FLUOROSIS in GUJARAT: A Disaster Ahead

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Background

After visiting 25 villages in North Gujarat and re-visiting 18 of them during the last 6 months and having discussions with team of doctors at the offices of Commissioner of Health at Gandhinagar and doctors of NGOs as well, we feel that the government and the NGOs and the doctors as well do not like to declare/diagnose 'fluorosis' as such, rather they would like to cover 'fluorosis' behind the mask of MSD (Musculo-Skeletal Disease). The attitude of not declaring fluorosis is a typical fact existing among the doctors and the health-bureaucrats of Gujarat since long. In other states like Rajasthan, Delhi, and Punjab this is not so. Some kind of rehabilitation has been found for fluorosis victims, and there are some arrangements for making fluoride-free water at places, to keep away fluorosis or as a measure of prevention from it. It may be the severity of fluorosis is high in those states compare to that of Gujarat, however, there should not be so much indifferent view towards fluorosis for its less severity. The gestation period of fluorosis is long and less predictable, it may happen that the problem may become all-out severe in a few years, and by the time the State Government becomes alert, it could be a disaster. Doctors, who are working in government Health Centers and in NGOs are also not much aware of how to diagnose this irreversible disease, which is developing slowly among the people over the years in the location, where fluoride contaminated water is used since long.

NGOs like Aga Khan Health Services in North Gujarat, also do not keep any details of *'Va'* or MSD in their health ledgers. Though they know very well that some of the severe cases may due to high fluoride content in water. They do not like to explore it even! All *'Va'* or 'Fluorosis' cases they put under the heading of 'MSD' and prescribe painkiller, in general, as medicine. One of the visiting doctors of Aga Khan Health Services even said, "We do not have any directives for clarifying fluorosis cases as they have for Malaria and Polio". A surgeon at Siddhpur Civil Hospital has expressed the same view. He did not refer any patient of MSD for blood and urine test to diagnose fluorosis, till date. He was there at the hospital for the past three and a half years at the time of investigation. "Probably the priority has been shifted towards 'communicative' diseases like AIDS, from this 'irreversible' disease like fluorosis", said an eminent doctor from Community Health Department of a Medical College in Ahmedabad.

Doctors around study districts never tried to go for a thorough examination of the local water or just by hunch also they have never tried to see the content of fluoride in urine or in blood in a human body suffering from MSD for a long time. There is not a single pathologist, who could tell us the availability of a fluoride-test kit used for detecting fluoride in urine or in blood. They had never done this kind of test in Mehsana, and Patan, [till the date of inquiry during the second half of May 2004] as told to this investigator. Very recently the government has taken a note of Dental Fluorosis [DF] among the school children of Gujarat, because it is easy to identify, as it is visible. All the painful fluorosis cases are overlooked as the case of typical *'Va'* or put them under the big mouthful name of Musculo-Skeletal Disease, which is nothing but a big canvas to avoid identifying fluorosis. We do not

know whether it is ignorance, indifference or apathy towards Fluorosis. What we understand that possibly they do not like to recognize 'fluorosis' as the outcome of the fluoride contaminated groundwater. While in Rajasthan they have recognized 'fluorosis' and brought some solutions by introducing Activated Alumina kit to kitchens.

People Under Risk

Though the percent use of water for domestic and drinking purposes is the lowest but it can make life unsafe if the quality of water is poor, and particularly if it is contaminated with fluoride and arsenic like chemicals. Worldwide domestic use of water is about 10 per cent (FAO; 2002b; Crops and Drops); in India, the domestic use is 4.5 percent (IRMA/UNCEF, 2002) and 'groundwater accounts for nearly 50% of the urban domestic and 80% of the rural domestic water need in India' (Dinesh Kumar et al, 2004).

Obviously there is a high demand for groundwater for domestic use. However, deepening wells to harvest groundwater unmindfully, deepens the problem of contamination with fluoride, nitrate, arsenic etc; especially, when it is extracted from underground, where water sits in pores in the rocks for long periods like in Aravalli Range in North Gujarat. Escalating water crisis in North Gujarat forces people to search for water deeper and deeper underground that has aggravated the problem of fluoride contamination. The problem becomes more acute when rainfall is less. During the past few decades, high quantity of fluoride in groundwater affected people of Gujarat, Rajasthan and many other states in India like Tamil Nadu, Andhra Pradesh, and Haryana. Among 32 states 17 are highly endemic to fluorosis. There are more than 60-80% districts affected by fluoride in Andhra Pradesh, Gujarat, Rajasthan, Punjab, Haryana and Karnataka. It is found that 66.62 million people are at risk to the problem of fluoride, in India, of which 6 million are children below the age of 14 years (Susheela, A Treatise on Fluoride, 2001, 16).

The Aravali hills pass through Rajasthan and are extended to Panchmahal district in Gujarat. The minerals like Fluorspar, Cryolite and Fluoropatite are found in abundance in these regions. A survey conducted by PHED [Public Health Education Department] in Rajasthan pointed out that 35% or 13021 villages in Rajasthan has more than 1.5 ppm fluoride in groundwater. The groundwater of 4341 or 52.6% villages of the total 8252 villages in Gujarat[1] is contaminated with more than 1.5 mg/litre of fluoride. But WHO's recommendation for permissible fluoride is 1.0 mg/litre[2]. The people of all these villages are under the risk of fluorosis. However, all of them may not be afflicted by fluorosis because it largely depends on the metabolism and the degree of immunity of a person.

Several studies have looked at the physiological and hydro-geological dimensions of fluoride contamination of groundwater, however, there are hardly any studies that have analyzed the social dimensions of the impact of fluorosis on quality of life. Similarly, no attempt has been

[1] Office of the Commissioner of Health, Government of Gujarat, Gandhinagar, as on 1.04.2003.

[2] Although 1.5 mg/litre is the upper permissible limit, the Bureau of Indian Standards (BIS) has amended the Fluoride Standard for drinking water in India during 1992; which now reads as follows: " 1.0 mg/litre is the upper permissible limit, however, lesser the better as Fluoride is injurious to health". [Ref: State of the Art Report on the Extent of Fluoride in Drinking Water and the Resulting Endemicity in India, Scientific & Technical Information Compilatio for UNICEF, New Delhi by Fluorosis Research & Rural Development Foundation, New Delhi; Ch – 1, p. 1.]

made to estimate the economic cost of fluorosis-related debilities, nor any such proper method has been devised, to declare a fluorosis patient as a 'fluorosis patient'.

The Science of Fluorine/Fluoride

Fluorine is the 13th most abundant element in the Earth's crust where it exists in the form of fluoride minerals and salts, such as Aluminium fluoride (topaz) and calcium fluoride (fluorspar). Fluorides often turn up as a constituent of granite and may form rich seams as the granite is eroded. The fluorides in these rocks will dissolve in water but they can reach high concentrations when underground water sits in pores in the rocks for long periods.

It Helps

Small amounts of fluoride compound help to combat tooth decay. This is because the fluoride ion attack enzymes that manufacture the acid in the mouth on which the bacteria set down that cause tooth decay. So water companies sometimes add sodium fluoride to public water supplies with a low natural fluoride content, particularly in the region, where children are suffering from tooth decay. Recently, this has been proved as wrong.

It Damages

But too many fluoride ions will cause mottled teeth and damage the rest of the body. The body absorbs fluoride ions mainly through the gut. It excretes some through the kidneys and sweat glands, but if the content is too high the ions will accumulate. Because fluoride ions are strongly negatively charged they have an affinity to positively charged calcium ions. So they are mostly deposited in the same places in the body as calcium - notably teeth and bones, where crystals of calcium fluoro-apatite[3] form. These crystals will often displace unbound calcium in the bones - especially if the body is short of calcium because of a poor diet. The crystals increase the density of the bone, putting pressure on nerves and blood vessels. This disrupts bone growth, especially in children, and causes pain and eventually paralysis.

Fluorosis

If groundwater contains more than 1.0 mg/l of fluoride and is used for a long time for drinking and cooking purpose then it may cause fluorosis. Fluorosis is a crippling disorder due to entry of fluoride in the body, which affects every organ, tissue, cells in the body, and results in health complaints having overlapping manifestations with several other diseases like gouts and osteoporosis. In short, it causes Dental Fluorosis, Skeletal Fluorosis, Bone Fractures, Fluoride Poisoning, and also Cancer. Fluoride damages the Pineal Gland, which secretes melatonin hormone in the brain. The melatonin controls functions such as, sleep cycles, jet lag, and hibernation in animals, immunity, and the onset of puberty. Fluoride also affects the reproductive systems and intelligence. Thus overexposure to fluoride is injurious to human life. It is a threat to the public life. The world is facing the challenge of eliminating fluoride from drinking water.

[3] Crystalline mineral of calcium phosphate and fluoride [from German *apatit,* from Greek *apate* – deceit (from its deceptive forms); COD.

Spread of Fluoride Menace

"Fluoride is a worldwide menace" as Fred Pearce expressed in his article (www.fluoride.org.uk/news/news_index.htm) 'From Bad to Worse: Ambitious targets and poor quality control'. An estimated 60 million people in India suffer from fluorosis caused by drinking underground water; most of it brought to the surface by hand pumps installed in the past two decades where, excessive natural fluoride is present in underground water[4]. India's escalating water crisis forces people to search for water deeper and deeper underground, is exacerbating the problem. When we pump water from deeper underground, we are tapping older water, water that has been in contact with the rocks for long. So it is more contaminated. As the water tables continue to fall in response to demand, fluoride levels in thousands of boreholes will continue to rise, many of them still untested. To avoid the Bacteria contaminated surface water they tried for groundwater but carelessness towards the quality of groundwater lifted through tube wells or hand pumps made the problem worse. The poison gushes to the surface from Chile to China, where there are an estimated 1.6 million victims, and from Ethiopia to Uzbekistan.

A plenty of research has been done in the US and in the UK and also in Australia for the use, misuse and prohibition of using Fluoride. The Fluoride is the 'problem child of industry'. This highly toxic industrial byproduct was marketed with a carefully planned official marketing programme to use it in the drinking water in the US in 1945, understanding that the use of fluoride would improve the health of teeth of the people, particularly of the children. Incidentally, this was proved wrong and later the adding of fluoride to drinking water was prohibited. However, by the time health of the nation was severely injured.

It is like 'Dare to think ... and speak?' situation to 'fight against fluoridation' [5] as a news letter said, "The more you learn about the subject, then the more you realize you have to fight it tooth and nail. If you are an effective fighter then you become dangerous. If you become dangerous, you become a threat. If you become a threat then you put your reputation, your career, your health and even your life in danger. Here are some scientists, who were either killed or had been asked to leave their job, like: Charles Eliot Perkins [Perkins was found murdered in Train carriage], Dr John Yiamouyiannis, Dr Phyllis Mullenix [Phyllis was asked to leave her job]. In recent times, Greg Wingard wrote in GANGA GANGOTRI that

[4] Hand pumps installed during the UN International Water Decade of the 1980s gave villagers control over their own water supply, and freed them from reliance on either polluted surface waters or expensive networks of pipes bringing water from distant sources. But the hand pump became a victim of its own success. The water decade, aimed ambitiously at producing safe and accessible water for all by 1990, became a race to sink as many wells as possible and as quickly as possible. India set its own tough target of at least one water source for every 250 people, no more than a mile from any community. UNICEF aided this project and encouraged Indian government to speed up the programme. The project got obsessed with 'number game', leaving behind the quality of water emerging from those hand pumps. Later Rupert Talbot, who used to run water policy for UNICEF in Delhi, estimated that at least one hand pump in every 10 were contaminated with unsafe levels of natural chemicals, mostly fluoride and arsenic, but also iron and salt. However, the project could have been more of water quality oriented than its quantity, which could have saved millions of children limping, round their villages today (www.fluoride.org.uk/news/news_index.htm).

[5] (http://fluoride.org.uk/infodoc/f10.html)

'Fluoride is a highly reactive poison, which is not essential in drinking water by any scientific measure'.[6]

In India, Fluorosis was first detected in Nellore district of Andhra Pradesh during early nineteen thirties by farmers. They found it among their cattle. Later they found the same symptoms of ache and pains in joints etc among themselves and among the people of neighborhood villages. The first medical report on Fluorosis was published during 1937 in the Indian Journal of Medical Research. Since then a lot of research work had been published primarily from Andhra and later from many other places of India (Susheela, A Treatise in Fluorosis, 15).

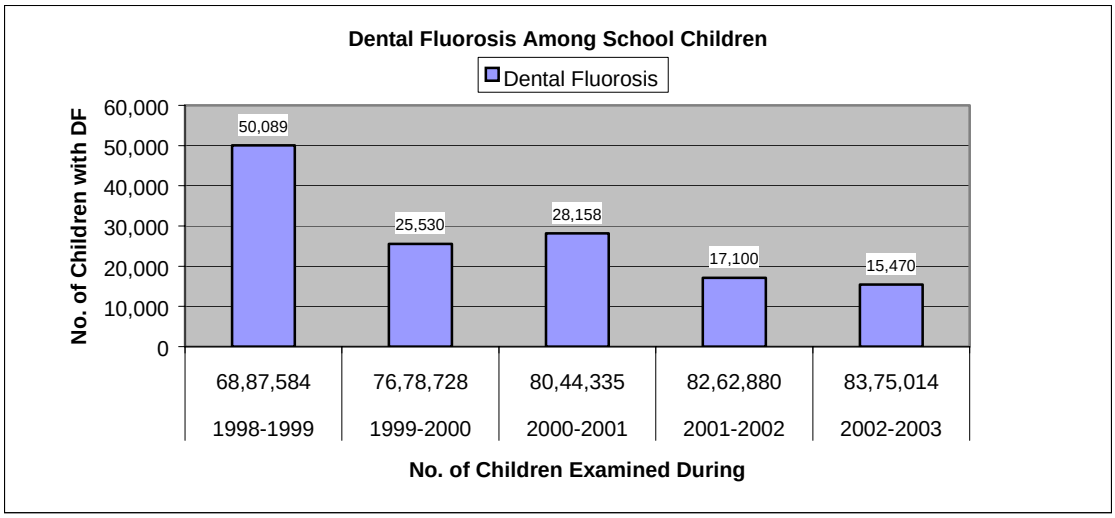
Difficult to Diagnose

Fluorosis is a crippling disorder due to entry of fluoride in the body. A proper thorough and in-depth pathological, radiological and physiological diagnosis is necessary before declaring a case or 'stamped' the case, as 'fluorosis' one, opined by many Medical Officers in the Office of the Commissioner of Health, GoG. It also needs to test the water being used by the patient and to know how long the patient is using the same water. The incubation period of fluorosis is very long. Many symptoms of fluorosis are somewhat alike with other diseases such as *'Va'*, arthritis, osteoporosis etc. At the village level, as told by the Medical Officers, it is very difficult to diagnose a patient properly, which requires analysis of X-ray, blood and urine by a good experienced doctor. Hence 'stamped' (the coin word used by the Government Medical Officers, Gujarat) cases of fluorosis are not available. However, it does not mean that there is no incidence of fluorosis particularly, when it is known that water is contaminated with fluoride and being used for a long time in the location. Hence cases of fluorosis are mixed with MSD and recorded as general MSD [musculo-skeletal disease] in hospitals and NGO's Health Centres as government did not want to recognize the incidences of fluorosis for reasons better known to them.

There are cases of Dental Fluorosis (DF) in thousands among school going children as reported in the School Health Programme of Government of Gujarat (GoG). The dental fluorosis is visibly detected and easy to diagnose and hence it is reported. The government declares DF after examining the children at their school. The report of the last five years from 1998-99 to 2002-03 (Chart – 1) shows that the incidence of DF is declining from 50 thousand to 15 thousands in Gujarat.

[6].[http://gangagangotri@yahoo.co.uk]Greg Wingard; http: naturalmineralwatergroup@yahoogroups.co.uk [naturalmineralwatergroup] Essential minerals for drinking water as WHO reports.
Greg Wingard <gwingard@earthlink.net>

Chart – 1: Percentage of DF Among School Children Examined in Gujarat



Source: Office of the Commissioner of Health, Government of Gujarat

Aga Khan Health Services of India [AKSHI] is working for fairly long years in Methan, Meloj and other villages around Siddhpur Taluka in Patan District in North Gujarat. Daily ledger of the center reveals that the 50% of the patients reporting is suffering from MSD. They do send patients for blood and urine examination but not specifically for fluoride test. We received the same report from CHC (Community Health Centre) at Siddhpur. We inquired with a pathologist at Siddhpur, who replied that he had not done any examination of blood and urine to find fluoride, so far. He had no knowledge of availability of a kit to examine fluoride[7]. Thus, we could not get any 'stamped' cases of fluorosis in AKHSI and not also in CHC at Siddhpur in Patan district in North Gujarat.

There is paucity of information and scientific study on fluorosis. However it may be mentioned here that Dr (Mrs) Vikas K Desai had carried out significant research in this area in 1993 taking 25 villages in North Gujarat as location of study. With a team of doctors, she did a baseline survey in and around Mehsana[8]. This study has primarily focused on preparing the baseline of sanitation, health, nutrition, and fluorosis problem for future impact assessment. Our attempt is to understand the social cost of fluoride contamination in groundwater in North Gujarat. For this purpose, we have taken a census survey of the same 25 villages studied by Dr Desai's Group in 1993 and then selected a sample of 200+ families. There is also one research paper of Dr R R Bhatnagar[9] that dealt with socio-economic and

[7] They do not like to explore it even! All 'Va' or 'Fluorosis' cases they put under the heading of 'MSD' and prescribe painkiller, in general, as medicine. One of the visiting doctors even said, "We do not have any directives for clarifying fluorosis cases as they have for Malaria and Polio". A surgeon at Siddhpur Civil Hospital has expressed the same view. He did not refer any patient of MSD for blood and urine test to diagnose fluorosis, till date. He was there at the hospital for the past three and a half years. "Probably the priority has been shifted towards 'communicative' diseases like AIDS, Malaria or Polio, from this 'irreversible' disease like fluorosis", said an eminent doctor from Community Health Department of a Medical College in Ahmedabad.

[8] Mehsana Fluoride Area Health Baseline Survey; Desai, Dr (Mrs) Vikas K; Govt. Medical College, Surat.

[9] Bhatnagar, R R , Impact of Excess Fluoride in Drinking Water on Human Beings and Animals.

psychological problems faced by the fluorosis patients in three villages of Mehsana district. But they did not estimate the social cost of fluorosis.

Objectives

To understand the various ways in which the afflicted are suffering, especially in terms of:

a) the cost they incur in treating their disease;
b) the loss of productivity and output;
c) the costs they are willing to incur to get rid of the disease; and
d) the cost they are willing to incur to save their family from the disease.
e) the awareness about Fluorosis and of the quality of water among people.
f) the affordability to get good quality of water.

Methodology

We have completed this study in two Phases. In Phase – 1, we have investigated the prevalence rate of fluorosis in 25 villages from Gujarat. In Phase – 2, we have done the detail study of social cost etc. from the sample of 235 households selected from the 18 villages of the same 25 villages from Mehsana and Patan Districts of Gujarat.

Phase – 1: For our study location in North Gujarat, we took the same 25 villages, which were surveyed by the team headed by Dr (Mrs) Vikas Desai mentioned above. This Project was surveyed in 1993 and the report was brought out in1994 under the name of 'Mehsana Fluoride Area Health Baseline Survey'[10]. We wanted to get the present prevalence of fluorosis in the same 25 villages for a ten years space, by taking a census survey using a short questionnaire [enclosed at the end]. We did the census by following steps:

a) We inquired about six very visible symptoms of fluorosis in the census questionnaire: Besides person-wise family details we collected whether a person is affected by any of the following symptoms related to fluorosis (1) Dental Fluorosis, (2) Can touch chest with chin, (3) Can Bend forward easily, (4) Can do sit-ups, (5) Can touch back of the head with hands, (6) Crippled. Dental Fluorosis has been placed separately. A person is called 'afflicted' with fluorosis or MSD, when one gives a negative reply to at least one of the (2) to (6) symptoms. Then we arrived at the percent of afflicted persons over the total population as the 'prevalence' rate of fluorosis or MSD in those 25 villages. This is a very simple estimate, since we did not take many other clinical symptoms related to fluorosis. We also did not capture separately skeletal and non-skeletal fluorosis in our census.

b) Next we tried to estimate the FIS (Fluoride Impact Severity) among these afflicted persons. We put a score '1' for each of these 6 symptoms; adding this score according to the occurrence (but not in any serial order of occurrence or not in any ordinal value of the severity) of symptoms in a person we arrived at the 'severity' of FIS for an afflicted person. The higher is the score of FIS; higher is the 'severity'.

[10] Mehsana Fluoride Area Health Baseline Survey, Project Report, Dr (Mrs) Vikas Desai, Professor and Head of Preventive and Social Medicine Department, Government Medical College, Surat, Gujarat.

c) We collected water-samples from the sources that people used for drinking in these villages. We got the water samples tested for TDS and Fluoride content at Ahmedabad[11].

Phase – 2: We collected some detail information from 235 households through a structured questionnaire [enclosed at the end] from 18 of the 25 census villages of Gujarat. This was for studying 'social cost' etc of the afflicted persons in these households following the steps below:

a) Each one of 25 villages were arranged according to prevalence rate of 'Va'/MSD/Fluorosis in a descending order.
b) Higher the presence of MSD-prevalence larger number of families (cases) was selected from that village.
c) The selection of families of afflicted persons were from the severity-scale, FIS of 6, 5, 4 and they were chosen randomly taking care of age and sex of the persons listed in census from the villages having more than 15% prevalence of fluorosis. The cases having FIS value of 3, 2, and 1 have been kept out of this sample.
d) Those villages having less than 15% prevalence of MSD have been kept out of the selection.
e) We were to select 200+ families; so 235 families were selected under stratified random sampling from 18 of the 25 villages of Gujarat. Of these 235 families 28 families[12] have no cases of fluorosis. We took these fluorosis-free families to understand the difference in socio-economic complex between the families with fluorosis and without fluorosis. There are 240 afflicted persons in 207 families, which means more than 1 person were sick in a family[13].
f) We also collected 81 urine-samples from these 240 persons [Gujarat] and got them tested for fluoride in urine from a laboratory in Ahmedabad[14]. The urine samples were collected randomly from afflicted men and women at different points of time in a day of investigation.

Phase – 1: Analysis:

The Prevalence of DF and Fluorosis

The 5 symptoms we have taken are the basic physical symptoms of 'fluorosis' to be checked initially for diagnosing 'fluorosis' (Susheela, 2001, 48). In an endemic locale, where water is contaminated with excess fluoride and is being used by the local population for a long time,

[11] Gujarat Institute Civil Engineers and Architects [GICEA], Ahmedabad.

[12] Fatehpura village is situated on the bank of the Sabarmati and very near to Dharoi dam. This village has very low fluoride 0.25 to 0.50 mg/litre in its 4 sources of water and the FIS value of the afflicted people is not more than 3. We selected 11 families from this village in order to find the difference between the fluorosis and non-fluorosis villages. We also have collected information from 17 families, where there is no case of fluorosis in their home, from the other affected villages.

[13] Collection of Data: Besides usual biasness, there was some over enthusiasm among the villagers in reporting their pain during our census data collection. As they felt that we were there from an agency to give them medicines or some help to get rid of their pain. But during our next visit when we went for detail data collection from selected houses, people were very reluctant to give their information as by the space of six months time they could guess that we were not in their village to give them a solution for their pain. It was a typical experience!

[14] Gujarat Institute Civil Engineers and Architects [GICEA], Ahmedabad.

and also if any of these 5 symptoms are found in a person, then that person should be taken for further investigation for 'fluorosis'. We wonder whether we can put these affected persons as 'fluorosis-prone' people. In that case, instead of putting them under the heading of MSD, we put them under 'fluorosis-afflicted' people. Therefore, now onwards all MSD or 'Va' cases we shall refer as 'fluorosis-afflicted' or simply refer as 'fluorosis' cases.

In our census the total population was found as 28,425 in 25 villages in Gujarat. This is 70.7% of 1991 population (40,228) of these villages[15]. A detail of census data has been shown in Annexure Table – 1. Of these 28,425 people nearly 36% or 10,126 persons were suffering from Dental Fluorosis (DF) and 16% or 4590 persons were suffering from at least one of the five symptoms of Fluorosis [Table – 1]. A detail age and sex-wise table has been given in Annexure – Table - 2. Among 4590 affected persons 14% or 643 cannot even walk properly and more than 64% per cent cannot sit-up and bend forward properly in Gujarat. They cannot move without some personal help or without hand-stick. Others, whose severity was found less could mange their daily chore with lot of pains, complained all most all of them. It's really a painful scenario in the villages!

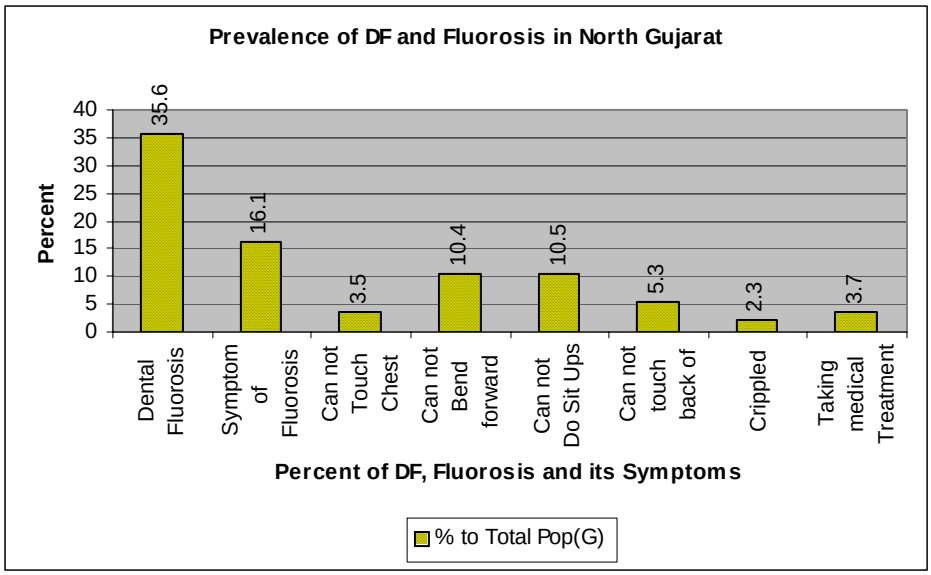
Only 4% of the total population and about 23% of the afflicted persons took medical treatment; rest 77% either could not afford or did not believe in medication to cure their pain.

Table – 1: Prevalence of 'Fluorosis-afflicted' Persons in North Gujarat

	Total Population	**Dental Fluorosis**	**Any one Symptom of** Va/ Fluorosis/ MSD Present (Afflicted)	**Can not** Touch Chest with Chin	**Can not** Bend forward Easily	**Can not** Do Sit Ups	**Can not** touch back of the head with hand	**Crippled** /unable to walk	Taking medical Treatment
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
All Age and Sex	28425	10126	4590	992	2956	2979	1515	643	1046
% to Total Pop	100.0	35.6	16.1	3.5	10.4	10.5	5.3	2.3	3.7
% to Afflicted			100.0	21.6	64.4	64.9	33.0	14.0	22.8

Source: Field Data: A census taken by IWMI, Anand, October 2003

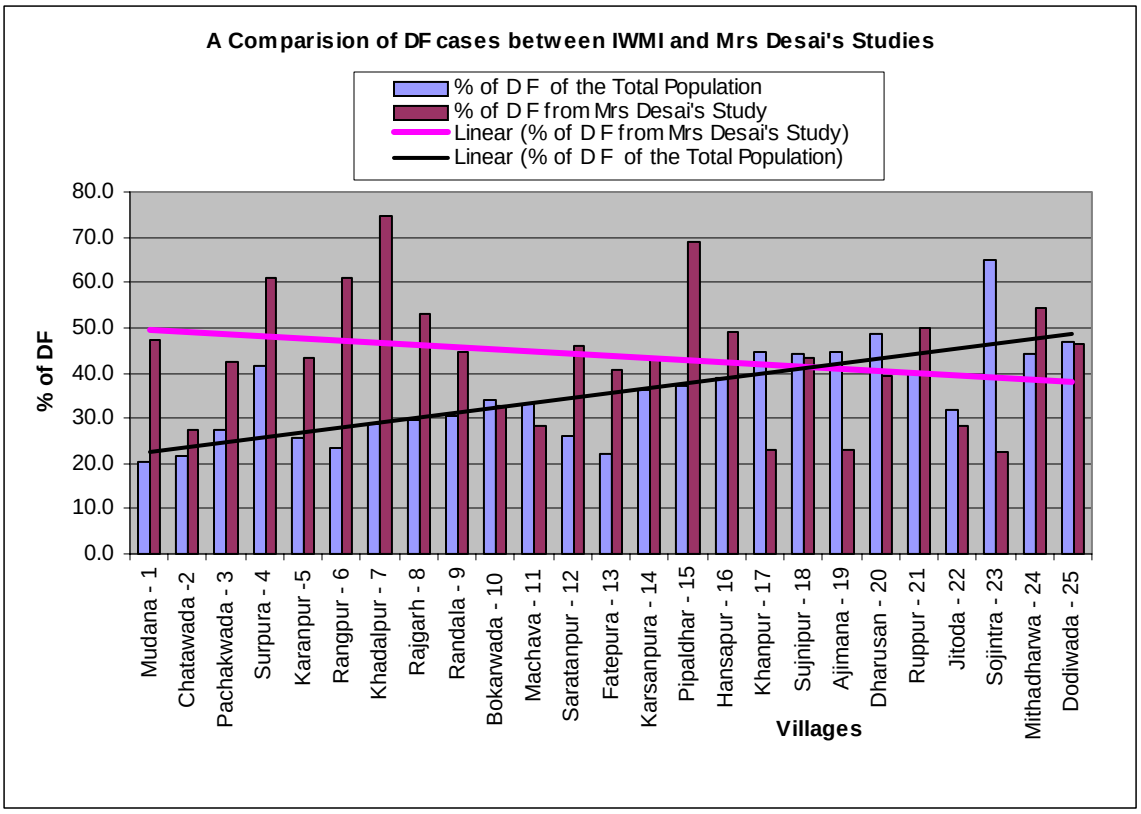
[15] Reasons of having less number of people compared to 1991 census are: (a) migration of families during these 13 years and (b) many families were not found on the day of our inquiry. People migrated towards Ahmedabad, Surat and Bombay for their livelihood. Families, who were not found on the day of our inquiry, were mostly out for a short period and their details were not available from their neighbours.



Source: Field Data: Table – 1

In Dr Desai's report, they have separately Skeletal and Non-skeletal Fluorosis, we have taken only Musculo-skeletal Disease or Musculo-Skeletal Fluorosis, and so we cannot compare these two studies for this purpose. But DF can be compared between the two studies. A comparative result has been shown in Chart – 2. There is a fall in DF cases during the last 10 years, in more than 50% of the study villages, when we put side by side the data of Dr Desai's study of 1994. Again, the total number of DF cases among school children shown as a decreasing experience in the record of Government of Gujarat [Chart – 1 above]. However, the over all linear trend of DF is increasing in our present of census of 25 villages. That is 'fluoride menace' is working quietly like a 'ghost'. The increasing trend is found in the villages like Mithadharwa, Sojintra, Ruppur, Jitoda etc., which are in Chanasma Taluka, where 10 years ago cases of Dental Fluorosis were much less. The average TDS and average Fluoride found very high in these villages, Khanpur 7.46; Machhwa 5.60; Mithadharwa 0.20; Rajgarh 5.60; Rangpur 1.93; Ruppur 6.00; Sojintra 6.50 (Chart – 4). Incidentally, Mithadharwa village has a supply of Dharoi's water very recently, so recent water report shows very low count of Fluoride. So the high DF cases that we have found are due the high fluoride that was present in the water earlier. Even there are high frequencies of MSD/fluoride-afflicted cases. By the time Dharoi's water has reached the village the irreversible damages have already been made by the fluoride menace.

Chart – 2: A Comparison of DF cases between IWMI and Dr Desai's Studies

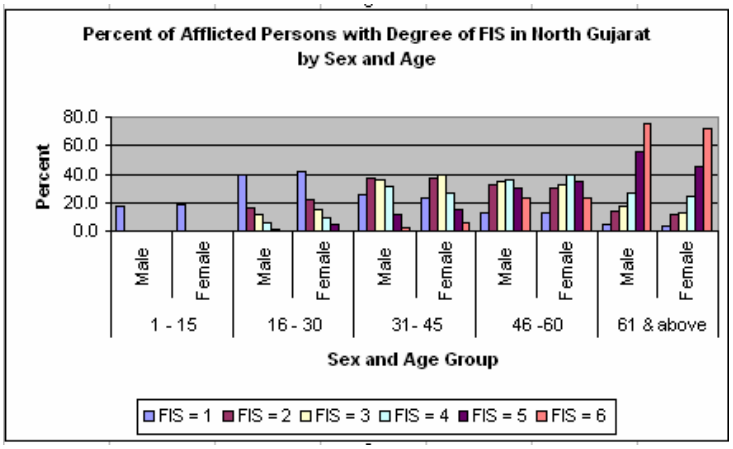


Source: Dr Desai' Report and Census Data of IWMI

Fluoride Impact Severity (FIS)

We tried to see the severity of fluoride debility among the afflicted persons and have done an exercise for getting the intensity of 'FIS' (Fluoride Impact Severity). We put score '1' for each of the 6 symptoms mentioned above. So, full score is 6 for six such symptoms, like DF, Cannot touch chest with chin, Cannot Bend forward easily, Cannot do sit ups, Cannot touch back of the head with hands, Crippled/unable to walk. It is added according to the presence of 'anyone of these symptoms' in a person and not in any serial order or not in any ordinal value for the severity. It's a simple scoring approach, higher the score, higher is the severity considered. If a person has reported any one of the six symptoms other than DF, we have declared him/her as an afflicted person of fluorosis. Except these physical symptoms we have not used any other clinical reasons here.

Chart – 3: Percent of Afflicted Persons with Degree of FIS in North Gujarat by Sex and Age



The percent of afflicted persons with FIS = 1 is found high in the age group of 16 to 30; for FIS value between 2 and 3, the number of afflicted persons are found more or less same in the age group of 31 to 60 years. However the percent of afflicted people with FIS = 6 increases steeply with age, especially after the age of 60. The severity of fluoride debility has a very grim picture particularly among the persons of above 45 years of age.

Quality of Water

We collected samples of water from the different sources in the 25 villages used for drinking and tested their TDS and fluoride content in the laboratory mentioned above. The content of fluoride and TDS were found to be source specific. If the water of Gram Panchayat tubewells is mixed with Dharoi-dam's water the fluoride and TDS both were found less. In some villages Dharoi's water was supplied by separate outlet or timings. People do not use water from a single source throughout the year, particularly, when multiple sources are available in the village, so we have taken the average TDS and fluoride content in water of a village where multiple sources were found.

Before we go to the details of the quality of water in terms of TDS and fluoride, let us see the changes in quality of water during the last 10 years between the two studies one by Dr (Mrs) Desai and the other by IWMI. The quantity of TDS and Fluoride have gone up except in a very few cases, proving that the quality of water has gone bad to worse during the last 10 years (Chart - 4 & 5). TDS or hardness of the water has gone up by 12 times in some villages. The quantity of fluoride has increased by more than double in some villages. It is due to the introduction Dharoi Dam's water, the fluoride has been found in a reduced quantity in some villages. Thirteen out of twenty-five villages have more than 500 ppm of TDS, which is the accepted upper limit of TDS (Chart – 4).

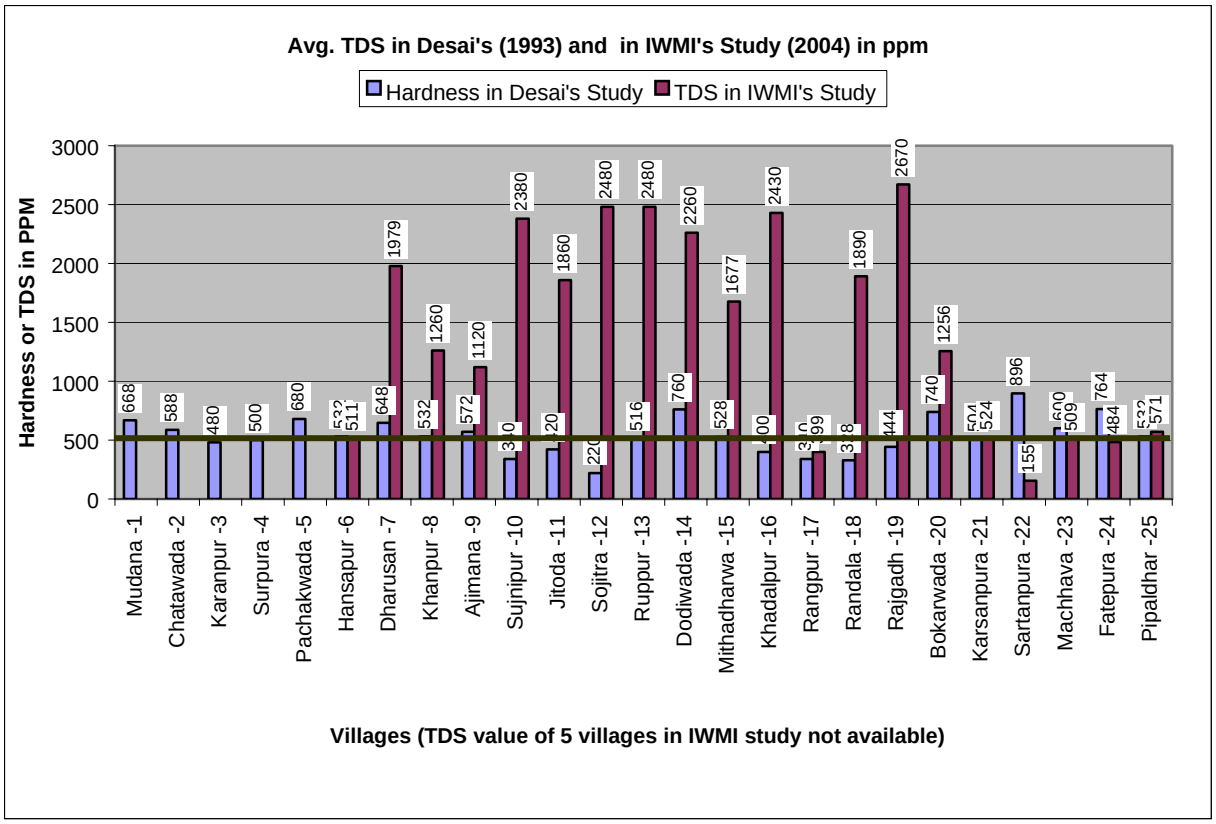
The average fluoride content varied from nil [Sujnipur] to 8.00 [Hansapur] mg/litre. A village with multiple sources, fluorides vary from 0.25 to 3.60 mg/l as in Rangpur, or 1.80 to 7.70 mg/l in Ajimana. An increasing trend of fluoride content is found in the water samples of these 25 villages (Chart – 5). There is no correlation between TDS and fluoride. High TDS in water does not mean the water would also be high fluoride content.

For example, water sample of Fatehpura has TDS of 581 mg/l and its Fluoride content is 0.40 mg/l, whereas in Karsanpura's water has TDS of 524 mg/l and its Fluoride content is 6.10 mg/l. The TDS difference between the water of these two villages is only 57 mg/l (less

than 10%), but the difference in fluoride content is 5.7 mg/l (nearly 93%) [Box – 1]. Dharusan water has TDS of a little above 2 times more than the TDS of Ajimana, but fluoride is less by nearly 31 times of Ajimana.

The quality of water with reference to fluoride and TDS has deteriorated during these ten years. Fluoride content has increased in 14 of 25 villages between these two studies. Many a time, government's effort to supply good quality water failed, and sometimes NGO's effort could not provide the right service in the long run. People's motivation, participation, and awareness could improve the situation.

Chart - 4: Comparison of Average TDS in Desai's (1993) and in IWMI' Study (2003)



Source: Desai's Report and IWMI's Field Data

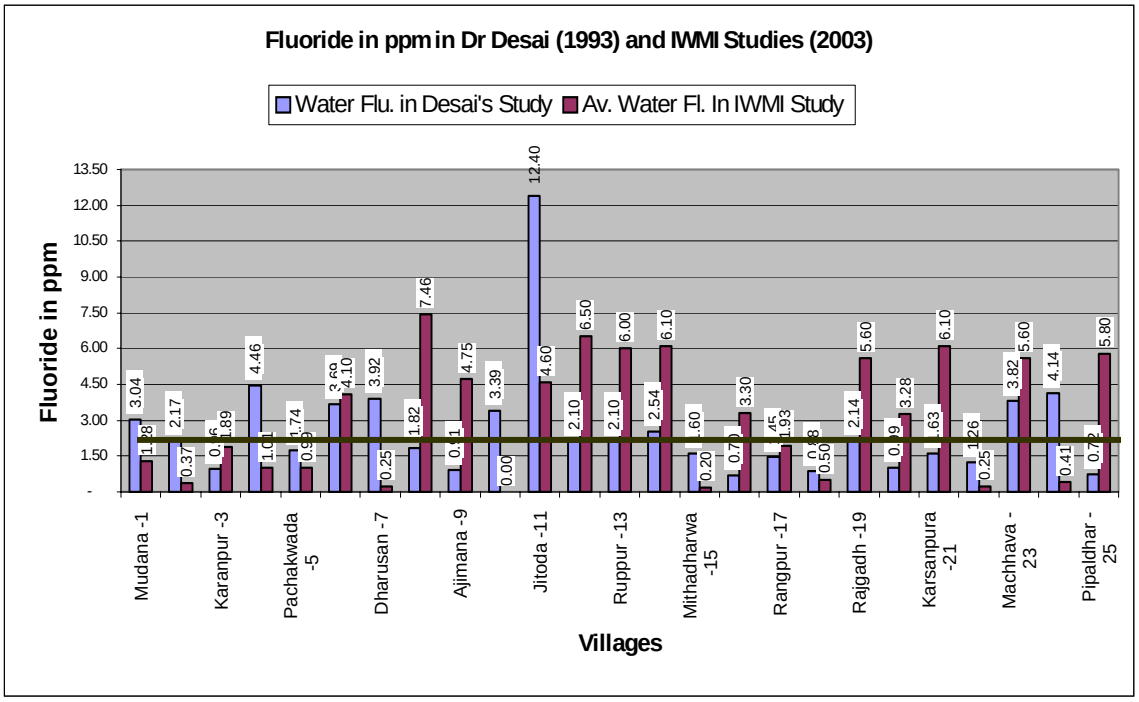
Box – 1: TDS and Fluoride content has no Direct or Indirect Relation

Villages	TDS mg/l	Fl mg/l	Villages	TDS mg/l	Fl mg/l
Fatehpura	581	0.40	Dharusan	3800	0.25
Karsanpura	524	6.10	Ajimana	1580	7.70
Rajgadh	2670	5.60	Sujnipur	2380	Absent
Bokarwada	2040	4.95	Mithadharwa	3180	0.20

Source: Field Data: TDS and Fluoride in 25 Villages

De-fluoridation plants made by state government did not work in villages, like Ismailpur in Chanasma Taluka, Methan in Siddhpur Taluka (Indu, 2002, 42), and Laxmanpura in Kadi Taluka (Hirway, 2003, 13-15). These three were low-cost Nalgonda type plants. These three plants were handed over to village Panchayat after initial 2-3 years of government's management. But none of the Panchayats could manage them. The reasons were almost the same everywhere, like short of finance to maintain, lack of people's participation, un-affordability of the people to bear the cost of fluoride free water, the choice of right place at the time of erection, and quality of raw water was not tested properly before erection of a plant. People wanted to get water at much low price. Ismailpur had another problem of

Chart – 5: Comparison of Fluoride in Dr Desai (1993) and IWMI Studies (2003) in ppm



Source: Desai's Study report and IWMI's Field Data

sharing maintenance expenses between the two villages since it was a joint programme of two villages – Ismailpur and Sojintra. Methan had a problem of revenue and hence for the maintenance. Because people of the villages were so poor that they could not afford to buy the de-fluoridated water even if they knew that they are suffering from fluorosis due to water – deep poverty could be seen among large part of this village. In Laxmanpura mainly lack of villagers' participation and awareness resulted in discontinuing the plant's service.

The state government also had tried with 11 big RO [Reverse Osmosis] plants in the late 1980s in different places of Gujarat. Five of them stopped functioning within two years of their erection. Reasons of non-functioning were mostly, technical; pre-testing of raw-water was not done properly before erection – like TDS of raw-water was not estimated correctly, which hit the capacity of the plants later and eventually stopped functioning, and some places appropriate sites were not chosen (CSMCRI, 1997, 93-95).

Regression Analysis:
We tried some Regression analysis with census data of Gujarat taking FIS as dependent variable. From the primary census data, we ran multiple regressions, using FIS as dependent variable and age, education, vocation, food type (vegetarian and non-vegetarian), year of suffering, medical treatment taken, TDS and fluoride as independent variables together for men and women. In the case of female, all the independent variables can account for 62.7% ($R^2 = 0.627$) of the FIS [Equation – 1]. In the case of male, all the independent variables can account for 67.9% ($R^2 = 0.679$) of FIS [Equation – 2] and it was found significant at one percent level of significance.

FIS for Female = 0.772 + 0.0103 Age (years) - 0.0146 Education - 0.0323 Vocation
[27.312] [27.815] [-9.699] [11.029]
+ 0.179 Food + 0.188 Year of suffering – 0.541 Medical treatment taken
[7.277] [63.014] [-60.562]
+ 0.00006 TDS + 0.0149 Fluoride
[7.885] [5.466]
$R^2 = 0.627$ Adjusted $R^2 = 0.627$ [Equation – 1]

(Figures in parenthesis are t value)

FIS for Male = 0.086 + 0.0086 Age (years) - 0.0025 Education + 0.0062 Vocation
[3.244] [28.014] [-2.239] [2.605]
+ 0.054 Food + 2.125 Year of suffering – 0.053 Medical treatment taken
[2.549] [92.204] [-5.197]
+ 0.00004 TDS + 0.0118 Fluoride
[6.262] [5.276]
$R^2 = 0.679$ Adjusted $R^2 = 0.679$ [Equation – 1]

(Figures in parenthesis are t value)

Out of all independent variables, education, food, and medical treatment are showing better b-coefficient. In case of education, result shows that, as people were getting more education, they probably become more conscious about their health and would be able to keep away from fluoride. In case of food, it is positively associated with the FIS. In the study area, generally, peoples are taking vegetarian food and these foods are deficient in calcium and other nutrients. As many researchers pointed out that sufficient intake of calcium, vitamin C, E and antioxidants in daily diet reduces the negative impact of fluoride on human body (Susheela, 2001, 99). The food with this kind of nutrients helps in managing fluorosis. In case of medical treatment taken, it is negatively associated with FIS. This can be explained as medical treatment provides some relief in the severity of the impact of fluoride.

Phase – 2: Analysis

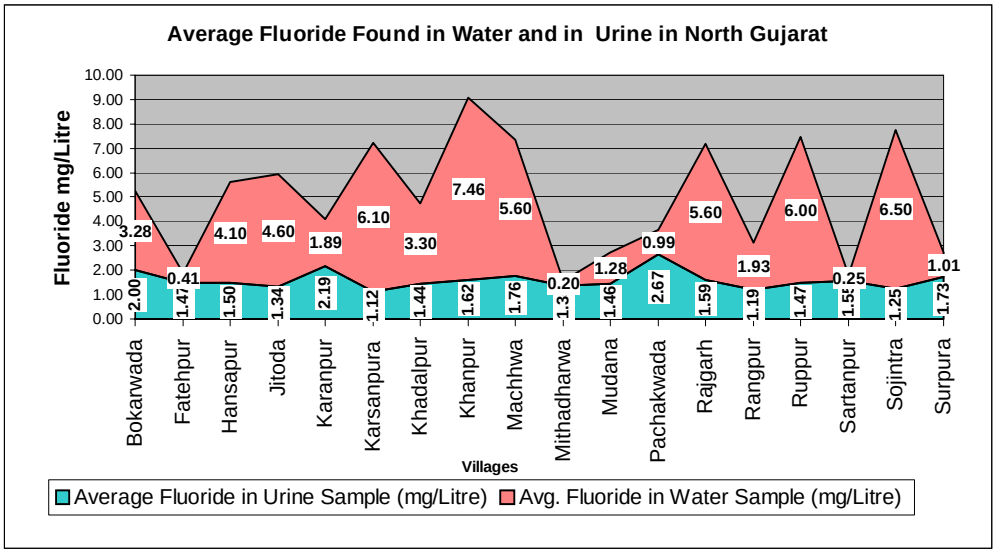
In Phase – 2, we tried to study the social cost etc. from the sample of 235 households selected by stratified random sampling as said under methodology above from 18 villages of the same 25 census villages of Mehsana and Patan districts of North Gujarat; and in the same way 352 households were selected from 25 of 37 villages of Banswara and Dungarpur

districts of South Rajasthan. The Structured Questionnaire has been given in the Annexure. We have analyzed this phase – 2 in two sections. In section – 1, we have discussed about the living environment, income and expenditure, awareness of the quality of water and perception of fluorosis of the selected families. In section – 2, we tried to see education, income groups of the afflicted persons, how much is the loss of their ability to work due to fluoride debility and to estimate the cost of medical treatment for the afflicted persons, the loss of earning for their incapability to work due to fluorosis.

Fluoride in the Urine

Gujarat: We have collected 81 (34%) urine samples from among the total 240 afflicted persons of the 207 afflicted households – 28 households of the total 235 do not have any fluorosis victims. The urine samples have been examined for fluoride in a laboratory at Ahmedabad[16]. In Chart – 7, we have shown the average fluoride mg/l found in the samples of water and in urine in 18 selected villages. The average fluoride in water in a village has been calculated as total

Chart – 7: Average Fluoride Found in Water and Urine



Source: Field Data

amount of fluoride found from all samples (ie, sources) in a village divided by the number of samples collected. Similarly, average fluoride in urine in a village is calculated as the total amount of fluoride found from all samples (ie, persons) of urine divided by the number of samples.

It is to be noted that normal upper limit of fluoride in urine is 0.1 mg/l, and the upper limit of fluoride in drinking water is 1.0 mg/l (lesser the better) [Ref. Per. Corr. from Dr A K Susheela,[17] Dated 7th June 2004]. If we go by this scale as base, then the average quantity of fluoride found in the urine, is alarming as it is varied from more than 11 times to 26 times

[16] The test was done by GICIEA [Gujarat Institute of Civil Engineers and Architects], Ahmedabad following standard SPADNS method.

[17] Dr (Mrs) A K Susheela, Executive Director, Fluorosis Research and Rural development Foundation, Delhi

(Chart – 7) of the suggested upper limit. Only 81 (34%) of the total afflicted persons' urine samples were collected, and if this is the picture for 34% percent, then what could be the total scenario? Only doctors can do further investigation for 'final diagnosis'.

Section – 1

About the Afflicted Families

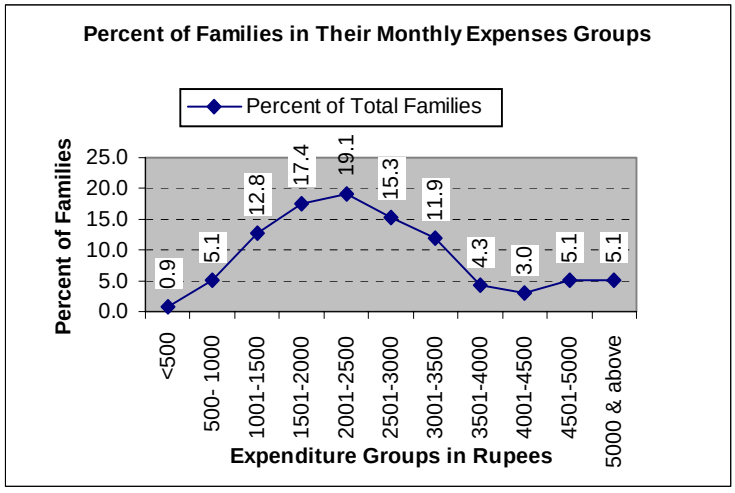
The 235 selected families have 1272 members with 647 men and 625 women. The earning members are 338 (88%) men and 48 (12%) women among the 386 total-earning members from all families. Farming is the main earning source – 159 families (68%) of the total 235 families are earning from agriculture, a few are engaged in agricultural labour, service and business etc.

Among 235 families, 193 families own land amounted to 1166.25 bighas, of which 631.5 bighas are irrigated. Of the total 1272 population, 571 (45%) have completed education up to Secondary School and 199 (16%) completed Higher Secondary and 49 (4%) persons are found to be graduates and 200 families (85%) take vegetarian food. There are *pucca*/concrete houses for 183 (78%) families of the total sample, and rest 52 (22%) families have *cuchcha*/thatched houses.

Of the total sample families, 216 (92%) houses have electricity, and a good number of families have consumer durables; 205 families (87%) have electric fan, 37 (15%) have radio, 62 (26%) have fridge; Colour TVs are in 61 (26%) houses, Black and White TVs are with 46 (20%) families and 50 (21%) families have scooters or Motorbikes.

The monthly expenditure of the selected families is mostly concentrated among three groups such as, Rs 1500- 2000, Rs 2001-2500 and Rs 2501- 3000. These 3 groups have 41 (17.4%), 45 (19.1%), and 36 (15.3%) households respectively, combining they make 52% of the total households (Chart – 9).

Chart – 9: Percent of Families in Their Monthly Expenses Groups in North Gujarat



Source: Field Data Phase – 2 (Data – 1)

Status of Water Supply

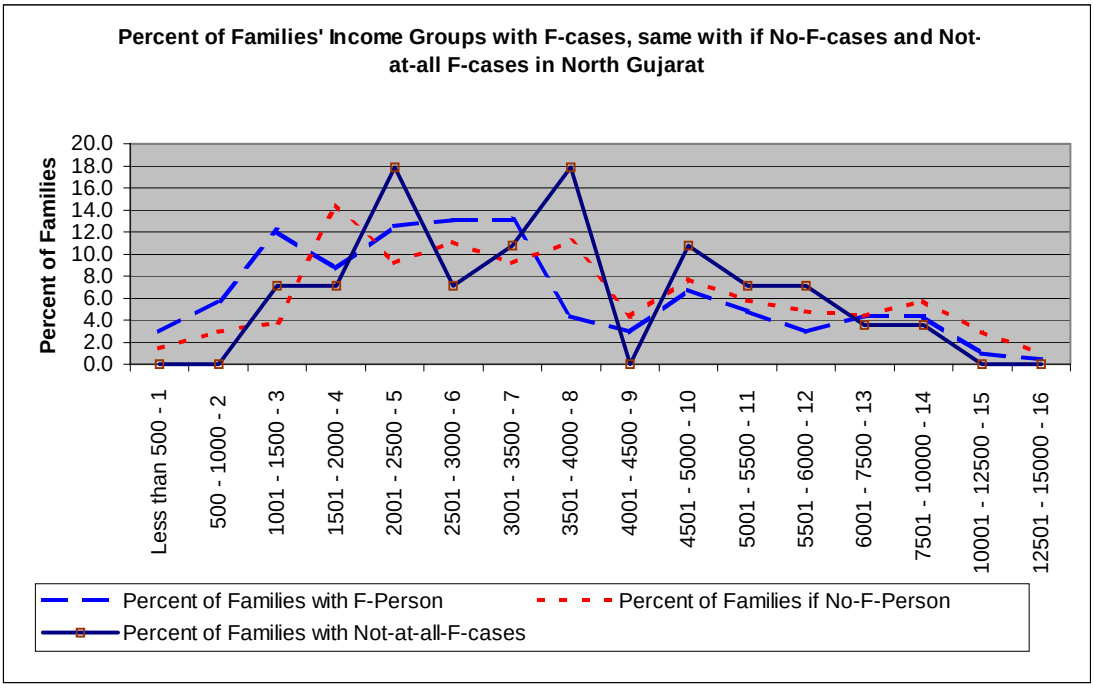
The status of water supply is under control of time. People store water daily. More than 50% families get the supply of water from a distance of less than 500 metres. There is not so much complaint about supply of water among villagers, except irregular timings. However, in many villages the complaint is of the quality of water supplied from the Panchayat wells. There are complaints of bad quality of water, which results in dental fluorosis among children and pain in body-joints among elderly people. There are complaints that the food cooked by the available water does not taste good. Pulses do not get cooked; tea becomes sour etc. Some people have complaints of rashes on their skin due to bad quality of water. The general view of people is that the government should solve the problem. In some villages, government's role did not give the right kind of support, even though the people suggested better and less expensive solutions for good quality of water, like in Mithadharwa in Chanasma taluka of Mehsana district or in Mudana in Siddhpur taluka of Patan district.

Water from Dharoi dam has solved some of these problems, but in some villages, villagers have the opinion that Dharoi's water causes cold and cough and some stomach troubles so they do not like to use it. In Surpura, people do not like to use Dharoi's water at all, because collection point at village is very filthy and soiled, and river water carries many unwanted dirty materials. Repeated requests to the Panchayat did not solve this problem. Possibly, change from ground water to river water has made all these complaints against acceptance. A filtration plant if installed to purify Dharoi's water at the village, may solve this problem.

Monthly Income Status

We describe the percent of afflicted families in different monthly income groups in Chart – 11.

Chart – 11: Percent of Families in Monthly Income Groups with F-Cases, same Families if No-F-cases and Families with Not-at-all F-cases in North Gujarat



Source: Field Data: Phase – 2: Data – 9; F = Fluorosis

We sought to capture the families' income level with and without fluorosis in their home. It was like (a) the family reported their income with fluorosis victims in their home and (b) what would have been their income if the fluorosis victims were not present in their home, and also (c) separately selected households not-at-all fluorosis cases, like in Fatehpura village, and some families from other villages, which never had any fluorosis cases. So, (a) group of income is for Families with 'F-cases', (b) the same families if 'No F-cases', and (c) families without any fluorosis cases ie, 'not-at-all F-cases' (Chart – 11). In the cases of (a) and (b): (b) went to a higher income group compared to (a), because, if they would not have any existing fluorosis cases in the family, they could have saved the amount of money, and thereby could put them in a higher income groups. There were some exceptions found in one or two groups of families, actually they could not estimate their income without the F-cases. These families felt that even if they did not have any cases of fluorosis, there would not have any changes in their income. In the case (c) the families of 'Non-F-cases' the income group is generally found to be higher than the families with 'F-cases', except in three income groups. These become apparent as long-term constant expenses on fluorosis put the families in a lower income groups. In the absence of fluorosis they would have definitely, been in a higher income bracket.

Contingent Expenses or Willing to Spend

We have asked the families with F-cases (Fluorosis-cases) that how much they would like to spend (in total) to get completely cured from fluorosis. Only 130 (55%) persons replied to this query, of which 91 (70%) expressed their wishes to spend for a permanent cure. The range of amount expressed to the contingent expenses depends on their present ability to spend and present income, which varied from Rs 100 to Rs 30,000 and the average contingent expenses found about Rs. 6000/- per family.

Awareness of Drinking Water

The awareness of the quality of drinking water and about de-mineralized packaged water was very poor. Some community in villages believed that water could never be 'bad' as it is 'God's gift', -- true! However, their belief was that people had made it bad. But 54% of the families believed that the drinking water of their village was 'good' and 31% families were aware of de-mineralized water. But only 4% of them are using packaged drinking water. They are of the opinion that there was a difference in the quality of water between the water supplied in the village and the packaged drinking water. These families were using this water for the last one-year after they were advised either by doctor or friends or relatives.

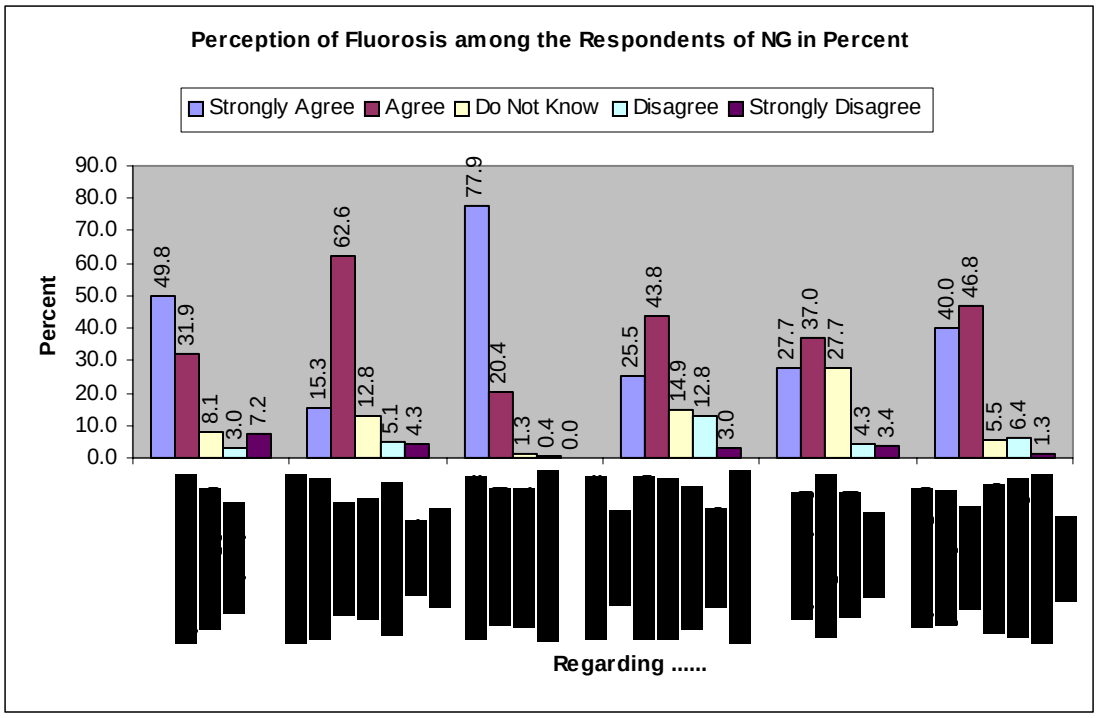
About 35% families expressed their views to use de-mineralized water if it would be available in the village and they would spend at least Rs 100-125 per month. More than 95% percent families had 'no-idea' about causes of fluorosis and 97% also did not know that any body got cured or recovered from the sufferings of fluorosis after using de-mineralized water.

Perception of 'Good' water and 'Fluorosis'

We got the feedback about the perception of respondents regarding fluorosis and its consequences through six different queries. The result has been given in Chart – 13 in percent form. Nearly 78% percent respondents had strongly agreed that skeletal fluorosis severely reduced the capacity for work and earning income. About 63% had agreed that dental fluorosis is a major problem for young people, especially girls, because it reduces their self-confidence. However, there was no such strong opinion that the skeletal fluorosis reduces the patient's interaction with other members of the community and leads to loneliness or isolation. Reason may be mostly people stay in a joint-family, or there are relatives and neighbours around the afflicted person. There is a community/family bond still prevailing in Indian village-life that may be working for not feeling so much lonely even though an afflicted person is not able to move much.

Further, there was no strong opinion or rather there was very 'soft agreement' (only 37% agree) with the perception that better quality of drinking water would reduce the skeletal fluorosis. At the same time they agree (strongly 40% and softly (47%) that the damage in the body due to 'fluorosis' was irreversible and no medicinal remedy was available for skeletal fluorosis. Hence, a solid belief that the water is 'the cause' for dental and skeletal fluorosis is still to be 'hatched' in the mind of the people of the study location in Gujarat.

Chart – 13: Perception of 'Good Water and 'Fluorosis' among Respondents in North Gujarat



Source: Field Data: Phase – 2 (from Data – 11)

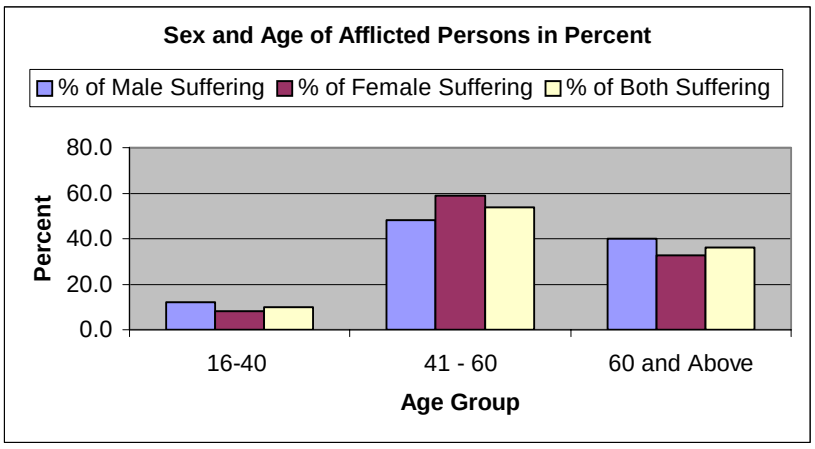
Section - 2

About the Afflicted Persons

There were 240 persons found suffering in North Gujarat from 'fluorosis' (as indicated above) from 207 families, that is more than one person in a family are victim of fluorosis. Almost equal percent of men and women are found among afflicted persons in the sample. Of these 240 persons 207 (86%) are suffering from fluorosis, whose average years of suffering was 8.25 years. Among the remaining 33 persons, 5 were suffering from DF and 28 were suffering from both DF and skeletal. Doctors diagnosed 173 persons as MSD but never they had been sent for further test for fluorosis. Doctors had agreed for 71 (30%) cases that the reason for MSD was the quality of water and only in 42 (18%) cases doctors said to the patients that 'fluoride' in water might be the cause of their suffering. Length of sufferings of the people varied from 1 year to 50 years. Nearly 19% pain stricken people was suffering from the last 10-15 years and 15% was from last 5-6 years. Men were suffering on an average of 8 years and women 8.5 years.

Largest number of afflicted people was found in the age group of 40 and 60 years. Of the afflicted persons, about 48% of male and 60% of female were from the age group of 41 – 60 years. This is the most vulnerable age, when damage due to fluorosis was most vividly seen (Chart – 15).

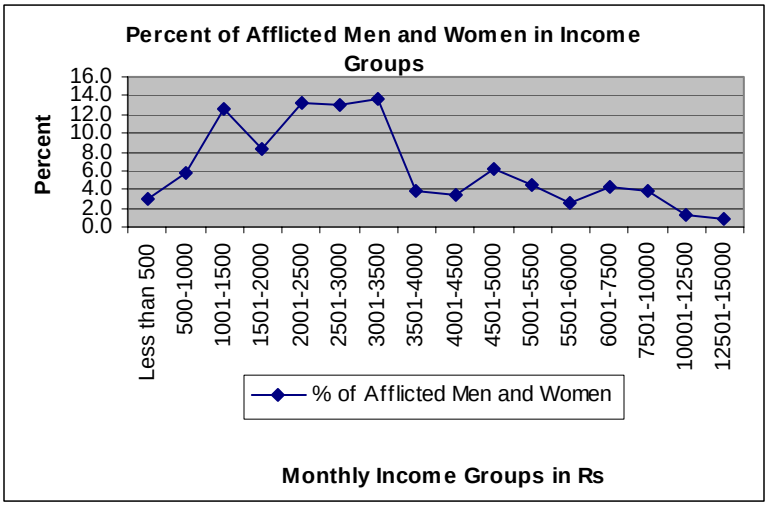
Chart – 15: Afflicted Persons in North Gujarat: Sex and Age



Source: Field Data (from Data – 3 and 4)

About 70 % (167 Persons) of afflicted person was from the monthly income group of Rs 500 to 3500/-. The percent of fluoride debility cases found reducing as the income increases (Chart – 16). Reasons may be that the people of high-income group used to have good nourishment from food and may be they had taken good medical care.

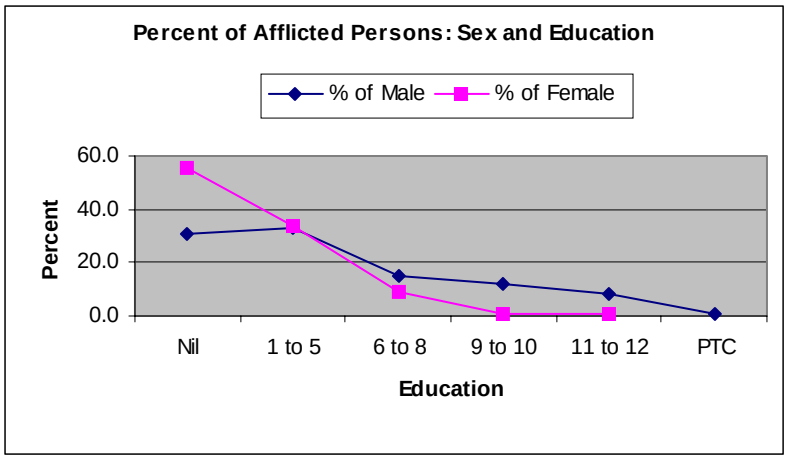
Chart – 16: Afflicted Persons in North Gujarat: Income Groups



Source: Field Data (from Data 3 and 4)

Referring the regression analysis above, it could be seen here that cases of fluorosis were reduced when education reached high (Chart – 17) among male and female both. Education makes better awareness, so people might be taking better care of themselves.

Chart – 17: Afflicted Persons in North Gujarat: Sex and Education



Source: Field Data (from Data – 3 and 4)

Spent on Treatment

We have prepared the Table – 2G to see the total expenses incurred by the families of the afflicted persons during their sickness. The average expenses per person per year[18] (pppy), was found to be Rs 861; for men Rs 664 and for women Rs 1076. The total amount of Rs 14,28,000 was the cost of medical expenses for 201 afflicted persons, who had taken medical treatment. Other 39 of 240 persons did not have medical treatment in recent times. Many of them were tired of medicines.

There are other costs too, like loss of income due to their inability to work. We tried to understand their declining behavioural activities and loss in capacity of earning. We also tried to estimate the losses for them who were working with their pains and getting less wage. We tried to quantify all these in the text that follows.

They Cannot Do

There was much loss in the normal activities if one suffers from fluorosis for a long time. They developed some physical disabilities (like cannot bend forward, cannot sit-ups etc.), which were noticed at the beginning. And because of these disabilities they could not perform some behavioural activities (like cycling, walk in the field, lifting load, taking care of children and cattle etc.). In Chart – 19, we have shown the activities they CANNOT DO for fluoride debility.

[18] We worked out the Total Medical expenses of the sample persons like this: since it was hardly possible to get exact amount of expenses made by the families, we asked for the expenses in groups of Rs 500s and 1000s class intervals. Then multiplied by the number of persons reported in those groups with mid-values of the classes to get an approximate value of expenses. In the cases where Rs 10000 and above were spent, the actual figures were taken; and finally totalled up. Lastly, total amount was divided by (a) the total number of afflicted persons (male 105 and female 96 = 201 persons), who had spent for treatment and (b) the average number of years (8.25 year) they suffered to get the average per person per year (pppy) medical expenses.

The loss of activity is immense, particularly the activities like bending forward, lifting loads, riding cycle, and walk in the field, and taking care of cattle in home became difficult to perform. Afflicted persons lost more than 70% of some of these activities.

Table – 2G: Spent on Treatment: Previous and Past Years in North Gujarat

Items		Men [114 men reported]		Women [94 women reported]	
People spent on Fluorosis till May 2004 Expenses Groups (Rs)		Men		Women	
Expenditure Groups (Rs) **[A]**	Mid-value of [A] **[B]**	No. of **Men** Reported in Groups **[C]**	[B] x [C] = **[D] Rs**	No. of **Women** Reported in Groups **[E]**	[B] x [E] = **[F] Rs**
0-500	250	13	3250	6	1500
501-1000	750	7	5250	11	8250
1001 - 1500	1250	13	16250	5	6250
1501 - 2000	1750	8	14000	13	22750
2001 - 3000	2500	8	20000	12	30000
3001 - 5000	4000	20	80000	17	68000
5001 - 7000	6000	14	84000	11	66000
7001 – 10000	8500	13	110500	4	34000
10001 + above	Actual Amount	9	242000	17	616000
Total		**105**	**575250**	**96**	**852750**
Total for 105+96 = 201 persons		**Rs 575250 + Rs 852750 = Rs 14,28,000**			
Average per male/female per year: (Taking 8.25 as average year of suffering per person)		**575250/105/8.25= Rs 664.1**		**852750/96/8.25= Rs 1076.7**	
Average per person per year: (Taking 8.25 as average year of suffering per person)		**Rs 14,28,000/201/8.25 = Rs 861.2**			

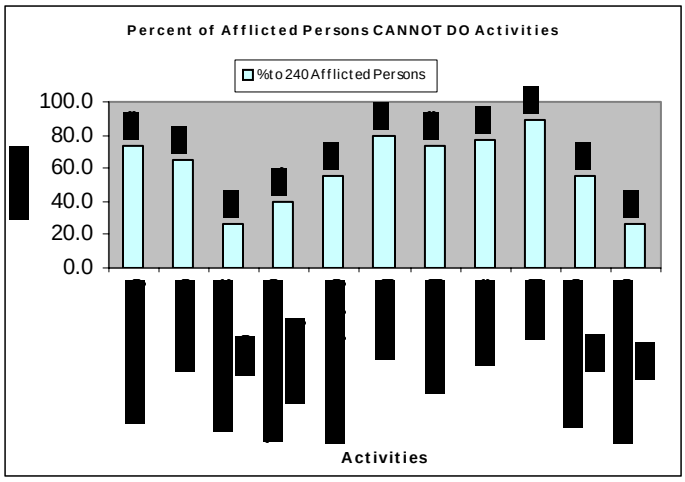
Source: Field Data

Capacity of Earning

They cannot earn their income, as before after losing their ability to do their normal or regular activities mentioned above. Of the total 240 afflicted persons 86 (36%) of them have lost 100% and 69 persons (29%) lost 75% and 21 persons lost (8.8%) of their earning capacity (Chart – 20). Thus 73% or 176 persons had lost more than 60% of their capacity to work or to earn their livelihood. Those who had lost their 100% capacity had settled with their life in the *chaarpoy* at their home and have become the dependant of their relatives and neighbours for the rest of their life. Those who have lost less, they still try to do some activities to earn for them or for their family, or do some help in home. They cannot do their normal job even if they would like to do; they do it with great effort and with pains. Say for example, 48% cannot do their normal work because of shoulder pain, 70% cannot do their

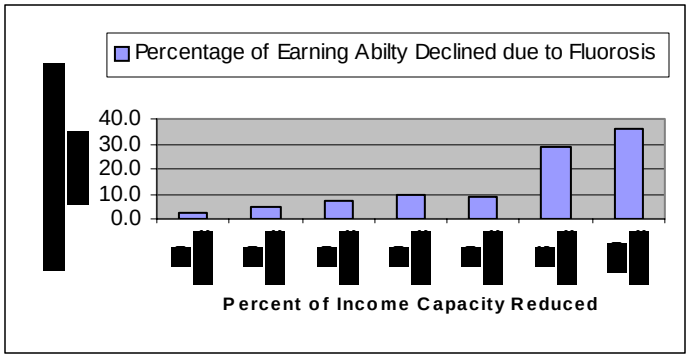
normal work due to pain in waistline, 95% for knee joint and 65% for ankle joint (Chart – 21a).

Chart – 19: Activities They CANNOT DO for Fluoride Debility in North Gujarat



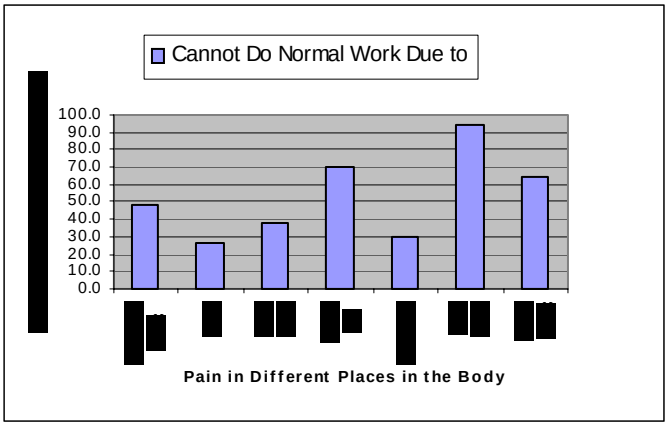
Source: Field Data (from Data – 6)

Chart – 21: Percent of Earning Ability Lost in North Gujarat



Source: Field Data (from Data 7)

Chart –21a: Percent of afflicted Persons: Cannot Do Normal Duties Due to their Body Pain in North Gujarat



Source: Field Data (from Data 7)

Cost of Fluorosis

Some of the afflicted persons could not do their regular work with their pain, and some of them could do. There were 98 (41%) persons reported of the total 240 afflicted persons, who could not do their normal duties for the last 7.3 years on an average. Their average age was 62 years (Table – 3G). They were mainly doing farming, agriculture labour and service. Their last average earning per person per month (pppm) was Rs 1295; but they used to earn Rs 1632 (pppm), if they were not afflicted and had received their old wages. This information we have collected from the field survey of the afflicted persons [for details see Q. 8, Working Capacity, Q 8.1, 8.2, 8.3; p. 4 -5 of the Questionnaire and also Annexure 6]. That means presently they are losing [Rs 1632 – 1295] Rs 337 pppm. So, the loss incurred in wages by these 98 persons during the last 7.3 years was: Rs 337 x 12 months x 7.3 years x 98 persons = Rs 28,93,077.6 or Rs 28,93,078.

Table – 3G: Working Capacity of the Afflicted Persons in North Gujarat (Those who declared 'Cannot Do' and 'Can Do' their Normal Duties)

Sl. No.		Those who declared **'Cannot Do'** their Normal Duties			Those who declared **'Can Do'** their Normal Duties		
1	**Cannot do** Their Normal Duties/Work	Of 240 Total Men and Women			**Can do** Their Normal Duties/Work	Of 240 Total Men and Women	
		98 (40.8%)				142 (59.2%)	
2	Average Age	62 years			Reported 'going' to work	54	
3	Their Past Occupation	Farming 59	Agri.Lab 35	Service 4	Their Present Earning*	Rs 1496	
4	They could not work** = 7.3 years				Go for Full Day Work with 'Pain' = 23 Persons		
5	Their Last Earning*	Rs 1295			Get same Wage	Yes = 16	No = 38
6	What they could earn, if they were not Afflicted* = **Rs 1632**				Wage* Received		
					16 at same wages = **Rs 1672**		
					38 at less wages = **Rs 1171**		
6a	Loss During 7.3 years	by these 98 persons **= Rs 28,93,078**[a]			by these 38 persons = **Rs 16,67,729**[b]		

Source: Field Data (from Data – 8) * [Av. per person per month] ** [Av. per person]

a. [Losing Rs 1632-1295] = Rs 337 pppm x 12 months x 7.3 years x 98 persons = Rs 28,93,077.6 or Rs 28,93,078
b. [Losing Rs1672-1171] = Rs 501 pppm x 12 months x 7.3 years x 38 persons = Rs 16,67,728.8 or Rs 16,67,729

However, 142 (59%) could do their normal duties with their pain. Of them only 54 persons went for some gainful work and earned an average Rs 1496 pppm. And 23 persons of them

got 'full day' work; 16 of 54 persons got job with the same old wage of Rs 1672 and 38 persons got job with Rs 1171 pppm, which is less than their earlier wages. However (54 – 16) ie 38 persons incurred loss Rs 501 per persons per month, as they did not get their old wages. The loss was: Rs 501 x 12 months x 7.3 years x 38 (as they could not work properly since 7.3 years average) = Rs 16,67,728.8 or Rs 16,67,729.

So the total loss through wages was Rs 28,93,078 + Rs 16,67,729 = Rs 45,60,807. This loss was incurred by 98+38 = 136 persons who reported loss in their wages. Therefore per person loss from wages is: 4560807/136 = 33535.4 ie Rs 33535. The cost of treatment was Rs 14,28,000 for 201 persons who were under medication (Table – 2G). Therefore the cost of medical treatment per person is: 1428000/201 = Rs 7104.5 ie Rs 7105. That is to say, the direct estimate of cost of fluorosis could be found as [Rs 33535 + Rs 7105] = Rs 40,640 per person for 7.3 years. Hence **per person per year cost** is Rs 40640/7.3 = **Rs 5567 only** without taking the cost of DF. The treatment cost for DF has not been taken because there was very few cases reported for treating DF.

In the prevalence rate in our census report above, we found 4590 persons (Table – 1) were suffering from at least one symptom of fluorosis. In the long run, these people would also reach to a situation of severe-fluorosis and they also have to spend on medical treatment and may lose their wages too. That is to say there may be a cost for these people also, and if we project this expenses for these people, when they would be total victims, the expenses would be Rs 5567 x 4590 = Rs 2,55,52,530 say about Rs 2.5 Crore. This amount will be a big liability to the society.

In Conclusion:

It is difficult to draw any conclusion for this multi-faceted problem of fluorosis or to propose a universally accepted strategy, which would be 'good' for all.

People need water, so they go deep to the underground and eventually harvest poisonous water to an extent unmindfully and finally are caught in the trap of irreversible 'fluorosis'.

The people of this study location have a very poor awareness about 'quality' of water and also have very poor information about the availability of fluoride-free or de-mineralized water. Even if it is available, their poor affordability prevents them to purchase. Nearly 199 (85%) families are from the monthly income group of less than Rs 5000. We have seen, in one of our earlier studies (Indu, 2002, 34) that 25% - 62% families, who had monthly income of Rs 4000 – 15000, in urban area, used to purchase de-mineralized water. But in this rural population there were hardly 10% families from the monthly income group of Rs 4000 – 5000; and only 11 families (5%) were found to use packaged drinking water. Surely, it is a very poor affordability of buying 'safe' drinking water.

People of the society are suffering from the 'irreversible debility' called 'fluorosis'. The question arises - what should one do, when one has to use 'willingly-or-unwillingly' the available fluoride content water in the village?

Our suggestion could be:

1) Develop the movement of awareness for 'good' and 'safe' water among the people of these villages.

2) Providing less expensive water filters (like Activated Alumina Plant being used in Southern Rajasthan) for de-fluoridation in home. It may be a personal kitchen filter, or may be a "Captive Demineralization Plant" [for example, the 'Kubhasan' Plant at Palanpur, organized by IWMI-EPGL, Dinesh Kumar et al, 2004].

3) There may be a 'Cooperative-Captive Plant' that could be organized by the villagers and not by any external agencies.

4) Or, it could be a big plant for de-fluoridation to be erected by government. In this arrangement we have seen the failure and a huge loss of public money (Indu, 2002, 42 and Hirway, 2003, 13-14). Instead of a big plant, there could be government intervention for preparing a plant that may be sized up to a village-need, which would be managed by the villagers only. This requires a separate mandate that could be prepared.

5) There is another possibility of reducing fluoride from groundwater is to mix river water with groundwater, which is now a practice in North Gujarat. The Sabarmati's water being taken from Dharoi Dam and is being supplied to villages. The water is collected in a swamp and mixed with groundwater at the village and then supplied to the end-users. We found that the fluoride content has been reduced noticeably (Annexure - 5). Of course, in some villages a few people reported that the water of Dharoi Dam did not suit them and it had irregular supply system. Or, it could be the water from Mahi-Sagar Dam supplied through pipeline in South Rajasthan. May be the initial cost is high, but not higher than the sufferings from fluorosis.

6) Further, groundwater should be recharged; check-dam or any other suitable procedure should be built up, which would also help reducing fluoride from the groundwater.

7) And, for the victims, state government or any NGOs should come forward for the victims' rehabilitation, like it is in Delhi [Dr AK Susheela's NGO]. Further, there should be a proper diagnosis procedure for all kinds of fluorosis instead of staying away from the problem. Health Department of Government of Gujarat and Rajasthan may take up this issue. They can make a scheme for fluorosis abolition progamme like Polio, Malaria or Tapeworm abolition programmes.

We believe, it is high time to recognize 'fluorosis' and think seriously to take some preventive measures for it, instead of keeping it behind the musk of MSD, and also to rehabilitate the present victims. Otherwise a large number of rural population in Gujarat will be seen walking in the style of 'cat-walk' with one or two sticks in their hands, which we have seen in many villages of South Rajasthan. Besides the medical expenses there is a huge loss in earning, plus a pitiable way of living, may cause an individual mentally sick. Eventually the victims would be a burden to the society. In a length of time this burden may be a disaster to the state, and later to the nation.

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