GROUNDWATER CONTAMINATION IN INDIA: DISCUSSING PHYSICAL PROCESSES, HEALTH AND SOCIO-BEHAVIOURAL DIMENSIONS

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ABSTRACT

The period for which harmful contaminants persist in groundwater varies by huge magnitudes – from few days or weeks for most biological contamination to centuries or more for several pesticides and industrial pollutants. The extent of impact of these pollutants on environment and human health also varies. Illness like diarrhoea and viral infections generally subside within a week whereas diseases such as Fluorosis and Arsenicosis can be lifelong afflictions. The social, health and economic impacts of such groundwater contamination depend not only on the spatial distribution of contamination in aquifers and the dependence of the population on that contaminated water but also on other aspects such as awareness of water quality, level of education and economic status of the populace at risk. A detailed understanding of the physical processes, the socio-economic and psychological behaviours behind the problem is necessary to provide a perspective that can guide us towards informed policies for bringing about improvement in the current situation.

Keywords: *Contaminants, Awareness, Reluctance, Health, Policy*

1. INTRODUCTION

The Annual Partner's Meet (APM) of the IWMI-Tata Water Policy Program (ITP) is a forum for researchers from Universities and other Institutes and practitioners from government and non-governmental organizations to gather in a single platform and discuss the current issues related to water in India. In the 2006 APM, a research theme and consequently a session is focused on "Groundwater quality and health impacts in India". In this session, there are research papers contributed by ITP researchers as well as from other institutes. The purpose of this current paper is to outline the broad scope of topics that are being thought about under this theme.

Important questions are:

How polluted are aquifers? (physical aspect): Some knowledge exists about the distributions of several contaminants such as high Fluoride, high Arsenic, excessive salinity, Iron in aquifers. Studies also exist about contamination of aquifers in industrial areas and aquifers prone to biological contamination. Current monitoring captures some of these, but it also leaves lots of gaps.

Who gets affected? (health, social, economic): Health impact of ground water contamination varies within a population living in the same region where groundwater is polluted. Some reasons for this are direct: varying immunity levels, individual metabolism and differential access to safe water etc. But there are other queries e.g. why some age groups are more affected by certain ailments, how cultural aspects, life styles interact to produce differential impacts is not well understood.

Why do we ignore? (behavioural): There is a bewildering prevalence of callousness or reluctance about health impact of contamination although knowledge about a quality problem in drinking water as well as awareness of and the capacity to pay for treatment might exist. Why is it that some people are absolutely unconcerned about the need to obtain good quality water, whereas some others are alarmed about the same? Why is it that instances of epidemic breakouts, which may cause fatal casualty, are forgotten very soon?

What can we do? (action, policy): Finally comes the concern of how to address the current situation: providing safer quality water in affected areas, preventing groundwater pollution where possible and sensitizing people to the problems emanating from polluted water.

2.0 THE PHYSICAL PROCESSES OF GROUNDWATER CONTAMINATION

Contamination of groundwater occurs due to naturally existing geogenic sources as well as substances that infiltrate into aquifers. The existence of contaminants and also transport of substances are highly site-dependant. Still, there are some regional variations that are broadly known:

a) Vast tracts of Rajasthan, Gujarat and Andhra Pradesh are affected by groundwater with Fluoride concentrations of greater than 1 mg/l. Fluorosis can lead to varying degree of afflictions: from dental problems to severe muscular deformity. The contaminant is found naturally in the rocks and sediments of aquifers and the depths of its occurrence vary with the formation. For example, in Mehsana district of Gujarat, high Fluoride concentrations are found in aquifer layers deeper than 100m, whereas in Vishakhapatnam, high Fluoride is found in shallow groundwater at depth less than 15m (Rao et al, 1998). Smaller areas of several other states like Punjab, UP, Karnataka, Maharashtra and MP also exhibit high Fluoride concentrations in groundwater.

b) High Arsenic content (greater than 0.05 mg/l) is found primarily in sediments of the Alluvial Indo-Gangetic-Brahmaputra basins (Chowdhury et al, 1999). Initially observed in high concentration only in Bangladesh and West Bengal, now the contaminant is reported from Assam and Nepal to parts of Pakistan. Newer areas are being discovered every year. Symptoms of Arsenic poisoning range from Diffuse Melanosis (darkening of skin) to Spotted Melanosis (pigmentation) and finally to Keratosis. In the final stage, the affliction can reach up to the stage of malignancy.

c) Coastal and inland salinity are found in large tracts of the country. Saurashtra and Kutch in Gujarat and parts of Andhra Pradesh, Orissa and West Bengal show intrusion of sea water into coastal aquifers. Inland salinity is present in the states of Punjab, Haryana, Rajasthan, Gujarat, MP, Maharashtra, UP and some pockets of other states. Apart from being harmful to the productivity of crops and soil quality, high salinity can cause ailments such as Kidney Stone.

d) High Iron concentration in groundwater is found in Eastern parts of the country, especially in Bihar, Uttar Pradesh and West Bengal. Prolonged intake of high Iron content water can cause haemochromatosis.

d) Increasing use of Nitrogenous fertilizers in India has led to Nitrate contamination of aquifers at levels greater than 40mg/l in many parts of the country (Agrawal et al, 1999). The states of Punjab and Haryana are in high risk from Nitrate contamination. Other states with areas showing high Nitrate levels are Gujarat, Tamil Nadu, West Bengal and Uttar Pradesh. Consumption of water containing high levels of Nitrate can be a cause for some types of Cancer. It can also cause the Blue baby syndrome which affects new born babies.

e) Pesticide contamination of groundwater has raised alarm in recent times. High pesticide content in groundwater has been reported in the agricultural intensive regions such as Punjab and Haryana. The health effects of pesticides are lesser known, but suspected to be harmful to humans and animals.

f) Many regions of the country have been marked as having aquifers polluted by industrial chemicals. These include areas in and around the towns in rural areas where industrial units are often located. Ankleshwar (South Gujarat), Chembur

(Mumbai), Patencheru (Hyderabad), Tiruppur (Tamil Nadu), Behala (Kolkata) are some examples. These aquifers show high concentrations of substance such as Chromium, Mercury and Lead etc., the effects of which can range from minor skin diseases to being carcinogenic and in some cases, directly life-threatening. Apart from these, there are numerous instances where effluents from small industries are released in unlined channels or dumped directly into borewells, as reported recently in South Gujarat and also in cities like Kanpur and Kolkata.

g) Groundwater acts as a conduit for various viral and bacterial diseases especially in shallow aquifers through mixing of sewage and infiltration from latrine pits. Since shallow groundwater is used for drinking in much of the Eastern Gangetic plains, this is a common problem in this region. The gastroentritic epidemics generally take peak during the time of monsoon. Some other regions such as South Gujarat figure high on this list. Diseases include minor afflictions such as Diarrhoeal, Viral and Ameobal infections to more severe diseases such as Cholera.

This national picture of groundwater quality is far from being complete, the main reason being lack of sustained attempts to monitor aquifer water quality. Monitoring stations are sparse, and even those are distributed across multiple agencies which do not have coordination between each other (Kumar and Shah, 2004). Consequently, the current picture of groundwater quality stems not from the efforts of monitoring the water quality, but more from the alarm raised by health symptoms caused by these high concentration levels of specific substances. The practice of this science has yet to arrive at the level of predictive ability, and is currently more for assessment purposes of known problems.

3. SOCIAL AND ECONOMIC IMPACTS

Pollution of environmental resources such as water imposes a cost on society. The costs of water pollution would depend for what purpose that specific water is being used. For example, in the case of saline water used for industrial purpose, one needs to consider the cost incurred on desalinating the water. In case of diseases occurring due to contamination, one needs to consider the health costs directly due to the affliction such as Fluorosis. These include both the treatment cost and also the opportunity cost in terms of lost wages. The canvas therefore is quite wide and one needs to define the boundaries clearly when defining the costs of pollution. One attempt at nationwide assessment of the cost of water pollution has been made by Maria (2003). The emphasis however, has been mainly at surface water pollution and the challenges in assessing the impacts of groundwater pollution have been mentioned in this paper.

A study of the socioeconomic impact of Fluorosis was conducted by IWMI-Tata Programme in 25 villages of North Gujarat by surveying a total number of 28,425 respondents (Shah and Indu, 2004, IWMI-Tata unpublished). Of these surveyed people, nearly 36% people were affected by Dental Fluorosis (DF) and 16% were suffering from at least one of the symptoms of Fluorosis. Nearly 23% of the afflicted persons took medical treatment; rest 77% either could not afford or did not believe in medication to cure their pain. About 70 % of the afflicted people were from the monthly income group of Rs 500 to

Rs. 3500 and they incurred an average cost (medical expenses + wage loss) for their ailments of Rs. 5,500 per person per year. The proportion of Fluoride debility cases declined with rising income. Better nourishment and medical care could explain this decline. This hints that, in general, higher income group people could escape the ill-effects of poor quality groundwater and that these impacts are distributed inequitably within society.

The methodology required for assessing a particular contamination problem is specific to the problem. For example, one cannot use this same methodology used for Fluorosis to gauge the impact of say, industrial contamination. There, one has to measure the impact on agricultural productivity (both quantity and quality), health costs on humans and livestock and also ecological costs. Therefore, there is a need for developing such specific methodologies and applying them to various such problems across the country.

4. SOCIO-BEHAVIOURAL DIMENSIONS

A SANDEE study using nationwide health survey data shows that less than 50% of surveyed people adopt any kind of treatment for drinking water (Jalan et al, 2004). Even amongst those who make this effort, simple filtration seems to be the most common technique adopted. Most rural households adopt simple cloth-based filtration techniques. This finding was reinforced by a primary survey conducted by IWMI-TATA programme in Anand district of Gujarat, which found that there is a small minority (less than 5%) of rural households that adopt proper purification techniques. This appears disturbing when the same study also reports high levels of Coliform bacteria found in deep tube-well water during the monsoon. This kind of contamination leads to short-term Diarrheal epidemics, unless otherwise there is a community-based treatment such as Chlorination.

Though the cost of simple water treatment such as boiling is very low when compared with possible medicine costs, it is rarely followed. There could be various reasons for this unwillingness. Education, income levels and awareness of water quality are important factors which influence the effort people take towards obtaining clean drinking water. Another study from SANDEE institute of households in New Delhi shows that on an average, people are willing to pay Rs. 25/month to ensure that drinking water is clean (Jalan et al, 2004). Increase in wealth and change in education status of the respondents has significant changes in their willingness to pay. Various other complex factors also come in, such as education and awareness level of the women in household, whether she reads newspaper etc.

On the whole, given that the same quality of drinking water is supplied to many households, there seem to be several other factors that account for whether people adopt proper purification for drinking water. Some of these are behavioural and cultural; others are economic, social and related to education and awareness. Considering the scenario of quality-related problems and the diversity of population in terms of culture and economic conditions, much needs to be explored towards this direction in India.

5. SOLUTIONS AND CONSTRAINTS

5.1 Water Treatment Technologies

Several major companies and research laboratories are addressing the question of developing technologies to treat polluted water. New biological and viral filters are being introduced. A recent technology from the National Chemical Laboratory, Pune consists of new generation filters using ultra-fine porous membranes that do not allow viral and bacterial organisms from passing through the pores. Such innovations are predicted to change the scenario of water treatment in the coming years. Solutions for Fluoride and Arsenic removal also exist. But, many harmful pollutants such as pesticides and some heavy metals cannot be removed by these purification techniques. Aquifer remediation by pumping out the polluted water is still a futuristic, expensive technology even for much developed countries.

5.2 Overcoming Attitudinal Problems

The aspect of technology though important, seems to be over-shadowed by other important issues. Less expensive filters for Fluoride removal such as Activated Alumina (AA) exist, but unless there is a basic awareness and urgency, simple aspects such as periodical cleaning (regenerating crystals) of filters become an impediment towards proper functioning of these systems (Shah and Indu, 2004, IWMI-Tata, unpublished). Most communities take clean drinking water for granted and spending even a minor proportion of their income towards obtaining quality drinking water is seen as a burden. Along with these, there is also a sense of denial on part of the government agencies in accepting the magnitude of the problem, partly due to prioritizing health problems. In North Gujarat, it was found that the government, NGOs and the doctors as well do not like to declare or diagnose 'Fluorosis' as such, rather they would like to cover 'Fluorosis' behind the mask of MSD (Musculo-Skeletal Disease). It might be ignorance, indifference or apathy towards Fluorosis. A similar situation existed with respect to Arsenic in West Bengal where it is now finally accepted as a serious health risk.

5.3 Drinking Water Market

For both short and long term quality problems, preventive action is certainly the best course. However, prophylactic action is seldom followed in case of water quality because of its long-term effects and endemic nature. Dissatisfied with the quality of water provided by urban municipalities and due to pollution of groundwater, many urban areas are witnessing a growth in packaged drinking water markets for meeting their domestic needs, for example in North Gujarat (Indu, 2003). Some cities such as Chennai have as much as 20% of their water supplies being met by tanker water (Londhe et al, 2004). In Vadodara city, it is estimated that the economy of informal water markets is as large as the municipal water supply itself (TOI, 2005). Much of this water arrives from urban fringes and surrounding rural areas, therefore leading to conflicts in water rights, as observed in Tiruppur city (Janakarajan, 1999). A reaction partly to the problem of polluted groundwater in urban

areas, the development of informal water markets is leading to conflicts between water for agriculture and that for urban areas.

5.4 Industrial Pollution and Prevention

Some positive moves in the implementation of pollution control laws and treatment procedures for industrial effluents are worth noting. In Ankleshwar, for example, a Centralized Secure Landfill facility has been operated by a local group of industries. In 5 years of its operation, it has collected and disposed off 2, 00, 000 MT of hazardous solid waste (http://www.uplonline.com/social/index.php3?pgidee=elt). Another common effluent treatment plant in the same area treats effluent from 225 member industries. These landfills and treatment facilities operated by groups of companies offer a good working model that can be followed by other such heavily industrialized zones across the country. Similar common treatment plants are also coming up in other industrial towns of the country such as Tirrupur city in Tamil Nadu.

The above discussion leads us to think the following:

- Implementation of pollution control laws for prevention of future contamination of aquifers. These laws need to be region-specific.

- Sensitizing and building behavioural practice of people towards understanding that good quality water is essential for overall personal health. The expense for good quality water is a cost of prevention for their future healthcare.

- The Public system needs to supply good quality drinking water to heavily polluted areas and for communities whose socio-economic conditions prevent them from being able to obtain/afford good quality water. This involves a cost and therefore separate mechanisms need to be developed locally e.g., dyeing units paying for water treatment in Tiruppur city.

- Where possible, create institutions that can adopt new technologies for water treatment and sustain their management, like Panchayat based water treatment in villages and captive water treatment plants in urban housing societies

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