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Exploring the Water Crisis and Viability of Unregulated Groundwater in India: An Analysis

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ABSTRACT

Water conservation and management are significant features of ancient Indian Vedic culture. However, India's rapid industrialization, globalization, and urbanization have posed a serious threat to this practice. Many metropolitan cities and other cities will likely have groundwater depletion in the near future. As per the 'United Nations University - Institute for Environment and Human Security (UNU-EHS)' report titled "The 2023 Interconnected Disaster Risks Report", India is close to reaching its tipping point of groundwater depletion. It also highlighted that 27 of 31 major global aquifers are depleting faster than they can be replenished. A combination of factors, including climate change, private land ownership, mechanical pumping, etc., led to the depletion of groundwater and water scarcity for farming and other purposes. Additionally, NITI Aayog and the Central Water Commission have released several reports that highlighted the plight of the country's aquifers. India's groundwater resources are not only a potential source for agricultural, domestic, and industrial needs in the country but also a threat to its sustainable development and equitable distribution. At present, there is no central law on the groundwater regulation. Although the Model Groundwater (Sustainable Management) Bill 2017 is an affirmative step, its effectiveness depends on implementation by state governments, the establishment of robust local institutions, and removing political incentives from groundwater management. Until now, landowners have enjoyed monopolistic access to groundwater due to common laws that recognize uncontrolled rights over the resources. These restrictions have perpetuated gross inequities in accessing groundwater, which makes a remarkable shift from previous laws. This paper evaluates India's existing groundwater laws to achieve sustainability, equity, and the effective execution of water rights. It also delves into the lacunae in the existing laws and suggestive measures to control the challenges of groundwater in India.

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INTRODUCTION

Groundwater depletion is a major environmental concern across the globe, particularly in India. The Earth's surface is covered by 60% water, and the human body is composed of about 70% water. India has 16% of the global population, but the nation possesses only 4% of the world's freshwater resources (Pandey 2023). As a result, India is facing water scarcity and increasing groundwater extraction over the past few decades. India heavily relies on groundwater resources, which is evident from the fact that the country relies on 80% of its rural drinking water, 50% of its urban drinking water, and nearly two-thirds of its irrigation requirements (Saha & Ray 2018). Since the 1960s, the Indian government has emphasized technology transfer initiatives like the "Green Revolution" as a key strategy to ensure food security, which has led to increased demand for groundwater resources in agriculture. It is found that rapid rural electrification, along with advanced pump technologies, increases the borewells to meet the water demands. It is also estimated that borewells have increased from 1 million to 20 million, making India the world's largest consumer of groundwater resources (Bekele Shiferaw 2021).

Water is a vital component for various life processes, and it is employed in several developmental activities. However, water is a non-renewable energy source due to its limited availability over a few centuries. Such water scarcity is primarily due to groundwater depletion driven by agricultural activities and climate change. India extracts 260 cubic meters annually, which accounts for 25% of the total global groundwater extraction (TPCI 2021). The Central Ground Water Board (CGWB), Government of India, estimates that 60% of the total irrigated area is attributed to groundwater irrigation, and 85% of the rural drinking water supply relies on it. It is also estimated that the water availability for agricultural purposes in the Indus, Ganges, and Brahmaputra River basins is expected to decline. This water decline could potentially impact the food self-sufficiency of 63 million people (approx.) (Wang et al. 2023). A recent report estimates that the rate of groundwater depletion in India from 2041 to 2080 will be three times the current rate due to the effects of global warming (Bhanja et al. 2017).

As the country's temperature increases, it will lead to an accelerated withdrawal of groundwater, thereby contributing to faster depletion. Groundwater is located beneath the land subsidence and fissures consisting of soil, sand, and rock. This water is stored within and gradually moves through the geological formations of soil, sand, and rock, which are known as aquifers. The diminishing levels of groundwater in various parts of the country can be attributed to continual extraction, driven by increasing demand for freshwater due to various factors such as unpredictable rainfall patterns, increase in population growth, rapid industrialization, and urban expansion. Consequently, there is an urgent need to address this situation. It is essential to address the root causes of the man-made crisis of water demands before exploring the potential solutions.

When the country witnesses a gradual increase in temperature, people will extract more underground water, leading to a faster depletion of it. Groundwater refers to the water present beneath the earth's surface in the cracks and spaces made up of rock, sand, and soil. This water is stored and gradually flows through geological formations of soil, sand, and rock, called aquifers. In different regions of the country, the groundwater levels have declined due to the continuous withdrawal of water. Such withdrawal is necessitated by increasing demand for freshwater for various purposes, population growth, industrialization, urbanization etc. Consequently, there is an urgent need to address this situation. However, before exploring potential solutions, it is crucial to understand the underlying causes of this human-induced crisis.

HISTORY OF GROUND WATER IN INDIA: A STATISTICAL ANALYSIS

The historical development of groundwater is a scientific practice that reached its peak in the Indian Himalayan kingdom before the 17th century. In Vedic scriptures, groundwater was praised as springs that bestowed health, happiness, and peace on the community. In India, the history of groundwater can be broadly classified into three periods (Angelakis et al. 2016), namely Pre-historic and Historic, the British period (1818 to 1947 AD), and the post-Independence period (Kumar et al. 2005). During these periods, the use of groundwater in various rock types was associated with the religious and cultural aspects of society. India comprises 15% of the global population, but the country possesses 6% of the world's water resources and 2.5% of the world's land (Kumar et al. 2005). Ground water is one of the most common resources accessible to all and anyone is allowed to drill a well and extract as much water as needed. Indian thinkers like Manu had interests in exploring the means of rainwater storage and identifying groundwater sources. Ancient texts such as Brihat Samhita and Arthasastra depict the Earth's interior as an intricate network of water channels, dividing it into multiple streams at different levels that support diverse plant life. The ancient sages' texts suggest that groundwater resources can be explored in areas with limited surface water, which would support our economy.

India's groundwater usage has witnessed a substantial increase from 70 km³ in 1940 to approximately 290 km³ in the present day (Mukherjee 2019). It is estimated that India extracts 253 billion cubic meters (BCM) of water per year. According to the Twelfth Five Year Plan (2012-2017) (Boruah & Naz 2020), there are 28 million groundwater irrigation systems in India. In addition to being overused, groundwater is being contaminated, which puts the water table at serious risk. It has been observed that almost 70% of all districts in our country have issues related to groundwater quality. The severity of India's groundwater crisis is evident through the reports from different parts of the country (Bhanja et al. 2017). It calls for need and mitigation both in the fields and in the policy of our country. After Independence, when there was large-scale introduction of mechanized pumping was introduced, which led to a dramatic increase in groundwater extraction in the country (Fischer et al. 2022).

The red flags over underground water depletion can be analyzed from the Fig. 1. (Sandrp 2017)

Fig. 1 shows the data per capita availability of groundwater in the country over the years. The rate at which the groundwater is declining in metropolitan areas shows that if current trends continue, in 20 years, about 60% of

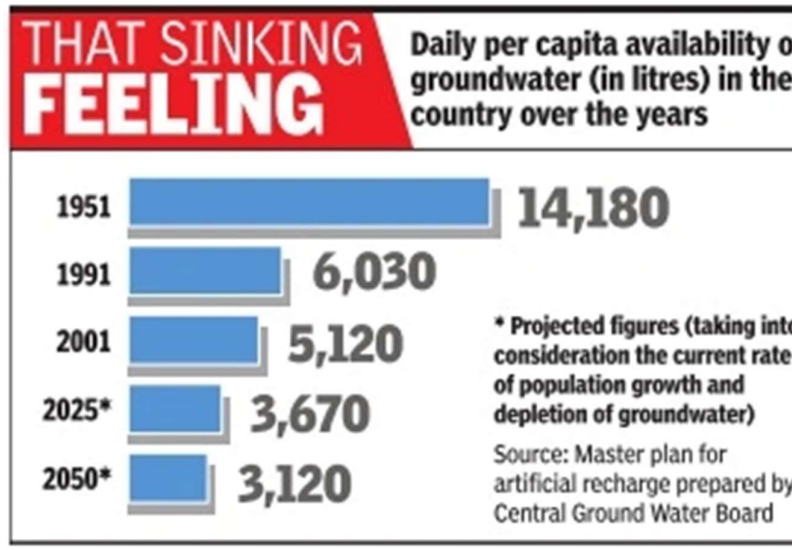


Fig. 1: Source: Central Ground Water Board.

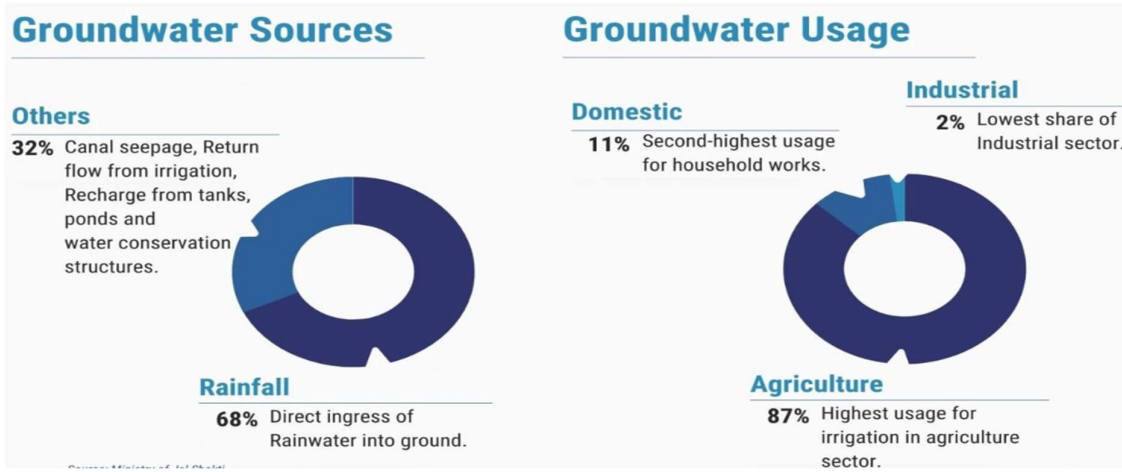
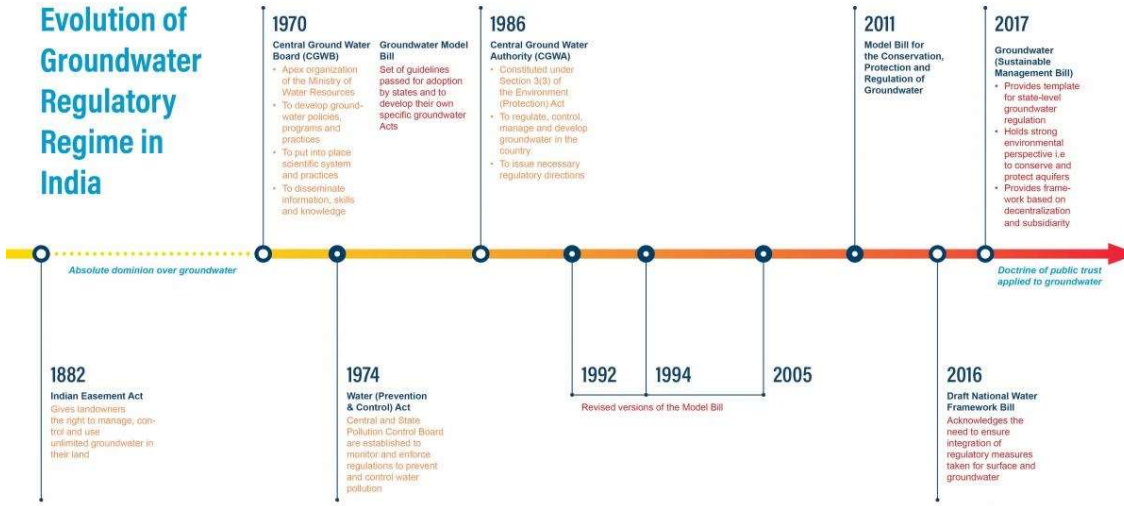


Fig. 2: Source: Ministry of Jal Shakti.

all India's aquifers will be in a critical condition (Gandhi & Namboodiri 2009).

In India, the 'Dynamic Ground Water Resource Assessment Report, 2022' released by the Ministry of Jal Shakti reported that the annual groundwater recharge is recorded at 437.60 billion Cubic Meters (BCM) (Koshy 2022). Such groundwater extraction has reached its lowest point since 2004, standing at 239.16 BCM compared to the 231 BCM recorded. In India, groundwater is predominantly used for irrigation purposes at '208.49 BCM', followed by domestic purposes at '27.05 BCM' and industrial usage at '3.64 BCM' (Mukherjee 2022). Fig. 2 shows the percentage of water in groundwater sources and its usage.

As per the CAG Report - 2021, the extraction of groundwater has risen from 58% to 63% between 2004 and 2017, surpassing the rate at which groundwater is being replenished (Comptroller and Auditor General of India 2021). According to the Central Ground Water Board (CGWB), around 17% of groundwater blocks are being over-exploited, meaning that the pace at which water is being extracted is higher than the rate at which the aquifer is being replenished. Furthermore, 5% and 14% of blocks are classified as crucial and semi-critical, respectively (Bekele Shiferaw 2021). The groundwater resources in India are in a precarious state in three key regions: the southern peninsular region, the western region and the north-western territory. The Dynamic Groundwater Resource Assessment Report -



Source: Sindhuja Janakiraman and Purnanjali Chandra (WRI INDIA 2022)

Fig. 3: Development of India's Groundwater Regulatory System.

2022 states that the number of groundwater units classified as "overexploited" has reduced by 3 percent, while the number of units classified as safe has increased by 4 percent compared to 2017. There has been a general enhancement in the groundwater conditions across 909 units. India uses more groundwater than the United States and China combined, accounting for 25% of the world's extracted groundwater. Currently, over 70% of India's water supply for agriculture comes from groundwater (Bhattarai et al. 2021).

REGULATION OF GROUNDWATER IN INDIA: CHALLENGES AHEAD

Groundwater resources are vital to human existence, as they provide a significant proportion of the world's potable water (Food and Agriculture Organization of the United Nations, 2012). Nonetheless, the indiscriminate application of groundwater has given rise to a multitude of concerns. Numerous scientific studies demonstrate that if groundwater extraction persists at an alarming rate, the resource will eventually be depleted (Singh & Singh 2002). Some of the problems pertaining to groundwater are over-extraction, climate change, legal laxity, insufficient monitoring, poor management, etc. In India, monitoring and managing groundwater resources will be critical to ensure their sustainability and availability for future generations. The evolution of the groundwater regulatory regime in India can be traced since ancient times, and it reflects that there exist several challenges to the preservation of groundwater in India. As shown in Fig. 3 illustrates multiple revised versions in Indian legislation aimed at asserting absolute dominion over groundwater, but it remains in its infancy state.

The factors can be studied in detail as given below to see the menace of the problem.

Rising population: The growing urban population not only increases the demand for water but also amplifies challenges associated with waste and contaminated water management. The surge in urban population intensifies the burden of water and waste management. One of the most significant consumers of groundwater is India, which accounts for around 25 percent of the total global withdrawal (Water Crisis in India: The World's Largest Groundwater User, 2022). In India, 48% of urban water resources rely on groundwater (Kulkarni et al. 2015). As the population increases, the proportion of individuals lacking access to clean water is expected to rise.

Unplanned urbanization: Unplanned Urbanization leads to depletion of groundwater resources. Unplanned urbanization activities, such as the expansion of built-up and paved areas, have resulted in the loss of water infiltration into the ground. The absence of green cover reduces evapotranspiration, while an increase in surface runoff leads to urban flooding and a decrease in groundwater recharge. An investigation carried out in the United States revealed that each 1% rise in the impermeable surface area results in a 3.3% escalation in the intensity of urban flooding (Gies 2024). Urban sprawl alters the groundwater cycle by transforming the natural environment, watershed, and flow direction. This could lead to a substantial decline or increase in groundwater levels, diminished well productivity, and a deterioration in water quality.

Climate change: The impacts of climate change, such as irregular rainfall patterns, significantly disrupt the ability

of groundwater to replenish, which poses a substantial risk to both the quantity and quality of available groundwater. The most recent assessment reports from the Central Ground Water Board (CGWB) indicate that numerous places are being excessively exploited, with a majority of them being classified as critical or semi-critical. India is the greatest consumer of groundwater in the world, using an estimated 230 cubic kilometers per year, which accounts for more than 25% of the total global usage, as stated in the 2012 World Bank Report (Saha & Ray 2018). It provides approximately 80% of the water used for domestic purposes and 45% of the water used for irrigation in total. If the current rate of over-extraction persists, it could result in around 60% of India's aquifers becoming critical and pose a threat to over 80% of the country's drinking water within the next two decades (Boretti & Rosa 2019). This has a significant effect on the fair, sustainable, and environmentally clean availability of water resources, therefore limiting the utilization of the 'right to water' for both present and future generations (Nidhi 2023).

Legal laxity: Many bodies are involved in groundwater control, which results in fragmented regulation and the lack of an "integrated and comprehensive" regulatory approach. In addition, the lack of legal regulations governing the extraction of groundwater has led to over-exploitation. Indian Easements Act of 1882, determines the groundwater rights associated with the land. As a result, a large section of the society is excluded from the right to groundwater and does not have the right to land. In addition, the lack of comprehensive data on groundwater resources makes it difficult to formulate clear guidelines for the proper management of groundwater.

Groundwater pollution: Groundwater aquifers become contaminated as a result of the infiltration and seepage of various substances such as road runoff, industrial waste, landfill sites, and micro-pollutants. Groundwater pollution is primarily responsible for nitrate, arsenic, fluoride, etc. The excessive utilization of groundwater and the growing prevalence of privately owned bore wells to meet the water demand and supply result in the lowering of the water table, land sinking, infiltration of salty water, and contamination of the underground water source. These phenomena have significantly depleted groundwater resources. The major stressors include a lack of interest and stakeholders' awareness, the unclear role of regulatory bodies, and the absence of a monitoring and planning system.

GROUNDWATER GOVERNANCE AND LAWS RELATING TO GROUNDWATER

Landowners have the right to access and control resources beneath the land, including groundwater resources. This right originated from the English Law, which was incorporated under the 'Indian Easements Act of 1882' (Wahi 2022). In the 1960s, the proliferation of mechanized pumps had significantly escalated groundwater consumption leading to a sharp decline in water tables. This phenomenon spurred an increasing demand for groundwater law reforms. The Indian government realized the imperative need for a legal framework to regulate groundwater. It introduced several initiatives (viz., laws and policies) to regulate groundwater resources. In 1970, the Central Government proposed to adopt a Model Bill for the regulation of groundwater, which underwent multiple revisions (1992, 1996, and 2005) (Cullet 2012). Recently, the Indian Government adopted the Groundwater (Sustainable Management) Bill, 2017 to better suit our needs (Mukherji 2020).

In 1987, India adopted its first National Water Policy (NWP), recognizing water as a prime natural resource and a precious national asset (Wahi 2022). This policy prioritizes drinking water for both humans and animals. It advocates for the integrated and coordinated development of surface and groundwater, accompanied by regulations to limit groundwater exploitation. Although, India has a groundwater policy, still, the country faces challenges related to groundwater management due to policy deficiencies. Hence, NWP has been modified but mostly, it retained the same. The revised policy reinforced the need for regulating groundwater resources in order to prevent over-exploitation, ensuring groundwater usage is within recharge limits. However, the revised policy remained merely suggestive, and lacks a clear approach for groundwater management. Furthermore, the Ministry of Water Resources issued a new National Water Policy in 2012 to meet the challenges in the water sector (Rathee & Mishra 2021). Under the principle of public trust, this policy acknowledged groundwater management as a shared resource by the state. The goal of this policy was to accomplish both food security and sustainable groundwater management responsibilities. The NWP, 2012 addresses issues relating to the management of water resources, planning water scarcity, etc, providing new guidelines for states to adopt. It is noteworthy that the states have the autonomy to adopt these guidelines (Pandit & Biswas 2019).

In 1997, the Central Ground Water Authority (CGWA) was constituted to regulate, manage, and develop groundwater (Rishikesh Singh Faujdar 2015). This authority has been constituted following the directives of the Supreme Court in *M.C Mehta v. Union of India* (1987 SCR (1) 819). In this case, the Supreme Court issued directives that the Central Government under the 'Ministry of Environment and Forest

(MoEF)' shall constitute 'The Central Ground Water Board as an Authority under section 3(3) of the 'Environment (Protection) Act, 1986'. However, the 'Ministry of Environment and Forests (MoEF)' has decided to designate the Central Ground Water Board, an existing scientific and technical body under the Ministry of Water Resources, as 'Central Ground Water Authority' under Section 3(3) of the 'Environment (Protection) Act, 1986'. Its main functions are critical/over-exploited regions identified to provide suitable measures for the regulation and development of groundwater. The CGWA has formulated guidelines setting parameters for assessing proposals relating to withdrawal groundwater that have been revised over time.

In 2017, the Indian Government introduced the Groundwater (Sustainable Management) Bill in line with the national water policy guidelines. This bill acknowledges groundwater as a fundamental right and a public trust (Pandit & Biswas 2019). The Bill also expands on the decentralization mandate and aims to provide local bodies with regulatory authority over groundwater resources. The proposed framework aims to increase groundwater resources by incorporating groundwater security plans and significant local involvement. Therefore, the groundwater will be used responsively and people and the state will play an active role in using groundwater and safeguarding it for present and future generations. The new bill acknowledges the incorporation of protective principles, such as the precautionary principle, which were missing from the water policy. It also suggests that the groundwater should be protected at the aquifer level. The 'Central Ground Water Board (CGWB)' is implementing the 'National Aquifer Mapping and Management Program (NAQUIM)' to aid groundwater sustainability.

The Central Government has issued updated regulations governing groundwater use. The amended standards require no-objection certificates (NOCs) for existing industries, commercial units, and major housing societies and ban new industry and mining projects in over-exploited zones. However, domestic consumers, including armed forces, farmers, and micro and small enterprises withdrawing up to 10 cubic meters of water per day, are exempted from the requirement of a 'no objection certificate (NOC)' from the 'Central Ground Water Board (CGWB)'. The Uttar Pradesh Cabinet, led by Chief Minister Yogi Adityanath, adopted the Ground Water Act on February 11, 2020. It is considered a progressive step in regulating groundwater to raise the state's declining groundwater levels. Hence, there is a need for all the states to reform their groundwater law because inaction increases existing inequalities in access to groundwater. It's high time for the State to act as a public trustee of groundwater to make sure that groundwater is protected, conserved, regulated, and properly managed.

The government has undertaken various initiatives shedding light on the concerning depletion of groundwater resources. The National Project on Aquifer Management (NAQUIM) and Atal Bhujal Yojana (ABY) have both been initiated to promote participatory groundwater management. The primary objective of the Atal Bhujal Yojana is to promote a shift in behavior by providing incentives. NAQUIM aims to create a detailed map of underground water sources to support well-informed decision-making. The Jal Jeevan Mission focuses on providing safe drinking water to rural households. The India-Groundwater Resource Estimation System (IN-GRES) is designed to facilitate annual assessments of groundwater levels. The Jal Shakti Abhiyan aims to promote rainwater harvesting and raise awareness through extensive campaigns (National Compilation on Dynamic Ground Water Resources of India 2023). Furthermore, the government implemented the Integrated Water Resource Management framework and the recommendations of the Mihir Shah Committee in an effort to enhance groundwater governance and utilization.

In the first place, Mihir Shah Committee Recommendations (Kumar 2018) should be implemented as follows: (a) There is a need to restructure the existing water commissions to form a new National Water Commission for collective management of ground and surface water; (b) The National Water Commission shall set up 8 divisions for a comprehensive water management approach. These 8 divisions include the Urban and Industrial Water Division, Water Security Division, River Rejuvenation Division, Irrigation Reform Division, Aquifer Mapping and Participatory Ground Water Management Division, Water Data Management and Transparency Division, Water Quality Division, and Knowledge Management and Capacity Building Division; (c) There is a need for participatory groundwater management, recognizing groundwater as a common pool resource for constant check on the groundwater extraction. Corrective measures like setting drilling depth requirements, and promoting crop patterns that avoid excessive withdrawal of resources are to be implemented.

Moreover, it is essential to prioritize the implementation of an integrated water resource management framework for groundwater planning and management. It encourages the planned use and administration of land and water resources. Furthermore, it is crucial to embrace water-sensitive urban architecture and planning. By controlling surface water, groundwater, and precipitation for water supply and demand, it aids in the management of the water cycle. There is a pressing need to implement a blue-green infrastructure approach. The gap in groundwater management can be filled

by increasing public awareness and engagement, as well as by fostering trust between communities and formal water sector agencies. It is necessary to conduct a policy review in the agricultural sector. The cropping system ought to be following the agroecology of the area. The abolition of agricultural subsidies on energy is something that should be done. These strategies aid in optimizing the utilization of groundwater in agricultural practices (Talat 2021).

NEED FOR DECENTRALIZATION FOR GROUNDWATER

India is experiencing a severe water crisis which requires urgent measures to address it (David 2024). Although the water crisis is often discussed, related laws and policies are least discussed. It is imperative to discuss the laws due to the rapid depletion of water tables, and it may exceed replenishment. The current legislation regarding groundwater employs a centralized 'command-and-control' strategy, where state-level authorities are responsible for regulating groundwater. However, such regulation is inadvisable for various legal reasons. Due to the diffuse nature of groundwater usage, a centralized system and agency using a command-and-control model would find it difficult to regulate the millions of extraction units that a state may have. It is very difficult to regulate groundwater, especially in regions/areas where groundwater is the primary water source. In many regions, regulating its use without interest among users could lead to outright opposition and non-compliance.

The Indian Constitution envisioned a 'participative' and 'decentralized structure' for the management of natural resources. In India, regulation of groundwater regulation is governed under these principles. Water law reforms of surface water have been implementing the ideas of decentralization and participation over several decades. It is recommended to advocate for the decentralization of authority to local governing entities, such as village panchayats and municipalities. Article 243G of the Constitution of India pertains to the delegation of authority and accountability to panchayats. It states that the "legislature of a State may, by law, endow the panchayats with such powers and authority ...." It is also witnessed that some states have implemented decentralization, which failed groundwater regulation. Kerala is renowned for its successful decentralization implementation in this regard. However, Kerala adopted the 'Kerala (Regulation and Control) Act, 2002' for a centralized regulation of groundwater.

Several recent legislative changes—particularly those targeted at encouraging investment and development—tend to flout the Indian Constitution's decentralization idea. The centralization of groundwater regulation is contrary to the basic principles of legal reforms on surface water resources. These water law reforms recognize decentralization and participation as fundamental principles. Hence, water law reforms show the co-existence of centralization and decentralization. The water law reforms require proper justification for the centralization of resources. However, it is found that there are no proper justifications for adopting a centralized command and control approach for groundwater resources. Additionally, it is found that the decentralization of water has existed for a long time, along with the cultural and ethnic pluralism of Indian society. The water ecology in India relies predominantly on rainfall, which exhibits a high degree of temporal variability and is distributed across many regions (Kumar et al. 2005). Hence, any endeavor to modify the groundwater legal system in India should be founded on the principle of subsidiarity (Koonan 2022). Implementing such a measure would demonstrate adherence to the notion of decentralization. It also provides abundant opportunities to address the concepts, customs, knowledge, and local requirements.

CONCLUSION

India's population accounts for approximately 16 percent of the global population, while the country possesses only four percent of the world's freshwater resources. Not only this, India is among the water-stressed nations in the world as a result of shifting weather patterns, recurrent droughts, and an excessive reliance on groundwater supplies. A United Nations assessment states that by 2050, India is predicted to experience acute water scarcity. It is crucial that the government swiftly conducts periodic analyses of groundwater sources in order to prevent the contamination of groundwater resources. The periodic evaluation can be calculated by considering elements such as the formation of new industries, the digging of new bore wells, effluents from industries, and other factors that contribute to groundwater contamination. The ideologies of the "Slow-Down Movement" and "Minimalistic Theory (Minimalism)" have been developed to promote sustainable development and efficient water utilization. Minimalism theory involves intentionally living and carefully analyzing the repercussions of one's activities. By embracing minimalism, individuals can effectively decrease their ecological footprints and prevent excessive consumerism from depleting the Earth's resources. Therefore, adopting minimalism is the sole approach to water conservation, which is crucial for achieving sustainable development.

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