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Ground Water Management: Need for Sustainable Approach

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Groundwater constitutes about 89% of the total fresh water resources in the planet. But in recent years, due to over exploitation of ground water and erratic nature of monsoon, there has been depletion of ground water across the world. Depletion of ground water has reached to the extent that it is virtually impossible to get the water table back. Even though there is a possibility of recharge of water from the other areas, the process is very slow and may take one year to replenish one meter. In view of this management of ground water has become one of the most significant issues in recent times. Added to it, there are also environmental problems such as aqua for mining, salt water intrusion, stream base flow reduction etc. For several reasons the efficient management of ground water resources through market mechanism has become difficult.

Against this context the present article attempts to analyze the need for sustainable ground water management in India. The article also briefly discusses the concept of sustainable ground water management, factors affecting ground water availability, different approaches towards developing and using available ground water with out adversely affecting the hydro-geological balance. Further, the paper highlights strategies for sustainable groundwater management, including development of aquifers, rainwater harvesting and artificial recharge methods. The article offers some relevant policy recommendations for sustainable groundwater management in India.

Significance of Groundwater Management

Sub-Surface water, or groundwater, is fresh water located in the pore space of soil and rocks. It is also water that is flowing within aquifers below the water table¹. It has been estimated that out of about 790 billion cubic meter of water that seeps into the soil, about 430 billion cubic meter remains in the top soil layers, and produces soil moisture which is essential for growth of vegetation. The remaining 360 billion cubic meters percolates into the porous strata and represents the actual enrichment of underground water. Out of this the water that can be extracted economically is only about 255 cubic billion meters. Thus sustainable groundwater management plays significant role in overall development of a country.

Groundwater is the primary source of water for drinking and irrigation. It is a unique resource, widely available, providing security against droughts and yet closely linked to surface water resources and the hydrological cycle. Its reliable supply, uniform quality and temperature, relative turbidity and pollution free, minimal evaporation losses, and low cost of development are attributes making groundwater more attractive when compared to other sources. Yet, at the same time population and economic growth have

¹ www.wikipedia.org

led to ever more demands on the world's groundwater resources and in many countries there are already significant impacts due to inadequately-regulated groundwater pumping and/or from pollution due to inadequate management. Especially in developing countries, these trends can lead to large socioeconomic costs, often for the poor².

With rapid growth in population, urbanization, industrialization and competition for economic development, groundwater resource has become vulnerable to depletion and degradation. Management of this valuable resource is determined by its accessibility and utilizability in terms of quantity and quality. Due to imbalance between demand and availability, management approaches are facing various ethical dilemmas. For an effective, efficient and sustainable groundwater resources development and management, the planners and decision makers have future challenges to assess the inextricable logical linkages between water policies and ethical consideration. Ground water being a hidden resource is often developed without proper understanding of its occurrence in time and space. Thus ground water management on scientific lines is the key for sustainability of this vital resource.

Groundwater Management in India: Major Issues

Ground water and its proper use assume great significance for a country like India. Unfortunately there is no accurate survey of ground water resources but, according to the estimate of National Commission for Commission on Agriculture, India's groundwater resources would be about 300 million hectare meters or about 10 times the annual precipitation. The annual exploitable potential is put at 45 million hectare meters. With the introduction of the new agricultural strategy in the early 1960s, there was an increasing use of tube-wells. Though in 1960, only one per cent of the net irrigated land received tube-well irrigation, by 1988 about 27% of the net irrigated area got the benefit of tube-well irrigation. By 2001, demands for industrial water also raised about 151 billion liters per day. The government initiatives to popularize deep bore wells for getting more water has lead to water tables to go down and. At the same time there was not much interest and initiative in favor of recharging the groundwater. Groundwater being a dynamic and replenisable resource has to be estimated primarily based on the component of annual recharge which could be subjected to development by means of suitable structures and which could be depend on the hydro-geological and climatic conditions.

In India, data on ground water levels are not widely published or made available outside government organizations. Extraction and recharge estimates are also unreliable. As a result, discussions on ground water depletion are always based on unrealistic data. However, it is a fact that falling water tables and depletion of economically accessible ground water reserves have serious socio-economic consequences in an agrarian country like India. Competition between rural and urban users is increasing and leads to conflict over ground water usage. Falling water tables also increase division among communities. Poor farmers are forced to abandon irrigation as falling water tables limit access to those who can afford to deepen wells. Deep wells need more electricity and thus lead to

² www.worldbank.org/groundwater

increase in energy related economic cost also. More over depletion of water tables will pose a threat to food security. Assured irrigation is important for food production. As water tables decline, poor farmers find it difficult to meet the huge energy requirement for deepening wells which ultimately lead to decline in food production. Therefore it is needless to point out there is an urgent need for conservation of this vital resource for the preservation of environmental security and sustainable agricultural development.

Approaches to groundwater Management

The issue of groundwater management is multidimensional, related to reliable assessment of available water, its supply and scope for augmentation, distribution, reuse/recycling, its existing depletion, pollution, and its protection from depletion and degradation. However, like surface water resource management, not much concerted efforts have been made for management of the hidden complex underground water resources.

The two generally acceptable approaches towards groundwater management are the following:

Optimal yield: This method allows for the deliberate short-term controlled use of storage between recharge events.

Controlled over exploitation: This approach recognizes that some permanent depletion in storage may be necessary to promote socioeconomic development where recharge is very limited.

The management options of groundwater in urban areas are generally based on the patterns of groundwater use, and the responsibility remains largely with municipal supply utilities, as well as with individuals. Rural users generally abstract groundwater themselves through wells that they own and control. However, large-scale, publicly funded tube-well development tend to be supply driven; legal and regulatory provisions at national level cannot be policed adequately; and, enhancement of indirect recharge may work for shallow groundwater circulation, but recovery of deeper systems requires sophisticated injection and alternative sources of high-quality water³.

From among these characteristics, two broad types of management approaches for groundwater emerge: (i) approaches encompassing tools such as power pricing, subsidies for efficient technologies, economic policies that discourage water intensive crops, etc. and (ii) approaches dealing with specific aquifers on the basis of command and control management through a resource regulator. Whichever approach is adopted, the development and management of these resources must be based on an adequate knowledge of a clear aggregate status/situation of groundwater aquifer system and its replenishment. In the context of the impact of climate variability and spatial variability in drought, two major gaps in groundwater management emerge, with significant implications for sustainable development (i) inability to cope with the acceleration of degradation of groundwater systems by over-abstraction, and effective resource depletion

³ P.S.Datta, Groundwater Ethics for its sustainability, Current Science, September, 2005.

through quality changes (pollution, salinity), and (ii) failure to resolve competition for groundwater and aquifer services between sectoral uses and environmental externalities⁴.

Strategies of Groundwater Management

Understanding the importance of groundwater resources and the growing demand for it makes it impertinent to search for effective strategies for managing the groundwater. For an effective supply side management, it is essential to have full knowledge of hydro-geological controls that govern the yield and behavior of ground water levels under abstraction stress, the interaction of surface and ground water in respect of river base flow and changes in flow and recharge dates due to their exploitation. Ground water management policies there fore will need to address a multitude of issues including

- Management of supplies to improve water availability in time and space
- Management of demands including efficiency of water use, sectoral interaction with economic activities etc.
- Balancing competing demands and preservation of the integrity of water dependent eco system.

In demand side management socio economic dimension plays an important role involving managing the users of water and land. Mere regulatory interventions like water rights and permits and economic tools of water pricing etc cannot be successful unless the different user groups are fully involved. For effective management of groundwater resources there is a need to create awareness among the different water user groups and workout area specific plans for sustainable development. Thus ground water management not only requires proper assessment of available resources and understanding of interconnection between surface and groundwater system, but also actions required for proper resource allocation and prevention of the adverse effects of uncontrolled development of ground water resources⁵. Sustainable development and management of groundwater requires the following strategies:

1. Scientific Development of Ground water

Scientific development of ground water involves a proper understanding of the local groundwater availability, its behavior and demand centric development with scientific planning. The need for scientific development of groundwater under different hydro-geological conditions involves the following elements:

Development of Deep aquifers: In many parts of the country deep aquifers are not fully utilized or developed which lead to under utilization of available groundwater resources. This under utilization from deep aquifers in some of the states including Haryana, U.P and Punjab, has resulted in a near stagnant condition at depths and provided the necessary time factor for the deterioration in quality of ground water. It is evident that the deeper aquifers in alluvial areas are not fully developed in upper reaches and the unutilized groundwater in confined aquifers ultimately is lost to the saline aquifers

⁴ Ibid.

⁵ Dr. Saleem Romani, Ground water Management:A key for sustainability, CESS papers, 2005.

adjacent to the basin boundary. This development of deep aquifers is important for development and management of groundwater for sustainable use.

Development of ground water in non- developed areas: Policy makers often pay attention to the regions where groundwater development has great potential and neglect other areas with hidden potential. In India, the eastern and northeastern region is yet to develop groundwater properly. Naturally, small farmers find it difficult to increase agricultural production due to non availability of water. There is wide scope for development of groundwater in these areas which often faces floods during rainy seasons⁶.

Development of Flood plain aquifers: Flood plains are good reservoirs of ground water. Thus sustainable management of flood plain aquifers offers excellent scope for its development and additional requirement of water. The development of groundwater in Yamuna flood plain Area in Delhi is an example of scientific management of water resources. Over development of shallow aquifers in flood plains creates the necessary sub-surface space for augmentation of groundwater from the river flows during the monsoon. Induced management is an effective management tool to meet the gap of demand and supply in areas adjacent to rivers with active flood plains. Thus proper development of flood plain aquifer is impertinent for groundwater development and management⁷.

Development of groundwater in Water logged areas: The water logged areas in canals command offer scope for ground water development by lowering the water table up to 6 meters or more. The inferior quality of water can be mixed with canal water in a proportion acceptable for irrigation. Thus additional water for irrigation can be created and more over the lower water table will help in rainfall recharge in the area that will help in improvement of soil and water quality⁸.

Development of groundwater in Canal Commands: One of the effective strategies for sustainable ground water management is to use surface water in one area and utilize the recharge by development of groundwater in areas adjacent to canal commands. This would result not only in proper utilization of available water resources but also the pumpage from groundwater storage will provide a sub-surface drainage to the areas, which are likely to be water logged.

Apart from these development of groundwater in coastal areas also needs to be addressed for the proper utilization of water resources.

2. Artificial Recharge of Groundwater

Another effective strategy is augmentation of available groundwater resources through rain water harvesting and artificial recharge. It is estimated that annually about 36.4BCM of surplus surface runoff can be recharged to augment the ground water. In rural areas,

⁶ Ibid.

⁷ ibid.

⁸ Dr. Saleem Romani, Ground water Management:A key for sustainability, CESS papers, 2005

techniques of artificial recharge by modification of natural movement of water through suitable civil structures like Percolation tanks, Check dams, Nala Bunds, Gully Plugs etc. have been found feasible. The roof top rainwater harvesting structure is also feasible both by augmenting the groundwater storage as well as by storing it in specially built tanks⁹.

3. Regulation of groundwater Development

One of the important strategies for sustainable management of groundwater is regulation of groundwater development in critical areas. Over development of groundwater resources is increasingly being recognized as a major problem. The tendency towards over development of groundwater resources is rooted in the rapid spread of energized pumping technologies, resource characteristics, demographic shifts and government policies. There is very little efforts to check the over exploitation and regulation of ground water resource. At present the only actual management is by limiting NABARD funds in blocks classified as grey and dark. Gujarat has passed a ground water management Act for regulating and controlling use of groundwater. However it is not easy to implement the legislations with out people's support and awareness creation.

4. Ensuring water for agriculture

The major challenge is proper prioritization of water resource allocation without affecting the water tables and agricultural productivity. Thus any sustainable strategy should rely on the assessment of the actual water to be allotted for domestic use, agriculture and maintaining eco system balance. More specifically, it should focus on a cost effective analysis of using water for different use, adept and improver water productivity, irrigation efficiency and post harvest processing. Some of the effective approaches, which can be applicable in India, include:

1. Encourage the non-sensitive ground water users to switch from exploitation of high quality aquifer to bad quality groundwater for major groundwater use.
2. Restrict withdrawal of abstraction rights from industries that have not installed water-efficient technologies.
3. Provide subsidies for improving the efficiency of irrigation water use in peri-urban areas in exchange for groundwater abstraction rights.

4. Checking Contamination of Ground Water

There is urgent need to check the contamination level of groundwater the groundwater protection from pollution can be ensured by several ways including:

1. Preparing vulnerability maps, based on distribution of travel times, chemical parameters, types of topsoil, sub soil and land use.
2. Delineating and prioritizing areas of high groundwater vulnerability for main sewerage extension.
3. Locating of landfill facilities to areas of low ground water vulnerability

⁹ *ibid.*

4. Restricting residential development served by inciting sanitation
5. Restricting the disposal of industrial discharges to the ground in vulnerable areas through introduction of discharge permits and appropriate charging to encourage recycling and reduction.

Limitations of Existing Approaches

Though there exists various strategies for sustainable management of groundwater resources, it often fails to create any positive impact on the sustainable use due to number of reasons. Due to absence of any pricing mechanism and strict regulation, indiscriminate groundwater exploitation, its wasteful utilization and land disposal of wastes continued. Research on ground water use in socio- economic context being relatively small, the highly technical knowledge of the aquifer systems is of relatively little use for practical management purpose. Most of the hydro-geological and groundwater development research has been fragmented, technocratic and relates to groundwater flow and remediation. For practical management practices, it is impertinent to examine people's indigenous adaptive strategies, climate change response etc. However in the present scenario less attention has been paid to these areas. For valuation of groundwater, key elements that may be necessary to consider are: (i) The strategic value of groundwater located near 'high-value' uses such as urban or prime agricultural areas, as opposed to aquifers located in less strategic locations and (ii) aquifers with high-quality water that is not vulnerable to pollution and the types of uses.

Need for Sustainable Approach

Food security and environmental security are the principal global issues of 21st century. Despite the phenomenal advances made in agricultural technology, there are several regions of the country where food production has either not kept pace with the increase in population or has barely kept pace with the increase in population. Although stagnation and decline in agricultural production can be due to political and social reasons, degradation of soil and water resources and lack of appropriate technology to address the basic issue of resource mobilization and management may be the primary factors responsible for low agricultural productivity. Water scarcity and poor water quality are major concern in numerous countries, which mainly depend on agriculture for livelihood of the people. Fresh water availability is already a major factor in sustainable use of resources. The water scarcity is further accentuated by ground and surface water pollution. UNDP warns that world soils and land resources have an important impact on the potential risk of enhanced green house effect. So it is impertinent to note that sustainable water management plays a pivotal role in food security and environmental security in the present era characterized by increasing conflicts over water resources.

The various strategies on ground water management clearly shows that successful management of groundwater needs an interdisciplinary and holistic approach

incorporating all stakeholders, technocrats, hydro-geological conditions, local specific environmental issues, indigenous methods of water conservation and usage etc. To make groundwater management sustainable there should be effective policy framework considering all the multidimensional aspects of the issues of water scarcity and over exploitation. There is a need for proper legislation to make rainwater harvesting mandatory to public and private buildings especially in urban areas. Secondly, there should be awareness creation about the significance of recharging ground water among public through various media. Thirdly, all users of water should conduct a water audit to see how water can be saved and used. Fourthly, waste water can be effectively recycled and reused in facilitating ecological activities. Finally any scheme will not succeed in sustaining scarce resources unless the people and the local governments are motivated and trained. With community participation and adopting locally available techniques water conserving structures can transform the lives of millions. Thus taking into account all the constraints related to proper management and protection of ground water source vis-à-vis the action needed to be taken at different levels, a multipronged integrated approach with a well conceived mix of professional, technical administrative and legal steps and community participation would pay the way for achieving the need for laying a strong ecological foundation for ensuring sustainable management of ground water resources.

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