10- Mitigating Water Quality Problems in Bundelkhand

- INREM FOUNDATION

(i) About INREM Foundation

INREM Foundation is a research institution probing societal issues concerning water, public health, agriculture and the environment. The institution develops innovative inter-disciplinary solutions and brings them into the wider domain of practice by participating with communities and government.

The goal towards a Fluorosis free India guides INREM's work for the past 10 years from its initial work in Jhabua and now to the rest of the country. In this journey, the organization started small from a community based programme in Jhabua (MP), developed a national network on the issue, known as the Fluoride Knowledge and Action Network (FKAN), and now scaling up through District level people centric platforms, and Technology aided platforms, across the country, on the Fluoride issue. Currently, INREM has presence in 9 fluoride affected districts of 5 states: Rajasthan, MP, Karnataka, Telangana, Odisha and Assam, with a state level partnership in Assam and Rajasthan with the state Water and Sanitation Support Organization (WSSO). It is now supported by the European Union (EU), Azim Premji Philanthropic Initiatives (APPI) Arghyam and UNICEF. These initiatives are now leading INREM closer to its goal of a Fluorosis free India.

INREM was constituted in 1994 with support from Winrock International, Ford Foundation and Rockefeller Foundation. It originally started with a need felt by natural resource economists to impact teaching, training and research in their field in India. Team-INREM together, they bring forward a combination of research skills, social work experience and innovative product development approaches. INREM projects are solution-oriented. The specific social and cultural contexts of solutions to pressing problems are imperative to the work of the organization. The work of INREM spans a variety of themes ranging from Water quality and health, River Basin Management, Water and Livelihoods and Issues concerning Policy and Governance the institution works in participation with a wide group of professionals and organizations who partner with INREM in activities involving both research and its application.

INREM is registered under the Societies Registration Act, 1860 and the Bombay Public Trust Act, 1950. The organization has a permanent FCRA account and is credited with 12A and 80G registrations.

(ii)Water Related Issues in Bundelkhand

The area Bundelkhand region comes under semi arid climate with low precipitation (900 mm/yr) and higher evaporation rate (1800 mm/yr). The J S Samra committee report on drought mitigation strategy for Bundelkhand has suggested that historically drought came every 16 years, which rose three fold during 1968 – 1992 to once every 5 years and became a recurring annual feature since 2004. Rampant poverty in the region has forced the population to exploit the environment. For instance, collections of fuel-wood through unsustainable tree-felling and reckless mining are the only activities left for the survival of local people's livelihood. The environmental problems in the region have a very complicated relationship with climatic conditions, variability and different aspects of the

population. In Bundelkhand there is also the problem of massive discrimination against certain sections of the society, which aggravates the already festering problem of discontent. The lack of proper implementation of development schemes further aggravates the problem of backwardness and environmental degradation

- **Water Resources**

In the last 13 years there has been a drastic reduction in annual average rainfall in Bundelkhand by 40%, with 60% decline in rainfall in the last 5 years. Bundelkhand received normal to above normal rainfall in 2011 with the danger of flooding replacing the water scarcity of drought. Bundelkhand region is drained by a number of rivers of the Yamuna river system. The main rivers are the Yamuna in north, Ken in east and Betwa and Pahuj in the west. The river Yamuna flows from west to east and its first order tributaries – the Betwa, Ken, Pahuj, Baghain, and Paisuni flow from south to north.

The Betwa contributes around 50% of the water available in Bundelkhand Upland and Bundelkhand Plain sub-regions; the Ken contributes around 25%. The Betwa, Ken, Pahuj and Dhasan are very important for irrigation in the region. Their seasonal fluctuations however, are very large.

A study of the water situation done in 131 villages of UP Bundelkhand, found that only 7% of villages had enough water to meet domestic needs throughout the year. In more than 60% of villages, drinking water was available for only one month. Throughout the Bundelkhand region, women had to spend an average 4 - 5 hours a day to secure around 20 liters of drinking water. Under such conditions of uncertain water supply in rivers, the availability of water from tanks and other surface bodies is very important to sustain irrigated agriculture and provide security to farmers. (Source: Water Aid)

Historically the need for security of water was recognized and Bundelkhand is known for its water bodies including the Pahuj reservoir, Barwasagar, Barwarlake, Aiaori Lake, Pachawara lake, Dakwan and Parichha reservoirs. A host of smaller tanks and ponds (tals) are found near Mahoba and Yikamgarh is famous for its tanks such as the Madansagar, Nandwara, Birsagar and Arjan lakes.

Surface water is the main source of water for domestic, irrigation and other purposes for local inhabitants. After treatment, the surface water is supplying to various areas through pipelines for municipal uses also. So the surface water is very much valuable resource for this region. Lakes are nearly thousand year old and come under the category of sacred lakes and are unique in terms of religious and ecological significance. Eutrophication, anthropogenic pressure, holy rituals and tourism have been the major factors which have contributed to its damage, deterioration and degradation with a consequent adverse impact on the lake water quality. Water Quality index (WQI) indicate that the lakes are moderately and slightly polluted and may not be used for domestic purpose without treatment but may used for irrigation.

(Source: Institute of Environment and Development Studies, Bundelkhand University, Jhansi)

Water Quality Issues

Apart from high fluoride contamination in Chitrakoot and Jhansi district as per the NRDWP reports, Iron, Nitrate and TDS issues are also highlighted. (Source: https://ejalshakti.gov.in)

(iii)INREM Foundation Interventions around Water Issues

a. Integrated approach and convergence

The concept of bringing in Safe drinking water and improved nutrition for healing from Fluorosis was first tested by INREM from 2010-12 in Jhabua with support from the Tata trusts (Forest lanterns, UNICEF, 2017). This resulted into the now well established Jhabua model of Fluorosis mitigation which leads to reversal of Fluorosis in children, suffering from disabilities. This was repeated in Hojai District of Assam with similar results, leading to the establishment of this convergence approach as the Fluorosis Mitigation Support Centre (FMSC) as a convergence between the PHE, health and other departments at the scale of a sub division for the PHE.

After these smaller scale experiments, the next step was to embed this into government programmes through convergence and help scale up the efforts to more number of people.

b. District level people centric platforms

The concept of District level convergence on Fluorosis and bringing together of civil society organizations (CSOs) along with government departments originated in Nalgonda with the District Fluoride Mitigation Centre (DFMC) in 2013. Since then, this concept was extended to Balasore in Odisha, and then with the support of EU now scaled up to Dungarpur in Rajasthan (with co-financial support from the UNICEF) and Chikballapur in Karnataka. Similarly in Assam, the initial FMSC model of Hojai District has now extended through a State level partnership with the WSSO to four districts of Hojai, Nagaon, Karbi Anglong and Kamrup. We can form similar platform in the Bundelkhand districts to mitigate water quality issues.

In all, INREM now operates in 9 Fluoride affected districts of the country, starting from Jhabua, 4 districts supported by the EU and 4 districts supported by WSSO, Assam.

Together, this leaves a footprint of several thousand habitations, and few lakh Fluorosis affected people that INREM is now able to reach out to through these efforts.

c. Leveraging technology aided platforms

Scaling up and reaching out to millions of people affected with Fluorosis, has brought the question and possibility of tools such as technology aided platforms that are now increasingly useful to achieve this. Arghyam has seeded the societal platform on Water, within which INREM is utilising education and data based technologies, for embedding them within the District level work that the organization is currently working on. In this process, courses are being created for online consumption, IoT based solutions are being innovated for online-offline interfaces, and data based platforms being experimented with to bring in multiple stakeholders together on a common platform at the level of a District and beyond. Currently, these technologies are being piloted across all of INREM's fluoride affected districts and experiments are showing promising results.

d. Scaling up with State and National Partnerships

Apart from the focused initiatives that INREM is conducting within 9 districts of 5 states, the organization is also building partnerships that are helping it to be influential at a much larger scale. Three examples of these are:-

- Assam WSSO partnership: By embedding a project management unit (PMU) within the state WSSO from 2018 and operating in four districts with the State government, INREM has been able to now establish rapport and have influence over a state level convergence model for Fluorosis in Assam. This can be potentially leveraged to have a State level programme for Fluorosis convergence for the entire Assam state.
- UNICEF partnership in Rajasthan: The district partnership in Dungarpur with the UNICEF is now planned to be scaled up on a state level based on a similar model as that of Assam, with extension to 4 districts of Rajasthan state from 2019.
- National health ministry nutrition mission: INREM has been able to successfully integrate Fluorosis within maternal health and nutrition programmes of the Ministry of health and family welfare, and a current pilot testing of the algorithm protocol is in process. This will help scaling up this screening of mothers, through programmes such as the National nutrition mission and Anemia mukt Bharat.

e. Coordinating and Leveraging from a National scale network

The FKAN initiative of INREM has been able to provide visibility to the Fluorosis issue, brought the convergence model to the fore, and enabled numerous other organizations and institutions to act on the issue. Organizations such as the Biome trust, Water Aid, Sehgal Foundation, People's Science Institute (PSI) and SaciWaters are part of the network along with INREM. Together with these organizations, INREM is now laying the base for a much wide Water quality network(WQN) that will help address drinking water quality and health issues on a national scale. The effort of the network helps amplify individual work, brings forward innovations, and connect them together towards needs of contaminated water and affected people on ground.

The effort now is to use technology and leverage the network capacity to work together on a common front for making difference to the lives of more than 100 million people affected by these problems across India.

(iv) INREM Foundation water quality Mitigation Approach and Solutions

Dealing with fluorosis needs to take two dimensions – of safe water free from fluoride and good nutrition rich in Calcium and related minerals.

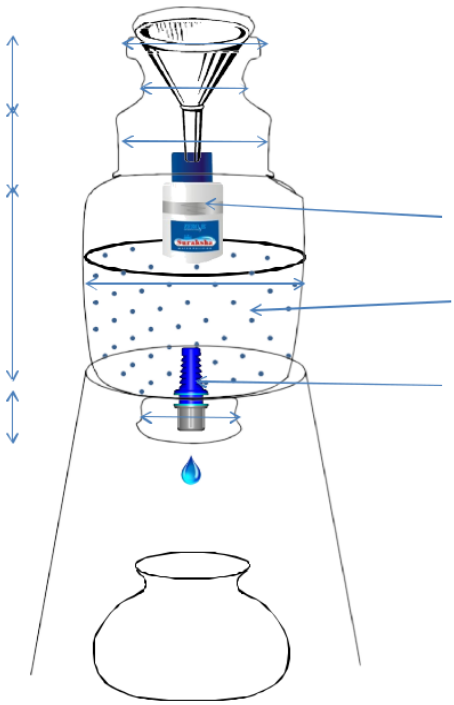
- **Safe drinking Water**

Within the geographical situation that people live in Jhabua and other remote villages and given problems of proper electricity and roads, one needs to think of technologies which can be easily maintained and used. Also, these need to easily connect with people's culture. One of the best solutions is to search for local water sources that are free from fluoride. Some of the hand pumps are always free from fluoride and most of the dug wells have very low fluoride too. Therefore, that safe fluoride free water needs to be the first option. However, to convince people opting for such water sources which are further away and sometimes also more scarce, is difficult.

With these in mind, INREM has developed an earthen pot filter which has Activated Alumina (AA) for fluoride removal and Zero-B as a disinfectant. The filter consists of an exterior casing currently made as earthen pot, filtration material known as Activated Alumina (AA), a micro-filter, Zero-B and other smaller parts. The final product on location is shown in Figure 1 and the schematic design diagram is in Figure 2.

Figure 1: Final product of INREM's filter on location in Jhabua

Figure 2 : Schematic design diagram of INREM's filter



- **Nutrition supplementation**

The Fluorosis of the kind observed in Jhabua is closely linked to the condition of malnutrition there. Especially as our studies show, juvenile fluorosis and Osteoporosis is due to a combined effect of low Calcium and high Fluoride intake. As recommended by medical specialists, enhancing certain nutrition can develop resistance to fluorosis and also remove fluoride from the body to some extent. We follow a combination of pharma supplements, food supplements and herbal products to provide Calcium, Magnesium and Vitamin C to fluorosis patients.

The situational background requires us to tackle the problem from many angles. In the longer term, food habits need to converge towards a more nutritious diet, but this is not possible unless the market supplies it and people can afford it. Since, to some extent, entry of fluoride in food cannot be avoided, we must look at ways of countering it within the body. Also prevention of disease should be of prime importance, eg., focusing on proper food for infants and their mother so that juvenile fluorosis and pregnancy related fluorosis is avoided. We look at three approaches:-

- Pharma supplements
- Food and herbal/Ayurvedic supplements
- Fortification of food

Our experiences

Within INREM's fluorosis mitigation programme in Jhabua, all of the following approaches have been tried. We list them here:-

Table : Different types of nutritional interventions

Nutritional Intervention	Type Of Supplement	Dosage and frequency
Calcium, Magnesium, Vitamin D3 and Zinc Tablets	Pharma Supplement	1 tablet per day providing 210 mg Calcium, 100 mg Magnesium, 200 I. U. Vitamin D3 and 4 mg Zinc
Amla tablets	Dried fruit extract in tablet form	1 tablet per day providing 20 mg of Vitamin C
Til Chikki	Food Savory	1 per day in Winter; 237 mg of Calcium and 32 mg of Magnesium for 20 g piece
Soya Chikki	Food Savory	Significant source of Proteins, Calcium and Magnesium; not estimated yet
Amla (dried)	Dried fruit	20 mg of Vitamin C in 1 g piece
Cassia Tora powder	Dried leaves	Roughly 5 g/day of dried powder providing 200 mg of Calcium, 20 mg of Magnesium, 5 mg of Vitamin C and 2 g of Proteins
Neutralizing mixture	Ayurvedic	Mixture enabling detoxification of fluoride and absorption of Calcium

Figure 8: Nutrition supplements (pharma and food based) being used currently

Traditional Knowledge

Traditional technologies have evolved to fit the environmental and social context of the region and that is why they are so very effective. Systematic integration of cultural heritage and appropriate traditional technology, skills and local knowledge systems within present day developmental efforts, can provide effective means of reducing the impact of water quality and quantity issues. In view of the desertification and land degradation processes in Bundelkhand, learning from traditional knowledge and mitigation strategies comprises tapping a wide range of accumulated experience to manage natural resources in drinking water, irrigation, farming, grazing, landscape restoration as well as the institutional and organizational arrangements required (Gupta & Singh, 2011). The ancient knowledge and technology of Bundelkhand incorporates wisdom instilled through millennia of experimentation and trial and error.

(v)Recommendations

Based on INREM foundation; the results of the study, and the findings, following are the recommendations for strategic interventions of planning and water quality mitigation in Bundelkhand region:

(a) A holistic programme of integrated watershed management comprising of integrated water resource management, nutrition, water supply, health, mid day meal, wasteland management, crop diversification, etc. need to be conceptualized and implemented.

(b) Adaptation to climate-change impacts and challenges of uncertainty relating to water and weather conditions/events, need to be a central component in disaster risk reduction and natural resource management for sustainable livelihood in the region.

(c) Integration natural resource management and adaptation must focus on ecosystem services sustainability and socio-economic simultaneously, enabling the practice water quality mitigation against health risk in a cost effective manner. The ecosystem based adaptation and mitigation shall form the basis of poor water quality risk reduction.

(d) Focus on knowledge promotion and extension has been significantly low than what was actually required. A knowledge management programme and system for water quality hazard risk and vulnerability analysis at local/village, taluka/tehsil and district level must

be commissioned as part of district water quality management framework. Traditional and local knowledge of dealing with climatic uncertainties and drought challenges need to be documented across the places in Bundelkhand. This need to include historical and latest developments, innovations and technological interventions in this direction, and must be made an integral part of overall strategy to deal with water quality and quantity issues.

(e) Changing the attitude and behaviour of the people in Bundelkhand and the official in the Government needs significant improvement towards taking the challenge and improving the situation from the futuristic and preventive approach. Thus, crop adjustment, livelihood diversification, accepting and practicing innovations, socio-political interventions and exchange of know-how with other areas of the country and beyond, need to be facilitated.

(f) Groundwater and surface water usage has been the topic of discussion and research at different levels and institutes but the concept of perspective planning for sustainable water resource management has been seldom affected in the results. Perspective plans at district/taluka/ tehsil levels must be drawn as a baseline of integrated district plan which shall also serve as basis for water quality mitigation plan. This shall be done by bottom-up decentralized planning approach. Grassroots and frontline workers should be included in the planning process.

(g) A network or consortium of institutions in Bundelkhand may be established considering the educational, research, training institutes, Universities and NGOs, which can be facilitated by the Central Government, to help promote exchange of knowledge and experience on relevant interventions with mandate of regional capacity building research, policy planning and extension.

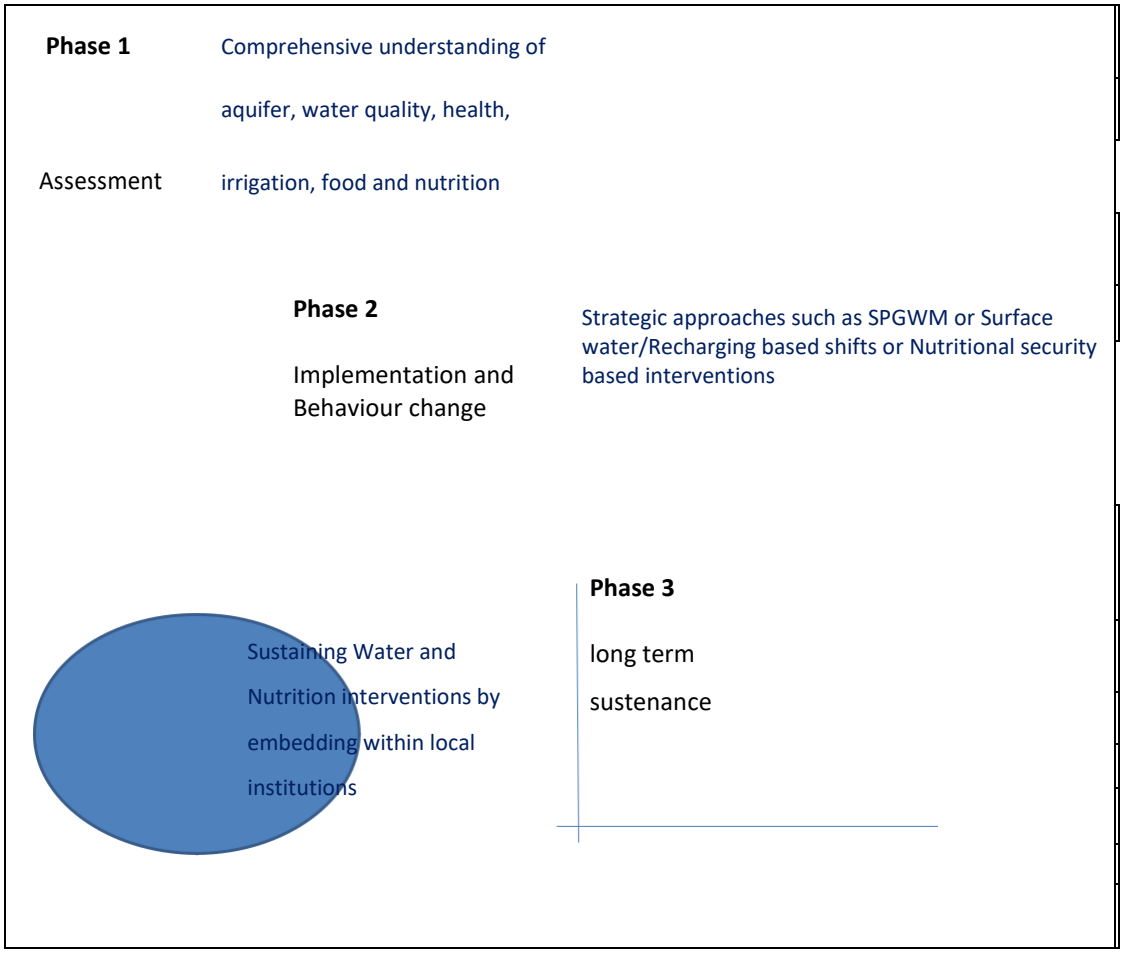
(h) Higher education needs diversification with emphasis on new areas of learning and training especially on alternative practices of livelihood and employment, economic and regional development, environment and natural resources, and management sciences. Though and will power strength of the youth, in particular of the women group need to be strengthened to enable the change from deprivation towards sustainable management of resources and systems.

(i) Fundamental and action research aimed at evolving and testing hypothesis regarding patterns of different water quality issues and their impacts, implications of mitigation measures on water resources and peoples well being, in particular food security, health and employment, need be promoted which shall also help evaluate various development programmes in terms of their relevant to the region.

(j) Trees and plants should be preserved now in order to prevent soil erosion and promote infiltration of water into the soil and ultimately, the aquifers. Civil society institutions need to be educated and strengthened to respond to water quality problem quickly. This is possible through better knowledge and information about the nature of the ground water contamination, potential sources of threats to ground water quality in their region and degree of vulnerability, the ill effects of using contaminated water and the possible preventive measures.

Recommended Actions

Mitigating water quality issues in Watersheds through community based water quality management plans



Expected Impacts

If above mentioned dots are considered for further research and policy making, it shall benefit the local community in a more enriched way and help the authorities accomplish the aim of sustainable water quality mitigation. Above strategic interventions are to make an impact on Unsafe water through frontline workers and local institutions of other departments (including water supply), such as schools, Anganwadis, primary health centres. Core communication is revolved around frontline workers of these departments, so that messages permeate through the community.

The approach of mitigating quality issues through Safe drinking water and nutrition, is then delivered through these local institutions, along with direct reach to communities.

Working on District level engagement to construct people centric platforms, of different departments and civil society organizations, for working together on these water quality problems at the scale of the district.

To eradicate severe forms of diseases arising from Unsafe and contaminated drinking water in rural India requires multi-disciplinary approaches. Primary stakeholders are the affected community with whom CSOs or Institutions will engage. The secondary stakeholders are frontline workers, to district level officers of depts such as Water supply, Health, ICDS, Education, along with key persons in local administration such as the District collector and head of Zilla Panchayat.

Village Scale: The seriously water quality affected individuals are the primary stakeholders of our action at the village level. Around this, their families, other community members, frontline workers of government depts., Panchayat members, who can directly engage with government development work.

District Scale: Government department and CSOs are the key stakeholders at this level, with the District collector often being the primary stakeholder of interest. The core departments here are being those of Water supply, Health, Education and ICDS with representation from agriculture, watershed and forest. Activists engaging with the issue locally become the key representatives of the community at this scale, and also in taking the issue ahead over the long term in a sustainable way.

Sector Ecosystem Scale: The core experts of each component of the water quality problem such as technology innovators, doctors, nutritionists, communication experts, media; CSOs working on related issues; policy makers and govt departments at state and national level and bodies such as the Niti aayog which absorb the inter-disciplinary elements of our work. Academia from different subjects are also increasingly becoming a group of interest.