

ANALYSING DEPLETION OF GROUND WATER IN AGRICULTURE THROUGH EFFECTIVE POLICIES AND SUSTAINABLE OPTIONS- AN ECONOMICCASE STUDY

Abstract

Natural resources are the cornerstone for fulfilling the needs of life on earth perpetuating generations since times immemorial. They have been utilized by various life forms ever since their inception and particularly mankind has found the most use. With the passage of time and the enhancement of knowledge and experience, resource usage is proliferating which can lead to problems like overexploitation, that effects such as pollution and environmental degradation, etc. It also poses a threat to future generations who might have to compete with the increasing global population for resources. In the case of the agricultural sector, the most widely used natural resource is groundwater resource which is a predominant source of irrigation. In most of the countries, groundwater exploitation had become very rampant and hence legislations were brought to regulate its usage and conserve it for generations to come. India is the largest consumer of groundwater in the world and it faces challenges ahead. Hence this paper outlines the scenario of the existing groundwater resources in the global and Indian context and focused mainly on the policy options to conserve and sustain the water resources that bears of changing climate situations.

Keywords: Groundwater, Natural resource, Depletion, Conservation

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I. INTRODUCTION

Natural resources are the key to the sustainable features of life on earth which supports and fulfills the ecological, social, and economic demands of mankind thus making itself distinct. They are derived from nature and find major use in domestic, industrial, commercial, scientific, and cultural value systems. Natural resources come in various forms such as air, water, energy (wind, light, etc.), useful flora (Shrubs, Trees, and Medicinal Plants), minerals and fuels, etc. They function as a source of raw material, acting as a sink and assimilating the waste that emanates out of production and consumption and rendering life-supporting and recreational services. These natural resources can be classified into renewable and non-renewable resources.

II. ECONOMIC IMPORTANCE OF NATURAL RESOURCES

Natural resources and ecosystem services are a part of the real wealth of countries. They contribute to improving the social and economic indicators of a nation such as income, economic growth, development, social security, and poverty reduction. Sectors related to natural resources provide employment and are the source for sustenance of livelihoods in backward communities (OECD, 2011). The value of the ecosystem services provided by the functioning of the natural resource systems such as wetlands has immense potential in the improvement the standard of living of the people who are residing in the vicinity of those areas.

III. NATURAL RESOURCE DEPLETION IN AGRICULTURE

Resource depletion is the consumption of a resource faster beyond its rate of replacement. The value of a resource is dependent on its availability in nature and the cost of extracting the resource increases as the resource extraction increases. Agriculture, which is dependent on natural resources for its operations and production, is facing a threat to its production and sustenance due to the depletion of resources, especially water resources. In this scenario changing the climatic conditions pose a great challenge in the protection and preservation of these resources.

IV. WATER'S ROLE IN AGRICULTURE

Water is a critical input for agricultural production and plays an major role in food security. Irrigated agriculture represents 20% of the total cultivated land and contributes 40% of global food production (World Bank, 2022). Irrigated agriculture is comparatively twice as productive per unit of land as rainfed agriculture, thereby allowing for more production resources availability and crop diversification. The flow of water in agriculture is by both physical and virtual means which implies the utilization of water by the crops based on its requirements. The food-water-energy resources form a nexus thereby balancing its supply and demand become essential for production purpose.

Due to population growth, urbanization, and climate change, competition for water resources is expected to increase which will impact agricultural production. Population is expected to increase to over 10 billion by 2050, and irrespective of whether it is urban or rural, this population will need food and fiber to meet its basic necessities. However, future demand

for water by all sectors will require as high as 25 to 40% of water to be re-allocated from lower to higher productivity and employment activities, particularly in water-stressed regions. In most cases, such reallocation is expected to come from agriculture as it occupies the highest share of water utilization. As of now, agriculture accounts (on average) for 70% of global freshwater withdrawals and an even higher share of “consumptive water use” due to the evapo transpiration of crops (World Bank, 2022) (UNESCO, 2022).

V. GROUNDWATER RESOURCES

Groundwater is an important water resource located in the saturated zones underground wherein the upper surface of the saturated zone is known as water table. Groundwater is held in the pores and fractures of underground materials like sand, gravel, and other rocks, These rock materials are called aquifers (US Gov Science dept) and they remain for a long period from days to millennia. Groundwater can either flow naturally out of rock materials or can be pumped out (Figure 1). Groundwater supplies wells and aquifers for private, agricultural, and public use and it is used by more than a third of the world's population every day for their drinking water. The global share of groundwater consumption by sectors is represented in the figure as follows:

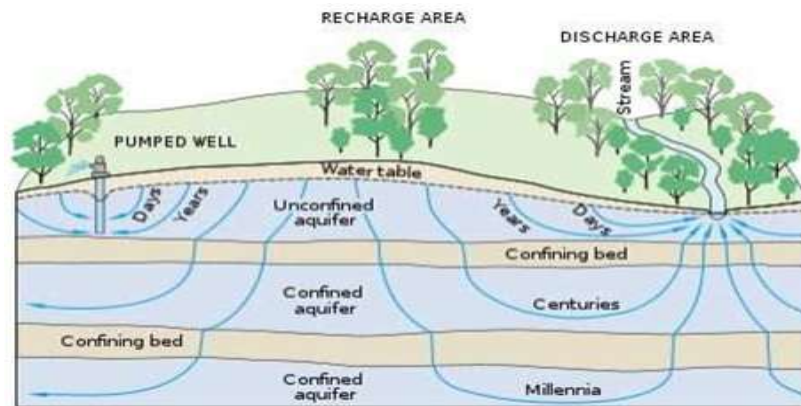


Figure 1: Water Table and the Ground Water Aquifers

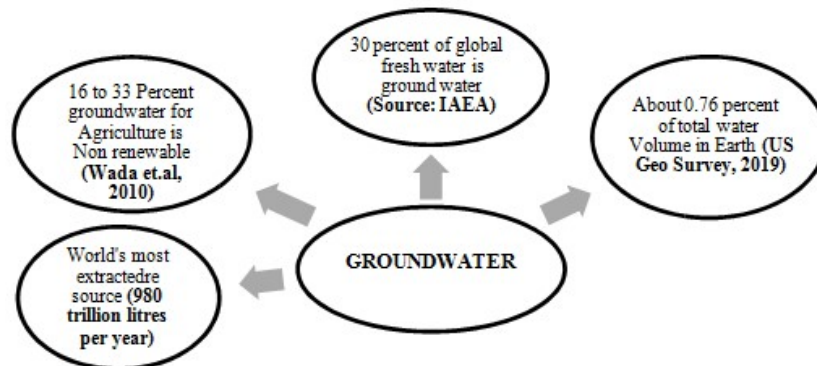


Figure 2: Factson Ground Water Usage

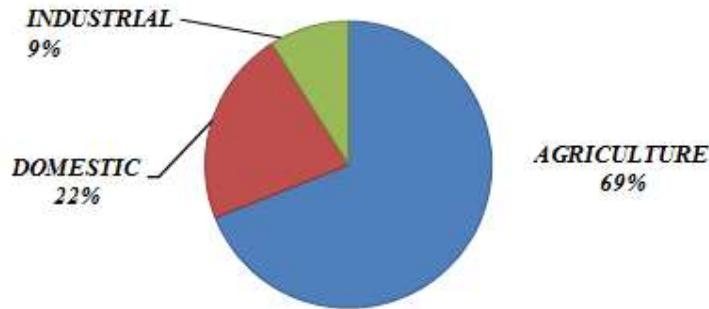


Figure 3: Share in Global Ground Water Consumption
(Source: UN Water Report, 2022)

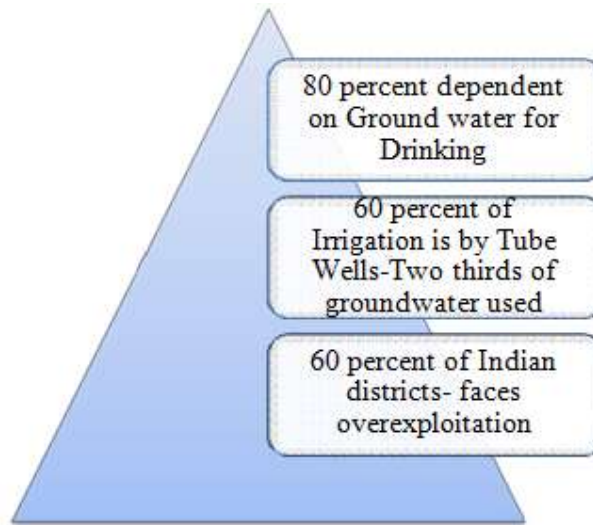


Figure 4: Ground Water Usage-Indian Scenario

It can be observe that in Figure 2 indicates agriculture occupies the top position in the consumption of groundwater followed by domestic (22%) and industrial sectors (9%). The figure-4 reveals the over-dependence of India on groundwater for its various sectoral water needs which stresses the need to optimize the use of groundwater resources.

Groundwater is considered to be a renewable resource but reaching a non-renewable state because less than 6% of the water around the world is replenished (**Emily Chung, 2015**). It is estimated that since 1960 groundwater extraction has more than doubled, which has increased groundwater depletion (**Wada et al, 2010**). Due to this increase in depletion, in some of the most depleted areas the use of groundwater for irrigation has become impossible or cost-prohibitive (**Konikow et al, 2005**). Overusing groundwater, old or young, can lower subsurface water levels and dry up streams, which could have a huge effect on ecosystems on the surface (**Emily Chung, 2015**). The depletion also causes a mismatch between the recharge of the groundwater table and the extraction. When the most easily recoverable fresh groundwater is removed, this leaves a residual factor with inferior water quality. This is a part

from induced leakage from the land surface, confined to layers, or adjacent aquifers that contain saline or contaminated water (**Konikow et.al, 2005**). In many places, seawater intrusion into the coastal aquifers is becoming a common phenomenon which is accelerated by over-exploitation of groundwater use and thereby rendering it unfit for usage.

Thus, there is a need to balance the demand and supply of groundwater resources for its long-term usage. The balance can be maintained by adhering to the following interventions: Augmenting the supply by strengthening the recharge sources and reducing the demand pressure by improving the water use efficiency are the focal points to be addressed like promotion of rainwater harvesting, creating more water storage structures and most importantly the conjunctive use of water. In agriculture, the frequent reduction in electricity subsidies in areas with abundant groundwater depletion can also help to solve the problem but overcoming the political obstacle is a key challenge to these changes (**Naresh et al., 2022**).

VI. CONJUNCTIVE USE OF WATER

Conjunctive use is the combined use of groundwater and surface water sources in a given irrigation command area which would increase the economic and environmental effects of each and also optimize the water demand and supply balance. A more planned conjunctive use and management of groundwater and surface water resources offers great potential for increasing water-supply security and water use efficiency for both irrigated agriculture and urban water supplies. Conjunctive water use management can be termed as a crucial intervention in the areas that were affected by changing the climate scenarios, especially in drought-affected areas; it provides a source of water for those people residing there. Rainwater harvesting and recharge irrigation structures like check dams, and percolation ponds are commonly linked with the surface and groundwater irrigation structures per and hence they play a major role in the recharging of the water sources.

Potential Benefits of Conjunctive Use of Groundwater and Surface Water Resources

Conjunctive usage of water has the benefits which are listed below:

1. It improves Water security.
2. The irrigated portion of the command area can be increased.
3. More precise water delivery.
4. Provides an opportunity to cultivate crops that produces high commercial value and may require precision irrigation.
5. Reduction of water logging and salinity issues in soil
6. Helps to reduce the salinity problem in the shallow aquifers to a particular extent.
7. Helps to increase the buffer space in the subsoil.
8. Better capacity to induce heavy rainfall and reduce flood runoff.
9. Increased Agricultural Production followed by Productivity. (**Jain, R.C,2016**)

VII. SUPPLY AUGMENTATION OF GROUND WATER RESOURCES

Some of the surface water resources that can be used to complement groundwater resources are tanks, canal systems, and small water reservoirs such as lakes, ponds, etc.

- 1. Tank Irrigation:** Tank irrigation systems capture monsoon runoff in the arid and semi-arid areas where they face the problem of water shortage. Apart from serving as a main source of irrigation, it also supports other sources by its supplementary and complementary role through the synergistic relationship of hydro-economic interactions.

In India, the largest number of tanks is found in the three southern states of Andhra Pradesh, Karnataka, and Tamil Nadu and the union territory of Pondicherry, which account for nearly 60 percent of India's tank-irrigated area (**Sivasubramanian K, 2006**). Thus tank systems provide ancillary support to the groundwater sources as they can take advantage of the local topography by the means of storing the surface water in a catchment area. They are also the storehouses of multi-functional ecological systems. Nowadays the tanks are declining due to various factors such as urbanization, encroachment of catchment areas, lack of proactive management, and neglect. So the policymakers should understand the various use values that these water resources offer and formulate effective measures to rationalize the resource allocation among the stakeholders who are competing for the usage of these common property water resources.

- 2. Demand Offset of Groundwater:** Offsetting the demand for groundwater resources is as important as recharging since it can bring efficiency in water usage and optimize production. Innovations in irrigation by the means of Drip and Sprinklers have reduced the wastage of water and proved to be an effective in increasing the productivity of the crops. Changes in cropping patterns by cultivation of less water dependent crops and farming methods like dry farming which involves very less utilization of water can also be followed and practiced to reduce the dependency on groundwater.

VIII. CONCLUSION

The changing scenario of climate change poses a great deal of challenges ahead in the conservation of natural resources especially in the case of water where the balance between the extraction and the recharge has become very wide due to the erratic shifts in the pattern of rainfall followed by sudden occurrences of droughts, cyclones, floods etc. Policymakers and stakeholders across the country must realize this alarming situation of the increase in scarcity of groundwater resources and without blaming each other for putting in this dire situation must work together and provide the necessary steps to preserve these water resources thereby maintaining the balance in their demand and supply as they comprise a valuable part of the common property natural resources. Need-based strategies must be formulated to optimize the production of basic needs without affecting these natural resources in the long run.

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