1963) Louw, A et.al in (1992) discussed about Fluorosis Preventation and Defluoridation of water .The WHO representative of Fluoride and human health emphasized on Geneva document 1970. Steyen (1963) discussed about chronic fluorine

poisoning, Ockerse (1944) about the relationship of fluorine hardness and PH values.Staz J. (1963) Fluoridation .In this forum the world Health Organization heath guide lines for drinking water quality (1984) was emphasized and was the core them of discussion. Schoeman (1996) has discussed water deluoridation and Environment. Susheela A.K. (2002) discussed about Fluorosis in Developing countries and about its remedial measures and approaches. Susheela A.K (2002) has contributed about 73 scientific papers (1964 to 1967) on various aspects of Fluorosis in India and abroad. The present study of Fluorine contamination of Jhabua will not only add to the scientific literature but will add to the new vent and opening of scientific research specially on for preventive, corrective and mitigating measures of water ecology and Fluorine borne diseases.

METHODOLOGY

In Jhabua district State and Federal Agencies has taken up various projects of water supply, ground water exploration, watershed development, rain water harvesting under various schemes. The Central ground Water Board, Ministry of water Resources reported several Problem villages in Jhabua district and ground water regime has been contaminated at many places. At places some villages are affected by Fluorine some villages were affected by Guinea worm (water borne disease) where water contain excessive amount of bicarbonates. In present studies about fifteen villages were studied in Jhabua district viz Tikdimoti, Umariya, Surdiya Kotda, Rambhapur,Behrapada,Thapli,Bawadi Khurd, Behawada Sadli Rama, Meghnagar, Petlawad, Jobat, Alirajpur to study water ecology of surface and sub-surface water quality pollution, Fluorine concentration, TDS, PH, and EC, Calcium, bicarbonates were determined.,

Water Quality Monitoring

In the area of study systematic water sampling was carried out and about 200 samples were collected from different water sources in 15 villages. Water quality parameters like Fluorine TDS, PH, Alkalinity, Electrical Conductivity (EC), Calcium, bicarbonates were determined.

The area has been studied in detailed and basic data collected from several villages, school children and placed in to different categories. The same were further summarized on the merits of intensity of Fluorosis. The sources of water included open dug wells, concrete dug wells, hand pumps, natural streams, rivers and ponds which are the sole domestic sources of water in the area supply.

Sample Collection and Analysis

In the affected area two temporary field laboratories were set up. Water samples were collected in polyethylene bottles, which were vigorously washed with detergents and rinsed with distilled water. As a precaution, all the sample bottles were again washed vigorously with the water to be tested. These samples were analyzed within 24 hours of collection in the field laboratories. Battery-operated handheld pH and EC meters were used to measure the pH and the electrical conductivity of the samples. Alkalinity, total hardness, calcium hardness and calcium were analyzed by titrimetric methods. A fluoride ion meter (Model 290A+ Orion, USA) was used to analyze fluoride concentrations in the water samples. The standard methods of water analysis prescribed by the APHA were followed in analysis of all the parameters.

Peoples participation and Awareness programs.

It is suggested that in Jhabua district in the area affected by Fluorosis a team of social workers, community workers, Artist Doctors , Geologist, Geohydrologist, Pedologist and scientist should udr take various aweress programme like street plays, rally with different banners and slogan to educate communities about Fluorosis its possible sources its causes and possible measures for mitigation of the problem. In addition different activities like puppet shows, dialogues with the villagers, posters banners pasting and distribution of pamphlets on Fluorosis should also be under taken in affected area to appraise them about the problem and its causes. In addtion series of community meetings may be coducted in each affected village to discuss plans for accessing safe water for domstic use diffrent options for corrctive and mitigation measures, costs and management systems. The mitigation plans of individual village finally may be prepared ad submitted to local administrators for their implemtaion.

DISCUSSION

Health Survey

A total about 1800 men women (28 to 40) and children (18 to28) participated Fluorosis survey carried out in 15 villages Jhabua district. The survey results are summarized in Table 2.

Table:2. Results of the Dental Fluorosis Survey

S.No	Description	Values
1	No. of Schools Surveyed	41
2	No. of Villages Students are resident in	207
3	No. of villages with very high prevalence of fluorosis	8
4	No. of villages with moderate prevalence of fluorosis	2
5	No. of villages with mild prevalence of fluorosis	5
6	Total no. of villages with fluorosis cases	15
7	Total no.of children surveyed	2580
8	No. of children affected by mild dental fluorosis	1210
9	No. of children affected by moderate dental fluorosis	447
10	No. of children affected by severe dental fluorosis	49
11	Total no. of children affected by dental fluorosis	1796
12	No. of children with suspected dental fluorosis	424
13	Total no.of children affected or suspected	1219

Chemistry of Water sources

The results of chemical analysis of water samples collected from affected villages are shown in Table 3. The results obtain demonstrate wide spatial variation in the values of all parameters analyzed. It indicates diversity in the geochemistry in the area. The Parameters like pH, EC, alkalinity, hardness and calcium were found to be within the prescribed limits for most of the water sources, where as Fluoride concentrations were higher than the prescribed limit of 1.5-mg/l. in drinking water sources of ground water and surface water in

most of the villages. It is observed that Fluoride and calcium concentration has inverse relation in occurrence in both surface water and sub surface water in the area

Fluoride Concentration in Drinking Water Sources

The results of chemical analysis of Fluoride concentration is given in Table 3. The fluoride concentrations varied between 0.2 –13.5 mg/l in all water sources studied. The concentrations varies place to place with the sources the over all spatial variation of is wide spectrum and diverse. It is significant to note that Fluoride concentrations in ground water sources is quite high as compared to the surface water sources .It appears to due to the dynamic nature of ground water regime which is influenced and controlled by geology and structural set up of the area. The average depth of bore holes in the area is about 250 feet which indicates that water is being tapped from both shallow and deeper aquifer and water table has exposure to wide verity of crystalline rocks which contain fluoride minerals

Table 3: Water Quality Profile of the Different Sources of Drinking Water

S. No.	Village	Kind of Source	No. of Source	Water Quality Parameters						
				pH	EC (μmho/cm)	Total Alkalinity as CaCO3 (mg/l)	Total Hardness as CaCO3 (mg/l)	Calcium Hardness as CaCO3 (mg/l)	Calcium as CaCO3 (mg/l)	Fluoride (mg/l)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.	Tidimoti	HP PW DW Nala	13 14 21 2	6.9-7.8 7.4-8.4 7.2-8.6 8.0-8.4	448-1379 474-1378 508-1173 655-778	200-536 192-628 180-784 296-374	140-324 124-266 78-388 226-254	18-242 24-174 36-176 104-116	10.9-97.0 9.6-69.8 14.4-70.6 41.7-46.5	3.5-11.8 1.715.5 1.2-12.3 2.5-4.2
2.	Umariya	HP PW DW River	7 9 1 1	7.1-7.4 7.3-7.8 7.7 8.1	579-790 404-997 790 197	244-376 180-418 358 84	196-308 140-388 222 70	112-164 110-176 80 70	44.9-65.8 44.1-70.6 32.1 28.1	2.8-6.3 2.5-6.7 5.0 0.40
3.	Surdiya	HP PW DW River Nala	9 11 65 1 1	6.6-7.7 7.3-8.0 7.6-8.0 8.3 8.2	293-1055 618-958 569-1065 240 830	128-570 304-468 264-544 102 426	214-428 132-258 188-288 84 254	46-210 42-174 100-164 60 160	18.4-84.2 16.8-69.8 40.1-65.8 24.1 64.2	0.2-5.50 0.7-8.10 1.3-4.5 0.40 4.45
4.	Kotala	HP PW DW River /Stream	24 24 7 2	7.1-7.7 7.3-8.1 7.8-8.5 8.2-10.1	537-986 406-1076 748-995 355-526	176-426 158-522 276-424 172-284	102-280 88-466 148-354 84-102	76-190 58-264 104-220 30-100	30.5-76.2 23.8-105.9 41.7-88.2 13.6-40.1	0.9-9.8 1.0-14.8 2.9-6.3 1.3-2.0
5.	Rambhapur	HP PW	10 5	7.1-7.5	540-1008 626-889	170-422 282-344	140-308 164-346	76-214 100-188	30.5-85.8 40.1-75.4	1.59-4.4 1.4-3.5

		DW River /Stream	6 2	7.2- 8.0 7.3- 7.8 8.1- 9.7	662-1224 559-730	166-354 234-316	228-528 96-150	174-212 40-84	69.8-85.0 26-33.7	0.9-3.2 2.3-3.4
6.	Thapli	HP PW River /Stream DW	26 18 16	6.6- 7.6 7.2- 8.4 7.1- 8.3	375-1223 456-1414 423-1132	80-398 180-582 160-526	114-422 104-328 64-348	34-186 34-146 24-92	13.6-75.6 13.6-58.5 9.6-36.9	0.2-2.5 0.6-4.0 0.5-2.2
7.	Bawdikhurd	HP PW DW River /Stream	41 58 101 2 3 1	6.8- 7.9 7.2- 8.3 7.2- 8.5 8.1- 9.0 8.9- 9.6 8.8	447-1411 393-1254 340-1359 744 516-793 883	120-430 130-676 104-622 312-344 214-334 428	102-524 104-494 84-564 194-254 116-130 212	78-320 48-310 40-356 80-90 56-66 60	31.3- 128.2 19.3- 124.3 16.0- 142.7 32.1-36.1 22.5-26.5 24.1	0.4-7.3 0.4-7.3 0.5-7.9 6.1-7.2 2.4-3.2 2.0
8.	Behawda Sadhi	HP PW DW River /Stream	9 9 9 1	6.8- 7.4 6.8- 8.0 7.0- 8.1 8.9	534-1037 296-1138 329-1166 384	223-476 142-616 144-522 232	140-288 78-266 126-286 88	80-168 52-238 56-198 60	32.1-67.4 20.8-95.4 22.5-79.4 24.1	0.5-6.7 1.0-5.61 0.6-11.9 1.8
9.	Jhabua	HP PW DW River /Stream	30 22 33 4 2	6.5- 7.6 7.0- 8.3 7.1- 8.3 7.6- 7.7 7.8	351-1172 426-1158 445-1646 641-915 770-917	110-682 182-596 188-982 308-406 364-468	122-512 156-470 66-406 208-322 258-288	62-190 60-214 34-198 80-120 92-100	24.8-76.2 24.1-85.8 13.6-79.4 32.1- 48.12 36.9-40.1	1.2-7.5 0.8-11.7 0.8-8.7 3.0-6.5 2.4-3.6
10.	Rama	HP PW DW River /Stream	31 16 72 2 1	7.0- 8.0 7.7- 8.7 7.6- 8.4 8.1- 8.4 8.3	362-1314 488-1358 495-1825 484-634 791	240-370 336-702 214-486 - -	102-344 168-356 60-392 126-196 178	20-136 14-152 8-138 64-48 24	8.2-54.5 5.6-60.9 3.1-55.3 27.3-15.2 9.62	0.7-7.8 0.9-7.9 0.4-7.4 1.6-1.9 5.29
11.	Meghnagar	HP PW DW River /Stream	37 46 118 3 2 1	7.1- 8.0 7.6- 8.4 7.2- 8.6 7.5- 8.4 8.2- 8.4 9.3	549-1152 305-1248 520-1154 542-743 653-707 593	238-478 112-442 218-548 226-314 312-352 276	138-388 108-394 140-388 110-234 192-200 154	22-256.0 10-154.0 14-240 14-196 38-84 28	8.8-102.6 4.0-61.6 5.6-96.2 5.6-76.2 15.2-33.7 11.2	0.9-5.8 0.9-5.4 0.9-6.1 3.9-4.0 72.3-2.7 3.8
12.	Alirajpur	HP PW DW River /Stream	5 8 42 2 2	7.0- 8.0 7.0- 8.0 6.0- 8.0 6.0- 7.0 7.0	579-829 544-1186 157-1076 184-285 422-425	196-406 128-294 40-574 52-122 182-190	146-218 86-254 54-256 44-70 78-84	80-126 44-176 30-186 34-62 60-68	32.1-50.5 17.6-70.7 12.0-74.6 13.6-24.9 24.1-27.3	15.43 2.0-11.1 0.3-14.0 0.2-0.7 1.8-2.4

13.	Jobat	HP PW DW River /Stream	23 4 27 6 1	6.8- 8.0 7.2- 7.9 6.5- 8.8 7.0- 9.6 9.1	393-857 468-634 303-1203 309-684 118	84-378 104-284 54-730 122-254 254	116-378 190-386 74-462 82-174 64	56-176 78-146 44-250 56-114 30	22.4-70.6 31.3-58.5 17.6- 100.2 22.4-45.7 12.0	14.65 0.4-1.8 0.4-7.8 0.4-4.1 0.5
14.	Petlabad	HP PW DW River /Stream	3 9 20 1 1 2	7.1- 7.2 7.0- 8.3 6.8- 7.9 8.4 8.1 7.6- 8.6	575-1083 422-1080 191-852 708 311 459-698	258-462 96-488 76-336 322 120 208-254	158-374 116-390 106-300 138 100 154-152	118-232 50-262 280-152 70 60 84-86	47.3-93.1 20.0- 105.1 160-60.9 28.0 24.1 33.7-34.5	9.60 1.0-6.5 0.7-7.5 3.2 0.9 1.9-2.1

Fluoride Concentrations in Drinking water and its impacts.

Data showing the relationship between the severity of Fluorosis and fluoride concentrations was extracted from the Fluorosis mapping exercises and the water quality monitoring exercises. It is summarized in Table 4. The average fluoride concentrations in drinking water corresponding to different degrees of severity of Fluorosis were also calculated and shown in Table 5 and Fig. 2.

Table 4: Fluorosis Concentrations in Drinking water and impact

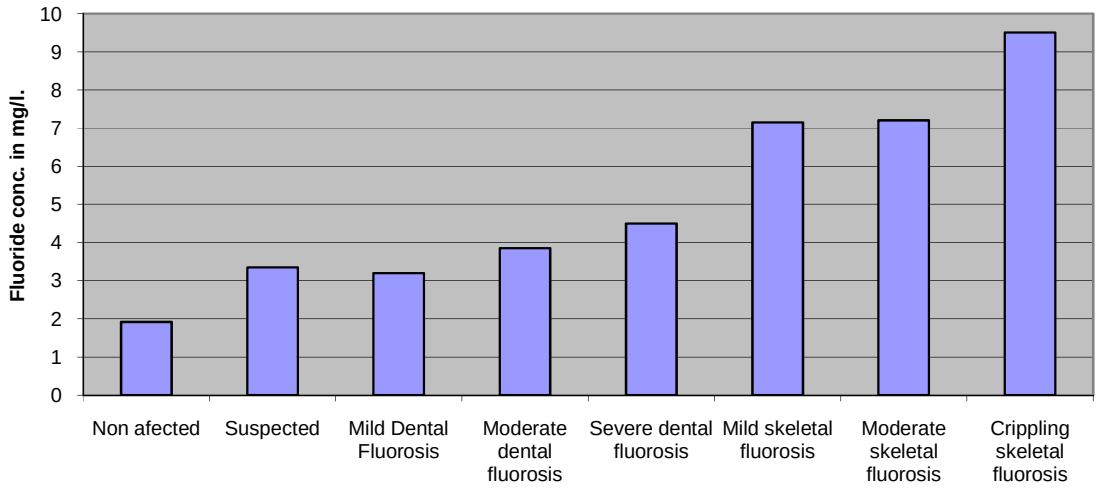
Fluoride Conc. in drinking water (mg/I)	**Severity of Fluorosis**							
	Dental Fluorosis					Skeletal Fluorosis		
	Non affected	Suspected	Mild	Moderate	Severe	Mild	Moderate	Cri
1	2	3	4	5	6	7	8	9
	No.	No.	No.	No.	No.	No.	No.	No.
<2.0	56	3	14	*	*	*	*	*
2.1-2.5	18	5	38	9	*	2	*	21
2.6-3.0	3	5	15	7	1	*	*	*
3.1-3.5	3	3	13	12	1	2	*	2
3.6-4.0	3	5	14	16	2	*	*	*
4.1-4.5	4	5	18	6	2	1	2	*
4.6-5.0	*	*	7	4	*	*	*	*
5.1-5.5	2	*	6	4	*	*	*	*
5.6-6.0	*	*	2	4	1	*	*	*
6.1-6.5	*	*	1	1	*	11	1	*
6.6-7.0	*	*	*	*	1	4	8	1
7.1-7.5	*	*	3	1	*	3	3	*
7.6-8.0	*	*	*	2	*	7	3	1
8.1-8.5	*	*	*	*	*	*	*	*
8.6-9.0	*	*	1	*	*	*	*	1
9.1-9.5	*	*	*	*	*	*	*	*
9.6.10.0	*	*	*	*	*	3	1	6
>10.0	*	*	1	2	1	2	1	7
Total	81	26	133	68	9	35	19	40

Table No. 5
Average fluoride concentration and impacts of Fluorosis.

Severity of Fluorosis	**Number of cases**	**Average fluoride conc. in drinking water (mg/I)**

Non affected	81	1.92
Suspected	26	3.35
Mild dental Fluorosis	133	3.2
Moderate dental Fluorosis	68	3.95
Severe dental Fluorosis	9	4.50
Mild skeletal Fluorosis	35	7.15
Moderate skeletal Fluorosis	19	7.20
Crippling skeletal Fluorosis	40	9.50

Fig. 2 : Average fluoride conc. Gard inspects of fluorosis



The ill-effects of fluorides in drinking water depend upon several factors, e.g., nutrition of the person at risk, the exposure period, etc. (1) Hence the same level of exposure to fluorides can have different effects on different people. Varying concentrations of fluoride in drinking water cause different degrees of Fluorosis in Jhabua district. Table 4 shows that cases of mild dental Fluorosis (discoloration of teeth) occur at fluoride concentrations as low as 2 mg/l. About 80% of the moderate dental Fluorosis (appearance of striations on teeth) cases are associated with sources containing >3 mg/l. The average fluoride concentration for severe dental Fluorosis (loss of teeth) is about 5 mg/l. While three persons using water containing above 3 mg/l reported mild skeletal Fluorosis (aching joints but no visible stiffening), the average for the remaining 30 cases was above 7 mg/l. Crippling skeletal Fluorosis (inability to walk without support) on the other hand most likely sets in due to exposure to fluoride concentration of more than 9.5 mg/l.

Strategies Control and Mitigation measures of Fluorosis.

The data of chemical analysis of fluoride concentrations in the water from the different sources critically analyzed synthesized and synchronized. Its spatial distribution in space and

time, its source and relation in geological columns were studied in relation to biotic aspects. The results and its derivation were shared with the communities at well-attended meetings in each village. These meetings were also used to raise awareness about various aspects of the subject. The communities were informed about:

• The geological rock strata soil and water of the area where they reside.

* The possible source of Fluorine contamination
* The causes and harmful effects of Fluorosis.
* Impacts of excessive consumption of Fluorine contaminated water.
• Nutritional interventions
• Certain precautions in fighting the disease
• Safe drinking water, a fundamental right
• Alternative sources of safe drinking water in respect to fluoride concentration
• Regular monitoring of water quality particularly with respect to fluoride concentration
• Sensitization of different groups within the society and the administration about Fluorosis and their mitigation measures

On the merits of results and derivations of studies separate meetings were also held with the community in each village to determine ways and means of accessing water supply with safe levels of fluorides. Among the options considered were:

i) Extending access to existing drinking water sources containing less than 1.5mg/l fluoride concentration
ii) Renovation or construction of sanitary wells at existing wells with less than 1.5mg/l fluoride concentration
iii) Recommendations of bore foe tube wells after geological and geohydrological consideration by geologist only.
iv) Installation of tube wells at locations of safe place and safe water aquifer.
v) After boring immediate water sampling from water from different depth levels and chemical analysis by concerned government agencies.
vi) After installation of pump and machine there should be regular sampling and monitoring of chemical parameters of water by concerned government agencies.
iv) Roof rainwater harvesting
v) De fluoridation of water using Nalgonda technique, activated alumina or reverse osmosis.

CONCLUSIONS

The project highlights can be summarized as below.

Fluorosis, both dental and skeletal, is endemic problems in fifteen villages of the area.
The villages around Alirajpur Jhabua Jobat located on Proterozoic rocks consisting of granites gneiss; feldspathic, granite and pegmatite are more prone to Fluorine contamination. These areas need more attention for detailed study.

Most of the currently used drinking water sources in these 15 villages have fluoride concentrations above the permissible 1.5 mg/l, some of the sources have fluorides as higher as 15.43 mg/l.

(iii) The incidence of Fluorosis with fluoride concentration in drinking water in the area revealed the following thresh-hold fluoride concentrations:

a. Initiation of mild dental Fluorosis: 2 mg/l
b. Initiation of severe dental Fluorosis: 4 mg/l
c. Initiation of mild skeletal Fluorosis: 6 mg/l
d. Initiation of severe skeletal Fluorosis: 10 mg/l

(iv) With systematic scientific inputs and information dissemination campaigns the affected communities were made aware of the problem and motivated to participate in its mitigation.

(v) No single technique or measure can ensure water of permissible fluorides concentration to all households of a village, except of course a village–level or a cluster level low–fluoride tube–well or de fluoridation plant along-with piped water distribution system. This is not only highly capital intensive but also poses maintenance and operation problems. It would also be an externally imposed solution, much beyond the expected village-level competence and unlikely to enhance self-reliance.

(vi) In 15 villages the communities have prepared proposals involving a mix of technologies appropriate for a village. These technologies are:

(a) Renovation and up gradation of existing low fluoride sources to make them fit for wider use.
(b) Defluoridation kits attached to hand pumps.
(c) Domestic defluoridation kits.
(d) Roof-top rain-water harvesting and storage.

(vii) The proposed plans involve an over-all financial input of about Rs 100 lac. This cannot be called excessive for the case of mitigation of a severe health problem of 21 villages inhabited by about 2150 households with 12,988 residents. Early steps need to be taken to finalize, detail and implement the proposed measures.

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