How can we think ahead on Fluorosis Mitigation?

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ABSTRACT

Fluorosis occuring from high Fluoride in water is a health disorder that is slowly enveloping millions of Indians – both rural and urban. In spite of numerous mitigation programmes, it passes on unnoticed and lies buried below tonnes of higher priority issues, both from the water and health angles – two perspectives that need to merge in order to address it completely. For decades, the emphasis towards Fluorosis mitigation had been totally from the water side, i.e. to supply Fluoride free water, with a pure source or by treatment of affected water. The push needed from the health side has been abysmally lacking, and only gaining slightly perhaps for the past decade or so. Ability and also infrastructure for detection of Fluorosis is very poor among doctors in affected areas, so where would there be a demand for better water among patients – all that they demand for is more pain-killers; making a big industry for cheap pain-killers across Fluorosis affected areas. This is why perhaps, so many defluoridation programs starting from the domestic or community based Nalgonda mechanism, or the Activated Alumina based domestic model, or now the Reverse Osmosis based systems, fail to catch up among patients. Estimates of several thousand crores worth of investments on these programs are almost down the drain. New programs are still being developed, yet, on the same path. Where would a true effort towards Fluorosis mitigation begin – would it keep feeding the need for governments and funding agencies to create new programs, for private sector to keep manufacturing and supplying defluoridation filters and for local organizations to implement these programs on a time-bound basis? Time and again, these failed experiments across the country only result towards the same consequence – they give the local water supply and engineering departments the opportunity to propose massive importing of water and supply of water to villages and towns by piped water supply. The cycle of Fluorosis detection, development of programs for defluoridation, its accepted failure and finally, a piped water supply scheme, is a common story throughout the country – one that is creating even more conflict among already strained regional water resources. It is another story of where each of these piped water supply schemes end to – lack of source water in summer, lack of funds for repair and maintenance, grossly over-optimistically designed schemes – haven't we had enough of these repetitive dramas. As children keep continuing to get affected with Fluorosis and increasingly in intensity, we face generations of adults whose symptoms cannot be reversed. It is of utmost urgency to seriously face Fluorosis and take steps towards addressing this problem.

Introduction

There has been much recent talk and debate about the “missing girls” in our society due to selective discrimination during pregnancy. It is perhaps easier to spot the missing ones amongst us, maybe difficult to spot the “silent millions” who accept their living reality as a matter of fate. Fluorosis is an easily preventable disease, but one that has now affected several million people in India. As it slowly spreads and creates these silently suffering patients, we strongly question whether the mitigation programmes that are currently on ground have any basis for bringing about change. When we see patients losing 10%-20% of their annual income due to this disease, it is really a serious problem especially for those on the borderline of poverty. When much of this disease can be prevented just by consumption of low Fluoride water and diet, why is it that we don’t see any improvement on ground? Why are numerous mitigation programmes taking off, but we see no sign of them after a couple of years? Are these programmes playing with the problems of millions, serving only the pockets of professionals? Is there a better way ahead?

Water induced Fluorosis is expected to have around 60 million patients exposed to risk in India. The main symptoms are those of Dental and Skeletal Fluorosis, and then allied diseases. On a secondary level, different other Fluoride related disorders include Kidney stones, risk to pregnancy, brain disorder etc. Generally, the WHO standard of 1.0 mg/l is an exposure limit, but lower degree of symptoms are present in even more patients in areas with lesser Fluoride than 1.0 mg/l. Apart from water, people residing in Fluoride affected areas are exposed to risk also from food-crops that are irrigated with Fluoride rich groundwater. There is also consumption of Fluoride from some common food items such as tea, black-rock salt etc., but Fluorosis resulting from such a route is not that widespread. Almost every state in India has some Fluoride affected villages, but the main affected states are Rajasthan, Andhra Pradesh, Maharashtra, Karnataka, Gujarat, Tamil Nadu and MP. States like UP and WB are also revealing more areas with high Fluoride. As groundwater use for drinking develops and newer sources of groundwater tapped, the prevalence is just increasing constantly. Some places are just few steps into the disease with only very young children affected, eg. Jhabua in western MP, but other places like say, Anantapur in southern AP have several generations of affected patients. In such places, the problem has become part of folklore, a gradual fact of life.

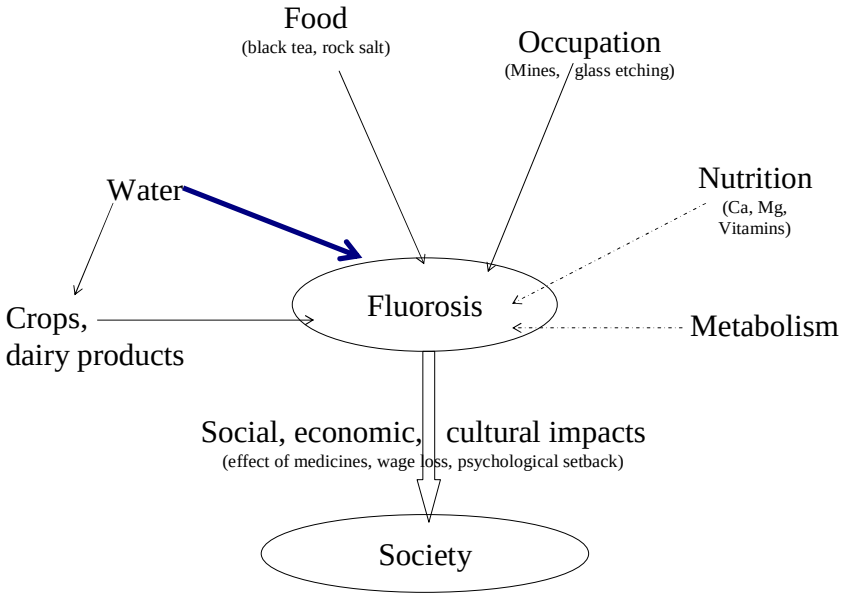
The water centric focus on Fluorosis mitigation is being criticized now with findings that a major amount of consumption of Fluoride actually happens because of food from crops that are irrigated with high Fluoride water. Some studies suggest that as much as 80% of Fluoride is consumed through food, the remaining directly from water.

Historically, numerous defluoridation technologies have been developed, but we can divide them into 3 main phases:

a - Nalgonda type mechanism
b - Activated Alumina type technology
c – Reverse Osmosis technology

Figure 1: Linkages to Fluorosis

(dark blue link is the main area of attention now)



Historic development of Defluoridation programs

The Nalgonda mechanism was popularized through efforts of NEERI starting from the 1970s (Nawalakhe et al, 1975). It requires adding only commonly available materials – Lime and Alum – and flocculation, sedimentation and filtration. Generally, the stirring requires a motored power and then settling for few hours. The name of the plant comes from the place where it was first implemented and popularized. Around 500 of these plants were commissioned by the central government as large community plants across the country in the 1980s and 1990s. But several problems were encountered both with the technology and with the management of these huge plants. Long settling time, sometimes more than 5-6 hours; high sulphate and aluminium concentrations due to Alum; were some of the technical problems, but apart from these all the plants ran into management issues once they were handed over to the community with the result that almost none of them survive today. As a result, investment of several hundred crore rupees (500 plants * 15 lakhs per plant approx = 750 crores) went totally into disuse. There was also an attempt at promoting domestic models of the Nalgonda type filter, but since they require much individual effort daily, they were not accepted.

In the 1980s itself, UNICEF along with IIT Kanpur tested the Activated Alumina (AA) technology for defluoridation which had been developed in the US in the 1930s (Churchill 1936). The defluoridation capacity of AA was much better than the Nalgonda type mechanism, since there was no daily processing requiring, only a regeneration of the AA material after, say 3-4 months for an average household with Caustic Soda (NaOH) and sulphuric acid. Mostly, the AA filters were promoted as domestic units and they were piloted in 2 locations with severe Fluorosis – Dungarpur in Rajasthan and Anantapur in AP.

Two organizations – Sanitation, Water and Community Health (SWACH) in Dungarpur and Mytry Social Service Society in Kadiri, Anantapur anchored these pilot testing of the domestic defluoridation units (DDUs). Mostly these programs after piloting in the early 1990s, went on into peak of implementation around 2000-01. The idea was to have DDUs in households to take care of domestic water consumption and regeneration to managed by Sanitary Marts either at the village level or in nearby towns. Resource persons in the village were trained for carrying out regeneration of AA material. Community regeneration centres were also constructed in Kadiri area.

The two organizations, SWACH and Mytry took very different routes. Whereas Mytry tried to absorb all activities of the manufacturing and maintenance in-house by going towards constructing a filter manufacturing plant, SWACH was more focused on creating village institutions that would later on take charge of material regeneration. Mytry later also obtained support from a venture fund to start a business around filter manufacturing which it successfully carried out by supplying filters to nearby towns. Mytry also found a client in UNICEF and different government department for implementing their programs in other states. Therefore the route that the DDU program took in Kadiri went on to create an infrastructure for defluoridation filter manufacturing in a small town of rural India, Kadiri, whereas such defluoridation filters are still not available in the bigger cities even today.

Mytry also established village-level AA regeneration centres and trained villagers to operate them. However, after 4-5 years of the program completion, the regeneration centres are in disuse. Even though villagers can travel to nearby towns for regeneration, they rarely do so. The only remaining users of AA filters are the urban ones who are serviced by Mytry and their agents. Otherwise, the rural defluoridation program is now defunct.

In Dungarpur, there was no attempt at establishing a business, but some of the village resource persons of SWACH still continue to conduct AA regeneration for a fee. A few hundred customers still continue to use AA filters even after 5 years of termination of the program. This sustenance is totally on a private basis and based on a few resource persons who have taken up as their own small business activity and were trained by SWACH.

But what about the thousands of DDUs distributed through these 2 programs? Can the massive investment on these programs be salvaged? If only some services are offered locally for AA regeneration and filter maintenance, there would be many more patients continuing to use these filters. But, what about sustenance of such an activity? Would it be commercially viable?

Reverse Osmosis as a physical process was known since 1748, but it was only in 1960 that practical demonstration of RO using membranes was achieved (Loeb and Sourirajan, 1960). After several decades of use in US and other countries, RO for community and domestic purposes came to India in the 1980s mainly in salinity affected areas for

desalination purposes. Soon, the industry developed manifold and a variety of products started developing. It was also seen as a possible technology for community plants and numerous plants were in place in southern Gujarat by 2000. By 2005-06, Gujarat has several hundred RO plants with 200 lph and higher capacity being used in a variety of management procedures privately and through village level institutions (Krishnan et al, 2007).

With regard to defluoridation, RO can treat it to the level of demineralization achieved. Potentially, RO can remove up to 98% of Fluoride ions, but in practice it depends on the level of pressure applied and membrane capacity. And also depends on quantity of fluoride available in water, if it more than 15 mg/l as it is found in cases of North Gujarat, even 90% removal may not fluoride to a permissible level. RO systems have also been used in many Fluoride affected areas now, initially as a private initiative, and in a business manner for bottled water plants, but now as part of government programs. The current trend for RO plants, starting from Gujarat and AP, but catching on in other states also, is to establish a public-private partnership by involving the RO supplier in a contract with the village institution, but monitored by a government agency. Different management arrangements exist, for example, complete investment by the private party, but payment per litre of supplied water by the villagers. In some places, a rough cost of Rs. 0.15/litre is set, but it varies based on the size of plant, level of treatment required and demand for RO water.

RO water as compared with Rs. 12/litre for current bottled water, is very cheap, but payment of Rs. 2/day for 10 litres, is still a difficult proposition for many rural families. In the existing plants, in rural Gujarat, we find that the RO water has 40% reach within the village on average. Some RO plants sustain with a very high cost per litre Rs 0.6/litre, or Rs 1/litre, but very few affluent families are able to afford this water and also run the plant. Therefore, in such cases, RO water would serve the more affluent families, and would perhaps leave out the poorer majority.

The health department's apathy to Fluorosis

Fluorosis mitigation is not about defluoridation, but about curing the ailment of Fluorosis – so mentions the Integrated Fluorosis Mitigation Manual produced by NEERI and the UNICEF (Devotta et al, 2007). Defluoridation alone is not sufficient to counter Fluorosis, in fact there are cases where almost 80% of the consumed Fluoride is through the medium of food that is grown by irrigating with Fluoride affected water (Reddy D. R., 2007). For that one must not only look at the Fluoride entering through food, but a variety of nutrition measures need to be taken into account (Susheela, 2000)

Whether it is Mehsana or Jhabua or Gadag, our experiences with District Medical Officers (DMO) has been similar. Today, in 2009, medical officers have heard of Fluorosis. But they express their helplessness in channeling very limited resources towards a problem such as Fluorosis which has not hogged national limelight till now. There might be funded programmes for Malaria eradication, Polio or AIDS, but unless

there is a stricture from the top for officials to act, proactive action is limited to some extreme isolated cases.

Table 3: Comparison of different defluoridation technologies

	Nalgonda	**Activated Alumina**	**Reverse Osmosis**
When introduced in India	mid 1970s	mid 1980s	mid 1980s
Chemicals	Alum and Lime	AA, NaOH and Sulphuric acid for regeneration	No chemicals
Maintenance	Removal of sludge	Regeneration after 4-5 months	Replacement of filter every 2 years
Defluoridation capacity	Not in all conditions	Falls down with several cycles	Depends on membrane; as much as salt removal; claimed to be 95%+

Some of the comments we have received from these officials have been:

- "Why don't you create a new program and we will give our support"
- "Yes, we know about this problem, but out staff is limited"

- "No, we have not heard of Fluorosis in our area"

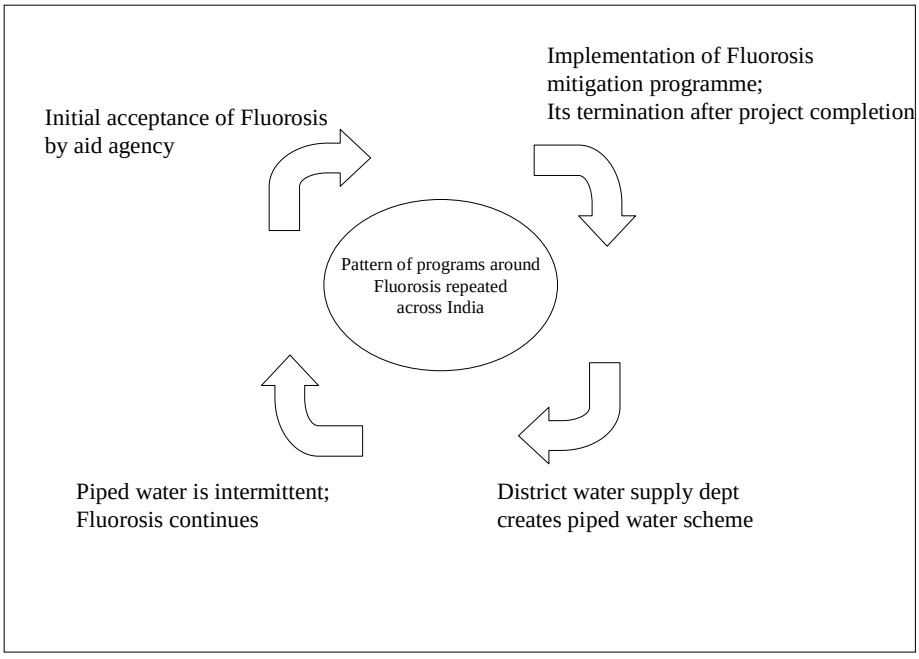
The health department acts according to priorities. Life-saving priority and epidemics always come first. On top of these emergencies keep arising, say with natural calamities such as floods. There have been doctors we have visited, for example in Jhabua, who are catering to 30,000 patients single-handed! They have to cater to immediate emergencies such as accidents, pregnancies etc, and therefore longer term problems such as Fluorosis go without detection. Moreover, previously Fluorosis was not in the standard curriculum for medicine students. Now it is present in the syllabus of preventive and social medicine. Therefore, most doctors are not trained in diagnosis of Fluorosis, nor do they have facilities such as specific kits for urine and blood testing, or water quality testing for confirmation of Fluorosis. In most cases therefore, these cases get passed off as those of Muscolo-sketelatal disorder or disease / deformity (MSD).

The standard recommendation from doctors is therefore pain-killers to relieve pain. Brufen based medicines are commonly recommended and in fact, some of our studies have taken the route of pain-killer sales to get to Fluorosis victims (Gadag field study of

Indu et al, 2008). Many of the victims of Fluorosis start from a dosage of low amount of pain killers which then increase to more than one a day, many a times requiring a dose to get up from bed in the morning. These expenses on medicine alone can go as high as up to Rs.2000/year for a family on average in Fluorosis affected areas (Indu et al, 2008).

But, why still this apathy from the health departments? We asked this question to one of the DMOs (District Medical Officer) our studies. The straight response was that Fluorosis is preventable and supply of safe drinking water is primarily the responsibility of the Public Health and Engineering Department (PHED). This is probably the reason why some of the Fluorosis mitigation programmes are hosted within the PHED department such as the one in Jhabua district. It is also in the case for North Gujarat where Dharoi dam's water was supplied mixed with groundwater in villages. Probably once the health department accepts Fluorosis officially, it somewhat absolves the PHED of its duty. But unless the health department officially accepts its responsibility, and trains doctors in detection, there would be no demand created among patients for a solution. Currently, the patients hardly understand the root cause of their problems. It is the responsibility of doctors to make them realize that.

Figure 1: Cycle of Fluorosis and water supply programmes



Making way for a pipe dream

Access to safe drinking water is now a fundamental right according to the 73nd Amendment. The Rajiv Gandhi drinking water programme and subsequent programmes such as Swajaldhara created infrastructure throughout the country for within-village sources of water. But, what about adequacy of the source and its quality? Official

acceptance that water quality is not fit for drinking means that an alternative source needs to be provided or the affected source needs to be treated. Through the 1980s and later, various programmes by UNICEF in different parts of the country established officially the presence of Fluoride and Fluorosis. These programmes were normally in partnership with government departments such as the PWD or with local organizations. In case the PWD or PHED is involved, there is a government "stamp" on Fluorosis – by the water department, not by the health department yet. This recognition is a key step, because once UNICEF exits from that district, and Fluorosis is yet left untackled, it then becomes the responsibility of the PWD or PHED to ensure that safe water is made available.

With numerous Fluorosis mitigation programmes across the country, UNICEF projects have achieved two things commonly:

1. They have created an official stamp on Fluorosis

2. By implementing a Fluorosis mitigation programme, albeit for a short time, they have shown (unknowingly) that local measures such as say, domestic defluoridation, would not work (atleast perception of government departments).

The second point here is important. If safe water has to be delivered and local measures are insufficient, then the only option is to import water. For importing water, one needs access (in most cases) to a reservoir, which is possible only with some say, at the state or national level on rights and access to the reservoir water. Given such access, it gives the PWD or PHED department to make a case for a regional piped water supply scheme to combat Fluorosis – surely large pipe water schemes is an easily sold dream, something if it ever combats Fluorosis or not, at least ensures the post retirement benefits of several stake-holders involved!

This cycle,

a) Recognition of Fluorosis
b) Implementation of Fluorosis mitigation programme
c) Termination of mitigation programme
d) Proposal and implementation of piped water supply scheme

is something, which is repeatedly occurring in many parts of India, not just affected with Fluorosis, but also with other water quality problems such as Salinity, Arsenic etc. More so, this cycle is getting repeated even in hilly tribal areas where pumping and transporting water is a major challenge, and then, sustaining supply with proper maintenance. Dungarpur, Jhabua, Mehsana, Amreli, Gadag, Anantapur, Dharmapuri – the list goes on for examples of this cycle. This access to remote water and supply is also giving rise to conflicts, such as seen in Dharmapuri recently between the Tamil Nadu and Karnataka governments. Experience with many of the regional pipe water schemes, even much acclaimed ones such as the Satya Sai Anantapur scheme, is that it starts with much fanfare and shining new pipes, but numerous problems kick in – availability of source reservoir water in drier seasons when there is competition with hydro-electric and irrigation needs; maintenance of pipe and pumps; huge losses of running the system due

to poor to nil tariff recovery – where do we hear of annual water charges being successfully recovered on system level for a sustained period?

Is it really possible to get out of this cycle?

Are there options for more sustainable local alternatives?

Possible ways ahead

Many of our health problems in the past have seen recovery and pathway towards solutions. But these have seen massive communication programmes for awareness and training of health workers. Nothing like this has happened for Fluorosis, yet on a mass scale. Mass media has a role to play in this for sure.

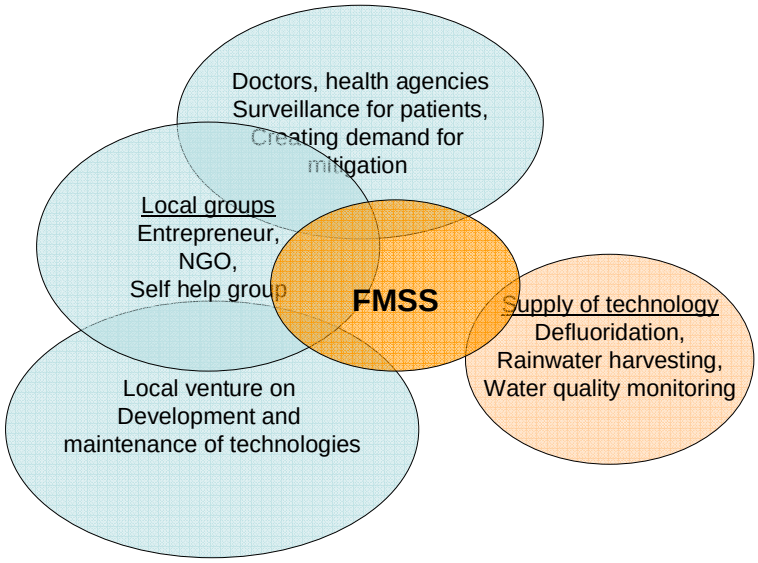
Doctors are at the centre of this problem. Even for sale of Fluoride removal filters, there is a need for doctors to be involved. Perhaps an incentive model for doctors in promotion of such filters needs to be pursued just like for some medicines as followed by some pharma companies. If water is seen as a major cause of Fluorosis and prevention is possible, then can health insurance schemes be utilized to address this problem? The National rural health insurance programme is now been implemented across the country. The annual expenses on Fluorosis due to medicines and loss of wage by patients comes to Rs. 5000-6000 per year (Indu at al, 2008). If this is already being incurred by patients, then shouldn't the annual treatment cost of removal of Fluoride from water of Rs. 500-600 per year, be covered by such an insurance scheme? In that case, hospitals which are now part of this scheme would be more actively involved in Fluorosis mitigation. However, accepting this logic of applying health insurance to Fluorosis is a major step forward in thinking, in that one should look at safe water as preventive for Fluorosis and that preventive care needs to be covered by the health insurance scheme.

In all, an entire package of options needs to be available locally to Fluorosis patients, to be termed as Fluorosis Mitigation Support Services (FMSS). Today, even for patients who can afford, there is no place they can visit for advice on the ailments and curative options. If one needs to buy a domestic filter for defluoridation, there is no such service available anywhere. What if all these are present together i.e. medical advice as well as on curative options. Even for Fluoride removal filters, such a service needs to offer maintenance on filters eg., repair of parts, regeneration of Activated Alumina (for eg), replacement of AA material etc. Apart from this, FMSS should be responsible in training of doctors and educating them towards proper diagnosis of Fluorosis.

All these require investment. At the initial piloting stages, it could run as an entirely funded program, but over time, it would need to generate revenue. Probably an idea such as FMSS can generate revenue from the services it offers i.e. training, sale and maintenance of filters, advice on Fluorosis mitigation etc. But the question is that whether the patients would pay for these services. This is probably where the health insurance programme needs to come in. If the services offered by FMSS can be paid for by the health insurance programme, then such a programme has a chance at long term

sustenance. However, these ideas need testing on pilot scales before they can be transported over to a national level.

Figure 2: A conceptual picture of Fluorosis Mitigation Support Services



References

Churchill H. V., New Kensington, Pa.: "Removal of fluorine from water", US Patent 2,059,553; filed Oct. 2, 1933; granted Nov. 3, 1936 (using activated alumina)

Devotta S., Rayalu S, Wate SR, Labhasetwar N, Biniwale RB, Godfrey S, Labhasetwar P, Chakma T, Swami A, Dwivedi HB, Parihar G, Saxena A., 2007, Integrated fluorosis mitigation : guidance manual. Nagpur, India, National Environmental Engineering Research Institute (NEERI). 102 pp

Indu Rajnarayan, 2002, Fluoride-Free Drinking Water Supply in North Gujarat: The Rise of Reverse Osmosis Plants as A Cottage Industry – An Exploratory Study, IWMI-Tata Program Annual Partner's Meet, Anand (Unpublished)

Indu, R., 2003, Fluoride-free drinking water supply in North Gujarat: The rise of Reverse Osmosis plants as a cottage industry, Unpublished report of IWMI-Tata Water policy programme, Vallabh Vidyanagar, India.

Indu R., Krishnan S. and T. Shah, 2006, Impacts of groundwater contamination with Fluoride and Arsenic: Affliction severity, medical cost and wage loss in some villages of India, in Proceedings of IWMI-Tata Program Annual Partner's Meet, Anand (to be published in International Journal of Rural Management, IRMA and Sage, 2007)

Krishnan S., Indu R., Bhatt S., Pathak F., Thakkar A. and U. Vadgama, 2007, Reverse Osmosis for rural water treatment in Gujarat, IWMI Tata Meet, Hyderabad, 2007

Loeb S. and S Sourirajan, 1962, Sea water demineralization by means of an osmotic membrane, Dept. of Engineering, University of California

Nawlakhe, W.G., Kulkarni, D.N., Pathak, B.N., Bulusu, K.R. Defluoridation of Water by Nalgonda Technique, *Indian Journal of Environmental Health, vol. 17.1, p. 26-65, 1975*

Reddy D. R., 2007, Dirisavancha: An endemic Fluorotic village in Prakasam district of Andhra Pradesh revisited after 66 years

Susheela A. K., 2003, A treatise on Fluorosis, Fluorosis Research and Rural Development Foundation