

# Community-based Water Quality Management in India

Issues and Challenges





WaterAid's mission is to overcome poverty by enabling the world's poorest people gain access to safe water, sanitation and hygiene education

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# CONTENTS

Executive Summary	1
Chapter-1	5
Background	5
Drinking Water Quality: Basic Issues	5
Groundwater Quality	6
Major Groundwater Contaminants	7
Need for Water Quality Management (WQM) in Rural India	8
National Rural Drinking Water Quality Monitoring & Surveillance Programme (NRDWQM&S) – An Overview	9
Initiatives from the Non-Government Sector	10
WaterAid India’s Initiative	10
Chapter-2	13
Introduction	13
Results and Discussion	13
Major trends in Water Quality in WAI Project Areas	20
Major WQ Trends in WAI’s Project Area	22
Analysis of WQ Trends	23
Chapter-3	25
Introduction	25
Methodology	26
Results and Discussion	27
Fluoride Concentration in Drinking Water Sources	29
Relationship between Severity of Fluorosis and Fluoride Concentrations	31
Dietary and Soil Survey	32
Fluoride Contribution in Human Being through Diet	33
Village Level Participatory Planning	33
Strategies for Fluorosis Mitigation & Control	34
Performance Testing of Distributed Domestic AA Kits	35
Inferences	35
WAI’s Intervention	36
Advocacy	37

CHAPTER-4	39
Introduction	39
Sanitation in India-Some Issues and Concerns	39
Situation Analysis	40
Contamination in the Water Cycle	49
Guidelines for Identification of New Sources and Construction of Latrines	49
WAI's Intervention	51
Impact of Cattle Waste on Groundwater Quality and Possible Mitigation Options – a Pilot scale study	51
Situation Analysis	54
Potential for Suggesting Alternative Management Options	55
CHAPTER-5	57
Issues, Challenges and Lessons from Community based Water Quality Monitoring in India	57
Sustainability of Community Based Water Quality Monitoring	58
Need for Sanitation and Animal Waste Management in Rural India	59
Water Quality Research and Setting up of Water Quality Criteria in India	59
Niche role for WaterAid India in Community based Water Quality Management	60
Advocacy on Water Quality Management	60
Annexes-I	63
Annexes-II	66

# Executive Summary

Safe drinking water is a constitutionally guaranteed right in India. Still about 480 million people in India lack access to safe drinking water. According to the Constitution of India water supply is a State subject while The Union Government is only responsible for setting water quality standards. Although an estimated Rs. 1,105 billion have been invested in water and sanitation since the first five year plan, yet the centralised systems of water supply and monitoring have been found to be ineffective. Official agencies in India now recognise that the participation of village level stakeholders and their institutions is essential for ensuring the supply of safe water and monitoring its quality.

To address the emerging need to decentralise water quality monitoring in India Rajiv Gandhi National Drinking Water Mission (RGNDWM) initiated a programme on community-based water quality monitoring (CBWQM); An initiative that seeks to ensure safe water through a comprehensive surveillance process, incorporating monitoring, data processing, evaluation, sanitary monitoring, data processing, evaluation, sanitary surveys, public health assessment and remedial and preventive action throughout the length and breadth of the country.

Efforts were initiated from the non-government sector as well. Several International Non-Governmental Organisations (INGOs) supported decentralised water and sanitation programmes across the country.

Almost during the same time, WaterAid India (WAI), an international water- focused advocacy organisation, began a programme on CBWQM as part of its country strategy for 2005-10. The approach was similar but WAI implemented the program through

its field partners across India. WAI hired People's Science Institute (PSI), a Dehra Doon based non-profit research and development organisation, as a technical support agency to train its partners. Following the trainings, (Water Quality) WQ data was generated using a field-testing kit and the major WQ problems were identified at the level of partners.

Refresher training on WQM (Water Quality Management), to sort out technical difficulties and logistical problems while carrying out the WQ tests, was organised later. This platform was also used for sharing and analysing WQ data with WAI's partners' staff, filling the gaps in recording and reporting the WQ data and a session on different available WQ treatment options. Since the major WQ problems had already been identified, the relevant water treatment options were also discussed. These included:

1. Reduction at the source
2. Point-of-use chlorination
3. Other treatment options (SODIS, copper vessels, sand filters, earthen pots etc.)

During this period water samples were collected from the project areas of different WAI partners and their results were validated by laboratory analysis. Major findings of this programme are as follows:

## **Major findings**

**Water Quality:** Faecal coliform (FC) contamination is a widespread problem in the project areas of all the field partners across states and regions that were monitored. Excess fluoride in the water poses a clear health risk in the eastern region (Bihar, Jharkhand, Orissa) and Andhra Pradesh (AP). Iron is the third major pollutant, particularly in the eastern region, Karnataka and Madhya Pradesh (MP). Nitrate is generally present

within the standard limit, except in isolated locations.

**Community-based WQ monitoring:** Success in training several Partner Organisation (PO)s' staff personal who belong to the local communities strengthens the case for establishing community-based WQ monitoring systems in India. The programme also highlighted the facilitative roles of Voluntary Organisations (VO) through a tripartite institutional engagement– WAI's field partners, the technical support organisation (PSI) and WAI – in such CBWQM systems.

The results or the WQ monitoring data generated by WAI's partners also illustrated the fact that the water supplied through groundwater is beset by problems of quality. The results identified three priority water contaminants- Fluoride, Faecal Coliform and Iron.

To test a field-based approach of providing safe drinking water to the affected communities in India, WAI initiated a series of pilot-scale research studies in different parts of India. First, a programme on fluoride testing and fluorosis mitigation was initiated in 5 villages of Palamu district.

**Highlights** of the fluorosis mitigation exercise in Palamu are as follows:

- A large number of people are suffering from different degree of fluorosis, both dental and skeletal.
- Most of the currently used drinking water sources in these 5 villages had fluoride concentration above the permissible limit 1.0 mg/L, some with fluoride concentrations as high as 12 mg/L.
- In some villages like Bakhari, Chukru, Andharbagh and Lalmathiya Tola, none of the currently used drinking water sources

contain fluoride within the permissible limit of 1.0 mg/L.

- The government initiatives for providing safe fluoride-free water through hand pump attachable fluoride treatment plants, provided by Public Health and Engineering Department (PHED), have not yielded any fruitful results in the absence of recharging facilities of the treatment devices. Water samples tested from these hand pumps have been found to contain fluoride concentrations as high as 12 mg/L in the treated water, with all the 10 tested plants having concentrations more than 1 mg/L. The removal efficiency has been found to be zero in every plant.
- No single technique or measure would ensure water of permissible fluoride concentration to all households of a village. On the basis of intensive discussion with communities, specific mitigation plans for each of the 5 villages have been developed. The plans used a specific mix of technologies appropriate for a village.

One of the key findings from the WQ monitoring results produced by all The partners WAI was the widespread presence of Faecal Coliform. The presence of Faecal Coliform actually indicates the level (amount) of human and animal waste contamination in the water. Human and animal waste contain the harmful pathogens, which directly affect public health. Hence another study to assess sanitary risk to groundwater sources was carried out. The objective was to understand the extent of a possible public health risk in WAI's project areas. The **Major highlights** from the study are as follows:

- Open defecation, poor system of solid waste and wastewater disposal, ill-maintenance of handpump platforms and unattended human waste and animal

waste constitute fairly high proportion of sanitary risk to groundwater sources.

- Contamination at various points of water cycle including storage, clearly indicated that communication addressed to target groups to bring about a behavioral change in hygiene and sanitation has not been internalised in many cases. As a testimony to the fact in most parts of the country there is hardly any maintenance of hygiene, both at the household and community level.
- Lack of technical knowledge about the siting of sanitation facilities and poor operation and maintenance has led to localised man-made pathways of groundwater pollution in different WAI project areas.
- From now on, WAI's field partners should develop and follow a set of guidelines prepared during the study to be followed while constructing new water sources and/or latrines.

Another pilot-scale study on impact of cattle waste on groundwater quality was initiated in 6 villages of Shivpuri and Morena districts (Madhya Pradesh) to understand the linkage between improper management of cattle wastes and its impact on groundwater quality within the overarching framework of sanitary surveillance. Following are the **highlights** of this study.

Proper management of cattle waste is a critical issue in reducing the sanitary risk of groundwater sources. Groundwater sources in the studied villages of two districts in M.P. are at major risk as presently no system of managing cattle waste is in place. 75 % of water sources were at high risk in Shivpuri villages, 100 % sources in the study villages were at high risk in Morena. The situation worsened during monsoon for obvious reasons.

Cattle waste should be used as an alternative energy option. If used judiciously, it may solve the problem of rural electrification to a large extent.

Finally, all these approaches identified a few critical issues and challenges that the community based water quality management should seek to address. There were issues of sectoral convergence, early warning signals, choice of technology, prioritisation of water contaminants and sample collection, and data management etc.

Sustainability (both financial and technical) issues were also a major concern. Hence WAI's future initiatives in CBWQM should address sustainability, by building technical and financial self reliance of the community, and that of its field partner organisations. Communities and partner organisations should be helped to work out the long term economics of operations and maintenance of any water quality management initiatives.

In this context, WAI should play a niche role by promoting community-based WQM models in areas affected by specific water contaminants (faecal coliform, fluoride and arsenic). It should promote rainwater harvesting in fluoride and arsenic affected areas. It should also promote source protection, sanitary surveillance and point-of-use chlorination in order to reduce the risk of pathogenic contamination of drinking water sources.

Collaboration with the government agencies should involve strengthening the government-run district laboratories through capacity building and facilitating of data management. WAI should also consider establishing centres of excellence for tackling fluorosis and arsenicosis along with various stakeholders.

WAI should continue to carry out focused research studies on community-based WQM in future. The focal areas for research could be studies linking water quality and disease burden and/or a comparative evaluation of various technological options for treatment interventions at the community level. One identified area for research could be routine monitoring of faecal coliforms and its linkages with diarrhoea. As a principle it should consider supporting water quality studies dealing with multiple contaminants. It should also consider institutional collaborations at various levels while carrying out such studies.

Some issues for advocacy emerging from WAI's experiences in WQM and its long-term vision may include setting up drinking water quality criteria for priority pollutants like fluoride, arsenic and nitrate. WAI should advocate for a more defined role of *panchayat* in the National Rural Drinking Water Quality

Monitoring & Surveillance Programme (NRDWQMS) programme in order to sustain the decentralised model. It should also advocate for a strict monitoring and evaluation system for the programme. Another area for advocacy could be the creation of a nodal agency at a central level, which should act as the repository of all the WQ data to avoid confusion. WAI should also consider creating and supporting a network of technical agencies to effectively monitor stricter implementation of effluent discharge standards to reduce surface and groundwater contamination.

WAI should regularly document the concepts and processes involved in implementing community based WQM approaches, which should highlight its achievements and shortcomings through presentations of case studies. It should document the best practices and lobby for their replication/adoption and scaling up at a later stage.

# Chapter-1

## 1.1 Background

Ensuring the supply of safe water is a major problem in developing countries. India is no exception. Centralised systems of water supply and monitoring have not been very effective. They are also prohibitively expensive. This is illustrated by the fact that an estimated 480 million people in India do not have access to safe drinking water.<sup>1</sup> Hence a radical reorientation in ensuring the supply of safe water has become imperative. Official agencies in India now recognise that the participation of stakeholders and their institutions, e.g., PRIs, CBOs, etc. is essential for ensuring the supply of safe water and monitoring its quality.<sup>2</sup>

In accordance with the new orientation, the Department of Drinking Water Supply (DDWS), Ministry of Rural Development, Government of India (GoI) pilot tested a community-based Water Quality Monitoring and Surveillance project in four districts – Nellore (Andhra Pradesh), Sehore (Madhya Pradesh), Allahabad (Uttar Pradesh) and Kangra (Himachal Pradesh). It is now scaling up these activities across the entire country through a programme designed by the Rajiv Gandhi National Drinking Water Mission.<sup>3</sup>

WaterAid India, an international water-focused organisation, is “committed to the goal of achieving drinking water, sanitation and hygiene for all”.<sup>4</sup> WAI works with local voluntary organisations to achieve

its above-mentioned goal. In 2006 it contracted People’s Science Institute (PSI), a Dehra Doon based resource organisation experienced in environmental quality management, to build the capacities of its partners in the field of water quality management. PSI was also asked to validate the data gathered by WAI’s partner organisations after their training. The present document reports the activities carried out under this contract and discusses related issues.

The report begins with a review of drinking water quality in India, its monitoring and related issues. The next chapters deal with an ongoing water quality management programme with various partner organisations of WAI, a case-study on Fluorosis in Palamu district, outlines the status and importance of sanitary risk in different WAI project areas across the country and stresses on the impact of cattle waste on groundwater quality through a case-study in Shivpuri district. The implications of the data for the water quality and sanitary risk in the different regions of India are discussed and relevant conclusions are drawn from the same. Recommendations for future programmes and policies are also presented at the end.

## 1.2 Drinking Water Quality: Basic Issues

The availability of safe drinking water is essential for human well-being and survival. In India ensuring the supply of safe drinking water is a constitutional mandate, with Article 47 conferring the duty of providing clean drinking water and improving public health standards to the State. In recent years High Courts around the country have

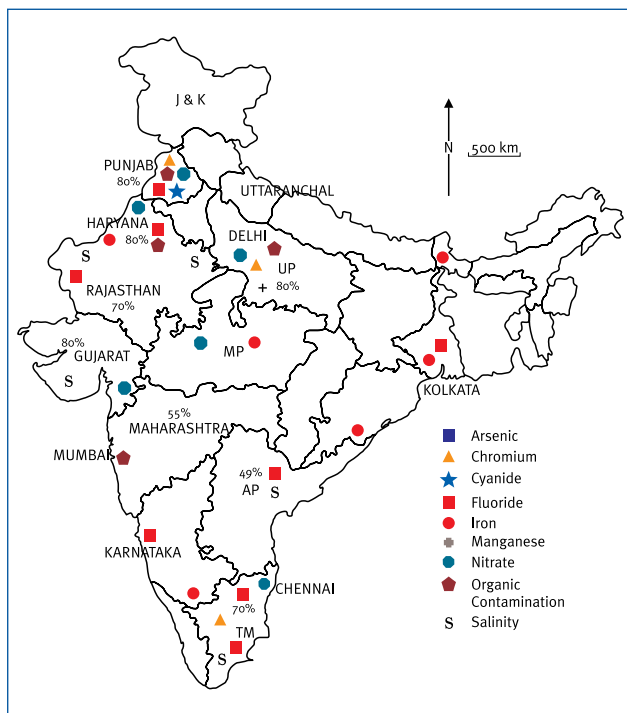
<sup>1</sup> Pangare G., Pangare V. & Das B. (2006): Springs of Life, Academic Foundation, New Delhi, p. 81

<sup>2</sup> ----- (2004): Nirmal Gram Patrika: Issue 3, Oct-Dec 2004, [http://ddws.ni.in/NewsLetterMain.asp?Newsletter\\_id=45&issue\\_no=302](http://ddws.ni.in/NewsLetterMain.asp?Newsletter_id=45&issue_no=302)

<sup>3</sup> Ibid

<sup>4</sup> ----- (2006): Water Quality Policy 2003, Revised September 2006, WaterAid India, New Delhi.

**Fig. 1. Groundwater Quality Map of India**



Source: Central Groundwater Board Of India, 2002

been recognising the right to safe drinking water as a fundamental right.<sup>5</sup> According to the Constitution of India water supply is a State subject. The Union Government is only responsible for setting water quality standards. State governments have established departments or special agencies for supply of domestic water in urban and rural areas. These agencies are also responsible for monitoring the quality of the water supplied.

The National Water Policy (2002) of India also emphasises through a generic statement—“Both surface water and ground water should be regularly monitored for quality. A

<sup>5</sup> For instance see the judgments of the Allahabad and Andhra Pradesh High Courts in Mukul Sharma v. Allahabad Nagar Nigam, All. LJ 3077, (2000); Diwan Singh v. SDM, All. LJ 273, (2000); Wasim Ahmad Khan v. Government of Andhra Pradesh, ALT 526 (DB); 2002 (5).

phased programme should be undertaken for improvements in water quality”.

Since the First Five Year Plan in 1951, investments made in water and sanitation have been estimated at Rs 1,105 billion. Yet, it is estimated that around 37.7 million Indians are affected by waterborne diseases annually, 1.5 million children are estimated to die of diarrhoea alone and 73 million working days are lost due to waterborne disease each year. The resulting economic burden is estimated at \$600 million a year.<sup>6</sup> Clearly, the health benefits in terms of reduction in waterborne diseases have not been commensurate with the investments made.

### 1.3 Groundwater Quality

Groundwater accounts for more than 80% of the rural domestic water supply in India.<sup>7</sup> Data collected in 1998 for the 54<sup>th</sup> round of the National Sample Survey (July 1999) showed that 50 per cent of rural households were served by a tubewell/handpump, 26 per cent by a well, and 19 per cent by tap.<sup>8</sup> In most parts of the country, however, the water supplied through groundwater is beset by problems of quality (See Fig.1). The over-dependency on ground water has places 66 million people in 22 states at risk due to excessive fluoride and around 10 million at risk due to arsenic in six states. In addition, there are problems due to excessive salinity, especially in coastal areas, iron, nitrates and others contaminants. Around

<sup>6</sup> Mid-term appraisal of the Tenth Five Year Plan, Government of India, Planning Commission, New Delhi.

<sup>7</sup> Tripathi S.K. (2000): Address at the National Seminar on Groundwater Management Strategies in Arid & Semi-arid Regions, Jaipur, June 2000.

<sup>8</sup> ----- (2002): Tenth Five Year Plan (2002-2007), Chapter 5.5, Academic Foundation, New Delhi, p.601.

1,95,813 habitations ( Data courtesy: State sub missions of ARWSP) are affected by poor water quality due to chemical parameters. The major contaminants that affect human health are fluorides, arsenic, nitrates and faecal coliforms. Other problems like excess iron, hardness and salinity affect the potability of water, without being harmful to human health.

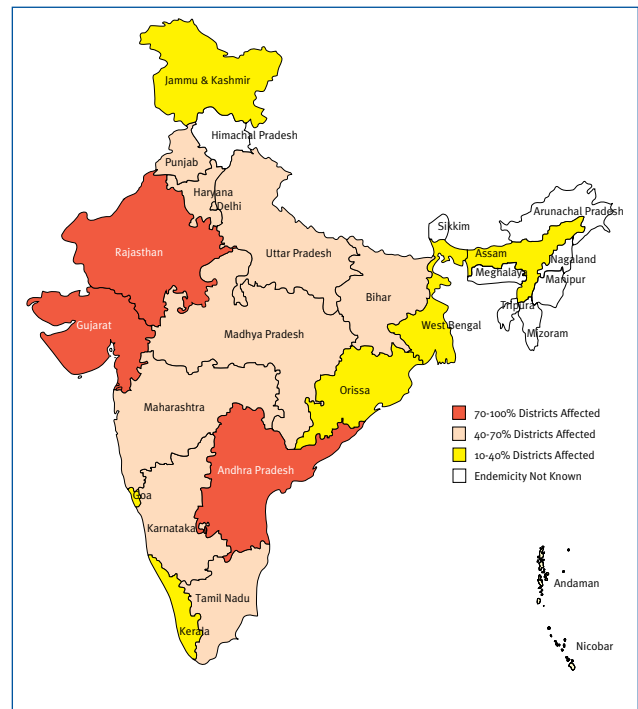
### 1.4 Major Groundwater Contaminants

India’s Tenth Five Year Plan lists excess fluoride concentration as one of the three major hurdles to the sustainable supply of safe water for domestic use. Twenty Indian states have excess fluorides in the groundwater (See Fig. 2). These states include all the nine states of India where WAI has its field partners. Nearly 66 million people, including 6 million children below the age of 14, suffer from dental, skeletal and non-skeletal fluorosis.<sup>9</sup> Fluorides generally enter the water from weathered fluoride bearing rocks like calcite, fluospar and fluoroapatite, etc. In some locations like Sonebhadra district in Uttar Pradesh industries also release fluorides into the atmosphere, surface and groundwater.

In India high arsenic (As) contents have been reported from West Bengal from the districts of Nadia, Murshidabad, Malda, Bardhaman, North and South Paraganas. The presence of Arsenic in water is geogenic. The entire Gangetic delta plain, which consists of alluvial soil, contains Arsenic in the deeper aquifers. It causes skin lesions and can lead to arsenicosis (skin cancer) at a later stage. Adverse health effects due to excess Arsenic in the groundwater became manifest among

<sup>9</sup> Susheela, A.K. (2001): A Treatise on Fluorosis, Fluorosis Res. & Rural Dev. Foundation, New Delhi.

**Fig. 2. Fluoride Endemicity in India**



Source: Susheela, A.K. (2001), *A Treatise on Fluorosis*

the exposed population in West Bengal within 8 to 10 years after large scale exploitation of groundwater began in the 1970s.<sup>10</sup> During recent years high arsenic contamination has also been reported in different parts of eastern U.P., Bihar and Jharkhand

Nitrate in groundwater is another cause for concern. The usage of fertilisers in agriculture, disposal of raw sewage, absence of nitrogen fixing bacteria in the root-nodules of leguminous plants and industrial pollution are the main sources of nitrates in the groundwater. Nitrates have been found in the states of Madhya Pradesh, Uttar Pradesh,

<sup>10</sup> Bhattacharya P., Chatterjee D. & Jacks G. (1997): “Occurrence of Arsenic-contaminated Groundwater in Alluvial Aquifers from Delta Plains, Eastern India”, *Water Resources Development*, v.13, n.1, pp.79-92.

Punjab, Haryana, Delhi and Tamil Nadu. In western India high nitrate in water has caused “Blue Baby Syndrome” in infants (within the age group of 0-6 months, especially those fed on formula diets) Recent studies indicate, nitrate in water may also lead to accumulation of N-nitroso amines in adults leading to cancer.<sup>11</sup> But further authentication of such studies needs to be carried out.

Bacteriological contamination, especially faecal coliform, is the most widespread groundwater pollution problem in India. Groundwater itself does not inherently contain faecal coliforms. Most of the groundwater coliforms come from the leaching of solid (human and animal excreta) and liquid wastes. The presence of faecal coliforms and related pathogens accounts for a number of waterborne diseases like diarrhoea, gastro-enteritis, jaundice, hepatitis, cholera, typhoid, polio, etc.

Iron, hardness and salinity impart an unpalatable taste to water making it unfit for drinking. Many coastal districts in India suffer from excess salinity in groundwater. Hardness is mainly caused by the presence of carbonate, bicarbonate, chloride and sulphate salts of calcium and magnesium in water. Iron is found in parts of Madhya Pradesh, Uttar Pradesh, coastal Orissa, Andhra Pradesh and Tamil Nadu.

## 1.5 Need for Water Quality Management (WQM) in Rural India

Seventy per cent of the population in India, over 650 million, still lives in the rural areas. And as a matter of fact poor water quality

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<sup>11</sup> Sawyer N, McCarty P.L. and Parkin G.F. (1994): Chemistry For Environmental Engineering, Fourth International Edition, McGraw Hill Publications.

affects the poor villagers the most. It affects their livelihood. They have to use their meagre earnings for treatment. A World Bank estimate indicates that rural people spend at least Rs. 100 every year for the treatment of water-borne diseases, which adds up to Rs. 6,700 crore annually. Still there is a complete lack of awareness among the poor and marginalised regarding the quality of water. Hence a water quality management programme (dealing with both water quality monitoring and treatment) is urgently required.

The first step towards ensuring safe drinking water supply is to generate reliable and accurate information about the water quality. Several government departments and institutions play key roles in monitoring water quality and setting standards for the same. The Bureau of Indian Standards (BIS) has developed the authoritative drinking water quality standards for India. The Central Pollution Control Board has set standards for surface water quality and effluent quality. While CPCB and the State PCB laboratories regularly monitor specific water bodies, the Central Ground Water Board is primarily responsible for monitoring groundwater quality along with the state groundwater agencies. But their network of monitoring stations is grossly inadequate for the purpose of monitoring drinking water quality. Other institutions like the National Environmental Engineering and Research Institute (NEERI), the All India Institute for Public Health and Hygiene, the National Institute of Hydrology, etc. undertake regular water quality research.

But as things stand now, not all the water being consumed by the community is of drinkable standards. Apart from the lack of coordination amongst various agencies on a day-to-day basis at the local level, neither

the PRIs, nor all WQ laboratories at the district level are properly equipped to tackle the issue.

There is also a gap with regard to trained manpower. Not all the results are properly recorded, and follow up corrective measures are not properly monitored. Hence to strengthen the WQ surveillance programme, capacity building of local communities becomes necessary. Following the training, the programme should also have a provision of regular follow-ups to identify any loopholes and to take corrective measures if necessary.

All State Public Health Engineering (or Water Supply) Departments have established water quality testing laboratories in each of their districts. But the infrastructure with all the monitoring agencies is also inadequate compared to the scale required. Water Quality survey data by RGNDWM has revealed 2, 16,968 quality affected habitations, with the following break-up: excess Fluoride – 31,306, excess Arsenic – 5,029 excess Salinity – 23,495, excess Iron – 1, 18,088, excess Nitrate – 13,958 and Multiple reasons – 25,092. It is estimated that 16 million samples need to be tested annually following a norm of one sample for every 200 persons.<sup>12</sup>

Looking at the enormity of the task, it has therefore been officially accepted that a community-based monitoring approach is essential to carry out the task on the desired scale. Accordingly, the Government of India pilot-tested a community-based water quality

monitoring approach in four districts of India. The RGNDWM has now scaled up the pilot programme throughout the country.

## 1.6 National Rural Drinking Water Quality Monitoring & Surveillance Programme (NRDWQM&S)–An Overview

An initiative that seeks to ensure safe water through a comprehensive surveillance process; incorporating monitoring, data processing, evaluation, sanitary monitoring, data processing, evaluation, sanitary surveys, public health assessment and remedial and preventive action throughout the length and breadth of the country. Separate Sub-Mission programmes have been part of the ARWSP to address specific quality problems. As part of expanding its outreach, it has now finalised a new Catchment Area Approach (CAA), a community-based water quality monitoring and surveillance programme for rural areas<sup>13</sup>, by utilising the available district and sub-district level water-testing infrastructure in educational institutions and private sector, and suitable capacity development of Panchayati Raj Institutions (PRI)s and other villages level functionaries. Under this programme state laboratories monitor the water quality upto the district level. In the surveillance part of the programme, schools, colleges, VOs, other local labs and community organisations are to monitor the quality of the water supplied at the gram *panchayat* or village level under the technical supervision and guidance of State Level Referral Institutions and a National Level Referral Institute. The National Institute of Communicable Diseases (NICD) under the Ministry of Health & Family Welfare has been

<sup>12</sup> ----- (2006): Guidelines for National Rural Drinking Water Quality Monitoring and Surveillance Programme, Rajiv Gandhi National Drinking Water Mission, New Delhi.

<sup>13</sup> Behari R. (2004): Nirmal Gram Patrika, Issue 3, Oct-Dec 2004, p.2.

designated as the National Level Referral Institute. The modalities for launching the programme throughout the country are being worked out in consultation with NICD. The state laboratories will periodically validate the results of the surveillance tests.

To institutionalise the reform initiatives in the water and sanitation sector, MOUs are being initiated with various states. All the states are preparing comprehensive documents on sanitation and water supply in their states. For specific endemic problems in a particular state, different remedial measures are being initiated. The whole effort is to provide low cost but effective practical solutions to the quality problems by combining community involvement with scientific water and sanitation management. However, though early to review, the initial experiences from the ground have been mixed.

## 1.7 Initiatives from the Non-Government Sector

The non-government sector has also made useful contributions to water quality management in India. Organisations of the U.N., international donor agencies and VOs have taken several important initiatives. UNICEF has worked closely with government agencies to ensure safe water supply. Its key interventions have been in the areas of strengthening water quality monitoring systems, facilitating research and development of water treatment systems, production and dissemination of IEC materials, organising training programmes for grassroots level workers and initiating demonstration projects.<sup>14</sup> It has supplied ion meters and

<sup>14</sup> UNICEF (undated): Mitigating Fluorosis Through Safe Drinking Water, UNICEF, New Delhi.

trained water analysts in the operation of these meters. UNICEF has made several significant contributions to the mitigation of fluoride, arsenic and bacteriological contamination of water in India.

Several international agencies like WHO, UNICEF, DANIDA, DFID and UNDP (WSP) have assisted in developing water quality guidelines. DANIDA has supported Karnataka's Rural Drinking Water Supply and Sanitation Project for sustainable drinking water supply in about 700 villages.<sup>15</sup> This project advocates decentralised, demand driven participatory approaches and strengthening the appropriate PRIs. DANIDA supported units offer professional support in project implementation.

## 1.8 WaterAid India's Initiative

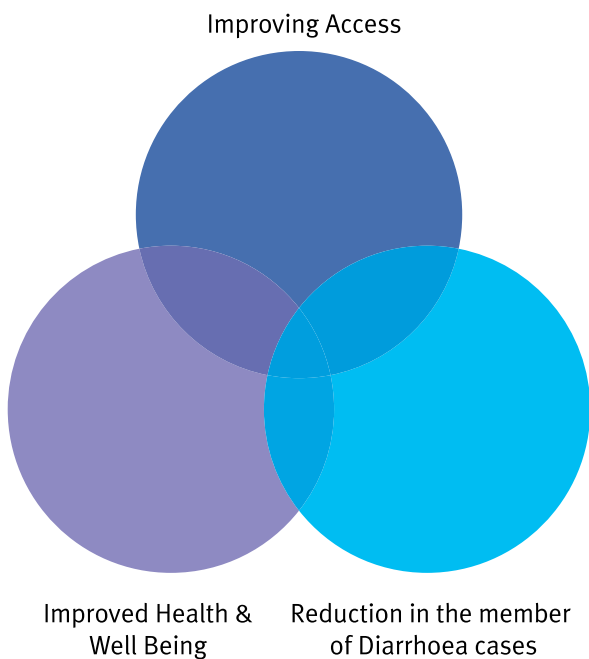
A new strategy running from 2005 to 2010 sets out the future plans and activities for WaterAid in India. During this time WaterAid will continue to focus on water, sanitation and hygiene education working with local partners on community managed projects.

### *The key aims are to:*

- Ensure that at least **245,000 people gain access to safe water and at least 200,000 people gain access to improved sanitation** every year by 2010, contributing to reaching the Millennium Development Goal (MDG) target of halving the proportion of people without access to safe water and sanitation by 2015
- Deliver hygiene education to 80% of these people to ensure sustainable good hygiene practices and a consequent 80% reduction in incidences of diarrhoea among children under five

<sup>15</sup> Ibid.

**Fig: Centrality of WQ in WAI's Water Policy**



The centrality of Water quality in WaterAid India's policy can be seen from the overlapping of its the focal areas- Improving access to safe drinking water, improved health and well-being and reduction in the member of diarrhoea cases.

WaterAid India (WAI) will continue to seek innovative ways to promote community collective action and create incentives for villages and schools to improve their water and sanitation situation. The Indian Government's commitment to the MDGs entails a huge task, as presently major gaps exist between the goals and the resources available. It is estimated that to reach the water and sanitation targets 48 million people need to be reached each year upto 2015, for which there is a shortfall of around US\$34 billion. In addition, incomplete decentralisation has meant that local government, that are meant to be responsible for water and sanitation provision, often lack the finance and capacity to carry out their work fully.

WAI believes local government service providers should be accountable to the communities they serve. WaterAid has been supporting civil society organisations to mobilise communities to demand improved water and sanitation services from their local government agencies. As part of this approach, each community has been trained to gather evidence of their circumstances, such as water point mapping, water quality monitoring, to take part in forums to discuss pertinent issues, and build partnerships and alliances with other communities or organisations. This experience of mobilising themselves, raising money, developing a water-user group and so on gives them experience of the process they would need to go through to demand other services such as health and education improvements. In this way communities are not passive recipients of aid but active agents of change.

In recent years WaterAid India has partnered with a Dehra Doon based technical support agency and local VOs in 9 Indian states to ensure the supply of safe drinking water in rural areas. WAI's objective is to develop a comprehensive plan for continuing water quality surveillance and treatment measures. The emphasis is on community-based activities supported by field VOs.

An analysis of WQ data provided by the state sub-missions under the accelerated rural water supply programme (ARWSP) in WAI's project area indicated multiple WQ problems in these areas. A careful examination also revealed that biggest chemical contaminants are Iron and Fluoride-affecting more than 10, 000 habitations out of a total 93746 habitations. A sizable population was also found to be affected by nitrate (about 6226 habitations).

**Table 1: Status of Water Quality in WAI's Project Area (According to state sub missions of ARWSP)**

S. No.	State/UT	Habitations Affected by WQ Problems						Total as on 31/3/2006
		Fluoride	Salinity	Iron	Arsenic	Nitrate	Multiple	
1	A.P.	1497	1058	0	0	0	0	2555
2	Bihar	383	0	21540	794	2000	0	24717
3	Chattisgarh	17	61	4932	11	0	0	5021
4	Jharkhand	1159	0	129	18	1	41	1348
5	Karnataka	5000	0	6633	0	4077	4460	20170
6	M.P.	3282	279	105	0	33	153	3852
7	Orissa	794	651	26136	0	0	435	28016
8	Tamil Nadu	452	61	68	0	104	735	1420
9	U.P.	2077	612	2375	0	11	1302	6377
	Total	14661	2722	61918	823	6226	7126	93476

Once the data was publicised, a need was immediately felt to verify this data. But it was a tedious task and had to be decentralised. WAI had already begun training its partners on WQ

through a technical support agency, which had taken a serious shape by now and the partner VO-supported community-based water quality monitoring programme was conceptualised.

# Chapter-2

## 2.1 Introduction

WaterAid India(WAI) initiated a community based water quality programme in nine states of India during 2006. The programme was implemented through WAI's field partner VOs in these states. WAI hired People's Science Institute (PSI), a Dehra Doon based research organisation, as a technical support agency to train its partners in the first phase.

The basic objectives of this programme were:

- i) To train WAI field partners on water quality management (WQM) and
- ii) To analyse and identify WQ problems in the different project areas.

PSI conducted capacity building workshops for WAI's regional partners in nine different states of the country during the first phase. A variety of topics covering different aspects of water quality monitoring and management were addressed using a combination of pedagogical methods.

The participants were trained to measure pH, temperature, total hardness, total alkalinity and the concentrations of chloride, total iron, nitrate, fluoride and faecal coliforms in water using the portable kit designed by PSI for the purpose. The data gathering formats were explained to them. Relative importance of each WQ parameter in terms of its health impacts was also explained. Following the trainings, WQ data was generated and the major WQ problems were identified at the level of partners.

The second phase of the programme began with a refresher training on WQM, which involved sorting out technical difficulties and logistical problems while carrying out the WQ tests, filling the gaps in recording and reporting the WQ data and a session on the

different available WQ treatment options. Since the major WQ problems faced in the various locations had been identified, the relevant water treatment options were also discussed. These included:

1. Reduction at the source
2. Point-of-use chlorination
3. Other treatment options (SODIS, copper vessels, sand filters, earthen pots etc.)

During this phase water samples were collected from the project areas of different WAI partners. The samples were divided into two portions. They were analysed simultaneously at the level of partners and at the PSI laboratory in Dehra Doon to validate the test results of WAI partners.

## 2.2 Results and Discussion

### *Water quality*

Forty-one partner organisations of WAI from eight states in eastern, southern, central and northern India reported WQ monitoring data. Water quality of 950 sources in over 300 villages was tested. The parameters monitored included pH, total hardness, total alkalinity, chloride, fluoride, total iron, nitrate and faecal coliforms.

Testing was carried out following the [Standard Methods for Examination of Water and Wastewater](#), as prescribed by American Public Health Association (APHA), Water Environment Federation (WEF) & American Water Works Association (AWWA) (20<sup>th</sup> Edition, 1998).

The data was compiled and analysed for violations of the faecal coliform (FC), fluoride, nitrate, total iron, total hardness and total alkalinity standards. FC, fluoride and nitrate have direct health effects, as mentioned earlier. Iron discolors water and imparts an

## Geographical Distribution of WAI's Partners across India



**Table 2: Distribution of Sources Monitored in Eastern India**

S. No.	Partner Organisation	Surface Water	Groundwater Sources			
			Dug Wells	Hand Pumps	Bore Wells	Total GW Sources
<b>ORISSA</b>						
1.	PJS, Bhadrak	1	0	26	41	68
2.	FREEDOM, Puri	0	8	29	0	37
3.	SSUD, Puri	0	0	31	0	31
	<b>Sub-Total</b>	<b>1</b>	<b>8</b>	<b>86</b>	<b>41</b>	<b>135</b>
<b>BIHAR</b>						
4.	GSSG, Jehanabad	0	7	43	0	50
5.	BJUP, Nalanda	0	13	63	0	76
6.	JVS, Nawada	0	4	25	0	29
7.	Aditi, Muzz'pur	0	3	26	0	29
8.	IDF, Patna	0	0	49	0	49
	<b>Sub-Total</b>	<b>0</b>	<b>27</b>	<b>206</b>	<b>0</b>	<b>233</b>
<b>JHARKHAND</b>						
9.	SHRMS, Palamu	0	0	36	0	36
10.	LP, Deoghar	0	14	7	0	21
11.	GJ, Deoghar	0	3	39	0	42
12.	LJK, Deoghar	0	8	33	0	41
13.	SATHEE, Godda	2	9	9	0	20
14.	VEDIC Soc., Latehar	0	15	15	0	30
15.	NBJK, Ranchi	0	10	6	4	20
	<b>Sub-Total</b>	<b>2</b>	<b>59</b>	<b>145</b>	<b>4</b>	<b>208</b>
	<b>Grand Total</b>	<b>3</b>	<b>94</b>	<b>437</b>	<b>45</b>	<b>576</b>

unpalatable taste to it. Hard water is not desirable for domestic use. The regional WQ status in parametric terms (focusing only on parameters of health and aesthetic importance) is discussed below.

### 2.2.1 Eastern India

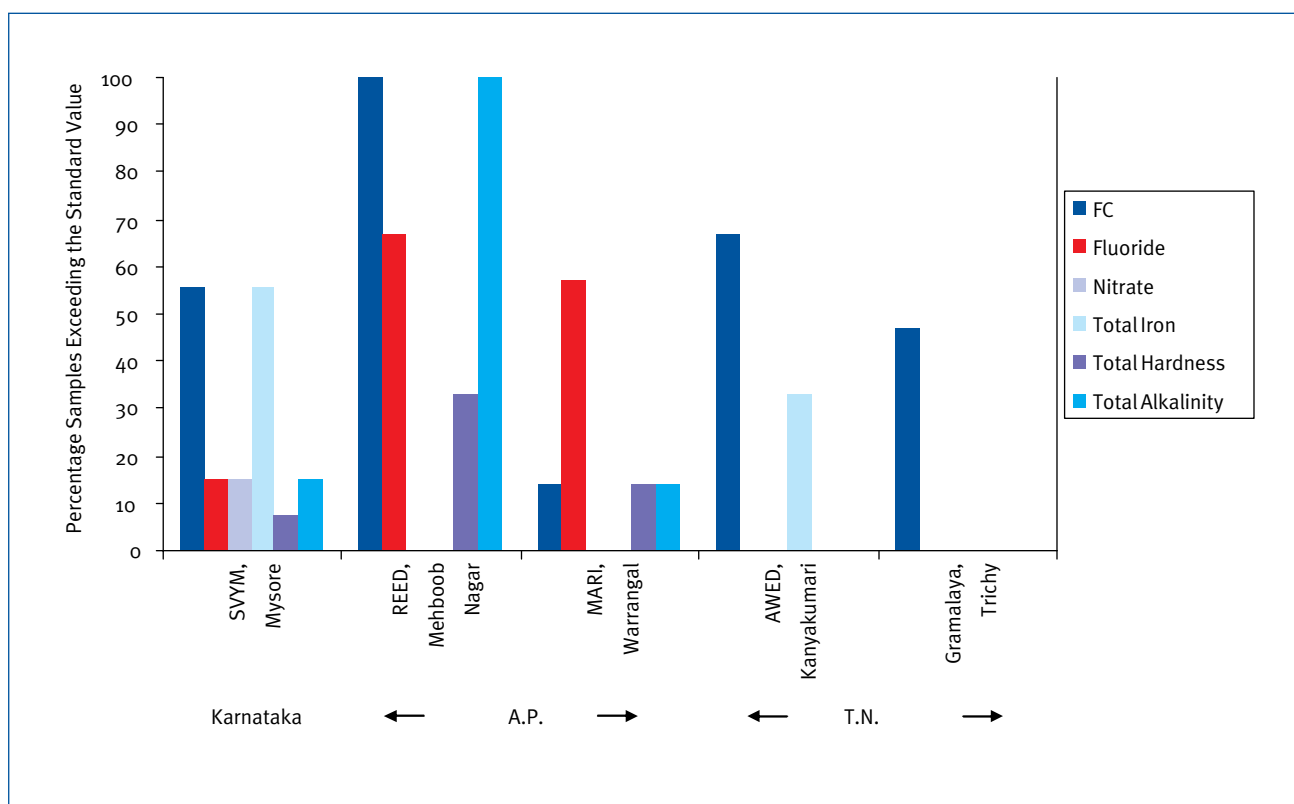
Fifteen organisations in eastern India reported WQ data from 215 villages – Orissa (62), Bihar (50), and Jharkhand (103). They monitored 136 sources in Orissa, 233 in Bihar and 210 in Jharkhand. These included 576 groundwater

and three surface water sources. Their breakup is given below.

The widespread presence of faecal coliforms and fluoride poses a serious health threat in this region (See Fig.3). Eleven out of 14 reporting found faecal coliforms in excess of the standard limits.<sup>16</sup> Eight of them, reported significant violations of the fluoride standard.

<sup>16</sup> The term significant in this context implies that more than 10% of the samples tested exceeded the standard value.

**Fig.3. Water Quality Monitoring Results from Eastern India (RoE)**



*Note: Missing bars mean no violation of the standards or no results accepted.*

High iron content was reported from all the project areas of the partners in the eastern region. This is not surprising since the eastern Indian states are rich in iron ores. Nitrate levels above the standard limit were reported from isolated locations. Eight and ten out of the 15 POs respectively, recorded hardness and alkalinity levels above the acceptable standards, though the number of such samples was small.

**Bihar:** Iron levels above the standard limit were found in 102 samples (45%) from all the reporting partners' project districts. A high number of violations of the acceptable fluoride standard were observed in four districts. Almost all the samples analysed in Nawada (90%) and Muzzafarpur (100%) districts showed fluoride levels above the standard value. Though the FC standard

is exceeded in 3 out of the 5 partners' areas, the excess is high (42%) only in the Jehanabad villages. Forty-two violations (18%) of the acceptable standard for alkalinity were recorded in all the districts. Significantly high values of FC, fluoride, nitrate and iron were reported for samples from Jehanabad district.

State	Parameters			
	FC	F	Fe	NO <sub>3</sub>
Bihar	17 (197)	40 (232)	45 (226)	3 (233)

*Note: Figures in brackets are for the total number of samples.*

**Jharkhand:** Fluoride and faecal coliform contamination of water are serious health risks in Jharkhand as evident from the

percentage of violations of the standards (See below). The high fluoride content is in keeping with Jharkhand's notoriety as a state where most districts show fluoride endemicity.<sup>17</sup> All the samples collected by field partners in Deoghar and Latehar had fluoride levels above the acceptable limit. While more than 25 per cent of the samples have excessive iron content, the levels of NO<sub>3</sub>, total hardness and total alkalinity are generally within the acceptable standards.

State	Parameters			
	FC	F	Fe	NO <sub>3</sub>
Jharkhand	34 (210)	68 (117)	28 (127)	1 (210)

*Note: Figures in brackets are for the total number of samples.*

**Orissa:** Faecal coliform and total iron contents were significantly high in the project areas

of all the field partners. No violation of the fluoride standard was reported from the coastal district of Puri. Nitrate levels are within the standard at all the sources monitored.

State	Parameters			
	FC	F	Fe	NO <sub>3</sub>
Orissa	27 (125)	19 (136)	31 (136)	0 (136)

*Note : Figures in brackets are for the total number of samples analysed.*

### 2.2.2 Southern India

Most of the partners did not report the number of villages covered. The individual partners monitored relatively few sources. Hence the results are only indicative. Only one sample out of the total 64 considered was a surface water source. Of the remaining, 54 samples were collected from handpumps (See table below).

**Table 3: Distribution of Sources Monitored in Southern India (RoS)**

S. No	PO Partner Organisation	Surface Water	Groundwater Sources			
			Dug Wells	Handpumps	Bore Wells	Total GW
<b>KARNATAKA</b>						
1	APSA, Bangalore	0	0	4	0	4
2	SVYM, Mysore	1	0	22	4	26
	<b>Sub-Total</b>	<b>1</b>	<b>0</b>	<b>26</b>	<b>4</b>	<b>30</b>
<b>ANDHRA PRADESH</b>						
3	REEDS, M.Nagar	0	0	8	0	8
4	MARI, Warangal	0	0	6	1	7
	<b>Sub-Total</b>	<b>0</b>	<b>0</b>	<b>14</b>	<b>1</b>	<b>15</b>
<b>TAMIL NADU</b>						
5	AWED, K'kumari	0	0	2	1	3
6	Gramalaya, Trichy	0	1	12	2	15
	<b>Sub-Total</b>	<b>0</b>	<b>1</b>	<b>14</b>	<b>3</b>	<b>18</b>
	<b>Grand Total</b>	<b>1</b>	<b>1</b>	<b>54</b>	<b>8</b>	<b>63</b>

<sup>17</sup> Susheela, A.K. (2001): A Treatise on Fluorosis, Fluorosis Res. & Rural Dev. Foundation, New Delhi.

State	Parameters			
	FC	F	Fe	NO <sub>3</sub>
Karnataka	48 (31)	13 (31)	26 (31)	3 (31)
AP	40 (10)	60 (10)	0 (10)	0 (10)
TN	50 (18)	0 (18)	6 (18)	0 (18)

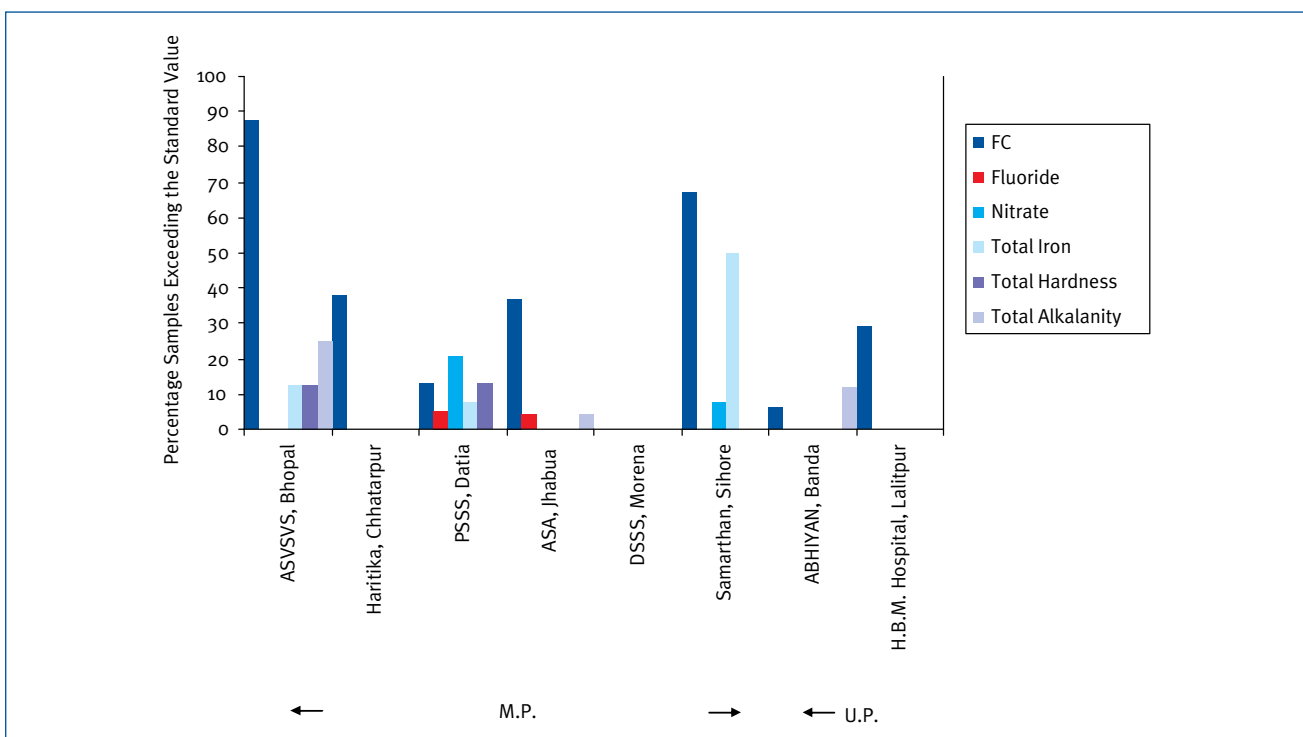
Note : Figures in brackets are the total number of samples analysed.

Faecal coliforms appear to be the main contaminants in the southern states (See Fig.4). Most samples in Andhra Pradesh had fluoride significantly above the standard value (1.5 mg/l). Andhra Pradesh is one of the three states in India with the highest endemicity of fluoride.<sup>18</sup> Nitrate concentrations above the standard have

been reported only from Mysore district in Karnataka. Iron in excess of the standard was found in Mysore and in one sample in Kanyakumari.

Since the number of sources surveyed from each state is low no observations need to be made separately for the different states.

Fig. 4. Water Quality Monitoring Results from South India (RoS)



Note: Missing bars mean no violation of the standards.

<sup>18</sup> UNICEF (undated): Mitigating Fluorosis Through Safe Drinking Water, UNICEF, New Delhi.

**Table 4: Distribution of Sources Monitored in Central & North India (RoS)**

S. No	Partner Organisations	Surface Water	Groundwater Sources			
			Dug Wells	Handpumps	Bore Wells	Total GW
<b>MADHYA PRADESH</b>						
1	VSS, Guna	0	4	11	0	15
2	ASVSVS, Bhopal	0	2	0	6	8
3	Haritika, Chattarpur	0	0	3	5	8
4	PSSS, Datia	0	9	31	0	40
5	ASA, Jhabua	0	2	25	0	27
6	DSSS, Morena	0	9	72	4	85
7	Samarthan, Sihore	0	0	15	0	15
	<b>Sub-Total</b>	<b>0</b>	<b>26</b>	<b>157</b>	<b>15</b>	<b>198</b>
<b>UTTAR PRADESH</b>						
8	ABHIYAN, Banda	0	9	16	0	25
9	PSSS, Jalaun	0	3	49	0	52
10	HBMH, Lalitpur	0	5	27	0	32
	<b>Sub-Total</b>	<b>0</b>	<b>17</b>	<b>92</b>	<b>0</b>	<b>109</b>
	<b>Grand-Total</b>	<b>0</b>	<b>43</b>	<b>249</b>	<b>15</b>	<b>307</b>

WAI's field partner in Mysore district reported violation of the standards for FC (56%), fluoride (15%), nitrate (15%) and total iron (56%). Both the partners from Tamil Nadu reported violations for FC whereas partners from Andhra Pradesh reported violations for FC and fluoride.

### 2.2.3 Central & North India

A total of ten organisations, numbering seven in Madhya Pradesh and three in Uttar Pradesh gathered water quality data from 198 and 109 sources respectively. All the samples were of groundwater, with handpumps accounting for over 80 per cent (See table below).

Faecal coliform contamination is the main water quality problem in both the states (See Fig.5). All the seven reporting partners found faecal coliforms in their

project districts, as against the standard requirement of no faecal coliforms in potable water.

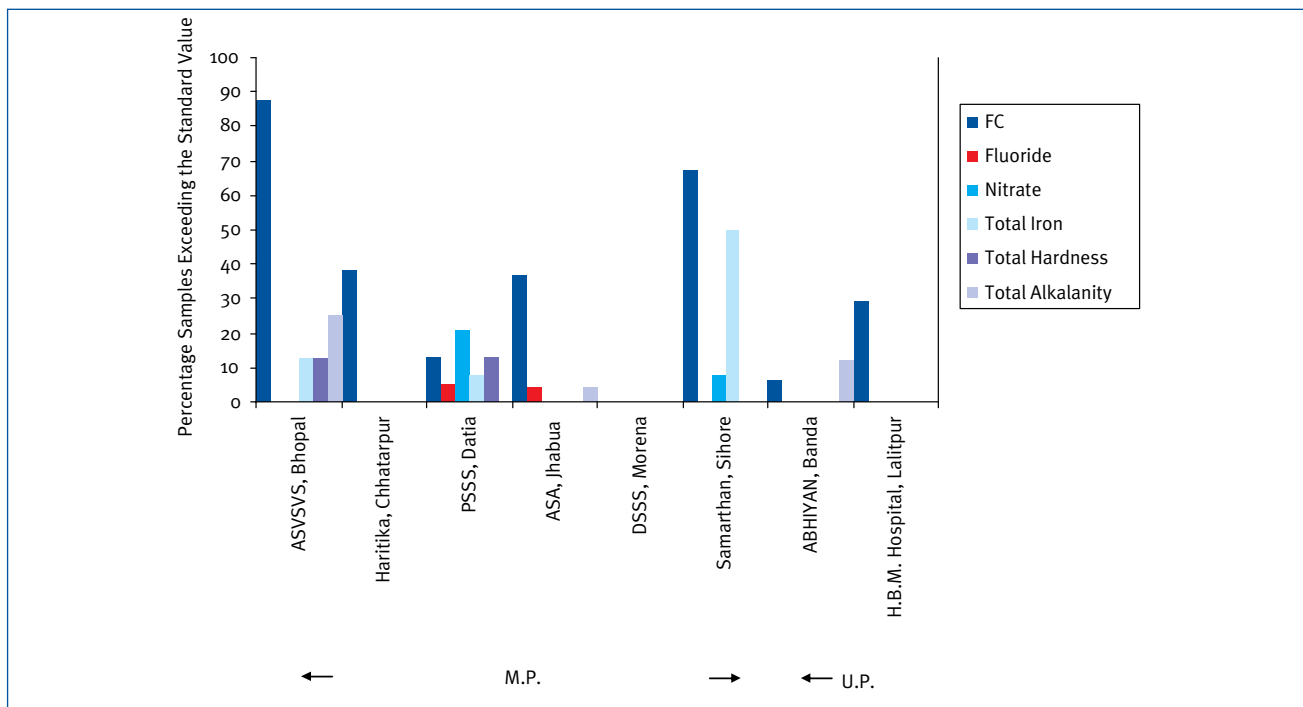
**Madhya Pradesh:** All the reporting partners in MP recorded faecal coliforms in a significant fraction of their samples. Fluoride levels were generally within the acceptable limit. Nitrate levels above the standard were reported from 21 per cent of the sources by partners in Datia district. Half the samples in Sihore district had iron content above the standard.

State	Parameters			
	FC	F	Fe	NO <sub>3</sub>
MP	35 (93)	3.5 (85)	17 (58)	15.5 (58)

**Uttar Pradesh:** The only significant problem is the presence of faecal coliforms in 29% of the samples from Lalitpur district.

State	% Samples Violating Standard					
	FC	F	FE	NO <sub>3</sub>	TH	TA
Uttar Pradesh	18 (38)	0 (17)	0 (17)	0 (17)	0 (17)	12 (17)

**Fig. 5. Water Quality Monitoring Results from Central & North India (RoW)**



Note: Missing bars mean no violation of the standards or no results accepted. See Appendix II

## 2.3 Major Trends in Water Quality in WAI Project Areas

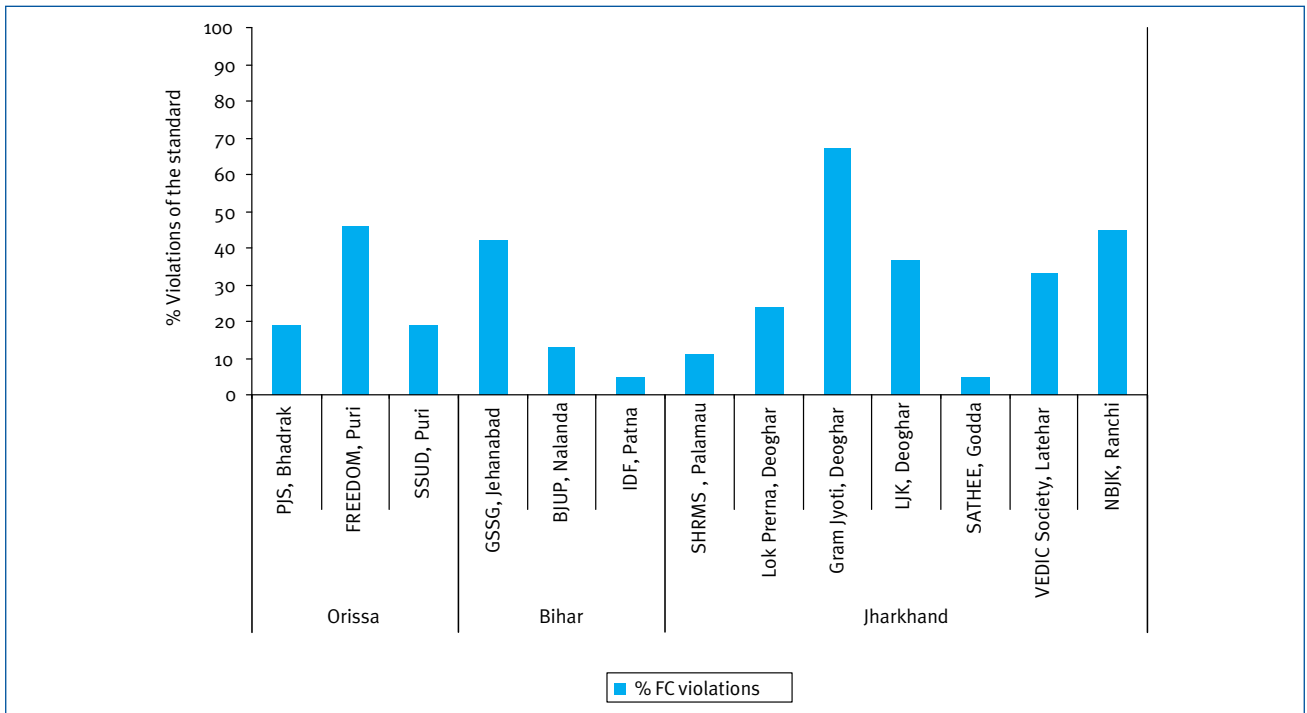
**Faecal Coliform:** Faecal coliform contamination is widespread in all the eight reporting states (See Fig.6). Six of the eight states reported that a fourth to half the samples had faecal coliforms,

in violation of the standard (See table below). Surprisingly Bihar and UP project areas reported only 17 and 18.5 per cent FC contaminated samples. Among the field partners with a large enough sample size, partners from Deoghar (Jharkhand) and Sehore (MP) had the highest contamination levels (67%).

Parameter	% Samples Violating Standard							
	Bi	Jkd	Or	Kar	AP	TN	MP	UP
Faecal Coliform	17 (197)	34 (210)	27 (125)	48 (31)	40 (10)	50 (18)	35 (93)	18 (38)

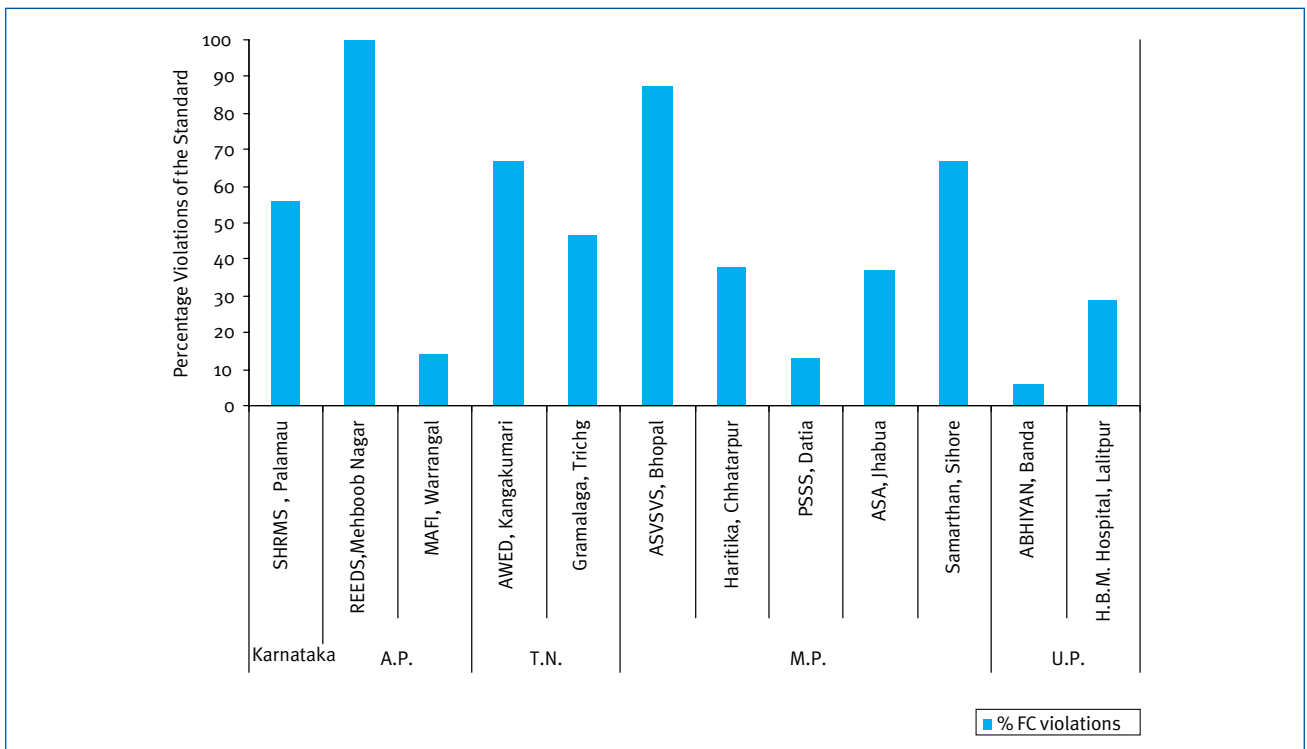
Note : Figures in brackets give the total number of samples for the state. Bi= Bihar, Jkd=Jharkhand, Or=Orissa, Kar=Karnataka, AP= Andhra Pradesh, TN= Tamil Nadu, MP= Madhya Pradesh and UP=Uttar Pradesh

**Fig. 6(a). Fecal coliform contamination in eastern India**



*Note : No sources in Nawada (Bihar), Bangalore (Karnataka), Morena (M.P.) and Orai (U.P.) districts showed any presence of faecal coliforms.*

**Fig. 6(b). Faecal Coliform Contamination in Southern, Central (M.P.) and Northern (U.P.) India**



## 2.4 Major WQ Trends in WAI's Project Area

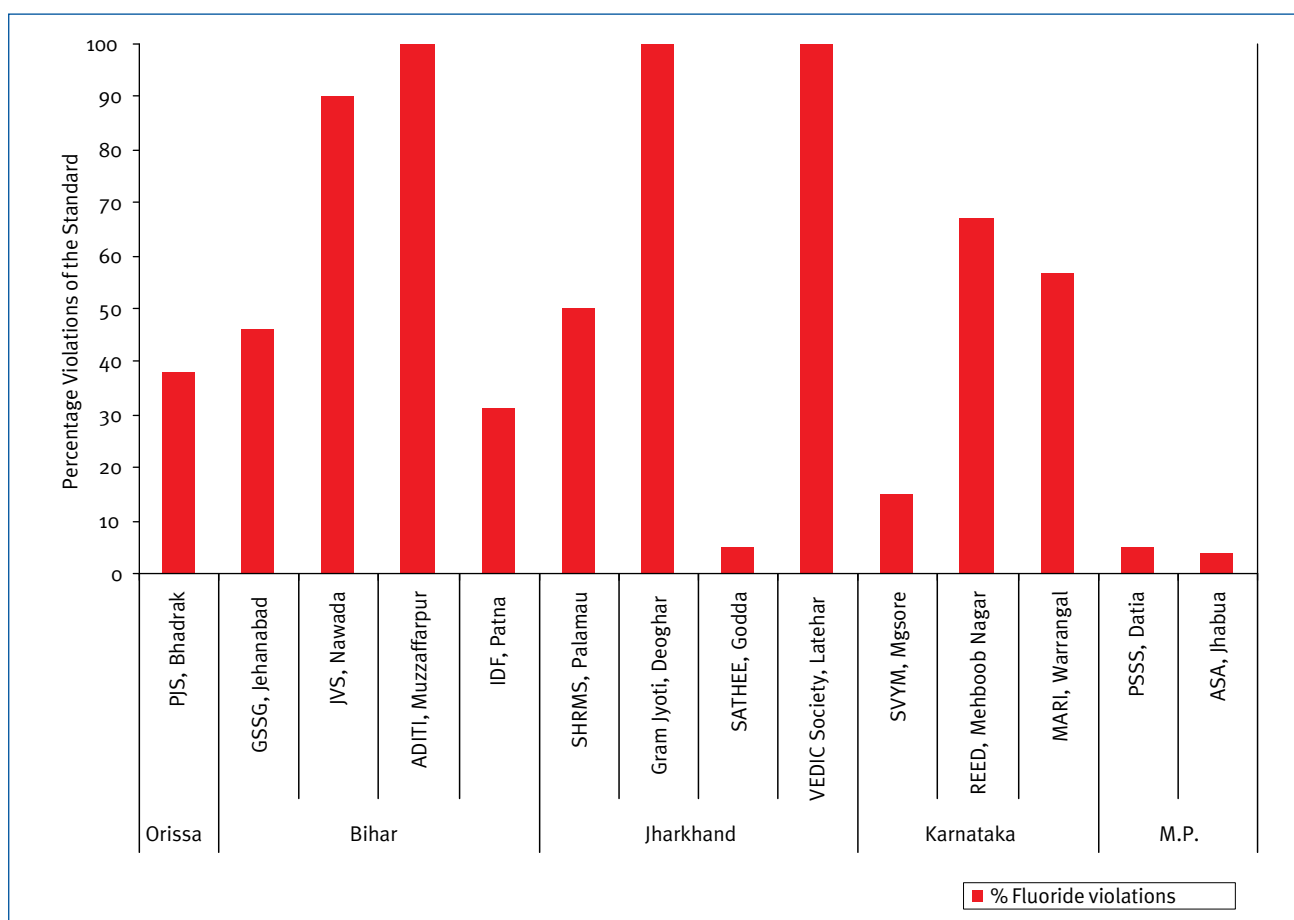
**Fluoride:** Violation of Fluoride standards (1.5 mg/l) violation is high (See Fig.7). Its presence is most widespread in the east followed by the south and then in MP and UP. None of the four surface water sources had any fluoride in them. It is generally

believed that deeper aquifers have higher concentrations of fluorides in endemic areas. This was observed in Bhadrak district (Orissa). Here only three handpumps out of 26 showed excess fluoride against 23 out of 41 borewells. All the samples monitored by partner organisations from Latehar, Deoghar and Muzzafarpur had fluoride levels above the standard.

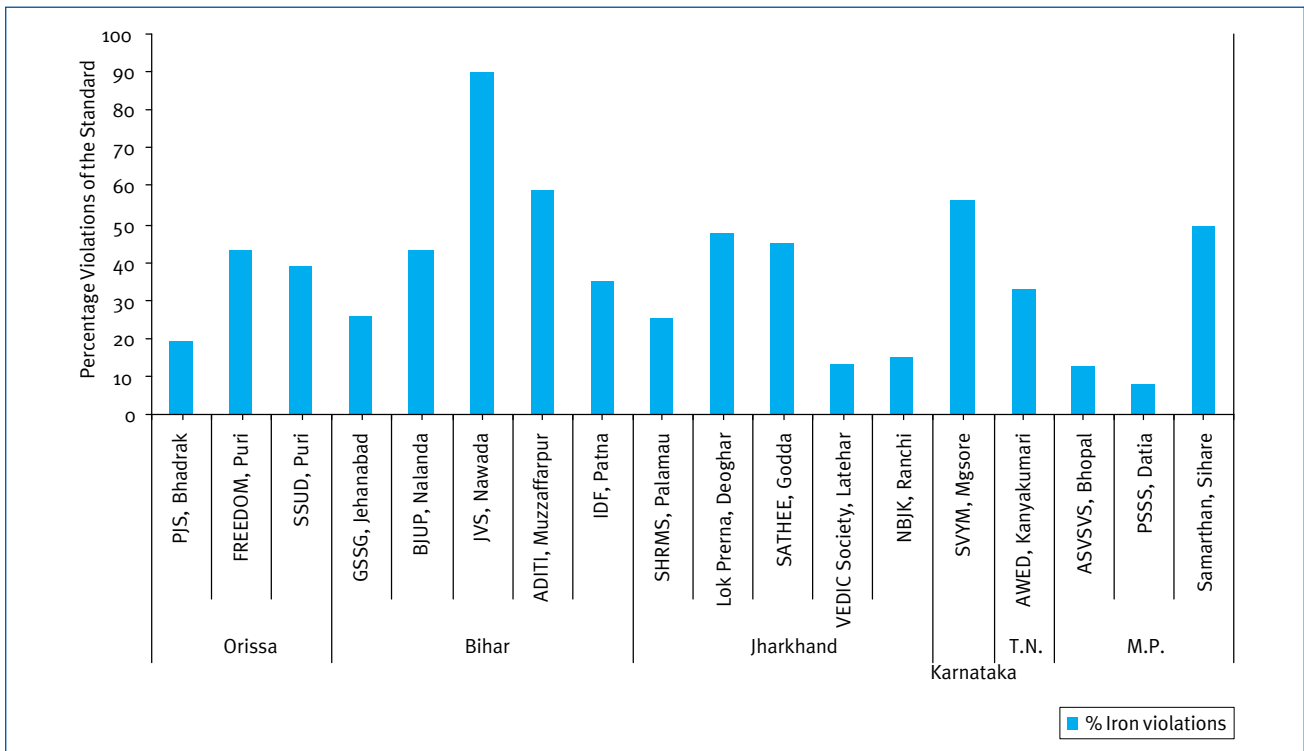
Parameter	Percentage of Samples Violating Standard							
	Bi	Jkd	Or	Kar	AP	TN	MP	UP
Fluoride	40 (232)	68 (117)	19 (136)	13 (31)	60 (10)	0 (18)	3.5 (85)	0 (17)

*Note: Figures in brackets give the total number of samples for the state. Bi= Bihar, Jkd=Jharkhand, Or=Orissa, Kar=Karnataka, AP= Andhra Pradesh, TN= Tamil Nadu, MP= Madhya Pradesh and UP=Uttar Pradesh*

**Fig. 7. Fluoride Contamination in India**



**Fig. 8. Iron Contamination in India**



Parameter	Percentage of Samples Violating Standard							
	Bi	Jkd	Or	Kar	AP	TN	MP	UP
Iron	45 (226)	28 (127)	31 (136)	26 (31)	0 (10)	6 (18)	17 (93)	0 (17)

Note: Figures in brackets give the total number of samples for the state. Bi= Bihar, Jkd=Jharkhand, Or=Orissa, Kar=Karnataka, AP= Andhra Pradesh, TN= Tamil Nadu, MP= Madhya Pradesh and UP=Uttar Pradesh

**Total Iron:** Iron is most widespread in the eastern region (See Fig. 8). Its presence in excess of the standard value is observed by all the 13 reporting POs in the eastern region. In the south it is present in a significant way only in Mysore district. Of the four reporting organisations in MP and UP only one found it to a significant extent.

### 2.5 Analysis of WQ Trends

Faecal coliform contamination is a widespread problem in all the states and regions that

have been monitored. Excess fluoride poses a clear health risk in eastern India and Andhra Pradesh. The limited data of fluoride contamination for Andhra Pradesh only confirms information published earlier. Iron is the third major pollutant, particularly in eastern India, Karnataka and Madhya Pradesh. Nitrate is generally present in acceptable amounts except at isolated locations. In Datia (MP) district, however, there are a relatively large number of sources with nitrate levels above the standards. This needs to be reconfirmed. Hardness and

alkalinity levels are usually found within the standard limits.

The WQ data generated at the level of partners suggested a clear trend. There were 3 major WQ problems in WAI's project area—Faecal Coliform, Fluoride and Iron (See Annexure I for a distribution of parametric trends in WQ),

which was in accordance with the survey data of state sub-missions of ARWSP. Once the major WQ problems were identified, few pilot scale research projects, addressing specific WQ problems, were initiated to provide safe drinking water to the affected communities. These projects were also expected to yield working models for future scaling up.

# Chapter-3

## Fluoride Monitoring and Fluorosis Mitigation in 5 Villages of Palamu District– Pilot Scale Exercise

### 3.1 Introduction

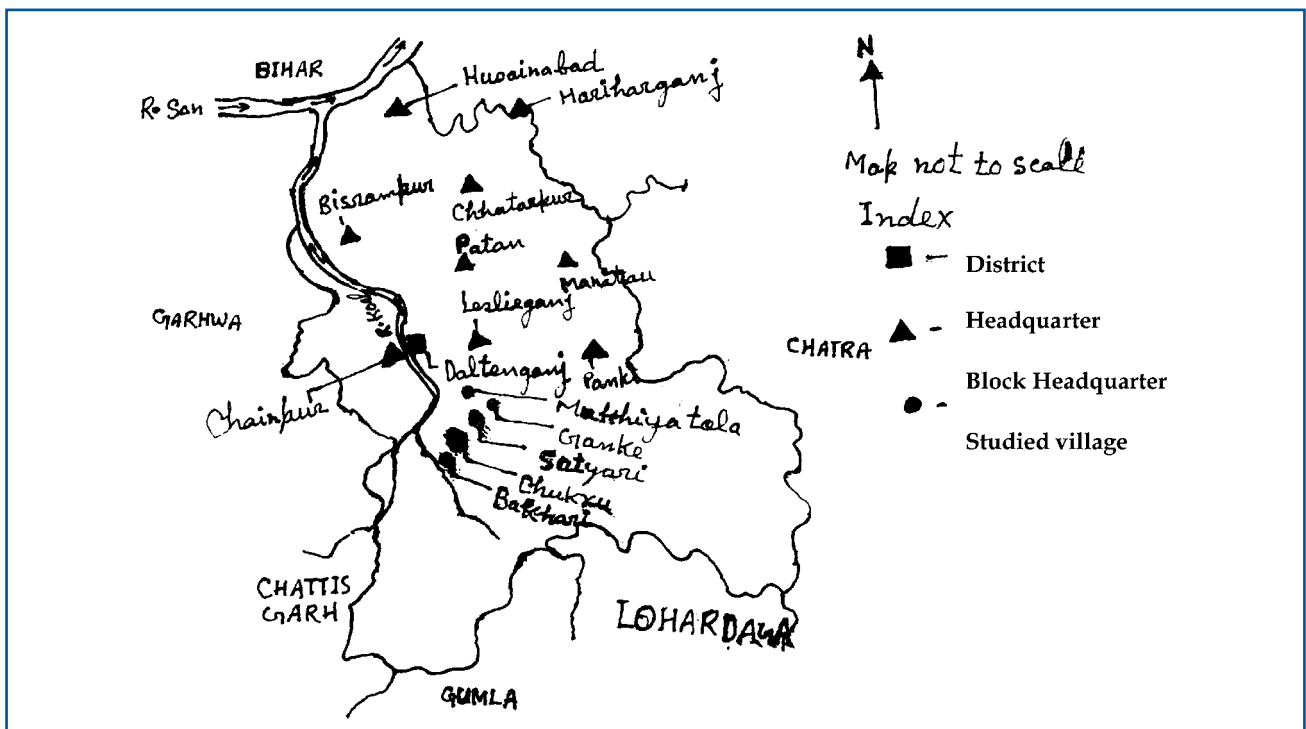
The first of the pilot-scale research studies was initiated in Palamu. Excess fluoride concentration in drinking water had led to different degrees of fluorosis in Palamu. WQ data generated by WAI’s local partner Society of Hill Resource Management School (SHRMS) also showed high fluoride in drinking water. Another hypothesis in the scientific community, however concluded, socio-economic conditions, diet practices, malnutrition, climatic conditions also played a major role in making Palamu vulnerable to fluorosis. The multi-dimensional nature of the problem and a fairly high percentage of poor and socially marginalised (about 50% percent of the population belongs to Scheduled Castes and Scheduled Tribes)

population made Palamu an ideal setting for the study.

Palamu district falls in the northwestern part of the Chhota Nagpur Plateau in the western part of Jharkhand. The topography is hilly and undulated, covered with deteriorated forest. Geology of the region is very complex; there are many kinds of mineral deposits and rocks in the region, which affect the groundwater quality. The majority of the people living in this district depend on groundwater sources (handpumps and open wells).

The district represents a rough terrain, poor socio-economic and demographic status, all leading to uncongenial living conditions. The unavailability of safe drinking water only compounds the existing problem. Fluorosis

Fig. 9. Location of studied villages in the district



has gradually become an issue of concern in this region.

The signs of fluorosis were first observed in Chukru village in 1992. Since then, much effort was made by the government and non-government agencies to control and mitigate the problem. Despite all such efforts, the problem has become worse. A report of Public Health and Engineering Department (PHED), 2006 reported fluoride concentration above 1.5 mg/L in 1340 drinking water sources of 275 villages in the district. It found fluoride levels as high as 7.2 mg/L in drinking water sources. The report definitely indicates that a large area of the district gets drinking water with excess fluoride.

With the help SHRMS, and a Dehra Doon based technical support agency (PSI), WAI began a program on community based fluoride testing and fluorosis mitigation in 5 villages of Palamu. The villages were selected based on reconnaissance survey, discussion with the field partner and from a collection of newspaper reports.

This paper presents the findings of the water quality tests and the accompanying health surveys. It also describes in a summary fashion the community-based activities for fluorosis mitigation planning. The criteria for selection of villages were severity of fluorosis, people's co-operation and participation, socio-economic and political conditions and accessibility of the villages.

### 3.2 Methodology

The study methodology involved the following activities

- Awareness campaign.
- Water quality monitoring with regard to concentration of fluoride in the water sources.

- Health survey, particularly in respect of dental fluorosis among children.
- Village level meetings to prepare participatory plans for control and mitigation of fluorosis.
- Setting up domestic defluoridation kits for demonstration at the household level.
- Setting up village level kit recharging centres.
- Assessing performance efficiency of the demonstration kits.

#### 3.2.1 Awareness campaign

As part of the awareness campaign, initiation meetings with villagers were organised in 10 villages (5 selected villages and 5 other villages). Visits were organised to schools to sensitise schoolchildren and teachers about the various ill-effects of fluorosis. The local community radio and skits were used to disseminate various information related to fluoride and fluorosis.

#### 3.2.2 Health survey

Following a reconnaissance survey and a village meeting in each village, a health survey was carried out along with the other activities. The health survey proforma included questions on water source and period, symptoms of kind/severity of fluorosis, diet practices and nature of income generating activities etc. The health survey was carried out by conducting following household interviews in 5 selected villages. Households for the survey were selected randomly.

#### 3.2.3 Water quality monitoring

Water samples were analysed at a temporary field laboratory set up at the SHRMS office in Medininagar. Fluoride concentration in water samples was directly monitored using

Fluoride Ion – Meter Orion 290 A+ in the field laboratory. Samples were collected following the procedure prescribed in the Standard Methods for the Examination of Water and Waste Water (20<sup>th</sup> Edition APHA). Analysis was carried out following the Ion Selective Electrode method.

### 3.2.4 Community-based fluorosis mitigation planning

A specially organised team of community workers, scientists and folk artists carried out a Sandesh Yatra for mobilising the affected village communities over three weeks in January'05 and February'05, covering all the targeted 21 villages. They informed the communities about the levels of fluoride contamination in the domestic water sources of their villages, the nature of fluorosis and possible measures for mitigation of the problem. Activities like puppet shows, street plays, dialogues with the villagers, poster-pasting and distribution of pamphlets on fluorosis were carried out in each targeted village. Mapping of the fluoride content in the different drinking water sources along with the affected households was also done in each village.

Once the water quality monitoring and Sandesh Yatra were over, a series of community meetings were held in each village to discuss plans for accessing safe water. The issues discussed at these meetings included options for mitigation, costs and management systems. Each village finally prepared detailed mitigation plans using this information.

## 3.3 Results and Discussion

### Health survey

Total 190 households (HH) were surveyed in the 5 selected villages. A total of 818 people

(420 males and 398 females) including 345 children below 18 years of age were covered in the survey.

The findings from the health survey were as follows:

- Children affected by dental fluorosis were 83% (287 out of 345) in the 5 villages. Among them, 53% of children were affected in Ganke, 38% in Satyari Tola (hamlet), 86% in Andharbagh, 78% in Lalmathiya Tola, 88% in Mukhiya Tola, 95 % in Bakhari and 83 % in Chukru. The prevalence of dental fluorosis was above 90% in 1 village and above 80% in 4 villages/hamlets. Only one village/hamlet had prevalence below 50%.
- Skeletal fluorosis (all 3 types; mild, moderate and severe) was found in 47 % of people. Among them 2% (11 cases) of people were suffering from severe skeletal fluorosis and 8 % (62 cases) had were from moderate skeletal fluorosis.
- People affected by skeletal fluorosis were 32% in Ganke, 49 % in Satyari Tola, 41% in



*Skeletal fluorosis among children in Palamau*

Andharbagh Tola, 50% in Lalmathiya Tola, 46% in Mukhiya Tola, 54% in Bakhari and 48% in Chukru. The prevalence of skeletal fluorosis was found to be above 50% in 2 places and above 40% in 4 places. Only one village/hamlet had prevalence below 40%.

- The findings of the survey indicated that in all the 5 villages studied severe fluorosis was rampant and the general health condition of the people was very serious. Details of the health survey are summarised in the following tables.

**Table 5: Details of Health Survey**

S. No	Village	Total No. of HH	Population	No. of HH Surveyed	Population covered		
					Male	Female	Total
1	Ganke	72	400*	17	48	37	85
2	Satyari						
(i)	Satyari Tola	47	282 <sup>#</sup>	13	22	27	49
(ii)	Andharbagh Tola	29	174 <sup>#</sup>	13	20	34	54
3	Mukhiya						
(i)	Lalmathiya Tola	24	144 <sup>#</sup>	9	19	15	34
(ii)	Mukhiya Tola	94	564 <sup>#</sup>	20	44	37	81
4	Bakhari	125	897*	56	123	115	238
5	Chukru	137	600*	62	144	133	277
	<b>Total</b>	<b>528</b>	<b>3061</b>	<b>190</b>	<b>420</b>	<b>398</b>	<b>818</b>

\*Source: Census of India 2001 ([www.censusindia.net](http://www.censusindia.net))

<sup>#</sup> Estimated from house hold size of panchayat, census 2001

**Table 6: Village Wise Status of Dental Fluorosis**

S. No	Village	No. of children surveyed	No of children affected with dental fluorosis				
			+	++	+++	Total	%
1	Ganke	45	21	3	-	24	53
2	Satyari						
a)	Satyari Tola	13	5	-	-	5	38
b)	Andharbagh Tola	28	6	18	-	24	86
3	Mukhiya						
a)	Lalmathiya Tola	18	6	7	1	14	78
b)	Mukhiya Tola	34	15	13	2	30	88
4	Bakhari	88	77	6	1	84	95
5	Chukru	119	105	1	-	106	81
	<b>Total</b>	<b>345</b>	<b>235</b>	<b>48</b>	<b>4</b>	<b>287</b>	<b>83</b>

+: Affected with mild case

++: Affected with moderate case

+++ : Affected with severe case

**Table 7: Village-wise Status of Skeletal Fluorosis**

S.No.	Village	No. of people surveyed	No. of cases of different degree of skeletal fluorosis			Total Affected	
			Mild	Moderate	Severe	No.	%
1	Ganke	85	22	4	1	27	32
2	Satyari						
i	Satyari Tola	49	22	2	-	24	49
ii	Andharbagh	54	13	5	4	22	41
3	Mukhiya Tola						
i	Lalamatiya Tola	34	15	2	-	17	50
ii	Mukhiya Tola	81	21	15	1	37	46
4	Bakhari	238	106	20	3	129	54
5	Chukkru	277	116	14	2	132	48
	<b>Total</b>	<b>818</b>	<b>315</b>	<b>62</b>	<b>11</b>	<b>388</b>	<b>47</b>

### 3.4 Fluoride Concentration in Drinking Water Sources

Fluoride concentrations varied between 0.2–15.5 mg/l in all of the 234 water sources monitored. The concentrations were observed to vary with the sources and the location in each village. Fluoride concentrations were much higher in ground water sources rather than the surface water sources. High fluoride concentration in the ground water is most likely due to fluoride-bearing underground rocks. Analysis of fluoride concentration in drinking water sources is summarised in the following points:

- Fluoride concentration was higher than the permissible limit (1 mg/L for safe drinking water) in 64% of drinking water sources of in Ganke, 90% in Satyari Tola, 88% in Mukhiya Tola, 97% in Bakhari and 92% in Chukru.
- There were only one or no safe sources (< 1mg/L of fluoride) in Bakhari, Chukru, Andharbagh Tola of Satyari village and Lalmathiya Tola of Mukhiya village.
- Fluoride concentration was found higher than 5 mg/L (considered dangerous and

may cause crippling skeletal fluorosis) in 11 water sources of Bakhari, 5 water sources in Chukru and Andharbagh each.

- Maximum fluoride concentration, 12 mg/L was recorded in handpump water in Bakhari village, 9.7 mg/L in well water of Chukru, 7.3 mg/L in Andharbagh Tola, 4.11 mg/L in Mukhiya Tola, 3.6 mg/L in Ganke and Lalmathiya Tola, 3.5 mg/L in Satyari Tola.



*Defunct defluoridation unit attached to handpump in palamau, Jharkand*

**Table 8: Fluoride Concentrations in Different Sources of Drinking Water**

S.No.	Range of fluoride (mg/L)	Number of drinking water sources						Total	
		HP	PW	DW	Bandha	River	Nala	Number	%
1	Ganke								
	<1.0	2	9	1	-	-	-	12	34
	1.1-2.5	6	8	1	1	-	-	16	46
	2.6-5.0	1	6	-	-	-	-	7	20
	>5.0	-	-	-	-	-	-	-	-
2	Satyari								
a)	Satyari Tola								
	<1.0	-	2	-	-	-	-	2	10
	1.1-2.5	5	10	-	-	-	-	15	71
	2.6-5.0	1	3	-	-	-	-	4	19
	<5.0	-	-	-	-	-	-	-	-
b)	Andharbagh Tola								
	<1.0	-	-	-	-	-	-	-	-
	1.1-2.5	-	1	-	-	-	-	1	6
	2.6-5.0	1	9	-	-	-	-	10	63
	>5.0	-	5	-	-	-	-	5	31
3	Mukhiya Tola								
a)	Mukhiya Tola								
	<1.0	1	3	-	-	-	-	4	13
	1.1-2.5	1	7	1	-	-	-	9	30
	2.6-5.0	4	13	-	-	-	-	17	57
	>5.0	-	-	-	-	-	-	-	-
b)	Lalmathiya Tola								
	<1.0	-	1	-	-	-	-	1	13
	1.1-2.5	-	1	-	-	-	-	1	13
	2.6-5.0	1	5	-	-	-	-	6	74
	>5.0	-	-	-	-	-	-	-	-
4	Bakhari								
	<1.0	1	-	-	-	1	-	2	3
	1.1-2.5	1	17	1	-	-	-	19	34
	2.6-5.0	8	13	2	-	-	1	24	43
	>5.0	3	8	-	-	-	-	11	20
5	Chukru								
	<1.0	-	1	-	-	-	-	1	2
	1.1-2.5	1	34	-	-	-	-	35	51
	2.6-5.0	8	19	-	-	-	-	27	40
	>5.0	2	3	-	-	-	-	5	7

*HP – Handpump, PW – Pukka well, DW – Dug well*

- Fluoride concentration was observed to be in a similar range in open wells and deep handpump water, but it was found to vary from location to location (pocket to pocket).

### 3.5 Relationship between Severity of Fluorosis and Fluoride Concentrations

Data showing the relationship between the severity of fluorosis and fluoride concentrations was extracted from the fluorosis mapping exercises and the water quality monitoring exercises. It is summarised in Table 8. The average fluoride concentrations in drinking water corresponding to different degrees of severity of fluorosis were also calculated and shown in Table 9 and Fig. 9.

The ill-effects of fluorides in drinking water depend upon several factors, e.g., The nutrition of the person at risk, the exposure period, etc. Hence the same level of exposure to fluorides can have different effects on different people. Varying concentrations of fluoride in drinking water caused different degrees of fluorosis in the studied villages of Palamu district. Table 9 shows that cases of mild skeletal fluorosis occur at fluoride concentrations beginning at 2 mg/L. About 80% of the moderate skeletal fluorosis cases were associated with sources containing >3 mg/L. The average fluoride concentration for severe skeletal fluorosis was about 5 mg/L. Crippling skeletal fluorosis (inability to walk without support) on the other hand most likely had set in due to exposure to fluoride concentrations of more than 4 mg/L.

**Table 9: Relationship between Severity of Skeletal Fluorosis and Fluoride Concentration in Drinking Water**

Fluoride concentration in drinking water (mg/L)	Different degree of skeletal fluorosis					
	Mild		Moderate		Severe	
	No.	%	No.	%	No.	%
< 1.0	3	1	-	-	-	-
1.0 - 2.0	13	4	1	2	-	-
2.0 - 3.0	99	31	3	5	-	-
3.0 - 4.0	138	44	32	52	2	18
4.0 - 5.0	29	9	4	6	1	9
5.0 - 6.0	16	5	11	18	2	18
6.0 - 7.0	16	5	9	15	-	-
7.0 - 8.0	1	0.5	-	-	2	18
8.0 - 9.0	-	-	-	-	-	-
9.0 - 10.0	-	-	2	3	1	9
10.0 - 11.0	1	0.5	-	-	1	9
11.0 - 12.0	-	-	-	-	-	-
12.0 - 13.0	-	-	-	-	2	18
<b>Total</b>	<b>315</b>		<b>62</b>		<b>11</b>	

(-) No cases

## 3.6 Dietary and Soil Survey

### 3.6.1 Vegetables & grains

In order to assess the fluoride contribution through food, a detailed dietary survey was undertaken and major food items were identified in the daily diet of the local people. It was found that food produces like rice, wheat, maize (grains), bodi, kurthi, (pulses), brinjal, potato, broad bean (vegetables) were consumed frequently. It was also found that the general dietary condition and the nutritional status of the surveyed population were poor.

Sampling for all these food produces were done in 3 villages namely. viz, Chukru, Bakhari and Ganke. Samples (500 gm) of foodgrains i.e., rice, wheat, maize, bodi, and kurthi were collected from village households. Samples (1kg) of vegetables—brinjal, potato, and broad bean were collected from agricultural fields. They were transported to The PSI laboratory in Dehra Doon and analysed for fluoride concentration.

### 3.6.2 Soil sample

Samples were collected below 9 cm depth. They were collected from different parts of field and mixed to form uniform sample. Samples were transported to PSI laboratory in Dehra Doon and analysed for fluoride concentration.

### 3.6.3 Fluoride content in vegetables and food grains

The Fluoride content in vegetables and food grains are shown in table no. 10. It ranged between 0.14 – 0.38 mg/kg wet weight in vegetables of Chukru village, 0.10 – 0.34 mg/kg wet weight in vegetables of Bakhari and 0.07 – 0.25 mg/kg wet weight in vegetables

of Ganke. It was slightly higher in potato than the content in brinjal in each village, and significantly higher than the content in broad bean (sem). The Fluoride content in brinjal was found to be significantly higher than the content in broad bean.

Food grains contained fluoride levels between 1.40 – 2.35 mg/kg dry weight in Chukru village, 1.38 – 2.10 mg/kg dry weight in Bakhari and 1.30 – 1.69 mg/kg dry weight in Ganke. bodi (pulses) had as high as 2.35 mg/kg dry weight of fluoride, followed by kurthi (2.21 mg/kg dry weight), rice (2.19 mg/kg dry weight), wheat (1.75 mg/kg dry weight) and maize (1.40 mg/kg dry weight).

The Fluoride content in vegetables and food grains varied according to the fluoride content in soil and in groundwater sources. It was higher in vegetables and food grains from Chukru village where fluoride content in the soil was 15.40 mg/kg and groundwater sources contained as high as 9 mg/L of fluoride. Vegetable and food grain samples from Bakhari (the soil having 13.20 mg/kg fluoride and water sources containing 7 mg/l of fluoride) were found to contain comparatively lower fluoride labels. While vegetables and food grain samples from Ganke had significantly low fluoride content as compared to the fluoride content in vegetables and food grain samples collected from all the other villages. Samples collected from this village also had significantly low fluoride levels (2 mg/L) in groundwater sources and 3.9 mg/kg of fluoride in soil samples.

The variation of fluoride could be attributed to the fact that the plants absorb fluoride from soil and groundwater significantly. The higher fluoride content in vegetables and food grains had a strong association with high fluoride levels in soil and water. A significant variation

**Table 10: Fluoride Content in Vegetables, Food Grain and Soil samples**

S.No	Vegetables, Food Grains & Soil	Fluoride Content		
		Chukru	Bakhari	Ganke
1	Vegetables			
i	Sem (Broad bean)	0.14	0.10	0.07
ii	Brinjal	0.16.	0.16	0.10
iii	Potato	0.38	0.34	0.25
2	Food Grains			
i	Rice	2.19	2.10	1.69
ii	Maize	1.40	1.38	1.30
iii	Wheat	1.75	*	*
iv	Kurthi	2.21	1.67	1.43
v	Bodi	2.35	1.95	1.50
3	Soil	15.40	13.20	3.90

*Fluoride content in vegetables is expressed in mg/kg wet weight, in food grains and soil in mg/kg dry weight, \* sample not analysed*

in fluoride content of vegetables and food grains from the same village could be due to differential absorption rates of fluoride by the vegetables from the soil.

### 3.7 Fluoride Contribution in Human beings through Diet

Fluoride *contribution* in human beings through diet is worked out in Table 11. The contribution was observed as 1.23 mg/day for Chukru, 1.15 mg/day for Bakhari and 0.97mg/ day for Ganke. At present there is no prescribed value of acceptable fluoride content in vegetables and food grains in India. So the values observed in the study could not be compared with any standard. But it can be safely concluded that fluoride intake in human beings through diet is quite less than the intake through drinking water in the studied villages and that fluoride contribution through diet is not considerable. It was the excessive fluoride intake through

drinking water that caused severe fluorosis in the area.

### 3.8 Village Level Participatory Planning

Pursnant to water quality monitoring and health surveys, village level meetings were organised. The major components of the planning were as follows:

- Water resources mapping, mapping households on each source, through Participatory Research Appraisal (PRA) exercise.
- Plotting fluoride concentration in drinking water sources with colour legend indicating fluoride concentration (i.e. green for <1 mg/L safe, yellow for 1.0 – 2.5 mg/L harmful, red for 2.5 – 5.0 mg/L dangerous and black for >5.0 mg/l very dangerous) on map. The same colours were used to mark and identify the water sources in the field.

**Table 11: Fluoride Content Intake in Human Beings through Diet**

S.No.	Major Dietary Item	Average Intake Quantity of Item (gm/day)	Average Fluoride Content (mg/kg)	Intake Quantity of Fluoride (mg/day)
1	Chukru			
i	Cereals	500	1.78	0.89
ii	Pulses	100	2.28	0.23
iii	Vegetables	500	0.23	0.11
			<b>Total</b>	<b>1.23</b>
2	Bakhari			
i	Cereals	500	1.74	0.87
ii	Pulses	100	1.81	0.18
iii	Vegetables	500	0.20	0.10
			<b>Total</b>	<b>1.15</b>
3	Ganke			
i	Cereals	500	1.50	0.75
ii	Pulses	100	1.46	0.15
iii	Vegetables	500	0.14	0.07
			<b>Total</b>	<b>0.97</b>

- Discussion with villagers about fluoride concentration in drinking water sources, extent and severity of fluorosis, role of defluoridation and diet practices in the control and mitigation of fluorosis.
- Discussion on possible options for provision of safe drinking water and their sustainable management.
- Discussion on domestic defluoridation filter, its management and maintenance.
- Training on performance testing of domestic defluoridation kit and recharging of Activated Alumina (AA) were also discussed.

### 3.9 Strategies for Fluorosis Mitigation & Control

The data on fluoride concentrations in the water from the different sources and the extent of fluorosis prevalence was shared with

the communities at well-attended meetings in each village. These meetings were also used to raise awareness about various aspects of the subject (refer to the previous page).

Separate meetings were held with the community in each village to determine ways of accessing water supply with safe levels of fluorides. Among the options considered were:

- Extending access to existing drinking water sources containing less than 1.5 mg/l fluoride concentration
- Renovation or construction of sanitary wells at existing wells with less than 1.5 mg/l fluoride concentration
- Installation of tube wells at locations of safe water
- Roof rainwater harvesting
- Defluoridation of water using Nalgonda technique, activated alumina or reverse osmosis

**Table 12: Selected Option-wise Estimate of Cost for Fluorosis Mitigation in 5 Villages**

S.No	Mitigation Measures	No.	Estimated Cost (Rs.)
1	Renovation and upgradation of existing low fluoride open wells	8	2,80,000
2	Roof top rainwater harvesting systems	2	2,56,000
3	Domestic defluoridation kits*	195	3,90,000
4	Handpump-attachable community AA kit	1	1,00,000
5	Rejuvenating existing domestic defluoridation kits	67	46,900
6	Sumpwell in river bed	1	1,50,000
	<b>Total Amount to be required</b>		<b>12,22,900</b>

\* Domestic defluoridation kits, Total no. 255, on stock 60, requirement 195.

### 3.10 Performance Testing of Distributed Domestic AA Kits

As a demonstration, 60 activated alumina-based domestic defluoridation kits were distributed among fluorosis affected people of the studied villages. Out of which, 20 defluoridation domestic kits were distributed in Bakhari and 3 domestic defluoridation kits were distributed in Chukru. Fluoride removal efficiency of the AA kits was field tested before it was distributed to the villagers. It was observed that the fluoride removal efficiency of the kits varied between 60 to 90%.

### 3.11 Inferences

The following inferences were drawn from the study:

- i) The Fluorosis situation in all the 5 studied villages is very serious; a large segment of about 3000 people were suffering from different degrees of fluorosis, both dental and skeletal.
- ii) Most of the currently used drinking water sources in these 5 villages had fluoride concentration above the permissible limit of 1.0 mg/L. Some of the sources had fluoride concentration as high as 12 mg/L. In Bakhari, Chukru, Andharbagh and

Lalmathiya Tola, none of the currently used drinking water sources had fluoride within permissible limit 1.0 mg/L.

- iii) With proper scientific input and educative campaigns, the affected communities could be made aware of the problem and motivated to participate in its mitigation.
- iv) The government had taken a lot of initiative for mitigating the problem of fluorosis in Palamu district. One such initiative was the use of handpump-attachable fluoride treatment plants, provided by PHED. Water samples were tested from these handpumps as well, but it was found that the fluoride concentration was as high as 12 mg/L even in the treated water. All the 10 units showed fluoride concentrations or more than 1 mg/L in the treated water, and negligible removal efficiency was found in every plant. This is a major health concern and warrants an immediate investigation by higher govt. authorities.
- v) No single technique or measure would ensure the supply of water of permissible fluoride concentration to all households of a village. On the basis of intensive discussion with involved communities, specific mitigation plans for each of the 5 villages have been developed. These

plans use a specific mix of technologies appropriate for a village.

The suggested technologies include:

- a. Renovation and upgradation of existing low fluoride open wells
  - b. Roof top rainwater harvesting systems
  - c. Domestic defluoridation kits
  - d. Rejuvenating existing domestic defluoridation kits
  - e. Sump well in river bed
- vii) Open wells, identified as an option for provision of low fluoride water was based on single monitoring. Before upgradation of these wells, there is a need to monitor their fluoride concentration for six months regularly. During this period communities can use these wells after cleaning and subsequent pot chlorination.
- viii) As diet practices in the villages are very poor from the nutritional point of view, initiatives for supplementing or ensuring a nutritional diet is required, and WAI has already started nutritional interventions in these villages.

## 3.12 WAI's Intervention

### 3.12.1 Recharge centre

WAI, helped by its technical partner, has established a recharge centre for domestic activated alumina kits at Chukru. To ensure an effective use of the domestic activated alumina kits by the villagers, a demonstration cum training session on kit recharging was also organised. With the consent of villagers the cost of recharging an AA kit was fixed at Rs.20 per kit.

Following the village meetings, a person was named as the operator for the centre. A group of villagers, who have been trained on the use and recharging of the kits, was given the responsibility of assisting the centre

operators. A group of 4 influential people was formed as the facilitator group for the centre; for supervising, ensuring its smooth running and assisting the centre operator. WAI's staff and its field partner, SHRMS, have been frequently visiting the centre and regularly monitoring its activities for the last one year. WAI's technical partner (PSI) will also monitor the activities and performance of the centre on a quarterly basis for improving and strengthening centre's activities.

### 3.12.2 Performance Testing of Fluoride Treatment Plants Installed by PHED

PHED had installed handpump-attachable defluoridation kits in several villages of the district and had invested a large amount of money on the installment of the plants. It was therefore essential to identify the performances of these treatment plants. An analysis by WAI's technical partner (PSI) revealed that all the kits were either dysfunctional or damaged/not in use.

Since, these kits may serve the purpose of defluoridation, WAI along with its technical and field partners identified two options for improving/rectifying the dysfunctional fluoride treatment units. One option was to identify and replace the cause of dysfunctionality of the plants, whereas the second option was to change the technology. For the first option, proper information about the technology of the treatment plants was very necessary. Hence for rectifying the dysfunctional fluoride treatment plants, the cooperation and support of PHED and the treatment plant installation agency became necessary. In tune with the above, WAI has started a dialogue with the PHED and the district administration for improving the efficiency of existing defluoridation plants.

### 3.13 Advocacy

As part of advocacy, WAI has been regularly holding discussions with the district administration and other donor agencies to mobilise resources for implementing the

fluorosis mitigation plans. It is also exploring various national and international forums to provide safe drinking water to the fluorosis affected community in 5 villages of Palamu district.



# Chapter-4

## *Sanitary Surveillance to Assess the Risk of Groundwater Contamination*

### 4.1 Introduction

One of the key findings from the WQ monitoring results produced by all the partners of WAI partners was the widespread presence of Faecal Coliform. The presence of Faecal Coliform actually indicates that the level (amount) of human and animal waste contamination in the water is very high. Human and animal waste contain harmful pathogens, which directly affect public health.

A sanitary surveillance is an assessment of conditions and practices that may constitute a public health risk. The assessment covers investigation possible sources of faecal contamination to groundwater at the source, in transport, at the point of delivery and at in the household level. It also deals with the defecation practices of the surveyed community. So a sanitary surveillance was essential to understand the extent of a possible public health risk in WAI's project areas.

First, there was a desk study involving background literature review, which was followed by an extensive field survey. Survey results were then analysed to understand the root cause of the problems. Following the analysis, a set of guidelines/ principles involving “dos and don'ts” of sanitation practices was developed. An excerpt from the literature review is presented in the following section.

### 4.2 Sanitation in India – Some Issues and Concerns

Improvement of sanitation and hygiene promotion becomes one of the biggest

development challenges in India. More than 80 per cent of India's rural population has no access to safe and hygienic sanitation facilities. An estimated 650 million Indians defecate in the open and 200,000 tonnes of faecal matter are deposited in the open.<sup>19</sup> The health costs are huge and worth considering at this very moment.

During 1998, The Government of India embarked on a Rural Water Supply and Sanitation (RWSS) Sector Reforms programme. The reform programme of the Government of India was a paradigm shift from a supply-driven to a demand-driven approach that focused on decentralised delivery through local elected bodies for the improvement of sanitation.

The 73rd Amendment to the Indian Constitution has put enormous power in the hands of *Panchayati Raj* Institutions (PRIs) and its lowest tier; the Gram *Panchayat* (GP) has been mandated for the service delivery of RWSS. In many villages, Village Water Supply and Sanitation Committees (VWSCs) co-exist with GPs, sometimes as sub-committees and at times independently. VWSCs are user groups of a particular RWSS service and they are meant to maximize user involvement in all phases of water and sanitation projects. The primary aim of the Sector Reform was to generate more demand-responsive and participatory approaches by empowering local governments and community groups to fully manage their own services without any outside support. It was believed that sustainability of the systems can be improved

<sup>19</sup> Progress for Children: A report card on water and sanitation in India, UNICEF 2007

if technical, financial and institutional decisions are made at the appropriate grass-root level.

Accordingly, The Central Rural Sanitation Programme (CRSP) was restructured in 1999 and the Total Sanitation Campaign (TSC) was introduced. TSC aimed at providing adequate sanitation facilities to the rural poor, generating awareness about health and hygiene, eradicating manual scavenging by converting all existing dry latrines into low cost sanitary latrines. The TSC was being initiated under the Sector Reform process to promote greater user involvement, lower subsidies, to facilitate NGOs role, and promotion of technologies.

However, it is just not about constructing latrines. One needs to be very careful while selecting a site for constructing latrines. The contamination of boreholes and shallow wells from on-site latrines is an issue that is generally poorly understood and irrationally assessed by organisations implementing water supply and sanitation programmes. This is a major concern as the health risks are often lower than popularly anticipated.

WAI has been involved in constructing latrines for community usage for quite some time now. To find out the risk to the groundwater sources (especially handpumps and borewells) due to the latrines already constructed and to minimize the risk of on-site contamination of handpumps and borewells while constructing the new latrines, WAI conducted a sanitary risk assessment study of some of its villages under its different project regions. It sought the services of PSI as a technical support agency while conducting this study.

The present report is an outcome of the above study. The method of risk assessment outlined

in this section is within the technical capacity of a villager and should be regarded as being the first step in gaining a better understanding of the problem. This report provides background information on the factors that led to microbiological contamination, the basic principles of risk assessment, and points those requiring more guidance, in the right direction.

### 4.3 Situation Analysis

The overall sanitary situations of each of the villages or urban slums that have been assessed for sanitary risk have been summarised in the tables given below. The tables give the total number of sources that have been analysed and the number of sources that have tested positive for faecal contamination. The criteria on the basis of which the sanitary condition has been determined are as follows:

- a. All the sources are at high risk or tested positive for FC: Very poor
- b. More than 80% sources are at high risk or tested positive for FC: Poor
- c. Between 60%-80% sources are at high risk or tested positive for FC: Average/poor
- d. Less than 60% sources are at high risk or tested positive for FC: Average
- e. Between 40%-60% sources are at high risk or tested positive for FC: Average/ Good
- f. Less than 40% sources are at high risk or tested positive for FC: Good

During the study, water samples were collected from the project villages of field partners of WAI and tested for faecal contamination. In case of eastern, central and northern India, The partners of WAI project villages were located far from each other, hence a few villages were chosen and all the sources of these villages were analysed.

**Table 13: Sanitary Situation in the Villages/Slums of Southern India**

Project Area	No. of Villages/ Slums Visited	Number of Source (s) Analysed	No. of High Risk Sources	No. of FC Samples Tested (+ve)	Overall Sanitary Situation
Warangal, A.P.	3	10	7	6	Poor
Mehboobnagar, A.P.	20	30	26	24	Poor
Mysore, Karnataka	15	25	20	19	Average/ Poor
Trichy (Urban & Rural), Tamil Nadu	4 urban slums and 4 villages	(A) 10 sources in the urban slums (B) 11 sources in the villages	(A) 9 out of the 10 sources (B) 6 out of the 11 sources	(A) 8 (B) 6	(A) Poor (B) Average
Nagapattinam, Tamil Nadu	5	10	10	10	Very poor

**Table 14: Sanitary Situation in the Villages/Slums of Central and Northern India**

Project Area	No. of Slums/ Villages Visited	Number of Source (s) Analysed	No. of High Risk Sources	No. of FC Samples Tested (+ve)	Overall Sanitary Situation
Bhopal, M.P.	2	4	3	3	Poor
Jhabua, M.P.	1	7	6	6	Poor
Durg, M.P.	2	8	3	2	Average - Poor
Datia, M.P.	1	8	7	7	Poor
Shivpuri, M.P.	2	4	1	1	Average - Poor
Attarra, M.P.	1	6	5	5	Average - Poor
Muzaffarpur, Bihar	1	22	16	16	Poor
Jehanabad, Bihar	1	22	17	17	Poor
Deoghar, Jharkhand	2	12	10	10	Poor
Ranchi, Jharkhand.	1 slum	13	13	13	Poor
Bhubneswar, Orissa	1 slum	13	10	10	Poor
Puri, Orissa	2	16	15	15	Very Poor
Gajpati, Orissa	2	12	10	10	Poor
Nuapada, Orissa	2	12	10	10	Poor

However, in case of southern India partners, since the villages were situated close to each other, it did not make logistic sense to visit all the villages. So instead of covering all the sources in a single village, representative samples were collected from a greater number of villages.

Along with the sampling, a questionnaire survey was also conducted in the villages. The questionnaire had eight basic questions regarding the sanitary condition of the water source which was tested for faecal contamination. Each question was given differential weightage, which was used to assess the sanitary risk of the water source. Generally, a positive answer to 5 out of the 8 questions indicated a high risk. If positive and negative answers were in equal numbers, the risk was medium and if the positive answers were less than 4, the risk was taken to be low (See Annexure-II for the sanitary risk assessment format).

A brief analysis of the sources analysed with a description of the water quality and the reasons for contamination is given in the next few pages.

#### 4.3.1 Sanitary situation in Eastern India

A high percentage (75%) of the total number of sources surveyed in eastern India was found to be at high risk. This region is mostly characterised by alluvial and calcareous alluvial soils. So the risk of groundwater contamination from on-site sanitation becomes minimal due to natural reasons. But in some locations, especially in coastal villages of Orissa, sandy soils are found. Understandably the risk of groundwater contamination in this area becomes high and any ill-maintained sanitation facilities adds to the existing



*Water spreading and no drainage around the source (Handpump of Gunnaur malli, village Soti Bheriyahi)*

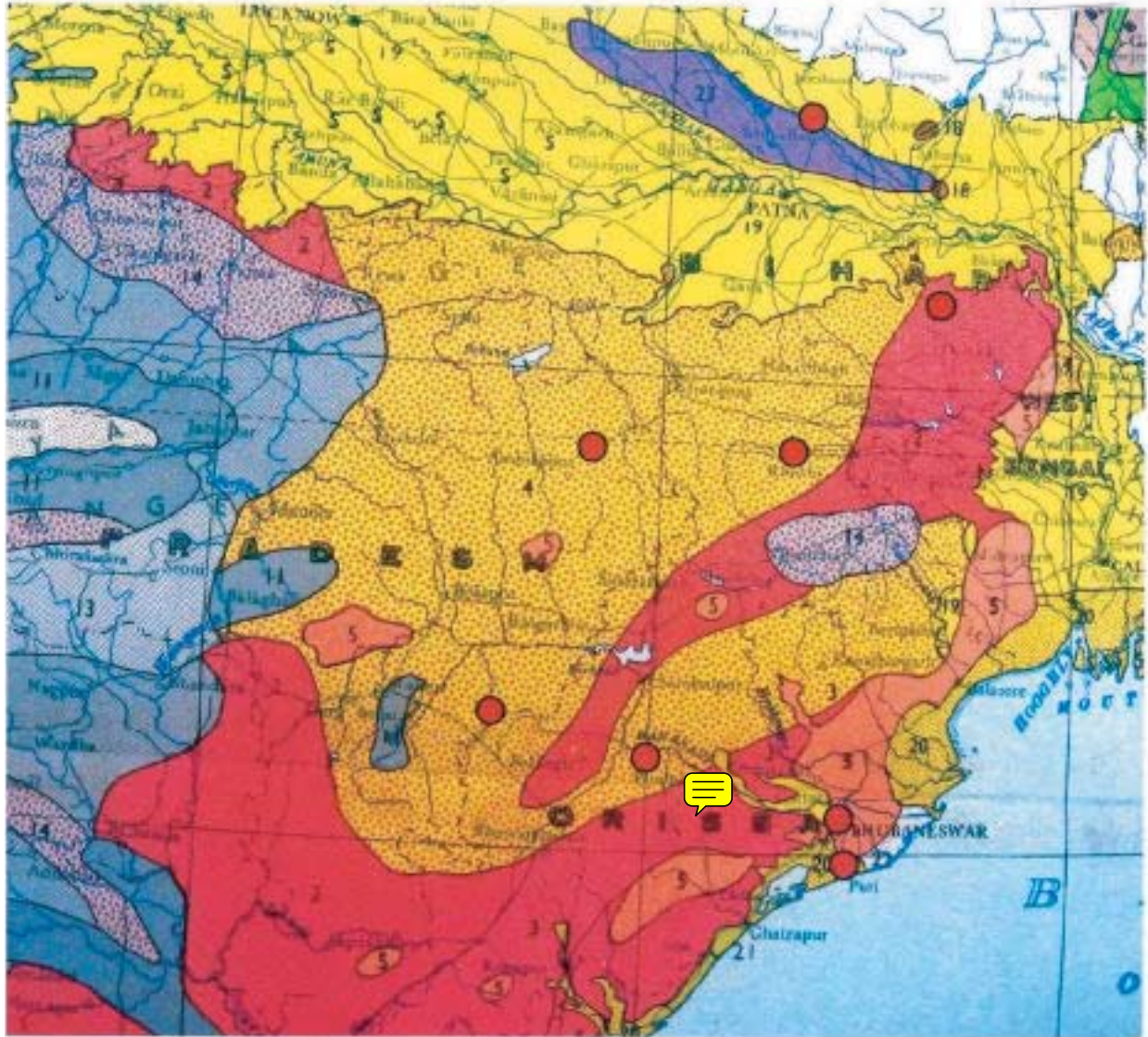
problem. The contribution of various soil classes in this region to the sanitary risk is presented in Fig. 1 (dotted points within the fig. indicate different sampling locations within the region).

Open defaecation, animal excreta, wastewater ponding near the water sources posed a high risk of contamination in this area. Cracked handpump platforms were commonly found in this region. Proximity of latrine pits to the water sources (10-15 metres on an average and in some cases as close as 3 metres from the water sources) also constituted a high risk of contamination.



*Water and garbage spreading and cracked drainage of the source (Handpump near Mahila Samiti, slum Vijonagar Joaklandi)*

## Soil Classification & Sanitary Risk Category-Eastern India (ROE)



### Sanitary Risk Category

More than 60%, Less than 70%

More than 70%, Less than 80% ●

More than 80%, Less than 90%

More than 90%, Less than 100%

### Soil Classification

- Alluvial Soils (Recent)
- Calcareous Alluvial Soils
- Red Sandy Soils
- Red & Yellow Soils
- Sub-Motane Soils (Podsollic)
- Medium Black Soils
- Deep Black Soils



*Handpump with no apron, presence of animal waste around the source*



*No apron area and animal interference to the source (Handpump of Ravendra Prasad, village Paharpur)*

### Village Paharpur, Bihar – Eastern India

This village is located in Patna district. The main sources of drinking water are hand pumps and open wells. A total of 20 sources were examined for sanitary risk and faecal contamination in this village. Among them 14 sources were at high risk and tested positive for faecal contamination.

The village is fairly congested and a large number of houses have soak pit latrines. The presence of animal waste and garbage dumps constituted a major risk to nearby water sources. Ponding of water near the sources was also a common occurrence, which was getting mixed with the garbage and animal waste and leaching into the groundwater.

In one location, liquid waste was dumped into an unused open well, which also posed a major risk of contamination to all nearby ground water sources, especially during the monsoon.

All household latrines were located very close to the water sources. In case of one of the sources, the latrine soak pit was just about 2 ft away from the handpump.

The open wells were also at a high sanitary risk and tested positive for faecal contamination.

### 4.3.2 Sanitary Situation in Central and Northern India

The sanitation situation in the villages of Central and Northern India shows that a moderately high percentage (65%) of the total number of sources surveyed are at a high risk. This region is mostly characterised by alluvial and calcareous alluvial soils. So the risk of groundwater contamination from on-site sanitation becomes minimal due to natural reasons. But any ill-maintained sanitation facilities or man-made localised pathways may constitute a risk to groundwater sources. The contribution of various soil classes in this region to the sanitary risk is presented in Fig.



*Prevention of animal interference but spreading of water around the source (Handpump near Sharda Prasad Yadav's house, village Tulsi Purwa, U.P.)*

## Soil Classification & Sanitary Risk Category-Central & Northern India (ROW)



### Sanitary Risk Category

- More than 60%, Less than 70% ●
- More than 70%, Less than 80%
- More than 80%, Less than 90%
- More than 90%, Less than 100%

### Soil Classification

- Alluvial Soils (Recent)
- Calcareous Alluvial Soils
- Red Sandy Soils
- Red & Yellow Soils
- Medium Black Soils
- Deep Black Soils

## Village Tulsi Purwa, Uttar Pradesh- Central & Northern India

The village is located in Banda District of Uttar Pradesh. It has 8 water sources – 5 handpumps and 3 wells, two open and one covered. Water from the handpumps is generally used for drinking. A few poor families also used water from the wells for drinking.

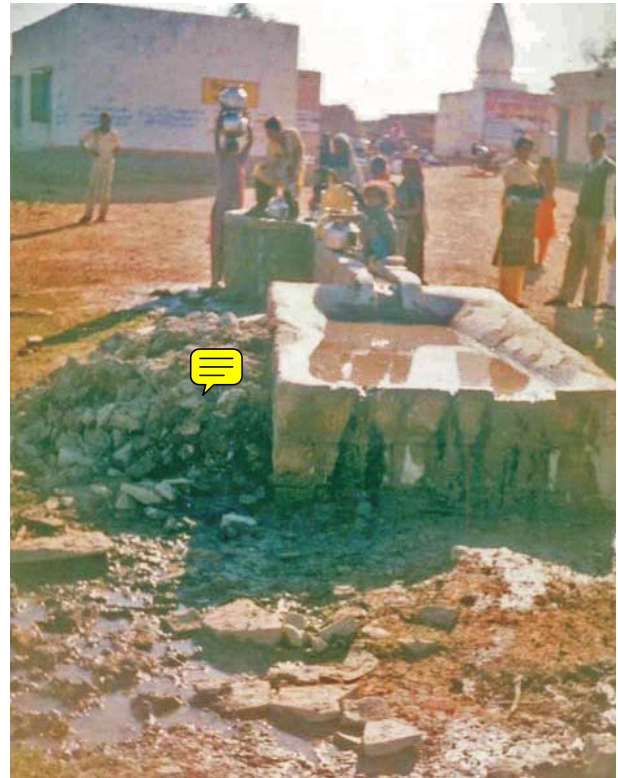
Sanitary surveillance revealed 5 high risk sources. Analysis of faecal coliform also corroborated the surveillance findings.

Most of the handpumps have agricultural fields close by. The faulty drainage system is a major problem of this village. Water accumulation and spreading was clearly visible near the handpumps. Open defecation sites were also located nearby.

Open wells were also at a high risk of contamination since they were located close to latrine soakpits. No chlorination was carried out in any of the wells.



*Animal interference and spreading of water around the source (Handpump near Chunua Riadas house, village Tulsi Purwa)*



*Spreading of water around the source (Handpump near school, village Patara, Sambhav Samaj Sevi Sansthan)*

2 (dotted points within the figure indicate different sampling locations within the region).

Indiscriminate dumping of solid waste and overflowing open sewer lines constitutes a risk to groundwater sources in most of the urban slums surveyed in this region. Another major risk of contamination observed in the different points of water cycle – during transportation, storage and/or unhygienic consumption.

Although contamination in the water cycle was

a common problem both in the urban slums and villages, it was worse in case of urban slums. Poor personal hygiene practices and open defecation in the area worsened the problem further.

Animal dung is one of the major issues of this region. Improperly disposed animal excreta near the water sources are a major concern especially in villages of Shivpuri district and animal dung can be found within 10 meters of the drinking water sources.



*Latrine used for storage purposes*

### **Chennareddypally, Andhra Pradesh- Southern India**

Lack of drainage facility and platforms around the handpumps alongwith open defaecation habits posed a major risk of contamination to all groundwater sources in the village. Latrines are hardly in use and are generally used as storehouses for the harvested crops. Latrines, which are in use, are located uphill to the sources.

Lack of personal hygiene practices was also evident from the field interviews. In one instance, animals and human beings were found to drink water from the same source.



*Handpump and the unused ISL proposed under NREGA at Chenredpally, REEDS, A.P.*



*Spreading of water around the source (Handpump at Mananpur, REEDS, A.P.)*



*Spreading of water and no drainage around the source (Handpump at Thimma Reddy Nagar, Mehboobnagar)*

### **4.3.3 Sanitary Situation in Southern India**

The sanitation situation in the villages of Central and Northern India shows a moderately high percentage (65%) of the total number of sources surveyed to be at high risk. This region is mostly characterised by red and yellow sandy soils and sub-montane (podsollic) soils. So the risk of groundwater contamination from on-site sanitation is very great due to the high permeability of the sandy soils. Any ill-maintained sanitation facilities or man-made localised pathways will increase the sanitary risk to groundwater sources. The contribution of various soil classes in this region to the sanitary risk is

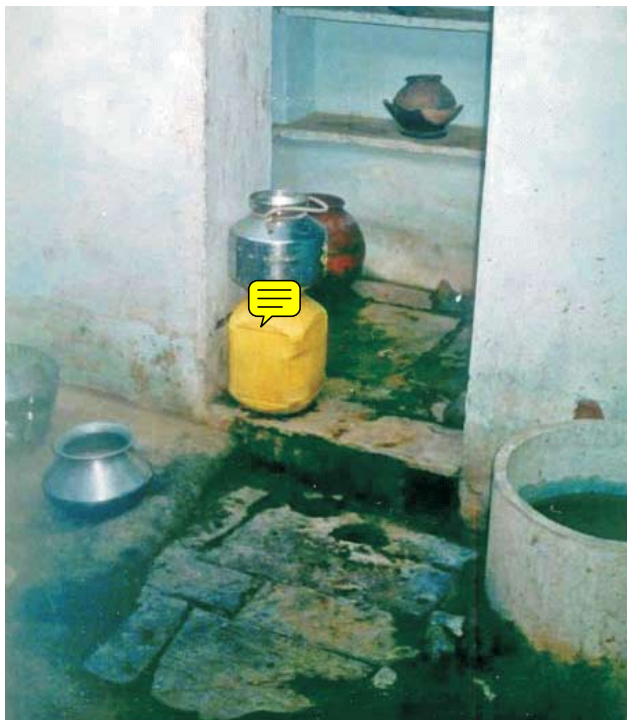


presented in Fig. 3 (dotted points within the figure indicate different sampling locations within the region).

Commonplace sanitation problems – open defecation, faulty drainage near the sources and very short distances between the latrine and the water sources. Socio-economically weaker sections of society mostly inhabit these villages. So there is a definite lack of awareness about hygiene and sanitation issues among them. The risk is mainly from animal waste contamination, faulty drainage, poorly maintained handpump aprons, and proximity to garbage disposal and open defecation sites.

#### 4.4 Contamination in the Water Cycle

Apart from the source, pathogenic contamination of water may occur at various



*Spreading of water and no drainage around the source (Handpump at Thimma Reddy Nagar, Mehboobnagar)*

points of the water cycle during handling, storage or drinking. Using this as a hypothesis, water samples were collected from various points of the water cycle and were tested for faecal coliform. Samples were also tested from the storage vessels used for drinking.

It was seen that in certain cases, although faecal coliform was not found at the source, but it was found in the storage vessels. These results were indicative of poor hygiene practices in the studied villages. In many cases, drinking water was either stored in uncovered storage vessels and kept at the ground level or no ladle was used for taking the water out of storage vessels.

#### 4.5 Guidelines for Identification of New Sources and Construction of Latrines

From the field study and questionnaire survey, some basic principles were identified for siting/constructing new latrines and drinking-water sources (mainly handpumps) in the project areas of WAI's field partners. While constructing and siting new water sources and/or latrines, these principles can be used as guidelines. A summary of these guidelines is presented below:

- Analysis of results revealed that soil texture and structure (broadly soil classes) are very important in terms of estimating the sanitary risk to ground water aquifers. The nature of the soil determines the rate of travel of pathogens to the groundwater according to its porosity and permeability. Generally the unsaturated zone of the soil acts as a major defence to prevent groundwater contamination. But once the pathogens reach the aquifer, the number of days they can stay alive in the aquifer

determine the possibility of contamination. So soil conditions must be considered during the construction and siting of the new water sources and/or latrines.

- The horizontal distance between the latrine and water point should be maintained at about 30 metres, especially in areas consisting of fine sand, gravels, sandy loam and fractured rocks. In highly populated areas where this distance cannot be maintained realistically, a minimum distance of 10 metres between the latrine and water point should be maintained.
- Any groundwater source (especially handpumps) should be moved higher than latrines, so that the flow of water is not from the latrines to the water sources.
- The vertical separation between the bottom of the pit and the water table should be increased by using shallower pits or vault latrines. This becomes especially important for coastal areas or areas with a shallower water table. In such areas a minimum distance of 3 metres has to be maintained between the bottom of the pit and the groundwater table.
- In areas with a shallower groundwater table, as in coastal areas, dry forms of latrines are a better option than pit latrines. If dry latrines are not feasible, the slope of the pan in a pit latrine can be increased upto  $45^\circ$  to ensure minimum water usage which will reduce hydraulic pressure and help avoid leaching of water into the groundwater.
- Construction of soak pits in Central and Northern India should be reduced, as it may consequently lead to groundwater pollution. Hence a survey focusing on carrying capacity of the area has to be undertaken before constructing the soak pits.
- In case of urban slums low-cost septic tanks can be constructed which can then be connected to the underground drainage system (UGD).
- A proper drainage system should be maintained. In case of areas with high water table the drainage from the water sources can be used for kitchen garden irrigation.
- Maintenance of the handpump platforms and aprons of the borewells in proper condition goes a long way in reducing contamination. In many regions across the country it has been observed that the grouting of handpumps are not good, which further increases the possibility of drainage to water to leach into the groundwater.
- Animal interference must be avoided as far as possible. In many cases across the country it was observed that animals and human beings drink water from the same source. There is also a commonplace occurrence of animal dung being found near the water sources.
- Indiscriminate disposal of garbage must be avoided near the water source. At least a distance 10 metres must be maintained between the water source and garbage disposal sites. Otherwise this could lead to contamination of groundwater sources eventually.
- Open defecation is practiced in most of the surveyed villages. Care has to be taken so that the site of open defecation should not fall in the catchment area of any surface water bodies. Leaching from contaminated surface water bodies may lead to the contamination of ground water which is used for drinking purposes, therefore steps should be taken to protect the surface water bodies from contamination.
- Drinking water should always be stored in a clean, pre-washed and closed vessel. Chlorination at the source or at the point-

of-use should be performed to remove any pathogenic contamination of the drinking water.

#### 4.6 WAI's Intervention

Improvement of environmental sanitation is far more important than building sanitary infrastructure. In view of the poor state of sanitary facilities and inadequate hygiene awareness in WAI's project area, WAI felt the need to improve existing physical infrastructure, which has to be supported by building community awareness on good sanitary and hygiene practices.

The experiences of some of these projects clearly show the need for community participation and a sense of ownership by the users. It also illustrates that risk assessment studies should be conducted before building any sanitary infrastructure. Until the need for and benefits of sanitation are realised and internalised, The mere provision of facilities will not provide the expected results. During last year, WAI, through its field partners across India, has spread the message of hygiene to more than 10,000 people.

About 30,000 people in India have benefited from the restoration of handpumps in WAI's project areas last year. It has promoted the use of garbage and composting pits for

collecting animal waste, dust bins to collect household solid waste, kitchen gardens to reuse the wastewater, handwashing facilities at schools to improve personal hygiene and built demonstration eco-san toilets to prevent groundwater contamination in coastal areas. Last year WAI helped 40,000 people in India to reap the benefits of improved sanitation.

As part of assessing sanitary risk to groundwater sources, all WAI field partners' staff have been trained on sanitary surveillance. It is backed up by periodic testing for faecal coliform in the water samples straight from the source or at various points in the water cycle. WAI will now adopt the above set of guidelines for constructing/siting water sources/latrines with slight modifications to suit the local conditions.

#### 4.7 Impact of Cattle Waste on Groundwater Quality and Possible Mitigation Options – A Pilot Scale Study

India generates over 1000 million tones of cattle waste annually. Most of it is unmanaged or improperly managed. This study was initiated to find out the linkage between improper management of cattle waste and its impact on drinking water quality. While

**Table 16: Pathogens present in animal feces**

S.No.	Organism	Major Disease	Primary Source
1	Maycobacterium avium	Pulmonary disease	Human/animal feces, soil, water
2	Pathogenic E. Coli	Gastroenteritis	Human/animal feces
3	Salmonella Species	Gastroenteritis	Human/animal feces
4	Giardia	Giardiasis	Human/animal feces
5	Cryptosporidium	Cryptosporidiasis	Human/animal feces

*(Source: Water Quality and Treatment: Published by American Water Works Association)*

assessing the risk to groundwater sources from on-site sanitation it was observed that animal waste contributes a major share of pathogenic contamination. This is especially important in the context of states like Madhya Pradesh and Uttar Pradesh where the cattle population is quite high. The study was designed to serve as a baseline and suggest sustainable cattle waste management in the study area through community participation. Since it was a pilot study, 6 villages of Madhya Pradesh were selected for the study.

#### 4.7.1 Objectives

- To assess the present mode of cattle waste handling, storage and management in each of the study villages
- To correlate cattle waste storage, water quality and the role of environmental

factors in contamination

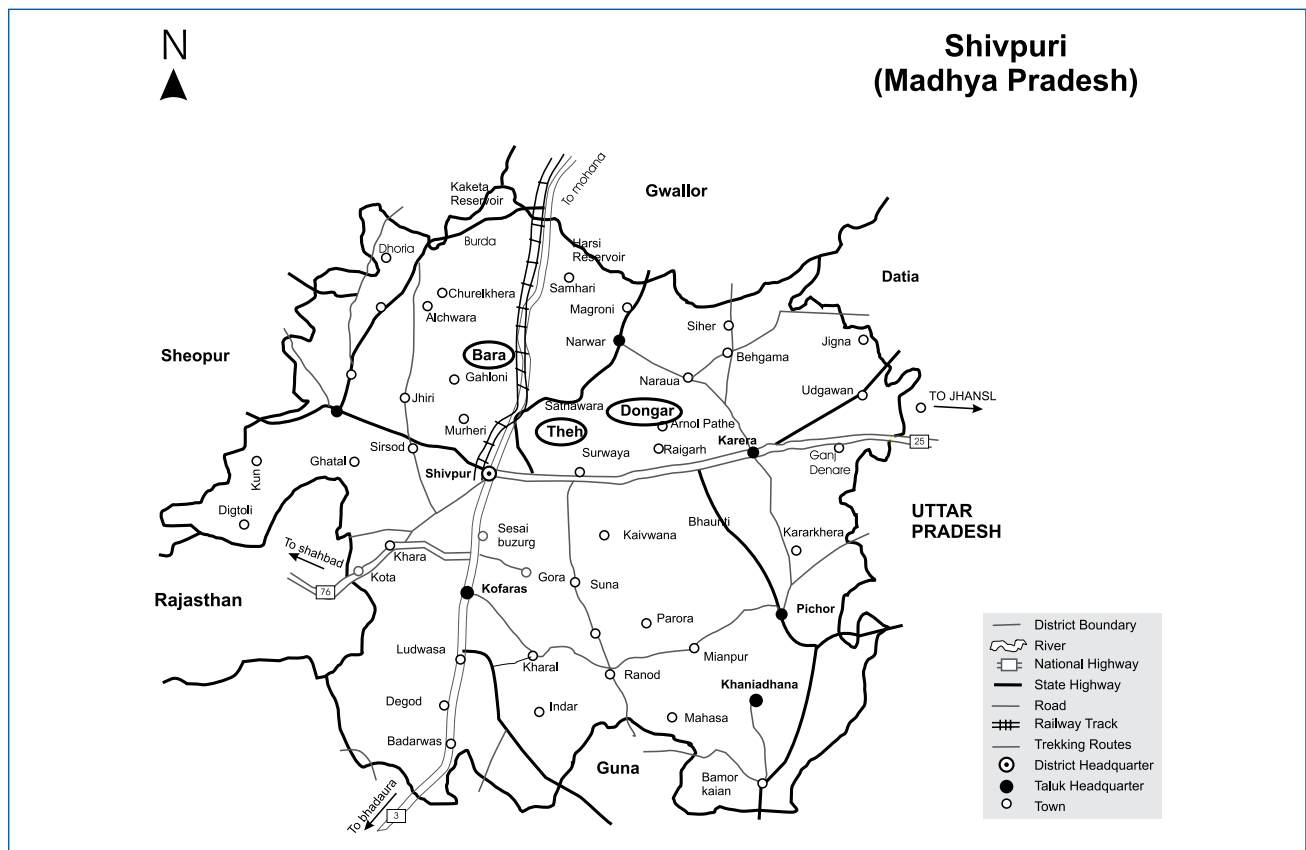
- To estimate energy consumption at the household level and suggest alternative management options

#### 4.7.2 Rationale of the study

Madhya Pradesh, one of the most backward states of India, also known as the heart of India is one such state, where cattle farming is a major source of livelihood for the people. As per the 2003 livestock census there are 3.5 crore cattle in the state. Shivpuri and Morena are two districts of Madhya Pradesh, where the traditional way of cattle farming is still being practised.

People in this area are living in extreme poverty. Their basic needs, such as safe

Map Showing Study Villages in Shivpuri District



drinking water, sanitation, education and health are not fulfilled. There is an urgent need to address sanitation problems while looking into the possibilities of alternative energy options out of the waste.

#### 4.7.3 Methodology

##### (a) Study area

The study area included 3 villages in Shivpuri district and another 3 villages in Morena district of Madhya Pradesh. Village selection was made after discussions with the staff of WAI's partner organisations. The first set of study villages Theh, Dongar and Barah are located about 30 km away from Shivpuri, the district headquarters, on the Agra-Mumbai national highway. The second set of study villages Sarpanchpura, Ajuddipura and Tilot are

located 30-50 km away from Morena, the district headquarters.

People in the study area are entirely dependent on the groundwater for their domestic as well agricultural needs.

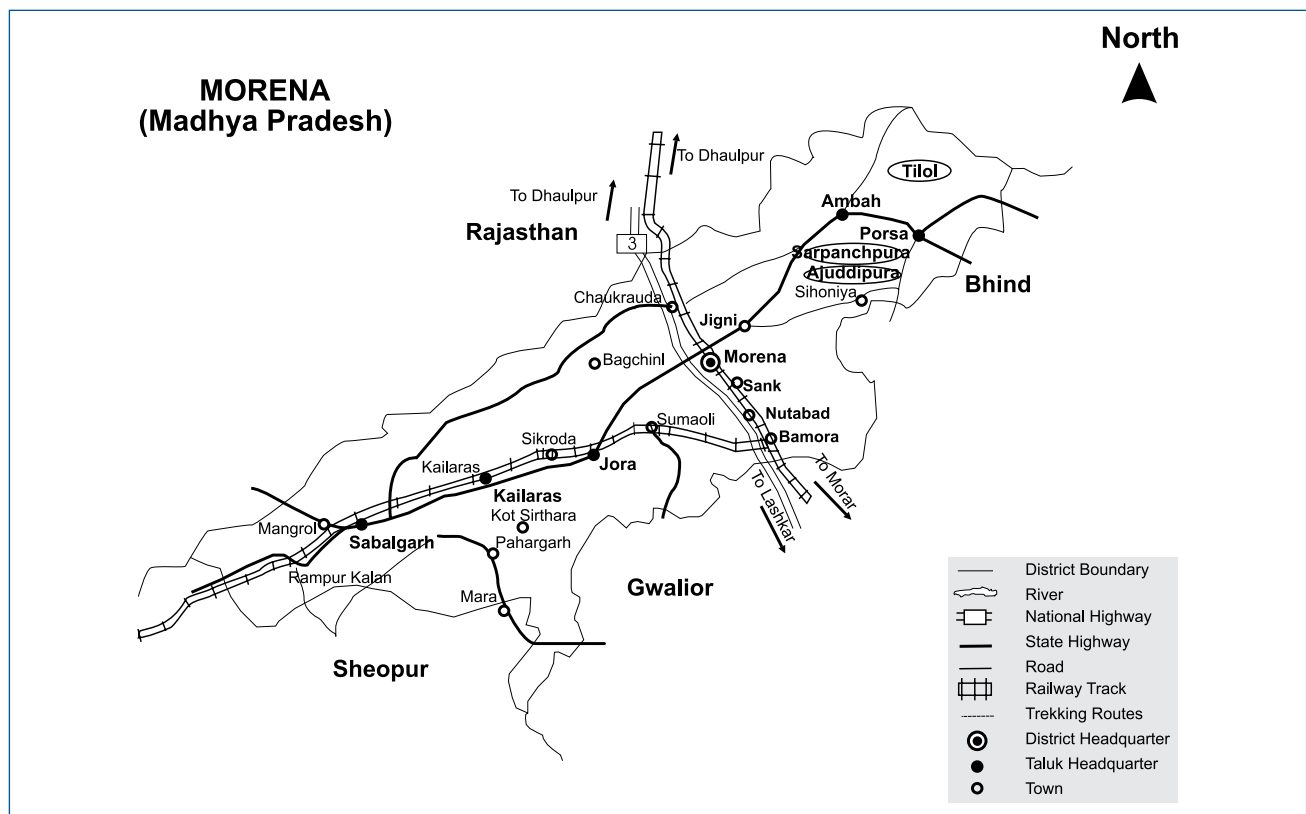
##### (b) Criteria for selection of villages

- i) Having people from poor socio-economic background
- ii) Having a large cattle population and huge amount of livestock waste generation, which leads to poor sanitation

##### (c) Surveillance of drinking water sources

A sanitary survey was carried out to find out the condition of the water sources, as well as potential sources of contaminants.

Map Showing Study Villages in Morena District



Cattle waste storage sites were located on the village resources map, particularly where such sites are close to the water sources. At each water source, inventory of the number of cattle wastes stored at each source; approximate distance from each storage site from the source was calculated. Various other factors, such as soil types, groundwater table level and direction of the groundwater flow (hydraulic gradient). Which were contributing to the risk of contamination, were also assessed. Unused wells can provide a direct path for surface water carrying pollutants to groundwater, these sources were also identified.

Other sources of contamination that have a similar nature to cattle wastes, such as latrines and open defecation spots were also considered, and spotted on the maps. Drinking water sources and the families depending on it were also identified.

## 4.8 Situation Analysis

### *Storage practices & utilisation of manure*

Traditional practice of cattle feeding, manure collection, its storage and utilisation were observed in the study villages. Compost pits which constituted a risk to groundwater sources were made uphill of the water sources. There was a marked variation in cattle waste management practices between the studied villages of the two districts, which is presented as under.

**Shivpuri:** Shivpuri has a low annual rainfall. Villages have scattered households. Cattle are being taken far away for open grazing. Fresh manure from the livestock yards is collected in baskets with bare hands and stored in pits or on the land at convenient places, mostly close to their houses. These



*Cattle yard near the source , Ajuddipura village, Morena (Madhya Pradesh)*

storage sites have neither lining nor roof nor any drainage facilities. Dung cakes are made with farm wastes (biomass) and dried at these sites. The used as fire wood for cooking. The rest of the manure is stored for a long time (in the monsoon season the manure is not removed from the storage sites) and applied to crop fields. The amount of manure used in the farm mainly depends upon the availability of manure, rather than requirement. Landless people and some farmers who have excess of manure sell it to the brick kilns.

**Morena:** Congested houses and habitations characterise the study villages of Morena district, in addition to intensive agricultural practices and abundant surface and groundwater sources. Cattle are fed and kept in the premises of houses irrespective of the proximity of surrounding water sources or kitchens. Very few households in these villages have household biogas plants. Fresh manure from the livestock yards is collected in baskets with bare hands and stored in pits or on the land at convenient places, mostly close to their houses.

These storage sites too neither had any lining nor roof any drainage facilities. Dung



Safe water handling practice

cakes are made with farm wastes (biomass) and dried at these sites. They are used as fire wood for cooking. The rest of the manure is stored for a long time (in the monsoon season the manure is not removed from the storage sites) and applied to crop fields. The amount of manure used to the farm mainly depends upon the availability of manure, rather than requirement. Landless people and some farmers who have excess

of manure sell it to the brick kilns. All the collection and utilisation practices are similar to Shivpuri.

Analysis of faecal coliform in water samples from the study villages in the two districts indicated that 75 % of drinking water sources in Shivpuri and 100 % of sources in Morena were at high risk of contamination due to huge accumulations of cattle waste.

High cattle population, intensive farming and congested localities were leading to huge quantities of livestock waste accumulations in all the villages.

#### 4.9 Potential for Suggesting Alternative Management Options

Shivpuri has a production of 15.5 tons of dung daily which serves as energy to 3,500 people, while Morena finds itself in a more severe position with 2,525 kgs (2.5 tons) daily, and space constraint presenting its storage it away from water sources. This position calls for a sustainable solution to be made available to the villagers.

The solution for water contamination is to isolate the cattle dung from the water source. The study conducted here is trying to provide a solution to the problem in such a way that the people are benefited and hence makes the solution sustainable.

Table 17: Per Capita Consumption Details

	Barah	Dongar	Theh	Tilol		Ajjudipura
Per captial Income	3809.38	3270.39	2709.37	5990.16	3193.78	3129.87
Per captial Fire Food Consumption/day	2.24 kgs	1.68 kgs	1.38 kgs	1.125 kgs	1.02 kgs	0.74 kgs
Per Captial Dung Cake Consumption/day	2.12 kgs	3.95 kgs	3.144 kgs	1.08 kgs	1.8 kgs	2.22 kgs

### *Village meetings to discuss alternative management options*

Village meetings were conducted in the study villages of Shivupri and Morena district to discuss alternative management options. All the issues related to cattle waste and plans for their proper utilisation and management were discussed. Given below are the alternate energy options that were discussed in the village meetings:

1. Biogas digestors for power generation and utilisation of waste heat for making clean drinking water
2. Domestic cooking fuel and electricity generation from biogas
3. Domestic biogas as a cooking fuel at individual households
4. Sanitary landfills

Among all the options, villagers mainly expressed their willingness to set up household biogas plants. Since the government was already giving subsidies to set up such plants in this area, it sounded like a better option.

### *Cost estimate for a household biogas plant*

Govt. subsidy Rs. 3,500.00  
Beneficiaries contribution Rs. 1,500.00  
Support Rs. 1,000.00 (through micro finance)  
**Total Rs. 6,000.00**

Villagers in Ajuddipura village have already decided to set up a community-based biogas plant. Technical feasibility and cost estimates are now being worked out by WAI's field partner in the region alongwith the community.

In Tilol, people showed interest in composting of wastes with modern echnologies, such as using 'Effective Microorganisms' for

decomposing waste and using it for organic farming. WAI's local partner is now exploring the possibilities of building capacities of the villagers to support this initiative.

Different cattle waste management and sanitary risk reduction options discussed during the village meetings is summarised below.

### *Suggested options for cattle waste management and sanitary risk reduction*

1. Shifting cattle waste storage sites as well as compost pits away from the water sources or to the village outskirts, particularly downhill from the water sources
2. Preventing stagnation or ponding near apron area and not allowing cattle to or drink water at the sources by providing alternative drinking water locations
3. Construction of soak pits by maintaining a distance of 5-10 metres from the bore hole
4. Regular testing of faecal coliform in all the water sources
5. Personal hygiene has to be promoted among the local people to prevent any further contamination (using ladles to take out water from or putting taps in the storage vessel) of drinking water.
6. Dumping of any kind of waste in unused wells should not be done. They have to be either closed or can be used for artificial recharging of groundwater
7. In Barah and Dongar, upgradation of existing open wells to sanitary wells will decrease the pressure on handpumps and will reduce the possibility of contamination.
8. Household treatment options, such as point-of-use chlorination should be promoted.
9. WAI alongwith local partners will help the villages mobilise resources for implementing various alternate energy options.

# Chapter-5

## 5.1 Issues, Challenges and lessons from Community based Water Quality Monitoring in India

The present chapter addresses the various issues, challenges and lessons learnt from community based Water Quality Management. The issues are those emerging from the field and are based on the practical experiences of the practicers in the field of community-based water quality management. They are outlined under the following heads:

- **Community Awareness & Early Warning Signals:** IEC material should be suitably tailored to create sufficient awareness among the rural communities about early warning signals related to the diseases like fluorosis and arsenicosis, based on sound water quality monitoring. Symptoms of fluorosis are often confused with arthritis. Experience shows that awareness is being spread after the disease became endemic. IEC material should be made to specifically address the symptoms before the disease emerges in a full blown form.
- **Issue of Sectoral Convergence:** This is a major issue in the areas of Water Quality Monitoring and Risk Mitigation. Presently different agencies including The Government of India are propagating decentralised water quality testing along with other agencies. Many times it is seen that efforts are being duplicated by various agencies. There is a need to address the issues of monitoring and intervention jointly, involving NGOs, government agencies, and other stakeholders. The use of existing PHED laboratories for data validation by NGOs is the first step in this direction..
- **Sample Collection and Data Management:** It is seen that sample collection from remote villages for analysis at the district

level is a major challenge in terms of manpower, transport of samples, preservation and analysis (bacteriological) etc. This comes in the way of QC/QA of WQ monitoring and analysis. Involvement of NGOs or self-help groups in sample collection would ease the burden on the government. Outsourcing of sample collection is a way out in tackling this issue.

- **Need to Prioritize Contaminants:** There is a need to arrive at a consensus among the practitioners of water quality testing to prioritize contaminants. This is in terms of monitoring, building awareness as well as intervention. Community awareness needs to be built up, based on the limitations of developing countries both in terms of monitoring and intervention.
- **Upgradation of Government District Laboratory (PHED):** District laboratories need to be upgraded in terms of capacity both in terms of monitoring, analysis of microbial parameters, data management. Presently the major weakness is limited capacity in analysing microbial parameters
- **Portable Water Quality Diagnostic Kits:** Many WQ testing kits are available in the market, including those promoted by The Government; many are developed by NGOs and research institutes. However, a major constraint is the lack of effective back up support in terms of refills which is often a bottle neck affecting regular monitoring in remote villages.
- **Problems of Multiple Contaminations:** Multiple contaminations are a major concern in rural drinking water supplies. Many agencies even today address bacteriological and chemical contamination in isolation. There is a need to have a holistic approach to address the problem. Technological options should take into consideration treating

turbidity, suspended solids and low levels contamination of fluoride and arsenic together along with pathogens.

- **Choice of Technology:** Ideally the choice of technology plays an effective role in combating contaminants. Low cost filters can be promoted at household or at the community level where contamination of fluoride and other elements are at low levels so that longevity of the filter is assured, thereby protecting the community health. However, at higher levels of contamination, the adoption of superior membrane technology plays an effective role in combating pollutants.

## 5.2 Sustainability of Community-based Water Quality Monitoring

- Institutional sustainability and role of Panchayats:** The *Panchayat* is one of the most viable institutions at the village level to sustain the decentralised water quality monitoring process. Training on Water quality testing is undertaken by various

agencies including state governments. However, sustained effort is needed to build their capacity rather than one-off training programmes as it done now. Sufficient funds should be allocated to the Panchayat to make this scheme functional.

- Village or Block Level Information System and Resource Centre:** At present there is total lack of information on water quality and disease surveillance at the village level. Water quality laboratories is located at District Level which is a major constraint in effective WQ management. Setting up an elementary WQ laboratories at the Village/block level would facilitate information flow, and help in building awareness and monitoring this intervention would facilitate efficient monitoring programmes.
- Financial and technological sustainability and community contribution:** Experience suggests that unless an entrepreneur/business-based model is setup, it is very difficult to make any scheme viable

### Financial Sustainability of Training Programme on Water Quality

Based on WAI's experiences on community-based WQM and expenses estimated by the RGNDWM, WAI proposes a cost estimate, which will take care of the financial sustainability of the programme\* at the *Panchayat* level.

- Annual honorarium to 2 grass root level workers (WAI's experience of implementing WQM at the field level suggests that 2 people will be adequate for running the programme at the Panchayat level) representing

VWSC/ASHA/Anganwadi/SHG/MMD/YMD: @ Rs. 500/p/mx2p= Rs. 1000/m for 2 persons; annual cost comes to Rs. 12000

- Cost of chemical refills annually: Rs. 1000
- Cost of disinfectants/remedial expenses: Rs. 1,500
- Annuity costs: Rs. 500

Adding the numbers in bold the total cost of running the programme at the level of Panchayat comes to Rs. 1,5000 annually or Rs. 1,250 per month.

So the monthly community contribution (assuming 500 families at the Panchayat level) comes to Rs. 2.50 per family per month.

sustainable in the community in terms of regular monitoring and intervention in the area of water quality.

- d. Here community contribution plays a vital part in making regular monitoring feasible in remote villages and can make the resource centre operational by equipping it with basic laboratory facilities initially to carry out basic water quality monitoring; provide low cost training, analytical services and mitigation O & M fund.

### 5.3 Need for Sanitation and Animal Waste Management in Rural India

A recently conducted study by WaterAid revealed that the majority of water sources in rural central and northern India are contaminated by animal excreta (WA 2007). Field experience of the study revealed that improper disposal of human excreta contaminates the surface water like rivers and lakes, while bad sanitary practices, which includes construction of toilets close to the drinking water sources and animal excreta, contaminate the majority of rural groundwater sources in India. Animal waste management and effective sanitation therefore, assumes greater significance in protecting rural drinking water sources.

### 5.4 Water Quality Research and Setting up of Water Quality Criteria in India

Another major challenge confronting Water Quality Management is to establish a realistic national drinking water standard based on scientific research which should take into consideration nutrition, local

climatic conditions, occupation etc. The Bureau of Indian Standards which has developed guidelines for drinking water quality standards for India, which is more or less the adoption of WHO guidelines for drinking water. But these guidelines are seldom applicable to India and south Asian countries. This is especially true in case of parameters like fluoride and arsenic which are considered as major contaminants causing a major public health concern in rural India where groundwater is the main source of drinking water.

In the case of fluoride there are many instances where symptoms of dental and skeletal fluorosis are seen among the communities in southern India where fluoride in drinking water is more than 0.5-0.8 mg/L (Krishnamachari 1976) as against 1mg/L as per WHO guidelines. Moreover, poor socio-economic conditions resulting in malnutrition also play a significant role in aggravating the disorder. Therefore, the adoption of lowered drinking water standard in case of fluoride and arsenic as compared to the WHO standard is highly desirable in the Indian context, considering the fact that the consumption of water is high due to the tropical nature of the climate, as compared to the west. The occupation of the majority of the people living in rural India is agriculture farming and it is this community who are dependent on groundwater. On an average they consume 4-5 liters of water per day and suffer from various forms of Fluorosis (Srikanth et al 1994). The traditional Indian food is semi-solid and contains more water and therefore increasing the body burden of fluoride and arsenic. Focused epidemiological research, therefore, is required to fix parameters of water quality and disease burden to arrive at a realistic national drinking water standard.

## 5.5 Niche role for WaterAid India in Community-based water quality management

From the foregoing it is clear that there are many issues, challenges and many grey areas areas where Water Aid can contribute effectively to address the gaps in the changing scenario of decentralised water quality management. These are outlined below.

### *Programmatic actions:*

- Develop community-based water quality monitoring models in critical villages affected by fluoride, arsenic, coliforms and address these issue holistically in terms of monitoring, data management, interventions based on a sustainable basis working with other stakeholders including the government.
- Promote routine monitoring for faecal coliform at critical villages and link it with health surveillance diarrhoeal research.
- Promote point-of-use chlorination in highly contaminated areas and chlorination at sance in the project areas of its working.
- Promote source protection as the ideal choice by undertaking sanitary risk assessment at regular intervals.
- Promote rainwater harvesting as an effective long term solution in arsenic and fluoride contaminated areas.
- Strengthen government district laboratories through capacity-building and facilitate data management.
- Promote/ Establish centre of excellence for tackling Fluorosis, arsenicosis with other stakeholders.

### *Research:*

- Conduct focused research correlating water quality and disease burden with the

help of leading scientific institutions and existing NGOs and community network/ platform available in different regions in the country.

- Evaluate various technological options available in the market for interventions at the community level affected by various contaminants.
- Support research that addresses multiple contaminants.

## 5.6 Advocacy on Water Quality Management

### *On National drinking water standards*

Lobby for developing realistic National standards for WQ without relying on western standards, especially while dealing with priority pollutants in India like fluoride, arsenic, and nitrates based on current understanding of the subject and based on focused epidemiological research.

### *On institutional issues*

The existing institutional setup for water quality management in India is based on centralised set up and with the shift towards a decentralised model the institutional setup needs major revamping. WaterAid plays a significant niche role in advocating a new model wherein the emphasis on a rural drinking water mission and the *Panchayat* has a more role to play in community-based water quality management. WaterAid needs to lobby for more decentralised funding in sustaining the effort.

### *Nodal agency for water quality data*

Lobby for creation of a single nodal agency that can serve as repository of WQ data,

source wise at the state level for coordinated intervention.

### ***Network of technical NGO***

Establish and support the network of technical NGOs who can function as watchdogs for implementing discharge standards of effluents

released into surface and groundwater and prevent surface and groundwater contamination.

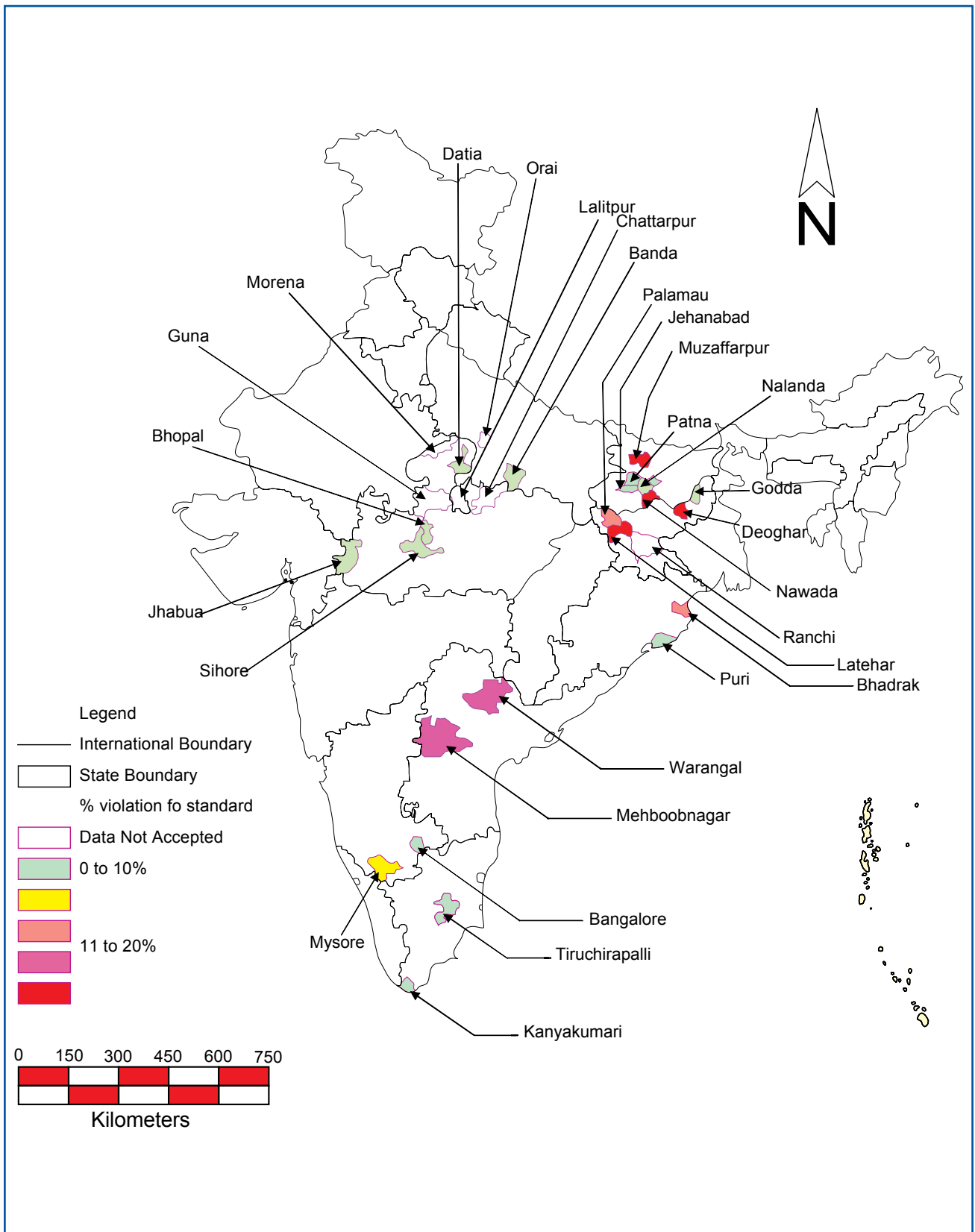
### ***Documentation of best models/practice***

Document periodically best practice/ working community models in different states for adoption and scaling up by government.

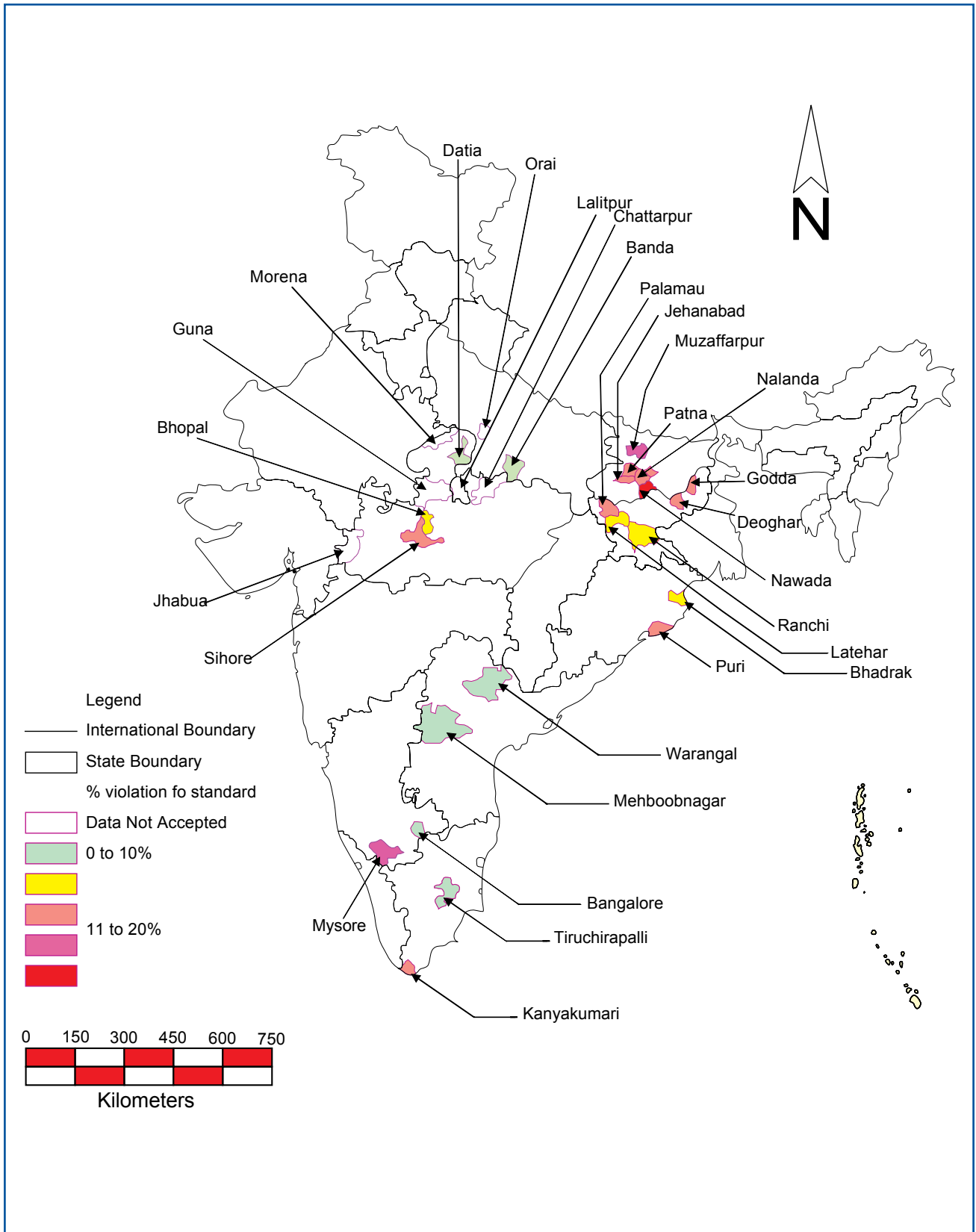




## B. Geographical Variation of Fluoride



### C. Geographical Variation of Iron



## Annexure-II

### SANITARY SURVEY CHECKLIST FOR DRINKING WATER SOURCE

Village: \_\_\_\_\_ Gram Panchayat: \_\_\_\_\_

District: \_\_\_\_\_

Number of Drinking Water Sources in Village: \_\_\_\_\_

Source Type being tested:  
(Handpump/Well/ Bore well with Reservoir or pipe water supply scheme)

Source Location: \_\_\_\_\_

Date of visit: \_\_\_\_\_

General Information: .....

Is water sample taken \_\_\_\_\_ Sample Number? \_\_\_\_\_

Water quality test report: To be attached or written with each sheet.  
(Bacteriological test only: Coliform test)

- |    |  |   |
|----|--|---|
| 1. | Is there a latrine within 30m of the borehole or the water source  | Y/N                                     |
| 2. | Is the nearest latrine leach pit? (Pit latrine that percolates into soil)  | Y/N                                     |
| 3. | Does any polluted stream flow into the source?<br>(Water-logging)  | Y/N                                     |
| 4. | Are there any other sources of pollution within 10m of the Water Source?<br>(e.g. animal sheds, fertilizers, solid waste, agriculture farm, etc) | Y/N                                     |
| 5. | Is there an unused well within 100 metres of the Handpump /Borewell?   | Y/N                                     |
| 6. | Is the drainage area around the pump house faulty?<br>(Permitting ponding and/leakage to ground)   | Y/N                                     |
| 7. | Is there any chlorination record<br>(If yes do give how and when it is done)   | Y/N                                     |
| 8. | Condition of Handpump Platform   | Damaged & cracked/<br>In good condition |

Date: \_\_\_\_\_

Surveyor's Signature \_\_\_\_\_



WaterAid – Water for Life

The UK's only major charity dedicated exclusively to the provision of safe domestic water, sanitation and hygiene education.

## WaterAid

Recognising water and sanitation as basic human rights and the foundation for overall development

WaterAid is an international charity established in 1981. Its vision is to enable poor communities gain access to safe and adequate water and sanitation. Presently, WaterAid works in 19 countries across Asia, Africa and the Pacific region. It operates through local partners, helping them set up low cost sustainable projects that can be managed by the community themselves.

WaterAid believes that water, sanitation and hygiene education are vital for the health, well being and dignity of poor people and provide the foundation for development and poverty reduction.

## WaterAid in India

WaterAid started working in India in 1986. Since 2003, WAI shifted its focus from Southern India to include the poorer states in the north to better target India's most vulnerable communities. Keeping that in mind, the country office was shifted to the nation's capital, New Delhi.

Currently, WaterAid India (WAI) works in the ten states of Andhra Pradesh, Bihar, Chhattisgarh, Delhi, Jharkhand, Karnataka, Madhya Pradesh, Orissa, Tamil Nadu and Uttar Pradesh.

## WAI's objectives are to

- Enable improved access to sustainable, safe and adequate water supply and sanitation through water, sanitation, health and hygiene projects
- Creation of a knowledge base for promotion and dissemination of best practices and advocacy at different levels for policy improvement towards sustainable health and hygiene benefits
- Develop and foster an enabling environment for effective programme implementation, in-country funding, organisational learning and growth

WAI also has liaison offices in Bhopal, Bangalore, Bhubaneswar and Lucknow



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