Drinking Water Quality in Rural India: Development, Future Challenges and Opportunities

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Abstract - Groundwater is of most importance to rural development in many countries of the world. Since a result of its prevalent distribution, low development cost, and normally tremendous quality, it has been the basic resource allocating the quick development of improved domestic water supplies for the rural population and in many areas has also supported a major increase of highly dynamic agricultural irrigation [1]. As a quality apprehension the ground water is frequently found to be contaminated with fluoride, arsenic, iron and salts. In recent years, Flurosis has emerged as major public health issue in rural India. At the technical level, some progress has been made in the development and use of field level diagnostic kits.

Decentralization of health related monitoring at the villages needs to be institutionalized and this requires capacity development at all the level [2]. Groundwater resources are so essential for meeting an arrangement of basic needs, from public health to poverty mitigation and cost-effective development. Because of high rates of thought required for irrigation, however, in some areas there is significant concern about sustainability of the resource base, because of declining groundwater tables and near immutable aquifer deterioration through saline intrusion.

There are also additional sustainability concerns as a result of the increasing frequency of groundwater pollution from over-intensive or improperly managed agricultural encouragement exercises. This article discusses the various components that impact effective water quality management in rural India. Experience suggest that redesigning of data management programme at village, district and at national level, up gradation of district level laboratories and addressing technical, legal and institutional components should become the first steps in achieving effective water quality management and providing better health to millions of people living in rural India[2]. It aim to raise consciousness of the key linkages between groundwater and rural development, and to make out appropriate technical and institutional move towards for improving the operational reliability of water wells and the sustainability of groundwater resources altogether [1].

Keywords- Groundwater, Domestic water, Aquifer, Sustainability, Contamination.

1. Introduction

“Groundwater will be the enduring gauge of this generation’s Intelligence in water and land management”, Australian Groundwater School, Adelaide. In many countries of the world from last 25 years ground water is the major importance to rural development. In India also there is a huge increase in the use of ground water. This is because ground water can be accessed relatively easily and cheaply, and gives a reliable source of high quality water. Ground Water plays a major role for the improvement of rural areas besides this there are also some challenges and some opportunities to increase the ground water level in these areas [1]. The intention of this technical paper to raise awareness of the key linkages between ground water and rural development, and to identify appropriate approaches for improving the operational reliability of water wells and the sustainability of ground water resources as a whole. Articles in this issue mirror the complexities and dynamics of rural livelihoods and modern thoughts on a way forward [3].

2. A Major Concern in Rural India

A. Water Quality Monitoring

In the world India is now the prevalent user of groundwater (Shah, 2009). The report of the Expert Committee on Groundwater Management and Government (Planning Commission, 2007) declares that, in 2004, some 28% of India’s blocks (nationally recognized administrative units) were in the semi-critical, critical or over-exploited category in terms of the level of groundwater development as compared to 4% in 1995 (Planning Commission, 2007). The new thoughts, which attempted to come across at managing groundwater beyond dipping dug wells and drilling tube wells or bore wells, began to be backed by data from State and Central agencies, making it possible to follow the national
scenario on groundwater over a time-line (CGWB, 1995 and 2006). At once the methodology of groundwater estimation was also improved (Groundwater Estimation Committee Reports, 1984; 1997). From the official data, we can clearly see that there has been a remarkable change in the groundwater scenario in the country even within a short period of 10 years (between 1995 and 2004) (Table I). The proportion of unsafe districts (semi-critical, critical and overexploited) has developed from 9% to 31%, the proportion of area affected from 5% to 33% and population affected from 7% to 35%. The Government of India’s Central Groundwater Board (CGWB), has made estimates of the accessibility of the country’s groundwater in 1995 and 2004.

An assessment of the data from these two time points reveals several remarkable changes in the groundwater scenario. On the basis of the ratio of gross annual withdrawal of groundwater to net annual recharge, districts and blocks can be classified into “safe” (ratio less than 70 percent) and “unsafe” (ratio greater than 70 percent) categories. The proportion of “unsafe” districts in India has grown from 9 percent in 1995 to 31 percent in 2004. The area and population under “unsafe” districts also has grown substantially. While the traditional Green Revolution states of Punjab and Haryana lead in terms of groundwater overuse, states like Rajasthan, Tamil Nadu, Uttar Pradesh, Karnataka, and parts of Madhya Pradesh are also heading in the same way. Almost all districts in Punjab, Rajasthan, and Haryana as well as 72 percent of the districts in Tamil Nadu and just about half the districts in Uttar Pradesh and Karnataka are now in the “unsafe” category.

Table 1: Comparative Status Of Level Of Groundwater Development, (1995 And 2004 In %) [4]

<table>
<thead>
<tr>
<th>Level of Groundwater Development</th>
<th>Total Districts</th>
<th>Total Area</th>
<th>Total Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50% (“Safe”)</td>
<td>8</td>
<td>89</td>
<td>80</td>
</tr>
<tr>
<td>50-70% (“Safe”)</td>
<td>10</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>70-90% (“Semi-critical”)</td>
<td>4</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>90-100% (“Critical”)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>&gt;100% (“Overexploited”)</td>
<td>4</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

In precise, of the 588 districts in India for which data is available, 178 districts have “unsafe” levels of groundwater development. Many of these also have severe water quality problems. Among those districts considered “safe,” as many as 169 districts have at least one of the three most serious water quality problems of arsenic, fluoride or salinity. Consequently, in combining quantity and quality of groundwater, a total of 347 districts (or 59 percent of all districts) have problems related to either the quantitative availability or quality of groundwater. This clearly indicates the severity of India’s current groundwater challenge [6].

3. Ground Water Development

The first step towards ensuring ground water development (safe drinking water) is to generate reliable and accurate information about water quality. Several government institutions and departments are involved in water quality monitoring, leading to overlapping of functional areas and duplication of efforts. Several technological options for treating drinking water quality in rural India:-

- Operation and maintenance of De-fluoridation and arsenic removal plants.
- Utility of field-testing water quality kits at community level and their limitations.
- Hand pump attached defluoridation plan lying dysfunctional due to absence of O and M in Palamu- district of Jharkhand state.
- Points of use disinfection.
- Need for integration of hygiene, sanitation and water quality intervention [2].

Once contamination is perceived in a water source, there is need for treatment. In case of rural areas, modern water purification technologies might not be practicable. In villages, it is important that simple technologies that are easy to use and can be operated without much technical know-how be promoted. The price factor is also important as technologies with high operational and chronic costs might not be useful. In India, one cannot abandon the use of traditional methods of water purification. The use of traditional methods, however, should not be publicised.
Table 2 – Treatment Methods [10]

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TREATMENT METHODS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity</td>
<td>Cloth Filtration, Slow Sand Filtration, Coagulation, Candle Filtration</td>
</tr>
<tr>
<td>Odour</td>
<td>Aeration, Carbon Filtering using charcoal, Boiling</td>
</tr>
<tr>
<td>Colour</td>
<td>Carbon Filtering using charcoal, Slow Sand Filtration</td>
</tr>
<tr>
<td>Bacterial Impurities</td>
<td>Boiling, Chlorination, Ultra Violet Radiation – SODIS, Slow Sand Filtration</td>
</tr>
<tr>
<td>Fluoride</td>
<td>Activated Alumina Technology, Nalgonda Technique</td>
</tr>
<tr>
<td>Ammonia</td>
<td>Chlorination, Boiling</td>
</tr>
<tr>
<td>Iron</td>
<td>Oxidation and settling</td>
</tr>
<tr>
<td>Hardness</td>
<td>Boiling and Settling/Filtration, Reverse Osmosis</td>
</tr>
</tbody>
</table>

unless its efficiency have been proved through proper research. Water purification can be carried out at the household level and at the community level. When one is talking about community based water purification systems, issues of ownership and impartial distribution becomes important. Social factors can play a role in determining access to water. In case of community based water purification systems, there should be a mechanism of contribution by the community and they can be made responsible for safeguarding to ensure sustainability.

A. Treatment Methods of Water Purification

The assortment of an appropriate technology is governed by approval by users. Use of modern technologies such as reverse osmosis and ozonation are effective in the treatment of water but their probability in a rural setting needs to be worked out in terms of capital expenditure and manpower in operating and maintaining such systems. There is also a must for proper field testing before any product is launched with appropriate certification and justification by prescribed authorities.

B. Greater Impacts in Reducing Poverty

The Central government are endowed with financial and technical support for rural and urban water supplies in India, while the planning, designing, construction, operation and safeguarding is undertaken by state government agencies.

Precedence and Programmes

- Since 2000, water quality monitoring has been accorded a high priority and institutional mechanisms have been developed at national, state, district, block and panchayat levels. The government has also outlined mandatory mechanisms to monitor the quality of drinking water and devise valuable Information, Education and Communication (IEC) interventions to propagate information and alert people on health and hygiene.

- The Government of India begin the National Rural Drinking Water Quality Monitoring and Surveillance Programme in February 2006. This think about institutionalisation of community participation for observing and supervision of drinking water sources at the grassroots level by gram panchayats and Village Water and Sanitation Committees, pursued by verifying the positively tested samples at the district and state level laboratories.

- Since 2006-07 ahead, the states have been directed to distribute up to 20 per cent of accelerated Rural Water Supply Programme (ARWSP) finances for approaching water quality problems.

- With the plan of setting up laboratories, the Government of India has endorsed 430 district level laboratories owing to which 252 have been established till 2005. Various state governments and other organisations have also set up 158 laboratories.

- The Government of India has prepared an allocation of Rs.1,040 crore for the current economic year (2007-08), to states and Union provinces for tackling water quality problems due to extreme fluoride, nitrate, arsenic, iron and salinity [5].

4. Challenges

Groundwater is an essential resource in India, description for over 65% of irrigation water and 85% of drinking water supplies. Conversely, in improvement trends it is
approximate that 60% of groundwater sources will be in a critical state of terrible conditions within the next twenty years. Local observations of annual water table decline exceeding 4 metres are common the whole time India.

So we have some sense of why India’s groundwater is being excessively exploited, but why is this so significant? Out of the mode from the physical absence of the resource, the state of groundwater quality in India is a critical health issue. As wells are drilled deeper in recognition of the declining water table, the water which is extracted frequently displays higher levels of arsenic, fluoride, and other harmful chemicals. The attendant health effects have been well documented all over India, particularly in poorer rural communities where there is no option for drinking water. Decreasing water tables can also support leakage from a contaminated peripheral source, such as saline water in coastal areas or surface water infected by sewage, agricultural fertilizers, and industry. Reduction of groundwater is not simply a case of drawing down a replenishable resource, but in all probability one of permanent dreadful conditions [8].

Monitoring ground water quality remains a major challenge in rural India because it is the major source of drinking water it remnants a major monitoring challenge believing the geographical extend of Indian village and the statement that many of the secluded villages are not easy to get to regular monitoring by central agencies due to transportation and communication problems. So it the rural population that endure the most from problem allied to fluoride, arsenic with microbial contamination

State drinking water mission under the Rajiv Gandhi National Drinking Water Mission (RGNNDWM) sanitation department throughout the public health engineering division consented to carry out the consideration of all drinking water sources. The National Rural Drinking Water Quality monitoring and Surveillance Programme was initiated in February 2006. The factor of the programme is monitoring and surveillance performance which consist of field testing kits (Chemical and Bacteriological) and strengthening of district level laboratories.

The purposes of the programme are as follows:

- In the country Monitoring and surveillance of all drinking water sources by the community.
- In the country decentralisation of water quality monitoring and surveillance of all rural drinking water sources.
- Institutionalization of community participation involvement of local village institution (Panchayat raj) for water quality monitoring and surveillance (WQM&S).
- Generation of awareness amongst the rural masses about water quality and water born disease.
- Building capacity of Panchayat / village institution to individual field testing kits take up full operation and maintenances (O&M) for WQM&S of all drinking water sources [2].

5. Groundwater Governance and Opportunities for Rural-Urban Co-Management

A. Mechanisms for Tumbling Tension

The major challenge for good governance of rural water supply consist of an urgent need to recognize and prioritise the courses of accomplishment required if continued growth of the world’s cities is to be sustained/ Urban-rural tensions are an predictable outcomes of growth and a common root cause of such tensions is “water scarcity” i.e. the need of access to an sufficient supply of suitable quality water. In such cases, crises are increased in peri-urban areas where urban, industrial and agricultural users directly vie for the same resource. In other cases, water paucity relates more to the inept water distribution system (reticulation networks – tanker supplies) than it is by the total size and quality of the water resource. This type of water paucity that has driven the volatile increase of private in-situ water wells in many cities all over the world. If the world’s quickly developing cities are to be provided with sufficient supplies of potable water on a sustainable basis, then vital solutions are necessitated. These solutions are definitely complex given that many cities face opposite political, societal and economic interests and limited economic resources for technological innovation and essential infrastructure. Conversely, the preferences are relatively simple and can usually be categorised into three basic options:

a) Increasing the available water supply

Beside various methods including accessibility of the water supply can be increased but not limited to:
- New groundwater resources;
- Resource mining;
- Aquifer recharge management using artificial recharge;
• Water blending;
• Substituting poorer quality water for some uses;

b) Demand Management

Through a wide variety of measures Demand for groundwater can be tempered. Usually, they consist of:
• Limiting the number and depth of wells through controls on the issue of well construction permits;
• Limiting accessibility to municipal supplies to certain periods of the day;
• Price structuring e.g. water metering and tariffs;
• Water conservation (e.g. use of technologies that use less water to perform the same task).

Within many developing countries, per capita usage of water is previously very low and there are few opportunities for important savings to be prepared at the domestic level by implementing water conservation practices unless major enticements for reducing water use are ascertained. Some reduction can be accomplished by limiting household ease of access to water to just a few hours each morning and evening, as is practiced in India (Limaye, 1997). Regrettably, this does little to control usage during those times water is made available. At the communal and municipal level, demands on the aquifer can be reduced by limiting pumping.

However, according to Morris et al. (1997), this is better achieved by severe controls on the construction of water wells (through licensing) as opposed to simply restricting pumping rates through permit for wells that are already constructed. Many disagree that it is pointless to regulate water usage if laws are not sufficiently implemented and violators are not accused. Limaye (1997) argues that the greater the number of rules and regulations, simply the greater the level of illegal activity. Possibly the most successful means of controlling demand is the hindrance that results from increased water tariffs. Since described by Morris et al. (1997), this can be accomplished at the wellhead by imposing reasonable charges for raw water based on one or more of the following:

• Recuperating full costs incurred by the authoritarian body for administering resource progress and assessing, observing and managing the groundwater resource
• With the possible cost of providing substitute raw water supplies to users in the event the source goes out of commission.
• Recognizing the full cost of environmental blows that will likely grow due to the water undertaking.

c) Proficient Management of the Resource

Finally there are limits to which supply can be increased and demand reduced. The long-standing sustainability of groundwater supplies for developing cities obliges that groundwater is managed far more efficiently. This means that water quality blows must be minimised and that accessible water reserves have to be managed to maximise their utility. Identifying that surface water is an important component of the rural water cycle and a critical water source for mainly areas, considerable additional management benefits can be obtained by optimising their combined growth through conjunctive use.

Conjunctive use recognises the interdependency between the ground and surface water resources of a basin and make sure that greatest benefit is obtained by integrating ground and surface water resources into a single resource management plan. According to Barber (1997), management of our groundwater systems should be emphasized by science. The role of the scientist is to address perceived problems and develop solutions that can be used by resource managers. Management practice can then evolve by incorporating scientific developments into an overall strategy to achieve best-available practice. Opportunely, the science is well progressed and there an affluence of excellent ground and surface water modelling tools that can be used for:

➢ Quantifying the water budget.
➢ Performing vulnerability assessments and identifying “ZO’s – zones of contribution” - areas around wells most in need of protection.
➢ Predicting groundwater travel times for contaminants in the system.
➢ Determining “optimal” pumping and water extraction rates, and
➢ Testing and evaluating alternative water management scenarios [9].

6. Conclusion

“A Vision for Sustainable Groundwater Development For Rural Water Supplies”
This paper has endeavoured to review the current thinking on sustainable groundwater development for rural water supply. If opportunities and challenges are addressed using the approaches outlined here, what might the rural water supply network might help complete by 2035? In India according to current records on the status of groundwater resources expose some alarming trends. The rate of withdrawal of groundwater has arrived at “unsafe” stages in 31% of the districts, cover up 33% of the land area and 35% of the population. The condition has severely got worse in a short duration of nine years, between the evaluations done in 1995 and 2004. Advance, a lot of the so-called “safe” districts has severe problems of water quality, which terrorizes their drinking water safety. Taking quantitative and qualitative aspects simultaneously, it would show that a total of 347 districts (59% of all districts in India) are susceptible in terms of safe drinking water in India. This is an issue of serious alarm, have need of a new approach.

7. Acknowledgment

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