

# SUPPLY OF ALTERNATE SAFE DRINKING WATER: A MAJOR REMEDY TO COMBAT FLUOROSIS

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## **Abstract**

*Fluoride contamination in drinking water is a great problem in many countries all over the world. A vast region of West Bengal also has been affected by fluoride contamination in drinking water which is very serious problem to the health of the people of the rural areas and socio-economic condition of the villagers. In west Bengal 43 blocks of 7 districts are reported to have fluoride contaminated water above 1.5 mg/l. Purulia district has been experiencing a silent but inevitable natural disaster in the form of fluoride contamination in ground water. Fluoride is known to cause diseases like dental fluorosis, skeletal fluorosis, non-skeletal fluorosis, dementia, abnormal thyroid function and other hormonal disturbances. Various preventive measures are found but supply of alternative safe drinking water is most effective to combat fluorosis.*

*For the present study, Bhul village of Dimdiha Gram Panchayat which is located at Purulia-I CD Block and Rugri village of Beko Gram Panchayat which is located at Kashipur CD Block of Purulia District have been selected. Both the villages are reported with fluoride contamination in drinking water of nearly 5.50 mg/l. But in the Rugri village fresh drinking water has been supplied since 5-6 years and in the later village no measures have been taken. A comparative analysis of the villages has been done with ten diseases suffered by the villagers. This study is based on the intensive field work and household survey, and focuses that the safe drinking water supply is the important alternate to fight fluorosis.*

**Keywords:** Fluoride, dental fluorosis, skeletal fluorosis, human intervention, pipe water supply

## **INTRODUCTION**

Impact of geology on human health has been identified since 4000 BC perhaps in Chinese Civilization (Appleton et al. 1996). Fluoride is an element which is present in the fluoride bearing minerals like fluotite, apatite, fluorospar etc. Fluoride from these minerals leaches into ground water and contaminates the groundwater. Human health is affected by the presence of fluoride in drinking water because fluoride has both beneficial and detrimental effects on human health. Contamination of drinking water is a public health problem in many parts of the world. Endemic fluorosis occurring due to consumption of groundwater contaminated with fluoride is

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threatening the health of millions of people in India and therefore is a challenging and extensively studied national health problem (UNICEF 2008). The amount of fluoride occurring naturally in ground water is governed principally by climate, composition of the host rocks and hydrogeology. Areas with a semi-arid climate, crystalline rocks and alkaline soils are mainly affected (Handa, 1975).

Fluoride is important for tooth and bone formation. The main source of fluoride for human body is usually drinking water while, other sources are food and air. Research has shown that a concentration of 1mg/litre of fluoride in drinking water reduces tooth decay. But, oral intake of fluoride more than 1.5 mg/litre results in different types of diseases. According to BIS (Bureau of Indian Standards, 1991) and ICMR (Indian Council of Medical Research, 1975), the highest desirable limit of fluoride is specified at 1.0 mg/l and the maximum permissible limit is 1.5 mg/l.

The problem of excessive fluoride in ground water in India was first reported in 1937 in the state of Andhra Pradesh (Short et al. 1937). Nearly 12 million out of the 85 million tons of fluoride deposits on the earth crust are found in India. At present, fluorosis is endemic in at least 20 states of India affecting more than 65 million people, including 6 million children. Estimation finds that 65% of Indian villages are exposed to fluoride risk (UNICEF, 1999). In West Bengal, excess fluoride in groundwater has been detected so far in 43 blocks spread over seven districts, viz. Purulia, Birbhum, Bankura, Malda, South Dinajpur, North Dinajpur and South 24-Parganas.

Fluoride pollution in drinking water is a public health problem. Fluoride is known to cause diseases like dental fluorosis, skeletal fluorosis, gastrointestinal, muscular neurological problems, abnormal thyroid function and other hormonal disturbances. Purulia district has been experiencing a silent but inevitable natural disaster in the form of fluoride contamination in ground water. Various methods of remedial measures are taken in various part of the country. Among the all measures first and most important is supply of alternate water of safe level of fluoride.

In the present work, a comparative analysis has been done taking two villages namely Bhul and Rugri villages of Purulia district, where highest levels of fluoride contamination in the tube wells are found as 5.74mg/l and 5.48mg/l respectively. In Rugri village, pipe water supply from nearby Darkeswar River has been introduced since 5-6 years but in Bhul village no human intervention is taken. As a result intensity of diseases suffered by the people is much less in Rugri than Bhul village.

#### **OBJECTIVES:**

The present study has been done to achieve the following objectives:

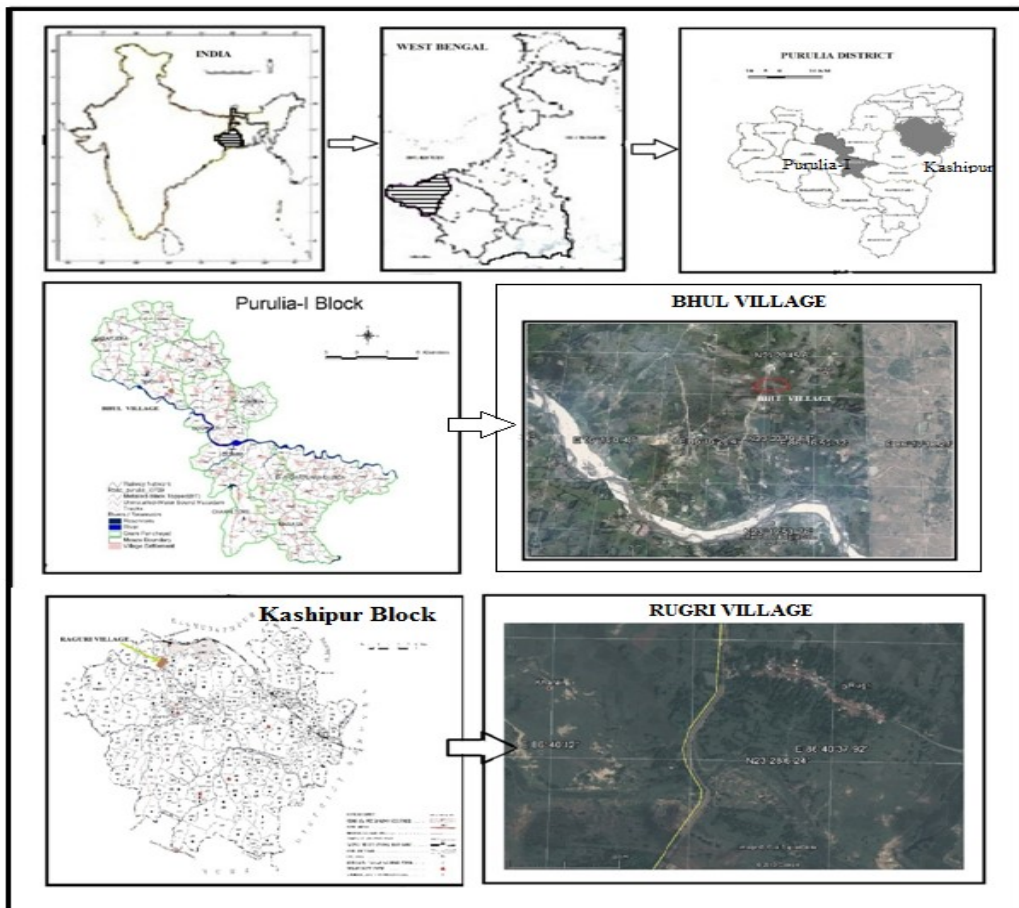
1. To identify the diseases suffered by drinking fluoride contaminated water

2. To compare the extent of intensity of diseases suffered by the villagers by drinking the contaminated water.
3. To find out some measures suitable for this area to alleviate the problems<sup>o</sup>
4. To measure the impact of pipe water supply which have safe level of fluoride
5. To identify alternate source of pure drinking water

### STUDY AREA:

For the present study, Bhul village of Dimdiha Gram Panchayat which is located at Purulia-I block of Purulia district and Rugri village of Beko Gram Panchayat which is located at Kashipur block of Purulia District have been selected. Bhul village is located on 23°20'45.6"N latitude and 86°16'52.32" E longitude whereas Rugri village is located on 23°28'10" N latitude and 86 °40'37.92' E longitude. In both the villages, tube wells are contaminated with fluoride. In Bhul Maximum level is 5.74mg/l and in Rugri village it is 5.48 mg/l.

Figure 1: Location Map of the Study Area



**DATABASE AND METHODOLOGY:**

Data have been collected from primary sources i.e., from door to door household survey of both the villages. Socio economic and fluorosis data of 50 families of each village are collected for purposive stratified sampling. Water from tube wells were tested to identify the level of fluoride contamination at the fluoride testing centres.

A comparative analysis of the villages has been done with **nine diseases** suffered by the villagers caused by drinking of fluoride contaminated water.

These are:

1. Dental fluorosis
2. Child skeletal fluorosis
3. Adult skeletal fluorosis
4. Muscular problems
5. Neurological problem
6. Gastrointestinal Problem
7. Polyurea & Polydipsia
8. Allergy
9. Still Birth & Repeated Abortion

Data regarding the diseases are analysed and compared. For the identification of diseases following symptoms are taken in consideration.

**Table 1: Symptoms of the Different Fluorosis Diseases**

Sl No	Diseases/Problems	Symptoms to Identify Diseases					
		White Opacity	Yellow Spot	Brown Spot	Black Dis-colourisation	Pitting/Chipped off	
1	Dental fluorosis	White Opacity	Yellow Spot	Brown Spot	Black Dis-colourisation	Pitting/Chipped off	
2	Child Skeletal Fluorosis	Pain in lower portion	Bent leg	Knock Knee			
3	Adult Skeletal Fluorosis	Heel and Knee pain	Pain in Hip region	Pain in backbone	Restricted joint movement	Stiff back & Neck	Bent forward
4	Muscular Problem	Muscle Weakness	Stiffness	Muscle Pain			
5	Neurological Problems	Nervousness	Tension	Tingling Sensation	Excessive Thirst	Urinate Frequently	
6	Gastrointestinal Problems	Nausea	Loss of Appetite	Pain in the Stomach	Gas Formation	Constipation	Inter Diarrhea
7	Polyurea & Polydipsia	Tendency to Urinate more frequently	Less Volume of Urine	Excessive Thirst	Yellow Red colour of Urine		
8	Allergy	Painful Skin Rashes	Pinkish Red Oval shape Spot	Bluish Red Spot			
9	Still Birth & Repeated Abortion	Still Birth	Repeated Abortion				

**SOCIO ECONOMIC STATUS:**

Any kind of impact of geographical phenomena on health of the people of a society depends on the socio economic status of the people of the area.

In Bhul Village, total population is 4,147 out of which male and female population are 2152 and 1995. General Caste, Scheduled Caste (SC) and Scheduled Tribe (ST) population are 61.15%, 33.28% and 5.57% respectively (Census, 2011). On the other hand, in Rugri village total population is 433, out of which male and female population are 223 and 210. This village is mainly SC dominated village, where 51.73% people are from SC communities, the proportion of General Caste and ST population are 30.95%, and 17.32% respectively (Census, 2011). As far as the literacy rate is concerned, it is higher in Rugri than Bhul. In Bhul 48.10% population is literate but Rugri 62.58% population is literate.

**Table 2: Comparison of Socio-economic Status between Bhul and Rugri Villages**

Table	Bhul			Rugri		
	Person	Male	Female	Person	Male	Female
Total	4147	2152	1995	433	223	210
Scheduled Caste	1380 (33.28%)	722	658	224 (51.73%)	118	106
Scheduled Tribe	231 (5.57%)	112	119	75 (17.32%)	40	35
Literate	1995 (48.10%)	1326	669	271 (62.58%)	162	109
Illiterate	2152	826	1326	162	61	101
Total worker	1750 (42.20%)	1197	553	129 (27.48%)	119	10
Main Worker	920 (52.57%)	772	148	76 (58.91%)	71	6
Marginal worker	830	425	405	53	48	5
Non Worker	2397	955	1442	304	104	200

*Source: Census of India, 2011*

**LEVEL OF FLUORIDE IN DRINKING WATER SOURCE:**

LEVEL of concentration of fluoride in drinking water is important because human health is affected by both the deficit and excess of fluoride in drinking water because fluoride has both beneficial and detrimental effects on health. Below the level of 1.0mg/l of fluoride in drinking water prevent dental caries but if the level crosses the limit of 1.5mg/l of fluoride concentration in drinking water then various dental, skeletal and non skeletal fluorosis occur on human health. Ground water based tube well is the only source of drinking water in Bhul village. Water sample reports of the five tube wells of the village shows that 80% tube wells are contaminated with fluoride above the level of maximum permissible limit. On the other hand, in Rugri village ground water based tube wells were the only source of drinking water but now, pipe water supply from nearby Dwarakeswar River has been introduced since 5-6 years. In this village, 40% tube wells are still fluoride contaminated. Pipe water is tested to find out fluoride contaminated and it is reported to have 0.27mg/l of fluoride. The detailed water testing results are shown in the following table.

**Table 3: Fluoride Level of groundwater based tube wells of Bhul village**

Sample No	pH	Iron	Fluoride (mg/l)	Hardness
1	7.06	0.1	<b>2.74</b>	300
2	6.90	0.2	<b>1.51</b>	240
3	6.35	0.5	<b>5.74</b>	320
4	6.90	1.2	<b>2.23</b>	630
5	7.21	0.5	0.64	180

Source: Field Survey, 2012-13

**Table 2: Fluoride Level of groundwater based tube wells of Rugri village**

Sample No	pH	Iron	Fluoride (mg/l)	Hardness
1	8.1	0.1552	1.18	324
2	8.1	5.6626	0.68	152
3	9	0.3842	<b>5.48</b>	60
4	8.5	0.3274	<b>3.52</b>	116
5	8.4	5.2832	0.70	100

Source: Field Survey, 2012-13

### DISEASE PROFILE:

In Bhul village, 43.92% people are fluoride affected and suffered by different diseases caused by drinking fluoride contaminated water. Male people are more affected than female population this may be due to the physiological and social causes. Male people drink more water than female due to large body mass and hard working outside home. On the other hand, adult girls of the village are married off to other area and the women come to village after marriage, are from other areas which are not affected by fluoride contamination. In Bhul village, 47.67% male population are fluorosis patients while 39.64% female population are fluorosis patients. In the Rugri village, percentages of fluorosis patients are much less than Bhul village. Here, 23.83% people are fluorosis patients at the village.

First symptom of dental fluorosis is chalky white teeth, then yellow and brown spot in the front teeth. It is the most obvious and easily diagnosed form of fluorosis. Dental Fluorosis is usually caused by over-exposure to fluoride when the dental enamel is actively mineralizing during early childhood. Children are very much prone to dental fluorosis affecting both the milk teeth and permanent teeth. An adult may show dental fluorosis and would mean he/ she was exposed to high fluoride in his/ her early childhood.

Out of total patients, 49.92% patients are suffered by dental fluorosis in Bhul village. Here also male patients are slightly more than female patients. In case of Rugri village, only 14.75% patients are suffered by dental fluorosis whereas male and female percentages are 19.35% and 10% respectively. There is also 1.89% children

suffered by skeletal fluorosis with the problem of pain in lower portion of the leg in Bhul village but there is no case of child skeletal fluorosis patients in Rugri village. Consumption of Fluoride contaminated water of more than 3.0mg/l leads to skeletal fluorosis of the people with the problems of heel & knee pain, pain in hip region, pain in backbone, stiff back & neck and finally bending forward. Percentage of skeletal fluorosis patients is 51.57% in Bhul village but in Rugri village it is 26.23% which is almost half. All other diseases and problems like muscular problem, neurological problem, gastrointestinal problem, problems of allergy and skin rashes, problems of still birth and repeated abortion faced by the people are less in Rugri village than in Bhul village.

**Table 4: Comparison in the Proportion of Different types of Fluorosis Patients between Bhul and Rugri**

Variables	Bhul			Rugri		
	Male	Female	Total	Male	Female	Total
% of fluorosis patient to population	47.67	39.64	43.92	32.84	31.15	32.03
% of Dental fluorosis to total Patient	51.09	47.76	49.69	27.27	15.79	21.95
% of Skeletal Child fluorosis patient	2.17	1.49	1.89	0.00	0.00	0.00
% of Skeletal Adult fluorosis patient	52.17	50.75	51.57	22.73	28.95	25.61
% of fluorosis patient with muscular problem	5.97	8.70	7.55	6.82	5.26	6.10
% of patient with neurological problem	1.09	2.99	1.89	2.27	5.26	3.66
% of patient with gastrointestinal problem	7.61	8.96	8.18	4.55	10.53	7.32
% of patient with polyurea & polydipsia	NIL	NIL	NIL	2.77	5.26	3.66
% of patient with allergy problem	4.35	7.46	5.66	4.55	7.89	6.10
% of patient with Still birth & repeated abortion problem	0.00	4.48	1.89	0.00	2.63	1.22

#### REMEDIAL MEASURES:

Various measures can be introduced to alleviate the problems of fluorosis. These can be classified into three categories. There are as follows:

#### Medical Measures:

- Surveillance of vulnerable group e.i., children, pregnant and lactating mother
- Screening for dental fluorosis in schools involving health centers, schools, Anganwadis, water service providers and local government.
- Vitamin supplement ( $\beta$ -carotene, along with vitamin E and vitamin C)
- Increase of Fluorosis Testing medical centers

#### Dietary Measures:

- Use fluoride free water for drinking purpose
- Restrict use of fluoride rich food items – black salt, tea, *supati*, *gutka*, *pan masala*, tobacco, etc because these items contain high level of fluoride
- Use of food rich in calcium, vitamin C, D,E, anti oxidant and proteins

#### Large Scale Measures:

- Regular Water Test in the affected areas
- Supply of Alternate source of drinking water
- Rainwater harvesting, Groundwater recharge
- Diversion of cleaner surface water from lesser-affected regions to more affected
- Creating awareness about the disease and the source of fluoride

#### **SOURCE OF SAFE WATER SUPPLY:**

In Rugri village human interventions has been taken and effort has been made to supply fluoride free water. Water supply from surface water is selected from nearby Darakeswar River which is 2 km from the village and distributed through pipeline to the village.

In Bhul village also supply of fresh water from Kangsabati River which is nearly 2 km can be used after proper treatment.

#### **CONCLUSION:**

Fluoride contamination of drinking water is a geo environmental problem though it is aggravated by various human activities. Fluorosis can be intervened by various ways but supply of alternate fresh drinking water either through community de-fluoridation or by pipeline from fresh source is most important. With proper awareness, education and implementation of the steps in proper way, then the people of the district will recover from the adverse effects of fluoride contamination of drinking water.

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