Falling Water Tables and Groundwater Sustainability in India

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Freshwater is a vital resource for which there is no substitute. Most of the freshwater on Earth is locked in ice caps, but of the remaining available freshwater more than 90% is below ground. Compared to surface water bodies, groundwater is relatively protected from contamination by overlying soils and geologic sediments. Thus, groundwater resources are ideal for human consumption. India's human population is more than 1 billion with an annual growth rate of approximately 1.9% (Census of India 2001). The people of India depend upon groundwater resources for survival. Yet, water tables are falling at an alarming pace across India, threatening the future of India's water supply with significant human and ecological impacts already evident.

For example, in Andhra Pradesh, a southern state of India (*Figure 1*), the groundwater in 26 of 46 *mandals* (similar to counties in the USA) are characterized as 'overexploited' (CGWB, 2006). India's Central Groundwater Board cites as reasons for this stress increasing population, deficient monsoons, unregulated wells, and economic pressures such as farmers' dependency on loans for costly agricultural inputs and fluctuations of product value on international markets (CGWB, 2006). Poverty stricken sectors of society cannot afford the technology required to compensate for dropping water tables (Postel, 1999). In some cases, farmers have taken their own lives due to these compounding stresses. The direct connection of suicide to water scarcity is not certain, for knowing the reason why any individual commits suicide is inherently difficult. However, an epidemic of farmer suicides—3,000 reported incidents in Andhra Pradesh alone—has inflicted many rural communities throughout the nation (Walden, 2004).

Falling water tables are also compounding the fluorosis epidemic in India. Fluoride is a common component of geologic materials underlying much of India. Fluorosis, a medical condition caused by over-consumption of fluoride, has health effects that range from stiff joints to cancer. As groundwater levels continuously decline, villagers are forced to drill wells past safe surface zones into the portions of aquifers that house toxic waters. India's Fluorosis and Rural Development Foundation now estimates 60 million people currently suffer some degree of the disease (Pearce, 2006).

Human-induced declines in aquifer levels also break surface-groundwater hydrologic connections. In the Maheshwaram watershed of Andhra Pradesh chronic depletion of groundwater has lowered the water table 15 m below the ground surface such that springs and streams formerly fed by groundwater have disappeared (Maréchal et al., 2006). The traditional 'tank' system of collecting surface runoff used by Indian farmers for hundreds of centuries is also disappearing. When subsurface soils and aquifers are at maximum water-holding capacity rainwater cannot infiltrate and will thus collect along the surface of a landscape. Ancient canals and spillways that follow natural drainage patterns direct seasonal floodwaters across the landscape into large reservoirs (tanks) semi-circumscribed by earthen dams that Indian farmers use to store overflow collected during the monsoon season for use during the dry season. However, as groundwater is extracted over time subsurface storages are continuously depleted, causing greater proportions of rainfall to infiltrate rather than run off the landscape into rivers and streams—or tanks. The falling water tables are reducing the tank structures characteristic of India's agrarian society to archeological relics (Figure 2). Similarly, shallow wells that previously provided built in risk management during years of monsoon deficits no longer intercept the water table (Figure 3).

The traditional system of 'chain tanks' previously ensured one region's deficient reservoirs to be filled by the surplus of another. The interdependence, illuminated by the tank system, among villagers has become threatened by inequitable distribution of water and power (Gunnell and Krishnamurthy, 2003). Farmers increasingly drill borewells from which water is sold to outside consumers. Even those who recognize that pumping water day and night is collectively threatening future livelihoods often feel as though they have no other option (Pearce, 2006). In a classic Tragedy of the Commons example, these farmers know that if they slowed their production, neighbors would continue to pump groundwater.

Indian government officials have recognized rampant groundwater overuse. Introduced in 2002, The National Water Policy stipulates that the total quantity of the nation's groundwater pumped out must be limited to annual recharge. India's Ministry of Water Resources recently assessed national groundwater resources, but found current data significantly lacking in vast areas of the country (CGWB, 2006). While farmers around the country report having to drill deeper every few years to reach ever receding groundwater, little national-scale data is available to accurately assess groundwater reserves and extraction and recharge rates.

For India's future generations to be ensured of a reliable water supply, sustainable management practices must be implemented to preserve the nation's dwindling groundwater resources. A critical first step in resource management is assessing the resource availability and rates of consumption and replenishment. India must develop a nationally integrated hydrologic monitoring network to improve the quantity and quality of available data. Without reliable hydrologic data, sustainable limits on groundwater use will be impossible not only to establish, but to implement and enforce. For the one billion people of India, though hidden from the naked eye, groundwater depletion is a real and serious issue deserving of political and humanitarian attention. Eradicating falling water tables requires collective implementation of both direct regulations and indirect measures. Such strategies include new agricultural regimes characterized with climate appropriate cultivars, allocation of water resources based on volumetric measures, and the implementation of energy tariffs to curb excess pumping. Water resource assessments should also be repeated often so that targets will be kept up to date and a resource base for future generations may be maintained.

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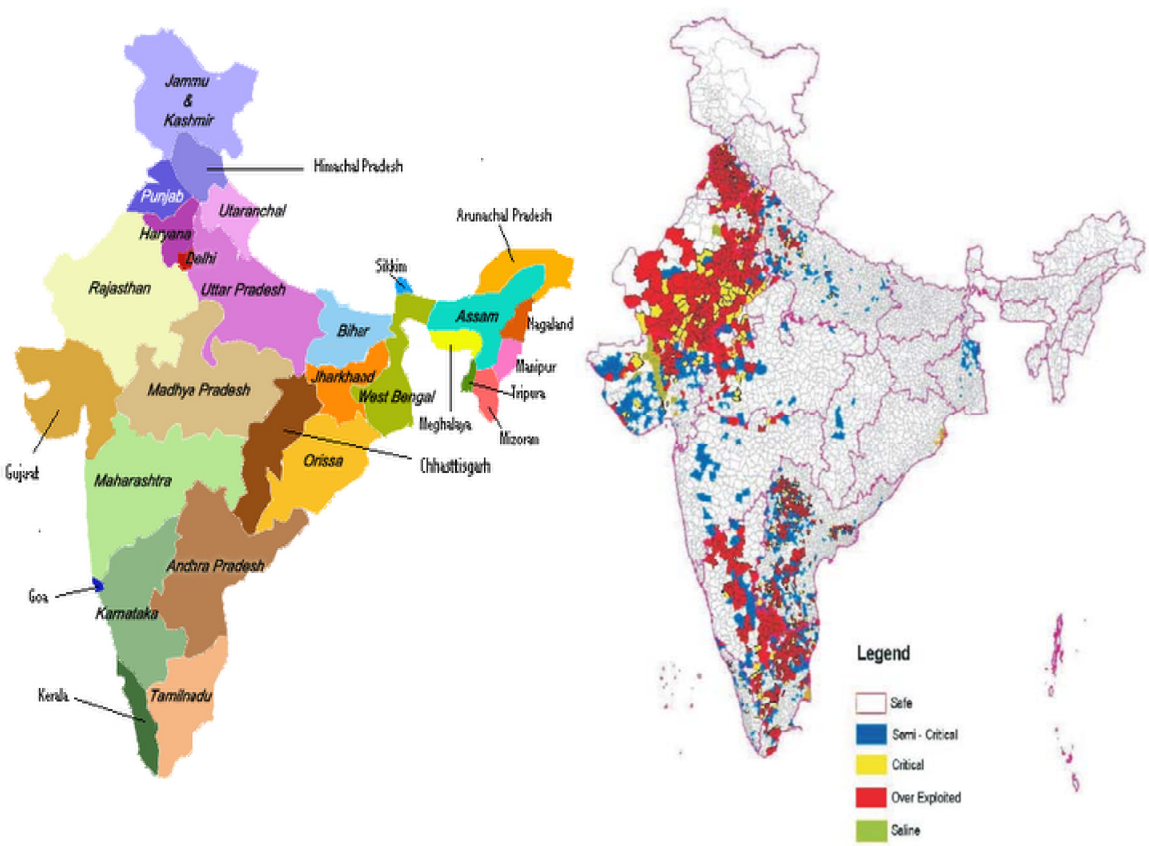

Figure 1. Indian state boundaries (left) and the extent of water scarcity (right) due to exploitation of groundwater resources reported as ranging from 'safe' to 'over exploited' (CGWB, 2006).

Figure 2. A naturalized, abandoned tank in Andhra Pradesh, India (author photo).

Figure 3. A south Indian dug well gone dry, now left in ruin (author photo).