Addressing high fluoride water supply with an integrated mitigation programme

Case study

Location: India

Type of approach: Treatment, water quality monitoring

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Project background and key drivers

WaterAid India's water quality testing in Kanker and Naupada districts revealed that fluoride contamination of the water supply was more widespread than the government water quality data suggested. In Kanker district, 12 of 25 Gram Panchayats (GPs) (village councils) water supply presented fluoride levels above national standards, with concentrations reaching 5mg/l (while maximum permissible standard is 1.5mg/l). Government data, however, indicated that only four of the GPs were affected. Odisha state is severely affected by fluoride contamination, with 17 of its 30 districts polluted. Naupada had the second highest level of contamination of all districts in Odisha.

While water quality issues were known, the **monitoring capacity of the Public Health and Engineering Department (PHED) was constrained by insufficient human resources and laboratory capacity** to test all waterpoints. This meant that testing was often limited to random and irregular small samples, hindering the capacity to track water quality trends and prevent contaminated water supply to be used as drinking water.

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To address this gap in regular monitoring, WaterAid India initiated a **community-based water quality monitoring approach**, involving the training and mobilisation of community 'cadres' (volunteers) to use field test kits (FTKs) to monitor water quality at water supply sources.

Furthermore, the scale and intensity of fluoride contamination that was observed, led WaterAid to strengthen the community water quality monitoring programme with an **integrated fluoride mitigation programme** in two districts – Kanker and Naupada – developed over a period of three years, with a focus on testing and developing local solutions. The Naupada programme is discussed on the next the page.

▲ Sensitising communities on the issues of fluoride contamination.

▼ Comprehensive water quality testing by volunteers.

Components of the integrated fluoride mitigation programme

Sensitising communities about the problem

WaterAid India first ran a public awareness campaign to address low public awareness of fluoride contamination. Seasonal variation in fluoride contamination levels contributed to community misconceptions about the health implications, and where skeletal fluorosis was not visible, community awareness was low.

Identifying the most effective water quality FTKs

To select the most suitable FTKs for the community water quality testing, WaterAid India assessed and compared the usability (time to perform each test and weight of kits), availability (supply and support by manufacturers) and reliability (~± 5% deviation from lab results) of 13 commonly used FTKs for eight different water quality parameters. Based on the findings, three different FTKs were then recommended for different parameters.

Introducing a water quality monitoring and surveillance system

Village-level volunteers – Jalbandhus, students, para-hydrologists, water user committee members, volunteers of the National Service Scheme (NSS) and Nehru Yuva Kendra (NYK) and women self-help groups, among others – were equipped with the knowledge and skills to test the quality of water using the FTKs. These volunteers can now perform regular monitoring of drinking water sources and purification systems effectiveness.

Similar tests were also conducted in schools. When samples exceeded safe standards, laboratory testing would be performed to validate the levels, and if contamination was confirmed, the results were shared with communities. The community involvement in performing the tests led to an increase in awareness and understanding on the impacts of fluoride contamination in the water supply – which was previously considered safe.

Developing local capacity

Frontline workers, representatives of Panchayati Raj Institutions and members of village water and sanitation committees, were trained on water, sanitation and hygiene (WASH) issues and fluoride contamination. This training has been instrumental in creating awareness and mobilising community action.

Identifying suitable fluoride treatment technology – communal versus household filters

The two photos on the right show fluoride filters that have been directly fitted to the public handpumps. The first was disconnected by the community as it was not functioning, and no one was able to repair it. The second pump has a common filter, but it was found to be ineffective at removing fluoride. This is a common problem relating to many of the filters installed or used – without regular monitoring, the filters can often fail to remove excess fluoride from the water, without the users realising as they assume the source is still safe. WaterAid India assessed the pros and cons of installing a filter fitted to the handpump versus household filters to identify most suitable for the context:

▲ Building local capacity for water quality testing.

▶ Accessing contaminated water from the fluoride removal plant promoted by the Government.

	Pros	Cons
Handpump-fitted filters	• Able to treat large volumes of water. • Provides access to all households (a communal rather than individual choice).	• High capital investment. • Local community don't understand operation and are unaware of regular back-washing procedure. • Repairs require a trained technician – so cannot be repaired locally and cost of repair is high. • Less ownership by users as it is a shared, communal facility. • Mostly planned and installed by government without considering community choice (top-down approach).
Household filters	• Simple technology. • Low capital and operational cost. • Easy to maintain by users without outside support. • Owned by the household so incentive to operate and maintain correctly.	• Some consumables are required, which are not available in the local market and may need to be facilitated by an non-governmental organisation (NGO) or volunteers (for example, a replacement cartridge or chemicals such as calcium or magnesium salts, which are only available by licensed suppliers). • Follow-up is required by trained volunteers or NGO staff, to ensure correct use.

WaterAid India assessed that the management model used for the operation of the community fluoride filtration systems was not suitable or effective. Service providers had stopped maintaining these systems after a year and communities were unable to perform maintenance by themselves, as the technology operation and maintenance requirements were too complex for community to perform.

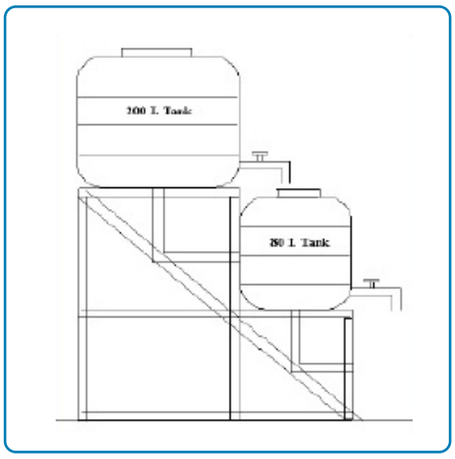
One key reason identified for this situation was that the service providers' contracts were awarded by departments at the district level, therefore not necessarily reporting to GPs – diminishing contractors' accountability and the GPs ability to control the effectiveness of the private service providers.

Based on this and the comparison above, the team decided to focus on household filters rather than communal water treatment facilities.

Testing and evaluating available household filters

WaterAid India tested a number of low cost fluoride treatment technologies for the removal of fluoride. Chemo-defluoridation (developed by National Environmental Engineering Research Institute (NEERI)), a Clay-based filter (developed by WATSAN) and a Fluoride Nilogon filter (a crushed lime stone-based filter, developed by Tezpur University). Treatment effectiveness, costs and availability of spare materials were assessed and the results are summarised below.

	Pros	Cons
Chemo-defluoridation	• Easy to install by users. • Some materials available locally (two buckets, sand and gravel). • Low maintenance. • Works well up to 5–6ppm of contamination and reduces fluoride to <1ppm. • No electricity required. • Cost per litre of treatment is 0.2 rupees.	• Chemical used for removing fluoride is not available in local market and has to be procured from licenced vendors of NEERI (National Environmental Engineering Research Institute). • Periodic cleaning/replacing of sand is required as the precipitate reduces the porosity and slows down the filtration rate.
Watsan Terafil natural water purifier	• Readymade filter. • No electricity required. • Low maintenance. • Works with up to 10ppm of fluoride contamination.	• Less effective in reducing concentration below the permissible limit. • Costlier than the Chemo-defluoridation. • Not available in local markets – supplied directly by manufacturer. • Cartridge needs to be replaced after six months.
Flouride Niolon filter	• Can be easily assembled locally. • Requires two buckets, crushed limestone and diluted phosphoric acid. Phosphoric acid is available in any chemical shop in the local market. • Most efficient of all three household filters, reducing concentration to 0.6ppm. • No electricity required. • Cost per litre of treatment is 0.05 rupees (lowest of all options). • Size can be customised based on volume of water to be treated.	• Suitable limestone needs to be identified locally.



▲ A schematic diagram of a Fluoride Nilogon filter and a Fluoride Nilogon filter for a household and a school.

Based on this assessment, the Fluoride Nilogon filters were selected as the best option – though the team continue to explore new products that are being developed by suppliers. Over 40 Fluoride Nilogon filters were then installed (some of a larger scale at community level, and others at household level) and water quality testing demonstrated effective reductions of fluoride to below maximum standard levels (for example, effluent fluoride concentration achieved between 0.48 to 0.01ppm, well below the 1ppm max permissible limit). In addition, alternative solutions – such as rooftop rainwater harvesting technology – was introduced for schools affected by fluoride contamination.

◀ The community accessing safe drinking water through a protected water source fitted with a rainwater harvesting system.

Setting up a community-based management model for the water sources and treatment plants management (with local government support)

To ensure long term sustainability of the water supply and the fluoride removal plants (both at community and household-level), WaterAid supported the establishment of:

- Water users group with mostly women representatives.
- Village volunteers, who were able to perform water quality testing using FTKs to assess the effectiveness of the treatment solutions. Along with performing operation and maintenance (O&M) of water supply and purification systems and the provisioning of essential equipment for minor repairs.
- A community-based system for the collection of water user charges to meet recurring costs and minor repair – while major replacements costs would be covered by the GPs budget.
- A water users group leading on monitoring the cleanliness around water sources and development of Water Security Plans (WSP).
- GPs were engaged to ensure they could support (financially and technically) any major repairs of the treatment systems.

▶ Institutionalising the water quality testing process.

Integrating fluoride education into school curriculums

WaterAid India worked with teachers to train 400 students to collect water samples from tube wells using FTKs and to test the water quality – particularly fluoride concentrations. 22,096 children were also screened for fluorosis to evaluate the health impact of high fluoride concentrations.

Challenges

- The limited technical capacity at GP level led to the water quality services work being contracted to private sector providers. These providers tend to promote and provide expensive high-tech treatment solutions, rather than introducing solutions that can be managed with local technical capacity.
- District government and laboratory officials were initially reluctant to accept WaterAid's water quality testing as these revealed a higher and more widespread fluoride contamination than government data suggested. The discrepancy between WaterAid and government data could also be attributed to the challenges in laboratories testing capacity, hindered by lack of equipment and reagents to perform the testing effectively.

Impact

- As a result of WaterAid's advocacy, based on its water quality monitoring, **the district health department is now monitoring fluoride levels and incidences of fluorosis** in communities where high concentrations of fluoride were observed. Most of the funding for monitoring is being provided by the local government, while WaterAid is continuing to provide technical support.
- Treatment technology options were reviewed and assessed to identify the most suitable and sustainable solution based on the availability of local materials, and the capacity for maintenance and financing.
- As an outcome of this work, there has been strengthened coordination between the Health and Nutrition, Education and PHED departments to work together on the fluoride mitigation programme.
- To complement the introduction of fluoride treatment technology, and address other issues related to the sustainability of ground water use and storm water management, rainwater harvesting solutions were also introduced by WaterAid. The Kanker district administration have run a mass rainwater harvesting campaign with a target to install around 6,000 rainwater harvesting structures.

Lessons

- **A detailed assessment and review of suitable technologies and an effective management model is the key to a sustainable long-term water treatment.** In this context, centralised managed water treatment systems-led to low sustainability if not regulated and monitored. While government officials prefer the use of centralised systems to maintain control over water supply management and finance, in Kanker and Naupada, it was observed that the delegation by government to private service contractors led to the lower accountability of local GPs and communities – therefore lowering the effectiveness of the treatment plants.
- The programme required **extensive learning and adaptation to ensure the approach was sustainable and responded to local needs**. This was possible thanks to the flexible approach of the programme design and the broad objectives – a flexibility that was **facilitated by a donor whose funding requirements could accommodate this**.

Resources

- Anonymous (no date). *Naupada – An intervention in addressing fluoride issues*. [Unpublished].
- Anonymous (no date) *Community-based fluoride mitigation – A brief note on the Kanker intervention*. [Unpublished].
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- WaterAid (2019). *WaterAid India-East programme*. [Unpublished presentation].

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