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Ground Water Quality and Quantity

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ABSTRACT

The world's population is facing a water crisis, which is expected to worsen dramatically during the 21st century. Problems due to over exploitation of groundwater, as well as from natural and anthropogenic contamination are major challenges facing humanity. This Special Issue contributes a selection of topics on groundwater quantity and quality issues that face different parts of the world.

Keywords—Groundwater, Quality, Quantity,Contamination,Challenges,Irrigation,DrinkingWater

I. INTRODUCTION

Groundwater has playeda significant role in the maintenance of India's economy, environment, and standard of living. India is the largest groundwater user in the world. Through the construction of millions of private wells, there has been a phenomenal growth in the exploitation of groundwater in the last five decades. The factors driving this expansion include poor public irrigation and drinking water delivery, new pump technologies, the flexibility and timeliness of groundwater supply, and government electricity subsidies. As a result, 29 percent of the groundwater assessment blocks in the country are classified in semi-critical, critical, or overexploited categories with the situation deteriorating rapidly. The government has no direct control over the groundwater use of millions of private well owners, both in rural and urban areas. In part, this is due to the absence of a systematic registering of wells with attached user rights and metering. In an indirect way, groundwater use is also sometimes limited through power shedding with limited hours of electricity supply, especially in rural areas.

II. HOW GROUND WATER OCCURS?

It is difficult to visualize water underground. Some people believe that ground water collects in underground lakes or flows in underground rivers. In fact, ground water is simply the subsurface water that fully saturates pores or cracks in soils and rocks. Ground water is replenished by precipitation and, depending on the local climate and geology, is unevenly distributed in both quantity and quality. When rain falls or snow melts, some of the water evaporates, some is transpired by plants, some flows overland and collects in streams, and some infiltrates into the pores or cracks of the soil and rocks. The first water that enters the soil replaces water that has been evaporated or used by plants during a preceding dry period. Between the land surface and the aquifer water is a zone that hydrologists call the unsaturated zone. In this unsaturated zone, there usually is at least a little water, mostly in smaller openings of the soil and rock; the larger openings usually contain air instead of water. After a significant rain, the zone may be almost saturated; after a long dry spell, it may be almost dry. Some water is held in the unsaturated zone by molecular attraction, and it will not flow toward or enter a well. Similar forces hold enough water in a wet towel to make it feel damp after it has stopped dripping. After the water requirements for plant and soil are satisfied, any excess water will infiltrate to the water table--the top of the zone below which the openings in rocks are saturated. Below the water table, all the openings in the rocks are full of water that moves through the aquifer to streams, springs, or wells

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from which water is being withdrawn. Natural refilling of aquifers at depth is a slow process because ground water moves slowly through the unsaturated zone and the aquifer. The rate of recharge is also an important consideration. It has been estimated, for example, that if the aquifer that underlies the High Plains of Texas and New Mexico--an area of slight precipitation--was emptied, it would take centuries to refill the aquifer at the present small rate of replenishment. In contrast, a shallow aquifer in an area of substantial precipitation may be replenished almost immediately.

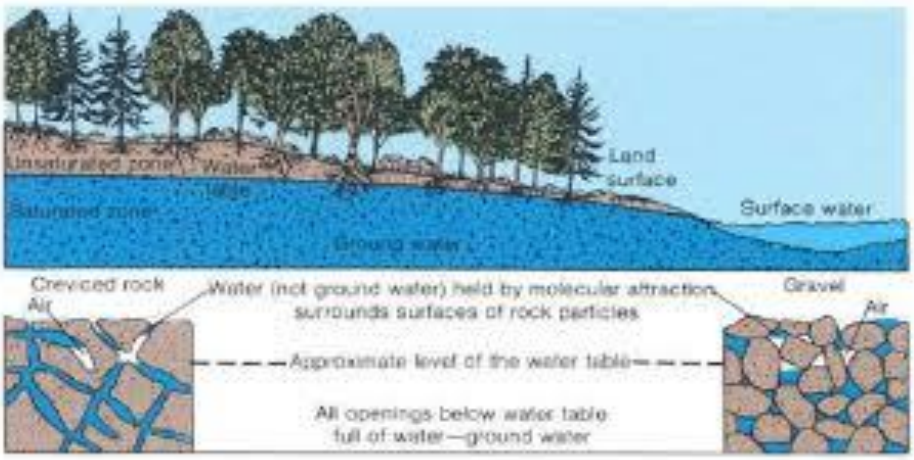

Fig.1 Shows occurrence of Ground Water

III. GROUND WATER QUALITY

For the Nation as a whole, the chemical and biological character of ground water is acceptable for most uses. The quality of ground water in some parts of the country, particularly shallow ground water, is changing as a result of human activities. Ground water is less susceptible to bacterial pollution than surface water because the soil and rocks through which ground water flows screen out most of the bacteria.

Water is a solvent and dissolves minerals from the rocks with which it comes in contact. Ground water may contain dissolved minerals and gases that give it the tangy taste enjoyed by many people. Without these minerals and gases, the water would taste flat. The most common dissolved mineral substances are sodium, calcium, magnesium, potassium, chloride, bicarbonate, and sulfate. In water chemistry, these substances are called common constituents. Water typically is not considered desirable for drinking if the quantity of dissolved minerals exceeds 1,000 mg/L (milligrams per liter). Water with a few thousand mg/L of dissolved minerals is classed as slightly saline, but it is sometimes used in areas where less-mineralized water is not available.

Ground water, especially if the water is acidic, in many places contains excessive amounts of iron. Iron causes reddish stains on plumbing fixtures and clothing. Like hardness, excessive iron content can be reduced by treatment. A test of the acidity of water is pH, which is a measure of the hydrogen-ion concentration. The pH scale ranges from 0 to 14. A pH of 7 indicates neutral water; greater than 7, the water is basic; less than 7, it is acidic. A one unit change in pH represents a 10-fold difference in hydrogen-ion concentration. For example, water with a pH of 6 has 10 times more hydrogen-ions than water with a pH of 7.

IV. GROUND WATER QUANTITY

On the earth, approximately 3% of the total water is fresh water. Of this groundwater comprises 95%, surface water 3.5% and soil moisture 1.5%. Out of all the fresh water on the earth, only 0.36% is readily available to use. Groundwater is also affected by water engineering: for decades and centuries, through improper disposal of wastes to the environment and subsurface areas many ground water have become contaminated. Efforts to protect the quality and quantity of groundwater have been made by cooperation between all government agencies, industrial parties and researchers.

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V. WHAT INFLUENCES GROUND WATER QUALITY?

5.1 Natural Condition

Variations in ion concentration determine water quality. As water moves down through the soil, it dissolves various minerals, which increase the water's ion concentration. Water containing iron may stain plumbing fixtures and laundry. People often compare the taste of water toiron and the smell of water to rotten eggs.These characteristics are determined by the amount of iron and sulfur ions.Water can also be described as hard or soft. Hard water has high concentrations of calcium and magnesium ions. Excessive hardness will leave solid deposits in water pipes and prevent soap from lathering. Soft water usually has high concentrations of sodium ions and allows soap to lather easily. Variations in ionconcentration determine water quality.

5.2 Human activities

Human activities influence ground water quality primarily through contamination. Groundwater contamination occurs when products such as road salts, gasoline, oil and chemicals get into the groundwater making it unsuitable for human use. Major sources of groundwater contaminants include landfills, septic systems, abandoned water wells and excessive fertilizer use. Contamination of groundwater is difficult to detect in early stages Prevention is achievable through a combination of actions including:

•Public awareness programs
•Groundwater monitoring
•Identifying highly susceptible aquifers
•Developing and following best management practices
•Proper site selection for activities and industries using hazardous chemicals
•Enhanced containment for storage of wastes and chemicals on vulnerable soils
•Reducing chemical use wherever possible
•Responding quickly to spills
•Proper construction, maintenance and plugging of water wells

5.3 Urbanization

Urbanization in India began to accelerate after independence,due to the country's adoption of a mixed economy, which gave rise to the development of the private sector. Urbanization is taking place at a faster rate in India. Population residing in urban areas in India, according to 1901 census, was 11.4%. This count increased to 28.53% according to 2001 census, and crossing 30% as per 2011 census, standing at 31.16%.According to a survey by UN State of the World Population report in 2007, by 2030, 40.76% of country's population is expected to reside in urban areas.As per World Bank, India, along with China,Indonesia,Nigeria, and the United States, will lead the world's urban population surge by 2050.

Urban Population in India

Urbanization in India from 2005 to 2015 and details the percentage of the entire population, living in urban areas.

Year	**Share of Urban Population**
2005	29.24
2006	29.57
2007	29.91
2008	30.25
2009	30.59
2010	30.93
2011	31.28
2012	31.63
2013	31.99
2014	32.37
2015	32.75

VI. COMMON GROUNDWATER CONTAMINANTS

1) Nitrates: Dissolved nitrate is most common contaminant in groundwater. High level can cause blue baby disease

(Methamoglobinamia) in children, may form carcinogens

& can accelerate eutrophication in surface waters. Sources of nitrates include sewage, fertilizers, air pollution, landfills & industries

2) Pathogens: bacteria & viruses that cause water borne diseases such as typhoid, cholera, dysentery, polio, and hepatitis. Sources include sewage, landfills, septic tanks & livestock's;

3) Trace metals: include Lead, Mercury, Cadmium, Copper, Chromium & Nickel. These metals can be toxic & carcinogenic. Sources include industrial & mine discharges, fly ash from thermal power plants either due to fall out or disposal in ash ponds. Industrial solid waste dumping and leaching into groundwater through rainwater;

4)Inorganic Constituents: Inorganic dissolved salts accumulation such as SO4, Chloride, etc. along with Na, K, building up high dissolved solids and combination of Carbonates, Bicarbonates along with Ca and Mg building up high hardness of water and converting soft/sweet water in to hard water creating gastrointestinal problems in human being if they consume groundwater as drinking source

5) Organic compounds: include volatile & semi-volatile organic compounds like petroleum derivatives, PCBs pesticides. Sources includes agricultural activities, street drainages, sewage landfills, industrial discharges, spills, vehicular emissions fall out etc.

VII. METHODOLOGY

7.1 Aquifer Mapping and Aquifer based Ground Water Management

- The National Programme of Aquifer Mapping and Aquifer based Management be taken-up on a big scale for management of ground water resources.
- In future, strategy for execution of schemes related to ground water resource planning, exploitation, use and conservation will depend upon area-specific aquifer management plans.

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7.2 Optimum Use of Ground Water and Planned Management of its exploitation.

• To protect ground water resources in the state, concrete interventions need to be applied for promoting its judicious, optimum and efficient use and also for its planned development/abstraction.

• Separate management interventions for urban & rural areas are suggested for implementation in the policy document.

7.3 Rain Water Harvesting and Ground Water Conservation/Recharge

• It has become imperative that the recharge schemes be implemented in an integrated manner based on geo -scientific norms, so that ground water situation could improve.

• Comprehensive recharge plans for ground water stressed major cities will be prepared.

• Roof top rain water harvesting system on buildings along with 'Combined Recharge System' will be implemented on priority.

• Effective system for enforcement and monitoring of various mandatory provisions related to ground water recharging will be implemented.

• In rural areas, Integrated recharge plans will be prepared to bring over-exploited/critical blocks of the state into safe category.

• Emphasis will be given to saturate each micro watershed of Bundelkhand-Vindhyans by different recharge structures.

7.4 Setting Ground Water Regulation Process

• For regulated & controlled exploitation of ground water resource and its harvesting/conservation in the state, formulation of practical and acceptable regulation process be considered separately for both urban and rural areas. Continuous Monitoring of Ground Water Quality and Environment Protection

• An integrated action plan for mapping of ground water quality be prepared by the Ground Water Department. On this basis, GIS based comprehensive mapping of ground water quality will be carried-out with the co-ordinated efforts different concern department.

7.5 Ground Water Study and Research

• New investigations and research studies in ground water sector will be Promoted Establishment of high level “Ground Water Research and Training Institute", as a Centre of Excellence in the state will be considered for promoting the advanced researches and studies in ground water sector.

7.6 Management of Ground Water Data

• Organized approach for collection and analysis of reliable data of ground water resources available with different departments will be ensured.

• To ensure effective management of ground water data in the state, a GIS based efficient “Ground Water Data Bank and Information System” (State Ground Water Informatics Centre) will be developed, as per the need of various sectors.

7.7 District-wise Water Management Plan

• “Water Management Plan” will be prepared for every district based on the local hydrogeological conditions, which will be separate for urban as well as rural areas. Training, Publicity-Extension and Public Awareness

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- For extensive ground water awareness, schemes will be prepared for propagating message of ground water conservation by launching large scale movement from "Panchayat to Panchayat" in rural areas and from "School to School" in urban areas.
- At government and non-government level, the capacity building and training programmes would be conducted in an effective manner. Strengthening of Existing Institutional System
- The need is to establish a well-defined institutional structure for ground water sector in the state.
- For new challenges of ground water, the Ground Water Department shall be strengthened with a new vision.

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