

Ground Water–Prospects, Issues and Management in India

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Abstract—Groundwater is one of the most valuable natural resources, which supports human health, economic development and ecological diversity. Overexploitation and unabated pollution of this vital resource is threatening our ecosystems and even the life of future generations. On the other hand, there are areas in the country, where ground water development is sub-optimal in spite of the availability of sufficient resources, and canal command areas suffering from problems of water logging and soil salinity due to the gradual rise in ground water levels. The irrigation sector remains the major consumer of ground water, accounting for 92% of its annual withdrawal. The development of ground water in the country is highly uneven and shows considerable variations from place to place. Management of ground water resources in the Indian context is an extremely complex proposition. The highly uneven distribution and its utilization make it impossible to have single management strategy for the country as a whole. Any strategy for scientific management RS (remote sensing) and GIS (geographic information system) of ground water resources should involve a combination of supply side and demand side measures depending on the regional setting. There is urgent need for coordinated efforts by various Governments and non-governmental agencies, social service organizations and the stakeholders for evolving implementable plan for effective management of this precious natural resource.

Keywords: Groundwater, Management, Irrigation, soil salinity.

1. INTRODUCTION

Groundwater has emerged as the primary democratic water source and poverty reduction tool in India's rural areas. On account of its near universal availability, dependability and low capital cost, it is the most preferred source of water to meet the requirements of various user sectors in India. Ground water has made significant contributions to the growth of India's Economy and has been an important catalyst for its socio economic development. Its importance as a precious natural resource in the Indian context can be gauged from the fact that more than 85 percent of India's rural domestic water

requirements, 50 percent of its urban water requirements and more than 50 percent of its irrigation requirements are being met from ground water resources. The increasing dependence on ground water as a reliable source of water has resulted in its large-scale and often indiscriminate development in various parts of the country, without due regard to the recharging capacities of aquifers and other environmental factors.

The unplanned and non-scientific development of ground water resources, mostly driven by individual initiatives has led to an increasing stress on the available resources. The adverse impacts can be observed in the form of long-term decline of ground water levels, de-saturation of aquifer zones, increased energy consumption for lifting water from progressively deeper levels and quality deterioration due to saline water intrusion in coastal areas in different parts of the country. On the other hand, there are areas in the country, where ground water development is still at low-key in spite of the availability of sufficient resources, similarly the canal command areas suffer from problems of water logging and soil salinity due to the gradual rise in ground water levels.

The estimated groundwater accounts for more than 95% of all fresh water available for use. Approximately 50% of Indians obtain all or part of their drinking water from groundwater. Nearly 95% of rural residents rely on groundwater for their drinking supply. About half of irrigated cropland uses groundwater. Approximately one third of industrial water needs are fulfilled by using groundwater. About 40% of river flow nationwide (on average) depends on groundwater. (Das., 2006).

2. TYPES OF GROUNDWATER:

Groundwater is the water that saturates the tiny spaces between alluvial material (sand, gravel, silt, clay) or the crevices of fractures in rocks.

Aeration zone: The zone above the water table is known as the zone of aeration (unsaturated or vadose zone). Water in the soil (in the ground but above the water table) is referred to as soil moisture. Spaces between soil, gravel and rock are filled with water (suspended) and air.

Aquifer: Most groundwater is found in aquifers—underground layers of porous rock saturated from above or from structures sloping toward it. Aquifer capacity is determined by the porosity of subsurface material and its area. Under most of the Indian conditions, there are two major types of aquifers: confined and unconfined.

Capillary water: Just above the water table, in the aeration zone, is capillary water that moves upward from the water table by capillary action. This water can move slowly in any direction, from a wet particle to a dry one. While most plants rely on moisture from precipitation in the unsaturated zone, their roots may also tap into capillary water or the saturated zone.

Confined aquifers: (also known as artesian or pressure aquifers) exist where the groundwater system is between layers of clay, dense rock, or other materials with very low permeability.

Evapotranspiration: Water returned to the atmosphere by evaporation from water and land surfaces, and by the activity of living plants.

Hydrologic cycle: Complete cycle through which water passes from the atmosphere and, eventually, returns to the atmosphere.

Saturation zone: The portion that's saturated with water is called the zone of saturation. The upper surface of this zone, open to atmospheric pressure, is known as the water table (pyretic surface).

Unconfined aquifers: More common than confined aquifers, unconfined aquifers have a permeable deposit that leads into the aquifer. Water may have arrived by percolating through the land surface. This is why water in an unconfined aquifer is often very young, in geologic time. The top layer of the aquifer is also the water table. Thus, it's affected by atmospheric pressure and changing hydrologic conditions.

Vadose zone: The area of soil and rock just above the water table.

Water-bearing rocks: Several types of rocks can hold water, including...Sedimentary deposits (i.e. sand and gravel), Channels in carbonate rocks (i.e. limestone), Lava tubes or cooling igneous fractures in igneous rocks and fractures in hard rocks

3. THREATS TO GROUNDWATER:

QUANTITY:

To meet demands of a growing population and other uses, an increased amount of groundwater has been used. Some typical threats to water quantity include overdraft, drawdown, and subsidence.

Overdraft: Generally, any withdrawal in excess of safe yield (the amount that can be withdrawn without producing an undesirable result) is an overdraft. This can result of permanent loss of a portion of its storage capacity and gradual change that can cause water of unusable quality to contaminate good water. In coastal basins, salt water intrusion can occur.

Drawdown: This differs significantly from overdraft. Results in a temporarily lowered water table generally caused by pumping. In this situation, water table recovers when supply is replenished.

Subsidence (sinkhole): This is one dramatic result from over pumping. As the water table declines, water pressure is reduced. This causes fine materials that held water to become compacted. In addition to permanently reducing storage capacity, land above the aquifer can sink ... from a few inches to several feet.

4. QUALITY:

Inorganic compounds, pathogens and organic compounds can negatively affect water quality. Nutrients (nitrogen and phosphorus) and heavy metals are two examples.

Nitrates can cause problems in drinking water or marine waters. Phosphorus can reduce uses of fresh surface waters. Heavy metals include selenium, arsenic, iron, manganese, cadmium and chromium and others are in excess quantities very harmful for human health. Pathogens including bacteria and viruses, have been attributed for more than 50% of the waterborne disease outbreaks in the U.S. *Cryptosporidium parvum* and *Giardia* both commonly cause illnesses when consumed. Organic Compounds include Volatile Organic Compounds (VOCs) like benzene, toluene, xylene, etc.; and Semi-Volatile Organic Compounds (SVOCs) like naphthalene and phenol; PCB's and pesticides. Petroleum stored in underground storage systems is one of the greatest threats to groundwater quality. Agricultural pest, nutrient and manure management practices can also threaten groundwater quality. Potential contamination depends on the type, method, amount, and timing of application, soil qualities, and hydrologic conditions. Using management practices can dramatically reduce risk of contamination.

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5. MANAGEMENT:

There are many, many tools that can be used to manage groundwater resources. **Zoning:** Regulations used to segregate different, and possibly conflicting, activities into different areas of a community. This approach can be limited in its ability to protect groundwater due to grandfathering provisions.

Overlay Water Resource Protection Districts: These ordinances and bylaws are similar to zoning regulations in their goals of defining the resource by mapping zones of contributing boundaries and enacting specific legislation for land uses and development within these boundaries.

Prohibition of Some Land Uses: These are not typically considered very creative tools. However, prohibition of land uses such as gas stations, sewage treatment plants, landfills, or the use/storage/transport of toxic materials is a first step towards the development of a comprehensive groundwater protection strategy.

Special Permitting: The special permitting process can be used to regulate uses and structures that may potentially degrade water and land quality.

Large Lot Zoning: Large lot zoning seeks to limit groundwater resource degradation by reducing the number of buildings and septic systems within a groundwater protection area.

Growth Control/Timing: Growth controls are used to slow or guide a community's growth, ideally in concert with its ability to support growth. One important component is in regards to groundwater's carrying capacity.

Performance Standards: This assumes that any given resource has a threshold, beyond which it deteriorates to an unacceptable level. Performance standards assume that most uses are allowable in a designated area, provided that the use or uses do not and will not overload the resource. With performance standards, it is important to establish critical threshold limits as the bottom line for acceptability.

Underground Storage Tanks: Three additional protection measures are often adopted to enhance local water resource protection, include: Prohibit new residential underground storage tanks, Remove existing residential underground storage tanks, and Prohibit all new underground storage tank installation in groundwater and surface water management areas.

Conservation Easements: Conservation easements allow for a limited right to use the land. Easements can effectively protect critical lands from development.

Well Construction/Closure Standards: A direct conduit to groundwater, standards for new well construction as well as identification and closure of abandoned wells can make a big difference.

6. CONCLUSION:

The highly diversified hydro geologic settings and variations in the availability of ground water resources from one part of the country to other call for a holistic approach in evolving suitable management strategies. The emphasis on management needs does not imply that ground water resources in India are fully developed. Effective management of available ground water resources requires an integrated approach, combining both supply side and demand side measures. Though, groundwater development for irrigation is feasible in these areas based on hydrogeological and environmental considerations, there is often a great economic barrier for the predominantly small and marginal farmers. A multitude of mechanisms have been developed or have emerged in these areas to enable farmers to benefit from ground water. Assured power supply is one of the key factors, the tariff, access and availability of which to a large extent determines the ground water use. Since the ground water development is mostly demand driven, it can be geared up through proper agricultural, credits, subsidy and energy support policies along with creation of suitable markets. In addition, the flood plains along the major river courses of the country offer good scope for groundwater development. There is urgent an need for coordinated efforts from various Central and State Government agencies, non-Governmental and social service organizations, academic institutions and the stakeholders for evolving and implementing suitable ground water management strategies in the country.

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