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Groundwater quality of Kerala – Are we on the brink?

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ABSTRACT

There is growing concern throughout India about the contamination of groundwater as a result of geogenic and human activities. In India, groundwater resources are being utilized for drinking, irrigation and industrial purposes. The groundwater is estimated to provide about 80 percent of water for domestic use in rural areas and about 50 percent of water for urban and industrial areas. With the rapid growth in population, urbanization, industrialization and other developmental activities, groundwater resources have become vulnerable to depletion and quality degradation. The causes of groundwater contamination include use, spillage, or disposal of pesticides, fertilizers, petroleum hydrocarbons, industrial chemicals, and waste products. The contamination can also result from geologic sources and changes in the existing land use. The importance of groundwater as a resource to the nation cannot be overstated. Kerala is strongly dependent upon groundwater and has considerable value both for its economic and social uses (i.e. drinking water, water supply system, agriculture, industry, and recreation), and for its role in maintaining a range of ecosystems at the surface and below ground. The contamination of groundwater can have adverse effects on these uses, ultimately leading, as water quality deteriorates, to the groundwater being unable to support or maintain these beneficial uses. In most cases this degradation is irreversible. Remediation is very expensive and is often unsuccessful. Consequently, adequate protection of groundwater quality must be a primary aim. Groundwater and surface water are often closely linked, and changes to quality or quantity in one resource frequently creates an impact on the other. Groundwater contributes to streams, lakes and wetlands, and is particularly significant in maintaining these surface water ecosystems in dry periods. Furthermore, surface water quality can affect groundwater quality through seepage and where surface water directly enters groundwater. Protection of surface water quality is often considered to be of paramount importance because impacts of contamination or poor water quality are readily observed. However, given the value of groundwater to the nation and the connections between surface water and groundwater, protection of the quality of groundwater should be given at least equal prominence to that of surface water. Additionally, there is a need for a greater awareness of groundwater, its key role in supporting a range of economic, social and environmental values, its significance in the hydrological cycle, and the need to protect these valuable but invisible resources.

1 Introduction

Groundwater is one among the Nation's most important natural resources. It is one of the major sources for drinking water, agriculture, industry, as well as to the health of rivers, wetlands, and estuaries throughout the country. Large-scale development of ground-water resources with accompanying declines in ground-water levels and pollution has led to concerns about the future availability of ground water to meet domestic, agricultural and industrial needs (Datta, 2005).

Kerala State lies as a narrow strip of land along the southwest corner of India bordered by Western Ghats on eastern side and Lakshadweep Sea on the western side. The State lies between the North latitudes 8° 18′ and 12° 48′ and east longitudes 74°52′ and 77°22′. The State has been divided into 14 districts and 152 blocks. Though the State is blessed with plenty of water resources and rainfall, the availability of water resources, especially groundwater is not uniform through out. It varies from place to place. The State has varied hydrogeological and geomorphological characteristics and hence the groundwater potentials differ from place to place. Increasing urbanization and growing dependence on groundwater for irrigation and industry has called for judicious and planned exploitation of the groundwater resources. For proper planning and management of groundwater development quantification of groundwater resources is one of the most important prerequisites.

In Kerala, nearly two decades ago, groundwater exploitations were restricted to unconfined aquifer through dug wells. In fact, common man then had enough knowledge to construct wells in the valleys since valley portions are the repository zones of groundwater. The effluent water table conditions had then enabled water flow in the drainages even during lean season. Presently with the advent of technology ,high-speed rigs and quality deterioration of surface water have resulted in uncontrolled exploitation of groundwater resources. Little measure has been taken by the government machinery and other departments to contain the unprecedented over-draft and to bring in measures to revive the depleted groundwater resources. Now new initiatives are in force to educate the people. But it is not an easy job to restrict over-exploitation of groundwater. In many places, supply of groundwater became a lucrative business. The free and or subsidized power supply policy further aggravated the condition. There is now a 'free for all' situation as far as groundwater utilization is concerned. There is considerable change in land use pattern and agricultural practice of the state. The area under paddy has declined from 801700 hectares (ha) in 1980–81 to 289974 ha in 2004–05, where as the area under commercial crops, rubber and coconut has increased considerably during the last two decade. The area under rubber has increased to 480661 ha in 2004–05 from 237800 ha of 1980-81. Similarly the area under coconut has increased to 899267 ha in 2004–05 from 651400 ha of 1980–81 (CGWB,2006).Groundwater development and its environmental implications like, over exploitation, decline of water levels, quality deterioration, sand mining, seawater ingress, spacing of wells with septic tanks/sewerage pits, change in land use, poor sanitation, water logging and climate change are to be studied in detail.

2 The environmental/quality issues and groundwater in Kerala

The environmental/quality issues associated with groundwater development are discussed below.

2.1 Effects of overexploitation on groundwater regime

The over extraction of groundwater i.e. excessive withdrawal beyond the normal recharge in any given area creates many harmful effects which could be identified as:

- Continuous lowering of water levels. (Both pre-monsoon and post- monsoon)
- Lowering of pump sets, causing low efficiency, higher cost of operation
- Reduction of yields of wells, well interference due to close spacing of wells, severe drinking water scarcity in summer months.
- Deepening of wells and increase in cost of groundwater extraction
- Damage to aquifers due to compaction, risk of ground subsidence due to inter-relationship between withdrawal and downward trend in water levels due to overdraft conditions.
- Total collapse of operation & management system of groundwater resource of the basin or watershed and disturbed planned and sustained development and regulatory system in the area.

2.2 Decline in groundwater levels

The analysis of decadal water level trend (1996–2005) indicates that 13% and 30% of monitoring wells are showing declining trend of more than 0.1 m/year for pre-monsoon data and post-monsoon data respectively (CGWB 2005 and Shaji *et al.*2009). The water level decline during post monsoon period is attributed to base flow, higher groundwater development for various uses and change in land use pattern. Similarly the piezometric head of Tube wells in Alleppey town show a decline trend. Since these tube wells are being pumped continuously for urban water supply this may leads to some environmental problems like land subsidence (CGWB (2005).

Lowering piezometric head is also noticed from Chavara industrial area. Detailed studies are required in these areas.

2.3 Quality deterioration

In general, the quality of the shallow groundwater in Kerala State is good. Incidence of high fluoride in reported from Palghat and Alleppey district. In Palghat district high fluoride is reported from deep sedimatery aquifer whereas in Paghat it is noticed in crystallines. The dug wells Plaghat are showing fluoride in the range of 0–5.75 ppm. The higher value is recorded from Kopanur (5.75 ppm). The bore wells are showing high concentration of fluoride, ranging from 0.3 to 3.12 ppm. The highest concentration is reported from Chinnamoolathara (EW of CGWB). The water supply from bore well of Eruthanpathy also shows 1.76 ppm of fluoride (Shaji *et al.*, 2007). This shows that in the eastern part of the district, fluoride concentration more

in both phreatic and deeper aquifers. Fluoride contamination in Alleppey district is reported from the samples collated from tube wells with a maximum value of 2.56 mg/l.

Higher content of nitrate and iron is reported in groundwater in many parts of the state. Bacterial contamination is being reported from all districts in dug wells and is growing in alarming stage.

2.4 Problem associated with fresh water lakes

Vellayani is one of the three rainfed freshwater lakes in Kerala, the other two being Sasthamkotta lake in Kollam and Pookkode lake in Wayanad. Sasthamkotta Lake is in news recently on account of waste dumping (James, 1999). Ravaged by pollution and land reclamation, the Vellayani freshwater lake here is facing a fresh threat to its existence from illegal extraction of sand in the fallow paddy fields along its periphery. Truckloads of sand are being removed daily from the vast lowland fields that were reclaimed from the lake by local farmers for paddy cultivation.

3 Sea water ingress

Kerala has about 600 kms long coast line. Coastal sedimentary formations are seen all along the Kerala coast but the prominent area lies between Ponnani in Malapuram district and Veli in Trivandrum district. Geomorphologically, the area is dissected by numerous rivers, backwater channels and lakes. In two areas namely Kuttanadu and Kole altitude of land surface lies below mean sea level. The shallow aquifers tapping the coastal alluvium are generally fresh with isolated pockets of saline water developed during summers close to the backwater channels, lakes and the tidal rivers.Amongst the Tertiary beds the aquifers in Vaikom beds hold fresh water to the south of Karuvatta in Alleppey district. The source of salinity in the Tertiary aquifers was studied in detail by CGWB. The salinity/brackishness of groundwater is due to leaching of salts from the aquifer material (insitu) and not due to sea water intrusion. Sea water ingress to the coastal aquifers due to over extraction is not reported from the Kerala Coast. However salinity is noticed in shallow wells close to the backwaters, lagoons, lakes and the tidal rivers. The rivers of Kerala often encounter salinity intrusion into their lower stretches during summer months. When the fresh water flow reduces, two major problems are encountered in these water bodies (i) salinity propagates more into the interior of the river (ii) flushing of the system becomes less effective. Both these have an impact on groundwater based water supply wells and other wells situated close to the rivers. Problems of salinity intrusion are also encountered in Bharathapuzha, Periyar, Meenachil and Kuttiyadi rivers. The extensive sand mining in river beds may further damage the system.

3.1 Pollution of groundwater bodies

Kerala is one among the most thickly populated state in India. As a result of the measures to satisfy the needs of the huge population, the rivers, ponds, wells, tanks and streams of Kerala have been increasingly polluted from the industrial and domestic waste and from the pesticides and fertilizers. Industries discharge hazardous pollutants like phosphates, sulphides, ammonia N, fluorides, heavy metals and insecticides into the water bodies. Recent trend is much alarming ie. depositing the chemicals from factories, E-waste (computer waste) and other biological wastes (chicken waste) in open wells and ponds.

3.2 Bacteriological contamination and poor sanitation

Open dug wells are important groundwater extraction structures in the coastal belt of Kerala and groundwater is the most common source of drinking water in these areas. In general, groundwater quality of Kerala is very good. Of late, these precious resources are getting contaminated by various effluents and anthropogenic activities. Open wells of Kerala have the problem of bacteriological contamination and studies have shown that faecal contamination is present in 95% of drinking water wells. This could be due to poor or poorly maintained sanitation facilities. Majority of the population have access to piped water but only some have proper sanitation facilities.

3.3 Water logging

Another local ground-water problem is water logging. Water logging has developed in some areas because of excess application of irrigation water obtained from surface-water sources.water logging is commomn in Kuttand and Kole land areas. In other areas, natural water logging problems have been intensified by irrigation practices. Water logging in the commands of major and medium irrigation projects is a known problem. According to the studies conducted by CWRDM, around 400 Ha of land in the commands of Malampuzha and Kuttiyadi irrigation projects are water logged. Water logging is due to (i) high density of irrigation (ii) wrong and defective methods of irrigation (iii) improper maintenance of nature channels (iv) hydraulic pressures from saturated areas at higher elevations (v) heavy seepage losses from canals (vi) absence of drainage canals in irrigated areas (vii) silting Pollution of water bodies

3.4 Problems associated with pesticides and insecticides

Numerous studies over the past four decades have established that pesticides, which are typically applied at the land surface, can move downward through the unsaturated zone to reach the water table at detectable concentrations. The downward movement of pesticide degradation products, formed in situ, can also contribute to the contamination of ground water. Once in ground water, pesticides and their degradation products can persist for years, depending upon the chemical structure of the compounds and the environmental conditions. We have now problems with endosulfan etc

3.5 Groundwater quality management plans

Groundwater quality protection should be pursued through an approach that is based on the beneficial use concept and implemented through an integrated approach, utilising a range of measures, including the key measures of:

- risk and vulnerability assessment;
- land use planning and management;
- regulatory measures (e.g. licensing)
- economic and market mechanisms (e.g. trading)
- human, financial and technical resourcing
- institutional arrangements
- availability of appropriate regulatory tools
- appropriate economic and market mechanisms
- community awareness and education

The approach should also account for managing interactions between water quality and quantity and between surface and groundwater. In the development of groundwater management plans, strategies to protect groundwater from contamination and maintain its Beneficial Use (including ecosystem values) should be included.

The effectiveness of groundwater quality management and protection relies on enforcement and a comprehensive, targeted monitoring program. Since monitoring often must be undertaken over the long term, it often suffers budget cuts or is neglected due to lack of resources. However, if baseline trends are not known, early response to potentially adverse impacts is not possible. Monitoring is a key activity to enable identification and protection of groundwater from pollution.

4 Conclusions

Traditionally dug wells met the drinking water needs and rivers, streams and ponds met irrigation and other needs of rural people in the state. Urban populace mainly depends on piped water supply (surface water) for their needs. Now after introduction of piped water supply to the rural area, the old Panchayath wells and other water bodies are being neglected. Groundwater below the land surface being invisible, the common man could not judges its availability in terms of the depth to groundwater table and quality. Their demands on land and groundwater and the consequences of these demands have been characterized scarcely. Due to absence of any pricing mechanism and strict regulation, indiscriminate groundwater exploitation, its wasteful utilization, and land disposal of wastes continued. In Kerala, We wake up in our homes and walk to the toilet, brush our teeth, sink and bath. We use lavish water (treated water) for cooking, washing clothes, gardening and car washing. In much of the world, however, this is not the routine. Daily life is marked by a lack of access to drinking water, sanitation and hygiene resources. Presently groundwater resource of the state is facing several problems. A new approach is very much essential for the governance and conservation of groundwater resources of the state. It involves participation of local people, NGOs, Govt. departments, planners, developers, Panchayath institutions and Scientists and environmentalists. However, research on groundwater use in the socioeconomic context being relatively small, the highly technical knowledge of the aquifer systems is of relatively little use for practical management purposes. Involvement of research institutions, University departments, NGOs, and other stake holders in development and management of ground water resources of the state is very much essential for adopting various water conservation techniques and ensure their adaptability in local conditions. The general attitude of the community in Kerala is that water is nature's gift and therefore be accessed free of charge, used and misused by all for whatever purposes intended. But it's high time to change our attitude towards water. The approach to groundwater quality protection and enhancement varies not only between States but also within them. Within our country, different agencies have differing responsibilities for groundwater quality. This gives an impression to industry and the community that groundwater quality protection in India is generally inconsistent and uncoordinated. It is important for groundwater management that responsibilities are clearly defined, coordinated and accepted by each agency. Furthermore, there is a "duty of care" responsibility on all agencies to act upon the information they receive.

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