FLUORIDE TESTING AND FLUOROSIS MITIGATION IN NUAPADA DISTRICT ORISSA: A SMALL PILOT-SCALE EXERCISE

I. INTRODUCTION

Nuapada district was carved out of the erstwhile Kalahandi district in 1992. It lies in western Orissa and shares a boundary with Mahasamund and Raipur districts of Chhattisgarh. It is predominantly a hilly and forested area. About sixty percent of the residents of Nuapada belong to the scheduled tribes in India. This area is deprived of basic amenities of life and suffers from abject poverty and starvation. The location of the study area is shown in Fig. 1. Government authorities and community-based organizations have sponsored a variety of development programmes in western Orissa to improve the standard of living of the residents of this area.

PSI along with Sahbhagi Vikash Abhiyan (SVA) is working in four districts (Nuapada, Kalahandi, Bolangir, and Burger) of western Orissa. The focus of its programme is on community based natural resource management and strengthening Panchayati Raj institutions for the same.

In March 2005, Jagdish Pradhan of Sahbhagi Vikash Abhiyan, which is partnering PSI in implementing the Gram Swaraj Abhiyan in about 400 villages of western Orissa visited PSI and heard about its fluorosis mitigation work in Sonebhadra district. He referred to reports of fluorosis in Karlakote Gram Panchayat of Nuapada district and requested PSI to undertake a fluorosis mitigation programme there. The EQMG team at PSI asked him to verify the news reports. SVA reported back that several fluorosis cases had been verified in different blocks of Nuapada district. In Sonebhadra district, the programme had been limited to 21 villages as against the proposed 25. Given the strong community-based organizations set up under the Gram Swaraj Abhiyan in Nuapada district, the EQMG team agreed to do a small pilot-scale project in the district.

Between May 2005 and July 2005 PSI and SVA workers carried out fluoride testing and health surveys in 9 selected villages, following which, a detailed fluorosis mitigation programme was chalked out for these villages.

Objectives

- To undertake water quality testing of drinking water sources in selected villages in a small, pilot-scale project.
- To assess the prevalence of fluorosis in the selected villages.
- Prepare plans through a participatory process to reduce the prevalence of fluorosis in the selected villages.

II. METHODOLOGY

Dental Fluorosis: The EQMG staff met with their colleagues from SVA and PSI to identify possible fluorosis affected areas, in the month of May 2005. These workers were first trained to identify the symptoms of dental and skeletal fluorosis. Secondary sources of information such as

newspaper reports and data from health surveys conducted earlier were used to find out the most affected villages. Now health survey was carried out in these short-listed villages.

A health survey focused on dental fluorosis, among children aged 6-16 years, was done in 9 villages of Senapali and Boden blocks. Three trained workers of SVA were involved in the health survey. A field protocol for this survey was prepared to document the data gathered. This data is tabulated in Table 1.

Table 1: Dental Fluorosis Status Among the Children (from 7 to 16 years age) in Villages Surveyed

SNo.	Name of Gram Panchayat	Name of Village	Total Children Surveyed	Status of Different degree fluorosis				
				Mild	Moderate	+++	Total	
							Nos.	%
Block - Boden								
1	Pharsara	Baklikhunti	107	52	34	1	87	81
		Amguda	157	79	37	5	121	77
		Tentelpada	44	25	6	0	31	70
		Pharsara	88	59	21	1	81	92
		Putupada	60	35	7	0	42	70
2	Khaira	Sukalpur	25	15	3	2	20	76
Block - Senapali								
1	Jharbandh	Jharbandh	24	11	0	0	11	46
		Malpada	75	36	3	0	39	52
2	Nangalbod	Nuamalpada	42	13	21	6	40	95
Total	**4**	**9**	**622**	**325**	**132**	**15**	**472**	**76**

Skeletal fluorosis: The EQMG team informed the villagers about the various symptoms of skeletal fluorosis at village meetings. The villagers suggested the names of people with these symptoms. Elementary tests were performed on them to identify the genuine cases of skeletal fluorosis. Forms with detailed information were filled out for those persons with skeletal fluorosis.

Water quality Monitoring: Fluoride concentrations were measured for 168 drinking water sources in 9 villages where the health survey had been done and in two additional villages where there were reports of fluoride contamination. The sources included handpumps, dug wells and ponds. Three local rivers, Sundhar, Indra and Patal Ganga were also monitored. Water supplied by the government in Karlakot, Karaijhola and Binapur villages, affected by fluorosis, was also tested for fluoride.

Sample collection and analysis: On-site analyses of water quality parameters were performed using PSI's water quality testing kit. Laboratory analyses were performed in a laboratory set up by PSI at the SVA campus in Bilenjore.

The water samples were collected in polyethylene bottles. They were vigorously washed with detergents and rinsed with distilled water prior to collecting the samples. A battery operated hand-held pH meter was used to test pH. Alkalinity and calcium were analyzed by titrimetric methods. A fluoride ion meter (Model 290 A+ Orion, USA) was used to measure fluoride concentration in the samples. Standard methods prescribed in the American Public Health Association's handbook (20th edition, 1998) were followed for analysing all the parameters.

Awareness campaign: Based on the results of fluoride content in drinking water, an awareness campaign was carried out in the selected villages. Eight villages had shown fluoride concentrations of more than 1.5 mg/l in their drinking water sources. Hamlet level meetings were organised in all the villages**.** Dialogues with the villagers, social mapping, fluoride distribution in drinking water sources, distribution of educational materials and a poster exhibition, etc. were integral part of these meetings. Workers from SVA and scientists from PSI facilitated these meetings. These meetings led to further discussions and meetings to evolve fluorosis mitigation plans for all the villages.

III. RESULTS & DISCUSSION

Dental & Skeletal fluorosis: Dental fluorosis was observed in 76% out of the 622 children surveyed in the 9 selected villages. More than half the children (325) were suffering from mild dental fluorosis, while 132 were moderately afflicted and 15 were diagnosed with severe dental fluorosis. Skeletal fluorosis was observed in Bastipada and Khandhapada hamlets of Nuamalpada village and in Sukalpur village.

Fluoride Concentration in Drinking Water Sources

Tables 2 to 4 present the fluoride monitoring data of the selected villages. Table 2 reveals fluoride concentrations greater than the accepted level of 1.5 mg/l in most of these sources. The highest fluoride concentration found in these sources is 7.5 mg/l in Nuamalpada village. The fluoride content varied from source to source in each village. It was much higher in groundwater sources (handpumps and open wells) as compared to surface water sources. The high fluoride content in groundwater is probably due to the presence of underground fluoride bearing rocks.

Seven villages, namely, Bakalikhuti, Tetelpada, Binapurpada, Putupada, Pharsera, Malpada and Jharbandh have higher concentrations of fluoride in handpumps compared to the open wells. The remaining 4 villages Sukalpur, Amguda, Numalpada and Belgaon have similar ranges of fluoride concentrations in the handpumps and open wells. This indicates that the former villages contain fluoride in the upper strata rather than the deeper strata of underground rocks. Most of the open wells in these villages exhibited a fluoride content below 1 mg/l. It was interesting to note that most of these open wells were not used for drinking.

Four grab samples were collected from tap water in Karalkot, Kerijhola, Binapur and Boden villages which were supplied with piped water by government agencies. The analysis revealed that three of the four samples had fluoride contents around 3 mg/l or more. Three out of the four

samples were from supplies withdrawn from deep borewells. This points out that supplying water from deep borewells may not be a viable solution to the problem.

Fluoride concentrations was also monitored in Sundher, Indra and Patal Ganga rivers. All of them had fluoride content below 1 mg /l. Hence, these surface water sources can be used for supplying drinking water, after treating them to remove bacteriological contamination.

Table 2. Fluoride Concentrations in Village Drinking Water Sources

S. No	Village's Name	Hamlet(Pada)	Range of Fluoride Concentration (mg/l)	No. of Water Sources				
				W	Hp	Pond	Total	
							No	%
1	2	3	4	5	6	7	8	9
1	Sukalpur	Sukalpur						
			< 1.0	1	*	*	1	7
			1.0 – 1.5	1	*	*	1	7
			1.6 – 3.0	4	2	1	7	50
			3.0 – 4.0	2	*	*	2	14
			> 4.0	2	1	*	3	21
2	Bakalikhuti	Bakalikhuti						
			< 1.0	2	*	*	2	15
			1.0 – 1.5	4	2	*	6	46
			1.6 – 3.0	3	2	*	5	39
		Sargiguda						
			< 1.0	2	*	*	2	18
			1.0 – 1.5	3	1	*	4	36
			1.6 – 3.0	2	3	*	5	45
		Madhupur						
			< 1.0	2	*	1	3	60
			1.0 – 1.5	*	2	*	2	40
3	Amguda	Bodlapada						
			1.0 – 1.5	*	4	*	4	57
			1.5 – 3.0	1	2	*	3	43
		Padarpada						
			1.6 – 3.0	1	1	*	2	100
		Jhakarpada						
			1.6 – 3.0	*	1	*	1	100
		Amguda-Bastipada						
			< 1.0	3	2	*	5	45
			1.0 –1.5	1	3	1	5	45
			1.6 – 3.0	*	1	*	1	10
		Jhulapada						
			1.0 –1.5	*	2	*	2	100
		Bandhpada						
			1.6 –3.0	3	2	*	5	100
4	Tetelpada	Tetelpada						
			< 1.0	*	1	*	1	17
			1.0 – 1.5	2	2	*	4	67
			1.6 – 3.0	*	1	*	1	17
5	Binapur	Binapurpada						
			1.0 – 1.5	*	1	*	1	100
6	Putupada	Putupada						
			< 1.0	*	2	*	2	17
			1.0 – 1.5	1	7	*	8	67
			1.6 – 3.0	1	*	*	1	8

			3.0 – 4.0	1	*	*	1	8
		Arjuna						
			< 1.0	1	2	1	4	80
			1.0 – 1.5	*	1	*	1	20
		Mahulapada						
			< 1.0	1	*	*	1	33
			1.0 – 1.5	1	1	*	2	67
7	Pharsara	Pharsara						
			< 1.0	2	3	*	5	56
			1.0 – 1.5	*	3	*	3	33
			1.6 – 3.0	*	1	*	1	11
		Kanakpur						
			< 1.0	1	*	*	1	25
			1.0 – 1.5	*	3	*	3	75
8	Malpada	Bastipada						
			< 1.0	1	*	*	1	20
			1.0-1.5	*	2	*	2	40
			1.6 – 3.0	*	2	*	2	40
		Routpada						
			< 1.0	*	1	*	1	25
			1.0 - 1.5	*	2	*	2	50
			1.6 – 3.0	*	1	*	1	25
9	Jharbandh	Vanpada						
			1.6 – 3.0	*	1	*	1	100
		Bastipada						
			< 1.0	*	1	*	1	11
			1.0 - 1.5	*	5	*	5	56
			1.6 – 3.0	*	3	*	3	33
10	Nuamalpada	Bastipada						
			1.6 – 3.0	*	1	*	1	9
			3.0 – 4.0	*	1	*	1	9
			> 4.0	5	3	1	9	82
		Hanspada						
			1.6 –3.0	*	1	*	1	100
		Khandhapada						
			1.0 – 1.5	*	*	1	1	12
			1.6 – 3.0	*	1	*	1	12
			3.0 – 4.0	1	2	*	3	37
			> 4.0	1	2	*	3	37
		Portipada						
			1.6 – 3.0	*	2	*	2	67
			3.0 – 4.0	*	1	*	1	33
		Kachharpada						
			> 4.0	1	2	*	3	100
		Podhpada						
			1.6 –3.0	1	1	*	2	67
			3.0 – 4.0	1	*	*	1	33
11	Belgoan	Belgoan						
			< 1.0	*	2	*	2	22
			1.6 – 3.0	1	2	*	3	33
			3.0 – 4.0	*	3	*	3	33
			> 4.0	*	1	*	1	11
	Total			60	102	6	168	

* Not found or monitored, W- Open well, Hp - Handpump

Table 3. Fluoride Concentrations in Tap Water Supply

S. No.	Description	Fluoride Concentration (mg / l)
1	Karalkot water Supply *	0.25
2	Kerijhola Water Supply **	3.88
3	Binapur Water Supply **	3.27
4	Boden Water Supply **	2.91

* Water Supply through lifting from River Sundar * * Water Supply from deep borewells

Table 4. Fluoride concentrations in rivers

S.No.	Description	Fluoride Concentration (mg / l)
1	River – Indra near Rajna Village	0.40
2	River – Sundar near Konabeer Village	0.48
3	Patal Ganga, Natural Stream	0.39

Relationship between severity of fluorosis and fluoride concentration in drinking water: The severity of fluorosis and the corresponding fluoride concentrations in drinking water are summarized in Table 5. This data is for only those persons who drank water from known specific sources. The data of Table 5 is further summarized in Table 6. It shows that the average values for the different degrees of severity of fluorosis in Orissa is less than that in Sonebhadra district. This is probably due to the local diet.[1]

[1] SUSHEELA, A.K. : A Treatise on Fluorosis, Fluorosis Research and Rural Development Foundation, New Delhi, 2001.

Fig. 1: Map of the study area – Nuapada district, Orissa

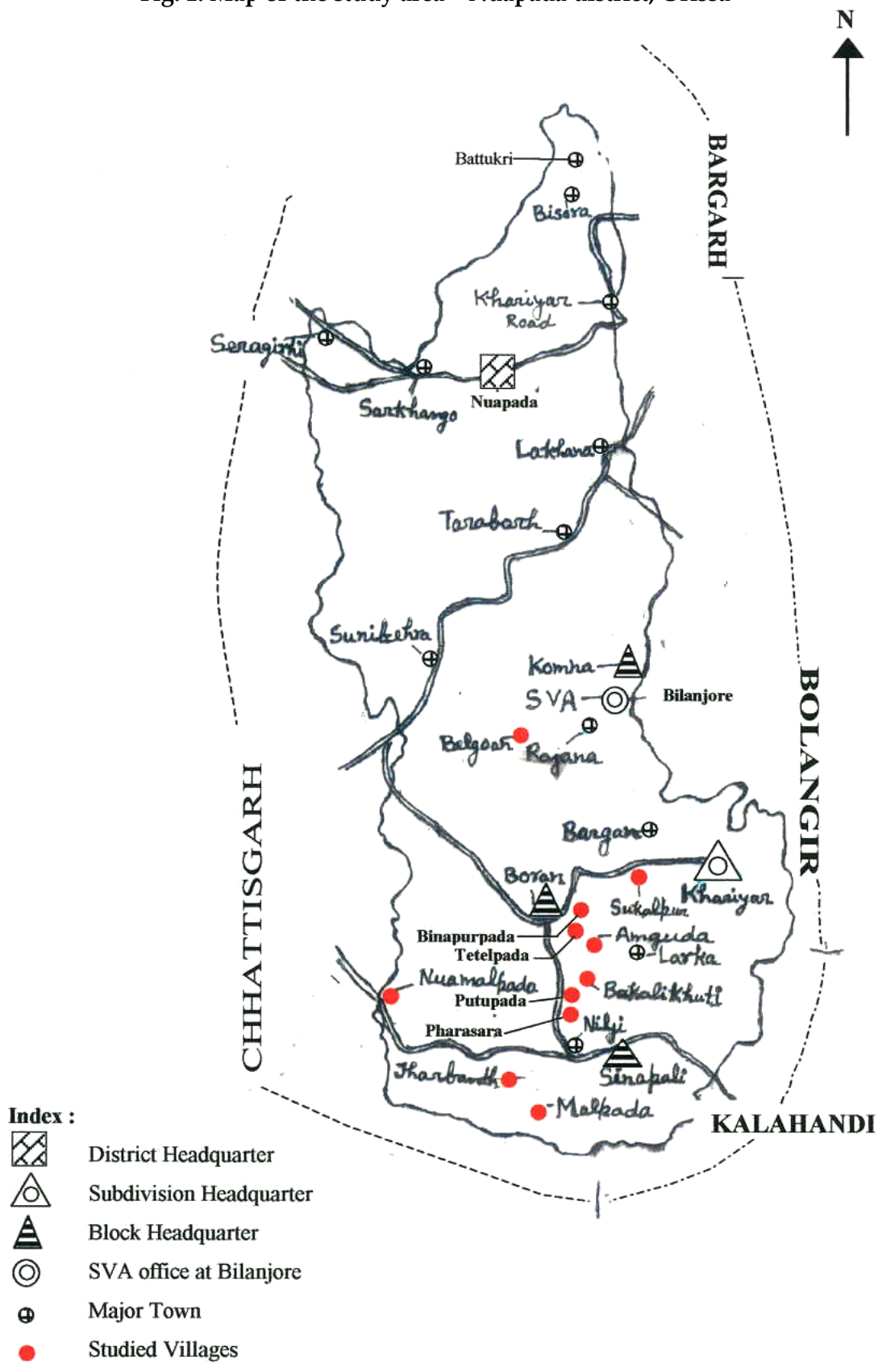

Table-5 Relationship between fluoride concentration in drinking water and severity of fluorosis

Fluoride concentration in drinking water (mg/l)	Different degree of fluorosis cases											
	A		B		C		D		E		F	
	No.	%	No	%	No	%	No	%	No	%	No	%
< 1.0	*	*	*	*	*	*	*	*	*	*	*	*
1.0 - 1.1	2	12	5	9	2	2	*	*	*	*	*	*
1.2 – 1.3	6	35	10	17	17	16	2	3	1	8	*	*
1.4 – 1.5	7	41	11	19	24	22	11	18	1	8	*	*
1.6 – 2.0	2	12	7	12	12	11	6	10	1	8	*	*
2.1 – 2.5	*	*	21	36	37	34	23	38	2	15	*	*
2.6 – 3.0	*	*	3	5	6	5	*	*	*	*	*	*
3.1 – 3.5	*	*	*	*	*	*	*	*	*	*	*	*
3.6 – 4.0	*	*	*	*	1	1	2	3	*	*	2	7
4.1 – 4.5	*	*	1	2	1	1	7	11	3	23	9	30
4.6 – 5.0	*	*	*	*	*	*	*	*	*	*	*	*
5.1 – 5.5	*	*	*	*	6	5	7	11	3	23	12	40
5.6 – 6.0	*	*	*	*	3	3	3	5	2	15	*	*
6.1- 6.5	*	*	*	*	*	*	*	*	*	*	7	23
6.6 – 7.0	*	*	*	*	*	*	*	*	*	*	*	*
Total	17		58		109		61		13		30	

*Not Found

A- Non-affected cases
B- Suspected cases of dental fluorosis
C- Affected by mild dental fluorosis
D- Affected by moderate dental fluorosis
E- Affected by severe dental fluorosis
F- Affected by skeletal fluorosis

Table 6: **Relationship between fluoride concentration in drinking water and severity of fluorosis.**

Severity of fluorosis	Number of cases	Average fluoride conc. in drinking water(mg/l)
Non affected	17	1.5
Mild dental fluorosis	109	2.1
Moderate dental fluorosis	61	4.22
Severe dental fluorosis	13	3.7
Skeletal fluorosis	30	5.0

Strategies for Fluorosis Mitigation and Control: The different options for access to safe drinking water identified by the villagers in their fluorosis mitigation plans are:

i) Use of existing drinking water sources with low fluoride concentrations
ii) Conversion of open wells with less than 1.5 mg/l fluoride into safe and sanitary wells
iii) Use of surface waters
iv) Sand wells

v) Roof Rain Water Harvesting Structures

vi) Use of defluoridation kits

The estimated costs for the different options in 7 selected villages are given in Table 7.

Table 7: Estimated direct implementation costs for the proposed fluorosis mitigation measures in seven villages.

S.No.	Mitigation Measures	No.	No. of household(s) benifitted	No. of beneficiaries	Estimated cost (Rs.)
1	Conversion of existing dug wells into safe sanitary wells	4	140	1260	168000
2	Conversion of existing concrete wells into safe sanitary wells	5	142	689	175000
3	Construction of sand wells in existing ponds with low fluoride content	5	222	1645	500000
4	Handpumps with attached defluoridation (community) kits	17	441 + 4 schools	2570 + 450 school children	1360000
5	Domestic defluoridation kits	32	32	191	32000
6	Roof rain water harvesting system for one school	1	High school	100 Children	360000
7	Community rain water harvesting systems	1	15	90	324000
8.	**Grand total**		**992**	**6995**	**2919000**

The total investment required for 992 households and 550 school children is Rs. 2,919,000 which works out to an investment of Rs. 417 per person. This is significantly lower than the estimated per capita investment in Sonebhadra district. The Gram Swaraj Abhiyan has created a high level of self-reliance among the participating communities. This is reflected in the higher level of community contributions in Orissa compared to Sonebhadra district. The proposed community contributions in Orissa are:

- For domestic defluoridation kits: 25-30%
- Community defluoridation kits: 10-25%
- Conversion of wells and construction of roof RWH systems: entire labour costs

PSI and its partner organization SVA will now seek the required funds.

IV CONCLUSIONS

The initial health survey of 622 children in nine villages of Boden and Senapalli blocks in Nuapada district showed that 76 per cent were suffering from dental fluorosis. A little less than half (80/168) the water sources monitored contained more than the acceptable limit (1.5mg/l) of fluoride. Correlation of the incidence of fluorosis and the concentration of fluoride in the water revealed the following threshold fluoride concentrations:

Initiation of mild dental fluorosis:	1.2 mg/l
Initiation of severe dental fluorosis:	3.0 mg/l
Initiation of skeletal fluorosis:	4.0 mg/l

These threshold values are less than the corresponding ones for the onset of different stages of fluorosis in Sonebhadra district. This is probably due to the restricted diet of the people in western Orissa.

The health and the water quality data were explained to the villagers at a series of meetings in each village, as part of an educational campaign. It led to the preparation of fluorosis mitigation plans for 7 villages. The villagers put forth a mix of approaches to access fluoride-safe drinking water. The physical works and defluoridation kits will cost about Rs.29,19,000 for 6995 beneficiaries. This works out to an approximate cost of Rs.417 per beneficiary. Displaying a high degree of self-reliance, the affected communities volunteered to contribute a part of the capital costs. PSI and SVA will now seek the required funds.