A Case Study of Fluorosis Mitigation in Dungarpur District, Rajasthan, India

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SUMMARY: India is among the many countries in the world, where fluoride contaminated groundwater is creating health problems. Safe drinking water in rural areas of India is pre dominantly dependent on groundwater sources, which are highly contaminated with fluoride, the concentration in 17 States being 1 to 48 mg/L. About 62 million people including 6 million children are affected with dental, skeletal and non-skeletal fluorosis.
In Rajasthan, 18 out of 32 districts are fluorotic and 11 millions of the population are at risk. In the absence of perennial rivers, surface and canal system, groundwater remains the main source of drinking water. It contains 2 to 20 mg/L of fluoride.
Defluoridation at household level has been popularised under the sponsorship of UNICEF. Few villages of Dungarpur district of Rajasthan are covered adopting both techniques of activated alumina and the Nalgonda technique. 800 defluoridation units were distributed in six villages. People are daily using the units for last four years and they felt significant relief in non-skeletal fluorosis manifestations.
The ongoing fluorosis mitigation programme appears sustainable due to active community participation. It is recommended for replication of in other fluorosis endemic regions of the world, with increased Information-Education-Communication, IEC, activities and involvement of Non-Government Organisations, NGOs.

Key words : Fluoride contamination, fluorosis, domestic level, defluoridation, community participation, IEC activities.

INTRODUCTION

High concentration of fluoride has been detected in the underground water in many countries, e.g. Kenya, Nigeria, South Africa, Tanzania, USA, China, India, Japan, Korea and Australia. Besides, 33 other countries have been reported to have high fluoride levels in the ground water 15.

Fluoride in excess of 1.0 mg per litre causes dental fluorosis if ingested regularly. It can also result in skeletal fluorosis and non-skeletal manifestations i.e. loss of appetite, joint pain, stiffness of neck and back pain, gas formation, laziness in routine life, increased urination etc, as commonly reported in fluorotic regions [16].

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17 states of The Indian Unionare affected by fluorosis. Severely affected states are Rajasthan, Andhra Pradesh and Madhya Pradesh. The endemic states with excess fluoride in drinking water are shown in Figure 1 & 2. Figures also show the total rural population at risk.

TABLE 1. Population (in millions) and percent of people at fluorosis risk in India.

State	Total p.	p. at risk	% at risk	State	Total p.	p. at risk	% at risk
West Bengal	56.21	1.65	2.9	Madhya Pradesh	38.36	1.68	4.4
Utter Pradesh	130.83	1.77	1.4	Karnataka	34.42	6.9	20.0
Tamil Nadu	39.19	7.64	19.5	Haryyana	14.57	2.17	14.9
Rajasthan	39.82	10.9	27.4	Gujarat	29.45	4.78	16.2
Punjab	16.05	2.07	12.9	Delhi	1.23	0.16	13.0
Orissa	29.8	3.26	10.9	Andhra Pradesh	52.31	13.5	25.8
Maharashtra	52.84	0.14	0.3	**All 14 states**	**535.08**	**56.62**	**10.6**

FIGURE 1. The classical setup of Nalgonda technique as developed in NEERI, Nagpur

Government of India is concerned with the severity and enormity of the excess fluoride problem and its serious health implications. A National Drinking Water Mission has been set up to implement various schemes of safe drinking water throughout India. Both the Nalgonda as well Activated Alumina Techniques are found successful in the country for defluoridation of water.

Rajasthan is one state where fluoride in high level is prevalent in all the 32 districts and has become a serious health hazard in 18 of them. According to the survey conducted by the Public Health Engineering Department in the recent past, the drinking water sources in 9741 out of 37889 villages, 25.7 %, and 6819 out of 45311, 15 %, habitations were found to contain fluoride more than 1.5 mg/L

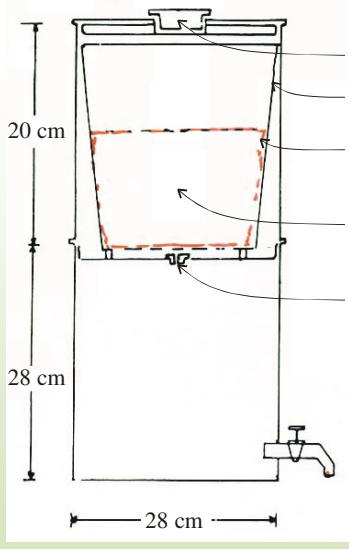

FIGURE 2. Sketch of the domestic filter utilising activated alumina.

In the absence of perennial rivers, surface sources and canal systems, groundwater, which generally contains high fluoride concentrations, remains the main source of drinking water for about 95 % of the population. The contents of fluoride in groundwater are increasing due heavy withdrawal of water for agriculture purpose and poor recharging

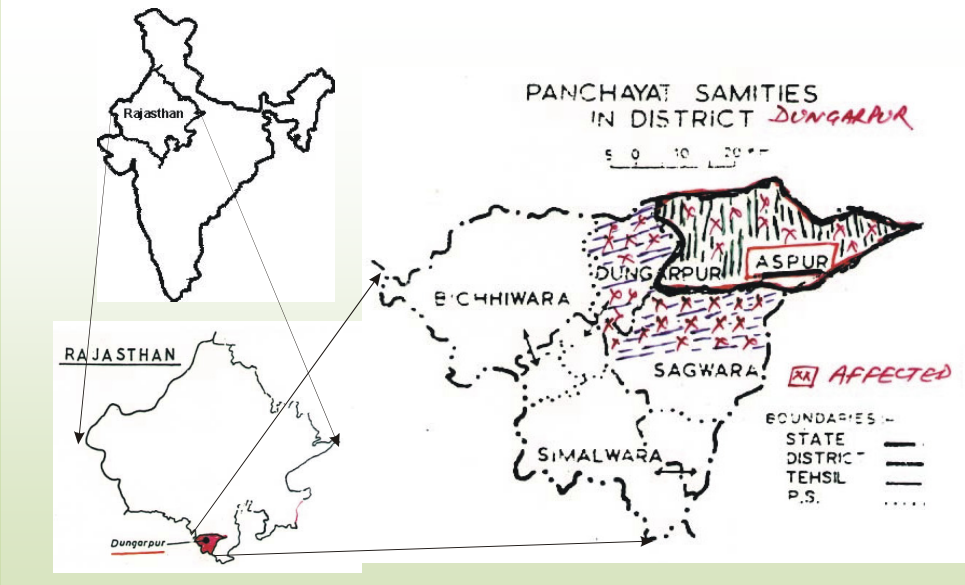

FIGURE 3. The project area.

The problem of excessive fluoride in drinking water can be solved by the following alternatives:

- Bringing fluoride free water from distance sources by pumping and lying long pipelines.
- Installation of defluoridation plants at water sources, and
- Defluoridation at domestic level.

The first two alternatives not only require high capital investments but also heavy expenditure on O & M, high level of close supervision and operation by trained and skilled persons.

In view of the above constraints and poor capacity of the beneficiaries to pay the cost of production of water, defluoridation of water at domestic level is the most appropriate solution. It is simple, cost effective and sustainable, being community based and community managed.

MATERIALS AND METHODS

Two proven techniques are utilised in the project:

Nalgonda Technique. The process is simple, technically sound and cost effective. It involves mixing of alum and line. Flocs, when formed by gentle mixing, absorb fluoride from raw water and decanted water will have fluoride in negligible amounts, Figure 1. It is recommended for treating water with total dissolved solids and total hardness not more than 1500 mg/L and 250 mg as CaCO3/L, respectively. Proper stirring required in this process. Total cost of one drum set is around US $ 15. Monthly recurring cost per family is meagre.

A A Technique. A company, Indian Institute of Technology in Kanpur carried out studies over the activated alumina technique for the last 7 years. The studies revealed that the filter with activated alumina is efficient in removal of fluoride at domestic level. The filter consists of a container having the plastic / steel bucket with activated alumina, Figure 2. The activated alumina needs regeneration once in 3-4 months. This can be carried out locally by the communities. The activated alumina can be regenerated at least 28 times over the course of its lifetime. Total cost of a filter is around US $ 30-35. Quarterly recurring cost is around 1/2 dollar. Sometimes there is slight increase in sulphate value during periodic regeneration but it is not harmful to human health.

Project area. In Dungarpur district, fluorite mineralization spread over to 200 sq. km. Area. More over, rocks like granite, granite - gneisses are exposed due to which ground water have excess quantity of fluoride ion. The potable water sources of more than 150 villages out of 827 villages contain 1.5 to 8.5 ppm of fluoride. Since February 1996 an action research pilot project (Fluorosis Mitigation Programme) was launched by SARITA in four villages of Dungarpur district of Rajasthan under the sponsorship of UNICEF. Later on after two years, due to active community involvement and cost sharing by the users, two additional villages were added in the ongoing programme.

Programme components. The key-components of this programme are:

a) Public awareness activities.

b) Community level training.

c) Baseline survey.

d) Information-Education-Communication strategy.

e) Water analysis in pre and post mansoon periods.

f) Hardware distribution of Nalgonda based drum sets and AA-filters.

g) Procurement of chemicals, i.e. alum and lime for Nalgonda process and NaOH and H2SO4 for periodic regeneration of exhausted Activated Alumina granules.

h) Field testing of defluoridated water.

i) Fortnightly monitoring and evaluation.

j) Regeneration methodology and training.

k) Cost sharing by the users.

l) Constitution of Watsan Committees, Pani Panchayats, and organisation their monthly meets.

m) Pre and Post-intervention medical examination of patients.

n) Replication strategy through involvement of government / PRI's etc.

o) Periodic documentation and mid-term correction.

The IEC tools such as wall-paintings, posters, slogans, students rally, puppet show, nukkad natak, audio-video cassette were developed and displayed. Resource persons, subject experts were called for short-term orientation training.

RESULTS

The achievements of last five years are:

a) 800 households of five villages adopted both the techniques and have realised the importance of defluoridated water.

b) Local population now understood the real cause of spread of fluorosis disease.

c) Beneficiaries felt significant relief in several non-skeletal symptoms of fluorosis, i.e. recover of appetite, least backache, activity in daily routine life, decrease in gas formation, less thirsty, least joint pain, no stiffness in neck etc.

d) 100 % cost sharing of recurring expenses have been observed.

e) Watsan committees, called Pani Panchayats, have been constituted in all the villages to self-sustain the ongoing programme.

f) There is active participation of community elected representatives, local schoolteachers, revenue officials, para-medical staff.

g) Increased Information-Education-Communication activities have awarded the people to own the AA-filters.

h) Local social workers have been trained to undertake periodic regeneration at village level;

i) Close liaison between UNICEF, State PHED, SARITA and local authorities observed in the programme.

j) Proposed need base replication strategy stress for effective involvement of users and the government.

k) Special schedules developed for house-to-house survey, pre and post intervention medical examination of fluorosis patients and for fortnightly monitoring.

DISCUSSION

Technology. From the last five years experience, it has been felt that due to scarcity of water and daily disposal of sludge, the Nalgonda technique was less preferred. Still there is need to invent low-cost, easy operational and adaptable AA-filter or other defluoridation units for its replication in all the 16560 affected villages of Rajasthan State, India. Technology option should be popularised. As per their purchase capacity, people will purchase defluoridation units, e. g. Nalgonda based drum set, Terricota AA-filter, plastic AA-filter, steel made AA-filter, defluoridation brick etc. For this purpose, sanitary marts should be opened at villages. The chemicals should also be available in such local shops. Installation of community based (AA-technology) defluoridation plants in affected localities and their proper maintenance. Implementation of regional water supply schemes from safe surface water sources is needed in affected localities.

Motivation. Continue motivation and awareness building are essential to make the programme successful. High level of awareness towards the disease and health benefits gained by the users is reflected in discussions. There is demand for more AA-filters among left-out families.

Finance. The financial and local man power assistance should be given by state Public Health Engineering Department / Panchayats to make the programme sustainable in long term. Presently there is no financial assistance from the Central / State govt. for subsidising partial capital cost of filters. The villagers of adjacent affected localities also showed willingness to own such units and to share full O & M costs.

Quality of medium. None of the households voiced any complaints about the defluoridation kits or regarding the taste of the treated water. The quality grade AA granules are not easily available in the market. The AA-granules of few manufacturing companies be approved by the government. Availability of quality grade but commercial NaOH, H2SO4, alum and lime be ensured through Public Health Engineering Department at local level.

Health achievements. Users informed that their health had improved considerably. Proper records of fluorosis patients should be maintained by State Medical and Health

Department. Research and development proper treatment of fluorosis should be encouraged.

Management. NGO's should be involved in the implementation of domestic defluoridation programme in affected localities. It is high time to concentrate over different aspects of this public health related problem to help the millions of the people from this crippling disease. The international donor agencies and other related institutions in association with government should grant funds to take up defluoridation at both community and household level and proper cure of disease be invented.

ACKNOWLEDGEMENT

The authors are thankful to UNICEF for sponsoring this ongoing programme and to Public Health Engineering Department and RNT Medical College, Udaipur (India) for periodic guidance in the programme.

REFERENCES

1. Agarwal V, Vaish A K and Vaish P 1997. Ground water quality: Focus on fluoride and fluorosis in Rajasthan. Current Science , Vol.73, no.99. pp.743-746.
2. Bulusu, K R and Nawlakhe, W G 1990. Defluoridation , NEERI, Publ. Nagpur (India).
3. India Institute of Technology 1996. Defluoridation of water using Activated Alumina, Kanpur (U.P.) India 48p.
4. India Institute of Technology 1998. Comprehensive report on Defluoridation using Activated Alumina, Kanpur (UP) India, 76p.
5. Keller. E. (1976) : Environmental Geology. C. Merill, Pub. Ohio, 489p.
6. PHED 1993. Survey of Status of Drinking Water supply in Rural Habitation, unpub. Reports, Public Health Engineering Department, Government of Rajasthan, Jaipur, India.
7. RGNDWM 1993. prevention and Control of fluorosis, Health Aspects, vol.1., Ministry of Rural Development, Rajiv Gandhi National Drinking Water Mission, Govt. of India, New Delhi, 89p.
8. RGNDWM 1993. Water Quality and Defluoridation Techniques, GOI, New Delhi, 58p.
9. SARITA 1995. Severity of Fluoride pollution in drinking water of the rural sector of Dungarpur district of Rajasthan, Final Project Report (unpub)104 pp.
10. WELL (1999) : Study of Fluoride Treatment, Andhra Pradesh Water and Environmental Sanitation Project, task No.: 41, for DFID, 48p.
11. UNICEF 1995. WATSON India 2000, 48p.
12. UNICEF 1997. Fluorosis, Health and epidemiological survey of some high fluoride villages of Dungarpur district, Rajasthan (unpub.), Department of Community Medicine, RNT Medical College, Udaipur, 49p.
13. WHO 1970 & 1994. Fluorosis and Human Health booklets.
14. UNICEF 1995. Plan of Action, UNICEF assisted pilot project for fluoride control in Dungarpur district of Rajasthan, Rajasthan Field Office, Jaipur (unpub.); 11p.

15. PHED, M. P. 2000. Booklet on International Workshop on fluoride in Drinking Water, strategies, Management & Mitigation, Public Health Engineering Department, Govt of Madhya Pradesh, Bhopal (22-24 January, 2001), 27p.
16. Susheela A K 1999. Fluorosis Management Programme in India, Current Science, vol. 77. No. 10, November, 1999, pp 1250-1255.
17. Department of Community Medicine, RNT Medical College, Udaipur (2000): Health and epidemilogical survey of some high fluoride villages of Dungarpur and Rajsamand districts, conducted for UNICEF, Jaipur, India, 38p.
18. SARITA 2000. Fluorosis Mitigation Programme in Aspur Block of Dungarpur district of Rajasthan, India, Review and Recommendation (unpubl.) Report. May, 2000, 9p.