Nature Environment and Pollution Technology
An International Quarterly Scientific Journal
p-ISSN: 0972-6268
(Print copies up to 2016)
e-ISSN: 2395-3454
Vol. 23 | No. 1 | pp. 125-137 | 2024
Original Research Paper
https://doi.org/10.46488/NEPT.2024.v23i01.009
Open Access Journal

Need for an Evolved Groundwater Justice in Rural Areas of Uttar Pradesh, India

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Nat. Env. & Poll. Tech.
Website: www.neptjournal.com

Received: 11-07-2023
Revised: 25-08-2023
Accepted: 02-09-2023

Key Words:
Groundwater
Legal reform
Sustainability
Groundwater justice
Co-evolution

ABSTRACT

As groundwater is the primary element of life, countries all over the world are experimenting with legal reforms. The degree to which law reforms combine justice and sustainability is a crucial question. In response to this question, the present article focuses on a case study of Uttar Pradesh, India. Our response is based on a content analysis of the Uttar Pradesh Groundwater (Management and Regulation) Act, 2019, and the Uttar Pradesh Groundwater (Management and Regulation) Rules, 2020. Three conclusions emerged from our investigation. First, the 2019 Groundwater Act and the 2020 Draft Groundwater Rules are primarily motivated by concerns about resource sustainability, particularly in areas where the water table is steadily declining. Still, neither the 2019 Groundwater Act nor the 2020 Draft Groundwater Rules propose any proactive groundwater justice measures. Second, we suggest that some locally defined basic elements are critical in supporting sustainability and – to a lesser extent – groundwater justice. These characteristics include a community's ability to (1) recognize a crisis and show a willingness to address it; (2) establish a rule-bound community groundwater resource; (3) demonstrate leadership and a sense of community; and (4) make use of awareness, information, and knowledge. Our third conclusion is that there is a need for community practices and state-led groundwater law to co-evolve; this co-evolution has the potential to create groundwater arrangements that support both groundwater justice and sustainability.

INTRODUCTION

Water is a very crucial compound of life for survival. Our ancient philosophers believed that the entire universe is made up of five major elements, viz. Air (*Vayu*), Water (*Jal*), space (*Aakash*), Fire (*Tej*), Earth (Soil), etc (Tari 2015). Groundwater resource is hidden in pores and cracks under the ground through percolating from the earth's surface or due to geological activities like volcanic activities or sedimentation (Velis et al. 2017, Fetter 2001, CR, 2012).

However, man is the most intelligent animal on this planet, and he is always in search of the easiness of life. For that, he is continuously modifying nature in a way that he can get a better life today without thinking about its future consequences, and it is so-called "Development." In 1987, due to awareness and research in various fields, it was recommended by the Bruntland Commission Report that the development should be sustainable, i.e., "Development that meets the needs of the present without compromising the ability of future generation to meet their own needs" (Keeble 1988). As water is crucial for any development, there is a need to think about respective sustainability development goals (Tari et al. 2022, Tari & Patil, 2017b, 2017a). Groundwater sustainability can be broadly defined as the "Continuous availability of groundwater of sufficient quality and quantity for ecosystem functions and future generations" (Velis et al. 2017).

The biosphere consists of three major spheres namely lithosphere, atmosphere, and hydrosphere (Fig. 1). For development purposes, man is using all possible reservoirs from the biosphere (Tari 2015). Fig. 1 depicts that all three spheres are major reservoirs for raw materials used in the development. Out of that hydrosphere is our major concern due to the importance and vulnerability of major water resources, i.e., groundwater on the 'Earth.'

A variety of human activities, as well as natural sources, can pollute groundwater; they render it hazardous and unsuitable for human consumption. The soil can allow substances from the surface of the land to pass through

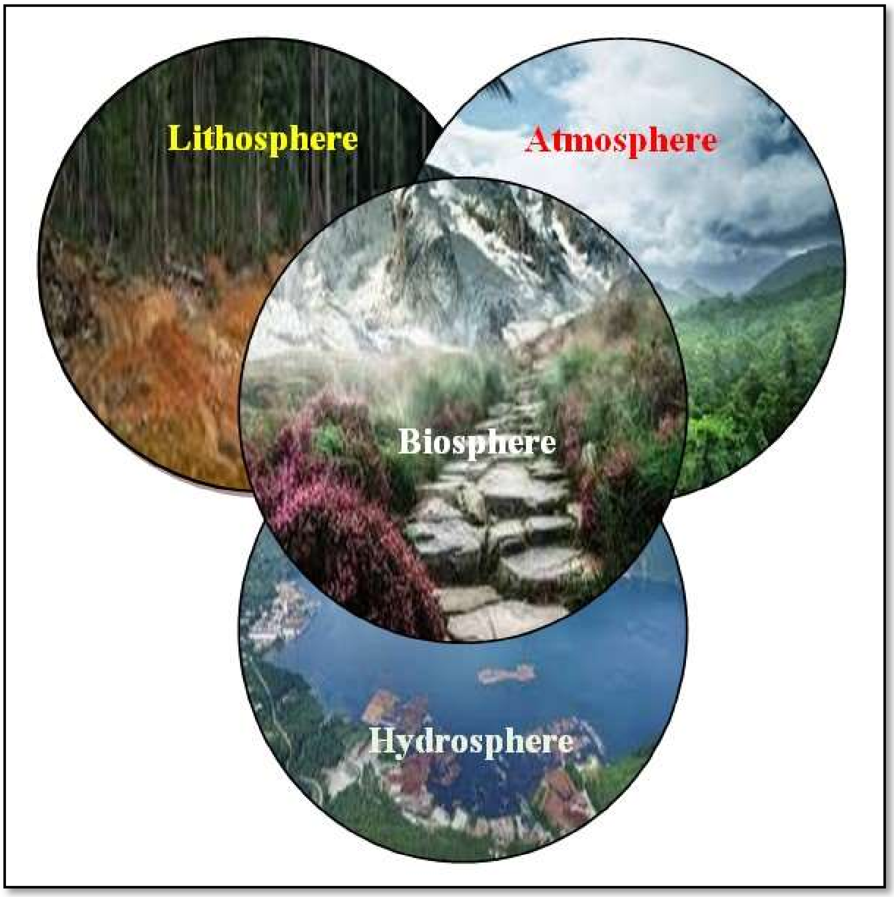


Fig. 1: Structure of biosphere.

it and end up in the groundwater. For instance, chemicals and fertilizers may enter groundwater sources. Used motor oil, hazardous materials from mining sites, and road salt may also leak into the groundwater. Furthermore, harmful compounds from underground storage tanks, leaking landfills, and untreated septic tank waste have the potential to pollute groundwater. Its depletion is very serious and needs immediate attention because groundwater is the only source of drinking water, particularly in rural areas.

GROUNDWATER: ISSUES AND CHALLENGES IN INDIA

Groundwater is prominently used as a source of drinking water for the majority of the world's population. Besides that, it also helps to provide nutrients and stabilizes relative temperature (Kløve et al. 2011). Therefore, the management of this precious resource is a major environmental concern. The movement of water under the ground is significantly slow, particularly at a speed of 0.01-10 $m.day^{-1}$ under natural conditions. The residence time (time required in storage) ranges from 10 to 1000s years (Foster 2013, Gleeson et al. 2012). The depletion of groundwater stock was considered a major indicator of water scarcity. Poor drinking water quality, a lack of water supply, deteriorated surface water systems, expensive cleaning expenses, high prices for alternative water suppliers, and/or significant health issues can all arise from groundwater contamination. The effects of polluted surface water or contaminated groundwater are frequently severe. For instance, crucial shellfish habitats have been destroyed in estuaries affected by high nitrogen levels from groundwater sources.

Groundwater contamination makes it impossible for the region to support plant, human, and animal life. Both the local population and the value of the land decline. It also has the impact of making industries that rely on groundwater for product production less stable. As a result, the impacted areas' companies would have to import water from other places, which might be expensive. Additionally, the water's low quality might cause them to shut down. In rural areas, a large portion of groundwater is going towards irrigation. Apart from irrigation, groundwater is significantly used in other developmental sectors such as industrial, food production and security, commercial, climate change adaptation activities, recreation, hydrological carbon dioxide sequestration, hydrological resilience, health, food and energy production, and hydrological energy access (Velis et al. 2017, Gramont 2011).

Overexploitation for intensive irrigation and other developmental activities can lead to depletion in water tables, aquifer drying, saltwater intrusion, groundwater contamination, water logging, increasing water salinity, etc (Singh & Singh 2002). Overexploitation is not the only problem with groundwater, besides that, deterioration in groundwater quality is another serious problem with groundwater. The assessment of the water problem was comprehensively reported by Balasubramanian (2015) and Singh & Singh (2002). The planet Earth has 71% water. Hence, it is called a blue planet. The physical distribution of water is shown in Table 1 (Water Science School 2019). Socio-economic dependency on groundwater is well explained by Burke (2001).

From data regarding the physical distribution of water (Table 1), it is clear that freshwater is only 2.5% of the total world's water. However, only 30.1% of total freshwater is groundwater, which can be used for other essential activities of life, i.e., domestic and development. The groundwater is indiscriminately used probably due to low cost and easily available technologies for extraction (Moench 2003, Cuadrado-Quesada & Joy 2021). Therefore, aquifers are rapidly declining, and the quality of water is continuously deteriorating because of pollution with time. The serious deterioration of groundwater resources in India will be addressed by Cuadrado-Quesada and Joy (2021).

Table 1: Physical distribution of world's water (Compiled by authors).

Sr. No.	Source	Percentage (%)
1.	Saline Water	97
1.1	World's Ocean	96.5
1.2	Other Saline	0.9
2.	Fresh Water	2.5
2.1	Ground Water	30.1
2.2	Ice and snow	68.7
2.3	Surface / Other fresh water	1.2
2.3.1	Waters in living organism	0.26
2.3.2	Atmosphere	3
2.3.3	Rivers	0.49
2.3.4	Soil Moisture	3.8
2.3.5	Marshes and Swamps	2.6
2.3.6	Lakes	20.9
2.3.7	Ground ice and Permafrost	60

(Source: Water Science School 2019, Balasubramanian 2015)

Boelens & Vos (2018) stated that the current status of groundwater resources is quite alarming as far as the global need for water is concerned. The most extracted raw material in the world is 'Groundwater.' However, the global withdrawal rate is 800-1000 km3/year, which exceeds the withdrawal rate of oil by a factor of 20 (Margat & van der 2013). India is one of the largest groundwater consumer countries in the world (Vijay Shankar et al. 2011). Groundwater management has to be done with the notion that groundwater is our common property (Vijay Shankar et al. 2011).

GROUNDWATER STATUS IN RURAL INDIA

Indian economy is significantly dependent on the agriculture sector. Therefore, India is the biggest consumer of groundwater for agricultural purposes (Shah 2009). The data, according to the 2001 Census, shows increasing numbers of groundwater irrigation structures, viz. wells, tube wells, etc. (Indian Agricultural Statics 2008). Tube wells account for 50% compared to all other irrigation structures. However, the number of tube wells rapidly increased after 1995 (Vijay Shankar et al. 2011) (Government of India 2001). Eventually, every fourth homeowner owns at least one groundwater irrigation structure in rural parts of India (Shah 2009).

The tube wells percentage dramatically increased from merely 1% as of 1960-61 to 40% as of 2006-07. The surface water has declined as of the 1950s from 60% to 30% in the first decade of the twenty-first century (Government of India 2001). According to the Government of India (2001), Punjab, Haryana, and Uttar Pradesh are states having 57% of tube wells in India. The major groundwater anarchy identified from census data is regarding tube wells, which depict that, on average, there are 27, 21.5, and 14.1% of tube wells /sq. m. of net sown area in Punjab, Uttar Pradesh, and Haryana, respectively (Vijay Shankar et al. 2011). According to the National Aeronautics and Space Administration (NASA) assessment from 2002 to 2008, three states, namely Punjab, Haryana, and Rajasthan, lost about 109 km3 of water, leading to a decrease in the groundwater table to 0.33 m/annum (Rodell 2009).

The contamination of pollutants such as arsenic and fluoride is increasing with a decrease in groundwater levels. Consequently, such water is not fit for human consumption and farming. The continuous increase in salinity and water logging events are making soil unproductive, thereby directly affecting the productivity and profitability of farmers (Singh & Singh 2002).

Table 2: Comparison of categorization of state-wise groundwater resource assessment 2017 and 2020 (Compiled by authors).

Sr.No.	State	Categorization (2017)	Categorization (2020)
1.	Andaman and Nicobar Islands	Safe / Saline	Safe
2.	Andhra Pradesh	Over-exploited/ Semi-critical/ Critical/ Safe/ Saline	Over-exploited/ Semi-critical/ Critical/ Safe/ Saline
3.	Arunachal Pradesh	Safe	Safe
4.	Aassam	Safe	Safe
5.	Bihar	Over-exploited/ Semi-critical/ Critical/Safe	Over-exploited/ Semi-critical/ Critical/Safe
6.	Chandigarh	Semi-critical	Semi-critical
7.	Chattisgarh	Semi-critical/ Critical/ Safe	Semi-critical/ Critical/ Safe
8.	Dadra and Nagar Haveli	Safe	Safe
9.	Daman and Diu	Critical/ Safe	Over-exploited/ Safe
10.	Delhi	Over-exploited/ Semi-critical/ Critical/ Safe	Over-exploited/ Semi-critical/ Critical/ Safe
11.	Goa	Safe	Safe
12.	Gujrat	Over-exploited/ Semi-critical/ Critical/ Safe/ Saline	Over-exploited/ Semi-critical/ Critical/ Safe/ Saline
13.	Haryana	Over-exploited/ Semi-critical/ Critical/ Safe	Over-exploited/Semi-critical/ Critical/Safe
14.	Himachal Pradesh	Over exploited	Safe
15.	Jammu and Kashmir	Safe	Safe
16.	Jharkhand	Over-exploited/ Semi-critical/ Critical/ Safe	Over-exploited/ Semi-critical/ Critical/ Safe
17.	Karnataka	Over-exploited/ Semi-critical/ Critical/ Safe	Over-exploited/ Semi-critical/ Critical/ Safe
18.	Kerala	Semi-critical/ Critical/ Safe	Semi-critical/ Critical/ Safe
19.	Ladakh	Safe	Safe
20.	Lakshdweep	Semi-critical/ Safe	Semi-critical/ Safe
21.	Madhya Pradesh	Over-exploited/ Semi-critical/ Critical/ Safe	Over-exploited/ Semi critical/ Critical/ Safe
22.	Maharashtra	Over-exploited/ Semi-critical/ Critical/ Safe/ Saline	Over-exploited/ Semi-critical/ Critical/ Safe/ Saline
23.	Manipur	Safe	Safe
24.	Meghalaya	Safe	Safe
25.	Mizoram	Safe	Safe
26.	Nagaland	Safe	Safe
27.	Odisha	Semi-critical/ Safe/ Saline	Semi-critical/ Safe/ Saline
28.	Punjab	Over-exploited/ Semi critical/ Critical/ Safe	Over-exploited/ Semi-critical/ Critical/ Safe
29.	Rajasthan	Over-exploited/ Semi-critical/ Critical/ Safe/ Saline	Over-exploited/ Semi-critical/ Critical/ Safe/ Saline
30.	Sikkim	Safe	Safe
31.	Tamilnadu	Over-exploited/ Semi-critical/ Critical/ Safe/ Saline	Over-exploited/ Semi-critical/ Critical/ Safe/ Saline
32.	Telangana	Over-exploited/ Semi-critical/ Critical/ Safe	Over-exploited/ Semi-critical/ Critical/ Safe
33.	Tripura	Safe	Safe
34.	Puducherry	Over-exploited/ Semi-critical/ Saline	Critical/ Saline/Safe
35.	Uttar Pradesh	Over-exploited/ Semi-critical/ Critical/ Safe	Over-exploited/ Semi-critical/ Critical/ Safe
36.	Uttarakhand	Semi-critical/ Safe	Semi-critical/ Safe
37.	West Bengal	Semi-critical/ Critical/ Safe	Semi-critical/ Critical/ Safe

Source: Central Ground Water Board (CGWB), Ground Water Assessment Report 2017 and 2020

Table 3: Categorization of assessment units from 2004-2020.

Sr. No.	Categorization of blocks	2004	2009	2011	2013	2017	2020
	Total assessed units	5723	5842	6607	6584	6881	6965
1.	Safe	4078	4277	4503	4519	4310	4427
2.	Semicritical	550	523	697	681	972	1057
3.	Critical	226	169	217	253	313	270
4.	Over exploited	839	802	1071	1034	1186	1114
5.	Saline	30	71	92	96	100	97

Source: (Central Ground Water Board 2021)

The comparison of state-wise groundwater resource categorization was assessed from Central Ground Water Board (CGWB) data (Table 2). As we can see in Table 2 there are only 12-14 states out of 37 with a safe category of groundwater in all blocks of the respective state in India in the year 2017 to 2020. However, some blocks of states are facing the dangerous situation of over-exploited, semi-critical, critical, and saline categories of groundwater (Table 2). However, the issue of assessment of groundwater is important because it was found that groundwater potential data estimated by CGWB are showing deviation from real-time examined data at regional levels. There are some incidents found that CGWB levels are showing high readings (Singh 2001).

As we can see in table no. 3 there are numerous units with a safe groundwater level. However, over-exploited blocks are also more in numbers, and these are increasing over the years, which is a dangerous situation for sustainability and water security in the future. Furthermore, Vijay Shankar et al. (2011) illustrated the comparative status of groundwater development from CGWB data. They found that there is a big challenge to groundwater resources in India as extreme exploitation is being done, viz. Punjab (145%), Haryana (109%), and Rajasthan (125%) can be considered unsustainable groundwater levels. Whereas Uttar Pradesh (75%), Gujarat (76%), and Tamil Nadu (85%) are considered states of India that are fast reaching threshold limits because of the quantitative depletion of groundwater to unsustainable groundwater levels. Almost all districts from Punjab, Haryana, and Rajasthan are in the unsafe category. However, 72% of Tamil Nadu and 50% of Uttar Pradesh and Karnataka districts are in the unsafe category (Vijay Shankar et al. 2011). The extreme decline of water levels, i.e., 1-2 meters per year, is found in some parts of India, viz. North Gujarat, Coimbatore, and Madurai districts of Tamil Nadu, South Rajasthan, Kolar district of Karnataka, Royalseema in Andhra Pradesh, Punjab, Haryana, and Uttar Pradesh (Singh & Singh 2002). However, in Madhya Pradesh, a long-term decline in groundwater level has been reported, i.e., 13.05 meters (Saksena 2000).

This kind of scenario will create non-accessibility of groundwater to poor farmers because of the increased cost of drilling tube wells and lifting groundwater, predominantly in groundwater-irrigation areas. Therefore, if these trends remain unchecked without proper management, then India will certainly face a major water crisis in the coming decades. It is a warning bell for researchers, geologists, and the government to investigate it as a major environmental concern.

The overexploitation of groundwater is a major problem for managers in groundwater-irrigated areas. However, large areas in the major canal periphery are suffering from waterlogging and associated salinity or alkalinity problems (Singh & Singh 2002). Singh (1993) reported that in some peripheral areas of the canal, the water table is rising high, i.e., 1m per year. Based on past development, it was reported that near about 1 million to 2 million hectares per year are brought under irrigation areas in India. However, it was assumed from data that 3% of the area would sooner or later become saline or waterlogged, and the rate of spread of water logging or salinization in irrigated areas in upcoming years would be about 30,000-60,000 ha per year (Singh 1998). This problem is a big challenge for engineers and managers to manage irrigation commands.

The Central Ground Water Board and state groundwater agencies in India, where each of them built up its monitoring network, are largely responsible for groundwater quality monitoring. However, there are concerns about how adequate the scientific data they provide is:

- The monitoring station network is not thick enough. Analysis of the quality of the water leaves out important factors that can be used to identify heavy metals, pesticides, and other harmful effluent contamination.
- There are few civil society organizations capable of doing the professionally demanding, technologically complex, and frequently politically sensitive duties required to provide the scientific data that is now accessible, notably the data on pollution.

The Indian Easement Act 1882 states that "every owner of land has the right to collect and dispose within his limits of all water under the land which does not pass in a defined channel and all water on its surface which does not pass in a defined channel," is frequently cited as the first legal reference to groundwater in India. This suggests that groundwater would have the same status as surface water flowing via a specified channel whenever it is discovered to do so. However, the Indian Easement of 1882 created a connection between the landowner and the right to groundwater. According to the constitutional requirements, "Water" is a state subject, and state governments are ultimately responsible for managing water resources. The complicated natural occurrence of groundwater in various hydrogeological contexts, its wide-ranging significance as a socioeconomic good, and difficulties with ownership have made it extremely difficult to manage groundwater scientifically. India's pollution watchdogs are the Central Pollution Control Board (CPCB) and the State Pollution Control Boards (SPCBs).

Therefore, in 1970, the Central Government created a Model Ground Water Control and Regulation Bill and sent it to all States to persuade them to adopt groundwater law as well as to ensure some degree of uniformity in the Acts of various States. Later, the Model Bill was updated in 1992, 1996, and 2005. The Model Bill's central idea is the creation of State Ground Water Authorities, which will have the authority to "Notify" a region for groundwater management and issue licenses for well-drilling in certain notified regions. Small and marginal farmers were excused from obtaining a permit for well drilling under the 1992 Model Bill. Users must register if they are already users.

There is little doubt that the country's current groundwater situation shows the necessity for a paradigm shift in the nation's groundwater law system. Initially, it is necessary to sever the connection between groundwater and landowner created by the Indian Easement Act of 1886, which is still in effect today. In the current system, groundwater rights belong to landowners, and landless people, who make up more than 30% of the population, are denied access to this essential right, even though groundwater serves as their primary supply of drinking and living water. The Supreme Court has declared that the public trust in (surface) water. Given that groundwater is a communal resource by its very nature, the public trust theory should also safeguard it.

Moreover, it ignores the fact that groundwater resources are more regional than surface water resources, making local management more efficient. Decentralization, as introduced in the 73rd and 74th amendments to the Indian Constitution in 1992, has granted municipalities in urban areas and Panchayati Raj Institutions in rural regions certain water-related authorities. Furthermore, there will be an increasing opportunity for user conflicts of interest when groundwater is put under more stress. The case of Hindustan Coca-Cola Beverages v. Perumatty Gram Panchayat, involving the Coca-Cola bottling facility in Plachimada, Kerala, is the most well-known (2005). The fact that the current groundwater regulation restricts additional extraction in previously "over-exploited" regions while making no plans to address the current water security is another disadvantage. No groundwater law incorporates the prevention and precautionary principles acknowledged in the Environment (Protection) Act of 1986 but more lately in the National Green Tribunal Act of 2010. To stop the bad practices connected with Permit Raj, the groundwater control system should adopt the transparency principles of the Right to Information Act, 2005. It's also necessary to review the Central Ground Water Authority's function. CGWA's advising function now only entails helping the states establish regulations for rainwater gathering.

Official recognition of the need for a new legal framework led the former Planning Commission to develop a draft Model Bill for the Conservation, Protection, and Regulation of Ground Water in 2011 (Model Bill for the Conservation, Protection, and Regulation of Ground Water 2011). The draft Model Bill advocated ending the century-old connection between property ownership and groundwater by designating groundwater as a common pool resource and designating the State as the public trustee of groundwater. It establishes the right to water and introduces the utilization of groundwater as a priority. Gram Panchayats and Municipalities, the lowest levels of democratic administration, were given the authority to manage aquifers wisely, followed by blocks, districts, and the State Ground Water Advisory Council. The regulatory structure outlined in the draft Model Bill from 2011 has too many agencies engaged, which would result in unwelcome bureaucratic red tape. Simplifying the institutional framework is necessary. To make groundwater legislation a revised and practical legal framework, it should sufficiently emphasize various groundwater management measures, such as micro irrigation, recycling, and reuse of groundwater. Therefore, a new review of the Model Ground Water Bill is necessary.

Even though monitoring the quality of rivers' water and groundwater has only lately come under their jurisdiction. However, "non-point" pollution from agriculture is not covered by monitoring. There are issues with the institutional design. The SPCBs carry out the combined tasks of enforcing pollution control standards and monitoring pollution. However, the possibility that consistent WQM and its correct distribution might call into question the Boards' legitimacy as an enforcement body deters them from effectively carrying out the first duty. The agency also lacks the administrative framework and legal authority to hold polluters accountable.

As a result, the agency is less successful in upholding pollution control standards. Polluters are deterred from doing so by the fact that the cost of pollution is far lower than the cost of remediation, while the Boards are not required to carry out environmental management programs. The most frequent cause of groundwater pollution is pumping-activated geo–geo-hydrochemical processes. The only real way to stop contamination after it has begun is to completely stop pumping. However, this is highly challenging because irrigated agriculture and livelihoods are dependent on groundwater in India for millions of rural communities. Pumping would be prohibited by any legal or regulatory action, which would deprive communities of their historical rights. Landowners have a de facto right to draw groundwater from beneath their property even though de jure rights in groundwater are unclear. Although nitrate pollution can be effectively reduced by using fertilizers in the recommended quantities, rotating crops, applying fertilizer at the right times, and using organic manure instead of chemical fertilizers, neither fertilizer use nor the disposal of animal waste is subject to any institutional regulations.

COMMUNITY PRACTICES IN RURAL REGIONS OF INDIA

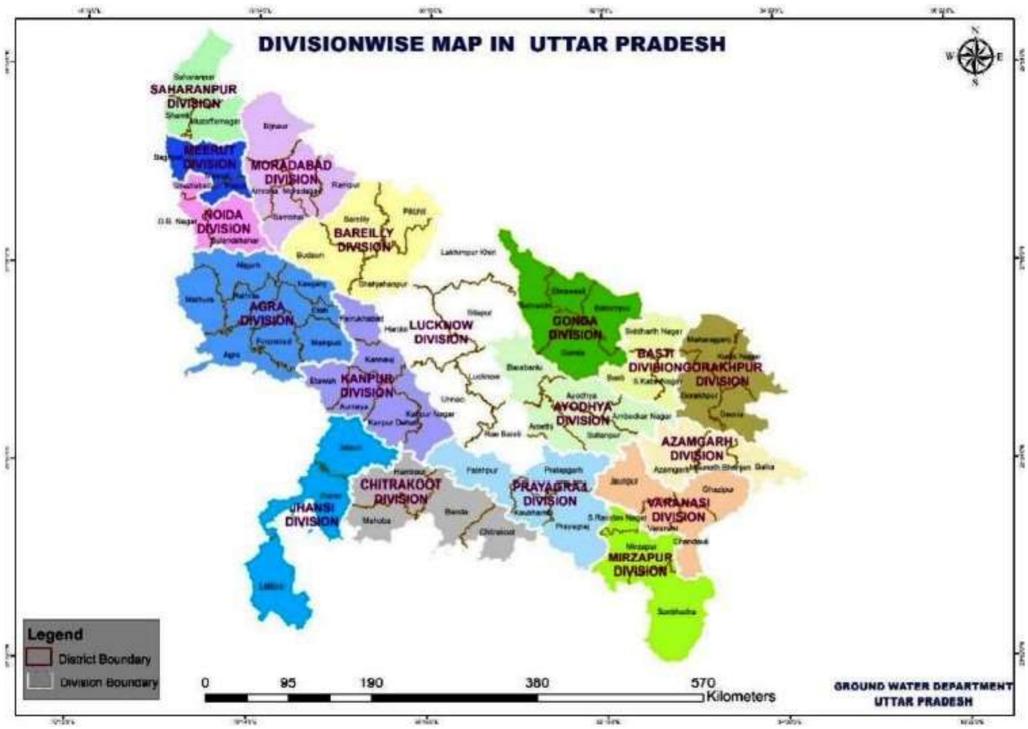
In rural India, there is more agricultural area. Hence, community practices in rural regions of India are more crucial in the vulnerability of groundwater. Some major reasons for groundwater depletion are slowly and gradually increasing pressure on aquifers, race for drilling and pumping of the groundwater, non-regulated groundwater extraction, large population, which leads to an increase in water consumption per capita, etc. According to the Planning Commission (2007), the sustainable yield management goal is ‘average withdrawals should not exceed long-term water recharge’ as far as groundwater management is concerned. For the betterment of future resources, this limit should not be crossed. As far as the agriculture sector is concerned, it is estimated that groundwater is a more convenient option for irrigation purposes because it is available at the point on the field under which farmers require minimum conveyance infrastructure. It also helps to save the cost of field management and ultimately increases profitability. Consequently, intensive irrigation has increased over time (Singh & Singh 2002).

In the western parts of India, people are supported by local Non-Governmental Organizations that have initiated a massive well recharge movement, which is particularly based on the principle of ‘Water on your roof stays on your roof; water on your field stays on your field, and water in your village stays in your village.’ However, Villagers have modified some 3,00,000 wells and open bore wells to divert rainwater runoff to them. These villagers, with the help of NGOs, have also constructed thousands of check dams, ponds, and other rainwater harvesting and water table recharging structures on self-help principles (Shah 2000).

Artificial recharge of groundwater reservoirs is an acceptable strategy for better management of the groundwater to counter overexploitation of the reservoirs. It helps prevent declining water levels of aquifers, storage of surplus surface water, and monsoon runoff protects saltwater intrusion in the aquifer, etc. Artificial recharge can be achieved by rainwater harvesting (RWH) and aquifer recharging with imported water. Chaddha D. K. 2000 opined that the potential of groundwater storage that can be used is 160 billion Cubic Meters (BCM). However, RWH is a more economical, technical, and feasible option for water management in rural as well as urban areas in India. The Ministry of Water Resources has started a program for rainwater harvesting and groundwater recharge, and for that, around 450 million Indian rupees were allotted in the 9th plan. The ‘Khadins’ of Rajasthan and ‘Tankas’ of western Gujarat are more crucial for groundwater recharge in the relevant parts of India (Shah 2000). Though CGWB and other governmental authorities are imposing pressure on groundwater recharge projects, it is essential to be very careful, especially in the urban parts of India, while planning and designing for the same activity. Because there are possibilities of entry of many pollutants such as toxic chemicals, bacteria, other total dissolved solids along with recharged water, etc. (Singh & Singh 2002). The series (over the period) analysis and comparative analysis were carried out by Zhai et al. (2021) to verify the existence of an increasing effect through laboratory leaching tests, and the impacts of aquatic chemical environment conditions like pH were also studied. However, they found that the increase of organic chemicals in the groundwater was one of the reasons for the release of ‘Fe’ and ‘Mn’ (Zhai et al. 2021).

CASE STUDY OF UTTAR PRADESH AND ITS RURAL REGIONS

Uttar Pradesh (UP) is occupying the Upper and Middle Ganga Plain. It is confined between the Himalayas in the north, the plateau region of the Bundelkhand in the South, and the Yamuna River on the west side. The UP is situated in north India and surrounded by Bihar and Jharkhand in the east, Uttarakhand and Nepal on the north side, Madhya Pradesh and Rajasthan in the south, and Haryana and Delhi on the west side. The state of Uttar Pradesh lies between North latitude 23°52’12” and 30°24’30” and East longitude



(Source: Groundwater Department UP and Central Ground Water Board Lucknow 2021)

Fig. 2: Administrative boundaries of Uttar Pradesh.

77°05’38” and 84°38’30”. It covers an area of 2,41,710 sq km. Whereas, administratively, Uttar Pradesh (Fig. 2) has been divided into 18 divisions, 75 districts, 340 tehsils, and 826 blocks (Groundwater Department UP & Central Ground Water Board Lucknow, 2021). According to the *Census* in 2011, the urban population of UP state is 39.9 million, and that of the rural region is 159.7 million. The most important concern is about 67% of the population living in rural areas and directly or indirectly dependent on agricultural produce for their livelihood. However, farm income can account for more than 20% of the income of a household (Census 2011).

Some of the Union territories/states are facing a relentless problem of groundwater level decline in India viz. Madhya Pradesh, Tamil Nadu, Uttar Pradesh, Gujarat, Rajasthan, Haryana, Punjab, Karnataka, Pondicherry, Maharashtra, and Delhi (NCR). In some districts of west Uttar Pradesh, groundwater levels are being declined to 0.66 m per year. Saksena R. S. 2000 opined that nearly 20% of the areas in Uttar Pradesh located outside the canal periphery have shown a decline in the groundwater table by 7 meters during the period 1972-85. However, in Tamil Nadu, the groundwater level has declined by 10 to 50m in some districts of the state in the last 40-50 years (Saksena 2000). The Central Ground Water Board has already started artificial recharge studies in the overexploited regions of Punjab, Maharashtra, Haryana, Uttar Pradesh, Jammu, Kashmir, etc. (Singh & Singh 2002).

The extractable Groundwater resources found as of March 2020 were 66.88 BCM (Billion Cubic meters). However, net groundwater availability for future use is 21.53 (Table 4). The dynamic groundwater status assessment of Uttar Pradesh was carried out by Ground Water Department UP and Central

Table 4: The dynamic groundwater status of Uttar Pradesh as of March 2020.

Uttar Pradesh (2020)		in Bcm
Ground water Recharge	Recharge from rainfall	39.05
	Recharge from other sources	33.15
	Total annual ground water recharge	72.2
Total Natural Discharges		5.32
Annual extractable ground water Resources		66.88
Current Annual ground water Extraction	Irrigation	41.29
	Domestic	4.74
	Total	46.03
Annual GW Allocation for domestic use as of 2025		5.38
Net Ground Water Availability for future use		21.53
Stage of groundwater Extraction (%)		68.83%

(Source: Groundwater Department UP and Central Ground Water Board Lucknow 2021)

Ground Water Board Lucknow in 2021. The working group assessed more than 836 units i.e., 10 urban cities having more than 10 lakh population were included in the assessment units. However, they have categorized assessed units viz. Safe, Semi-critical, Critical, Overexploited, etc. Out of 836 units, 544, 177, 49, and 66 units were found to be safe, semi-critical, critical, and overexploited groundwater resources, respectively (As of March 2020).

GROUNDWATER REGULATION IN UTTAR PRADESH

Groundwater is still a necessity in Uttar Pradesh as it accounts for not only their drinking use but also for their irrigational purposes. Therefore, because it has tremendous use in Uttar Pradesh, the laws regulating the usage of the same should be very sturdy in meeting the problems faced at present. However, all the rules that regulate the groundwater in Uttar Pradesh are based on the principles that were in use during the British colonial period. There have been proposals by the Central Government to regulate the groundwater regime in India since the 1970s. However, it is also not sufficient to meet the current needs of groundwater depletion.

The legal framework for groundwater used today finds its origin in the nineteenth century which has been later confirmed in the Indian Easements Act 1882 during the British period. That period observes a series of judgments given concerning the use, accessibility, and depletion of groundwater resources. In the case of *Chasemore v Richards*, the groundwater that had no definite course and percolated through the underground strata would not be covered under the same rules and regulations that cover the water flowing in rivers and streams. This ruling gave a lot of leverage to the landowners who could use the groundwater at their convenience, and it was also upheld in another case of *Acton v Bundell*, where it had been clearly stated that since the landowners had complete control, neighbors' claim could not be considered for the same. There has been a constant need to draft sturdy groundwater regulations owing to the reduced groundwater tables and mismanagement. The government addressed the issue by formulating a Groundwater Development and Management Model Bill, 1970 for the states to adopt, which has also been revised in 1992, 1996, and 2005. The States have been slow in adopting the regulations for groundwater conservation. However, all the States or Union Territories that have adopted the groundwater regulations find their base in the model bill by the government. The league has also followed Uttar Pradesh by formulating the Uttar Pradesh Groundwater Conservation, Protection, Development (Management. Control and Regulation) Bill, 2010 (hereinafter Uttar Pradesh Groundwater Bill).

The groundwater Bill suggests various measures and ways to curb the exploitation of groundwater. The few major highlights of the Bill would be as follows:

1. It aims to set up a Uttar Pradesh Groundwater Authority, which shall be empowered to declare areas as critical, semi-critical, and over-exploited to regulate the groundwater in the areas accordingly.
2. This Authority shall be under the direct control and supervision of the State Government.
3. It provides for the setting up of various associations, such as resident welfare and water users in both urban and rural areas, for reducing the exploitation of groundwater in those areas.
4. The Act places civil servants regulating the groundwater along with a member from a non-governmental organization and a member who has expertise in technology from the National Institute of Hydrology in Roorkee.
5. The Local level authorities do not have any direct power as the Bill does not propose their power directly. However, they shall be responsible for assisting the higher-level authorities in terms of capacity building, looking into how the Bill is being violated, etc., in their area.
6. There are also various other proposals that the Bill suggests making, such as the provision of service providers. These service providers shall be responsible for inspecting the amount of groundwater being withdrawn by the users and have a check on the rainwater harvesting and recharge measures adopted and their efficiency in general.
7. The Bill also proposes to register the drilling agencies in order to curb the exploitation of groundwater resources.
8. The consumers of groundwater residing in critical areas are supposed to get registered by applying for a certificate of registration. The consumers using groundwater resources for industrial or commercial use also must apply for a certificate of registration.
9. The Bill also proposes for a different level of pumps to be allowed or regulated in rural, critical, or over-exploited areas. The level of pumps allowed depends on the category the area falls into.
10. The rural areas are permitted to pump 7.5hp without any regulation. However, pumps above this compulsorily must be self-regulated with the help of established water associations.
11. The semi-critical areas have a stricter mechanism than the above-mentioned one. In the urban areas, it accounts

for pumping of only up to 0.5 hp, which will have to be regulated by the local bodies in those areas.

12. No well can be constructed by any entity in over-exploited areas in order to save the further curbing of groundwater resources in that area.
13. Therefore, it can be said that the UP Groundwater Bill finds its base in the Model Bill laid down by the government. It does distinguish users of groundwater and categorizes different areas into different levels based on the level of groundwater in that area. However, this Bill does not prove to be an effective measure to curb all the problems related to groundwater in Uttar Pradesh.

Demarcation has been laid down between the surface and groundwater as it is completely based on the scientific data and understanding of groundwater, which does not lay down a demarcation with surface water. Therefore, the landowners are vested with immense powers to freely use the groundwater without any proper regulation. The landless groundwater users are not even included in the purview of this Bill, which makes it socially inequitable in all forms.

The Bill does not include in its purview the fundamental right to water of the citizens by not including in its ambit the landless owners, which makes it derogatory or inconsistent with part III of the Constitution. The Bill focuses only on the personal level issues that the landowners and their neighbors could face, which therefore makes it redundant to tackle the groundwater problems at the aquifer level and take a holistic approach to the environmental degradation of the groundwater resources. The Bill has proposed too many institutions at different levels but has no binding mechanism to make these institutions answerable to one single entity. This scattered system of accountability and answerability will lead to redundancy in the working of these institutions.

Therefore, there is a dire need not only for regulation to regulate the groundwater sources but also to bring in essential reforms for the deteriorating effect of groundwater resources. A few of the possible ways in which it could be achieved are as follows:

1. A unitary nature of water regulation is appreciated, which shall include in its purview of regulation not only the groundwater but also the surface water, which shall enable a holistic way of preserving our water resources.
2. Proper respect for the fundamental rights of the landless people should be given as it leads to the violation of their rights. Everyone has basic needs, and water is one of the most essential in them and, therefore, should not be denied in any manner whatsoever.
3. Any unreasonable use of water resources that becomes a threat to the aquifer should be curbed and properly regulated.

THE UTTAR PRADESH GROUNDWATER (MANAGEMENT AND REGULATION) ACT, 2019

The enactment of the Uttar Pradesh Groundwater (Management and Regulation) Act in 2019 was a decisive response to the critical issues stemming from uncontrolled extraction of groundwater, declining water levels, and contamination affecting both urban and rural areas of Uttar Pradesh. This comprehensive legislation introduces a multifaceted approach to promote responsible and sustainable management of the state's groundwater resources. The key provisions and notable aspects of the Act are as follows:

1. **Formation of Committees:** The Act establishes a range of committees at various administrative levels, including Gram Panchayat, Block Panchayat, Municipal, and District levels. These committees are vested with the crucial responsibility of effectively managing and regulating groundwater resources. Their primary roles encompass devising strategies for the protection and conservation of groundwater.
2. **Groundwater Security Plans:** At the heart of the Act lies the emphasis on developing and implementing Groundwater Security Plans. These plans, created at both the Gram Panchayat and Block Panchayat levels, are designed to ensure prudent groundwater management and tailored solutions to region-specific challenges.
3. **State Groundwater Management and Regulatory Authority:** A pivotal aspect of the Act is the establishment of the Uttar Pradesh State Groundwater Management and Regulatory Authority (SGWMRA). This authoritative body is tasked with providing guidelines, identifying regulated areas, and offering expert advice to the government on effective water conservation practices.
4. **Registration and Regulation:** The Act mandates the registration of existing users engaged in commercial, industrial, infrastructural, and bulk groundwater usage, covering both notified and non-notified areas. Additionally, the Act imposes restrictions on the construction of new wells in notified areas and closely monitors the extraction, sale, and distribution of groundwater.
5. **Fees and Penalties:** Noteworthy are the specified penalties for non-compliance outlined in the Act, encompassing fines and potential imprisonment. The

Act differentiates between various user categories, imposing more severe penalties for repeat offenders and those found guilty of polluting groundwater resources.

6. **Rainwater Harvesting and Environmental Safeguarding:** The Act places a strong emphasis on sustainable practices, encouraging actions such as rainwater harvesting, self-regulation, groundwater replenishment, and measures to prevent waterlogging. It underscores the importance of adopting suitable technologies and designs to achieve these objectives.
7. **Impact Assessment and Transparency:** Transparency is a fundamental aspect of the Act. Authorities are required to conduct thorough assessments of the social and environmental impacts of their initiatives. This commitment to transparency extends to the proactive disclosure of information related to impact assessments.
8. **Groundwater Grievance Authority:** The Act introduces the establishment of a dedicated Groundwater Grievance Authority responsible for addressing concerns related to groundwater management and regulation.
9. **Groundwater Fund:** A significant feature of the Act is the creation of a Groundwater Fund designated for various activities aimed at effective groundwater management. This encompasses conservation measures and initiatives to enhance efficiency.
10. **Governmental Powers and Exemptions:** Acknowledging diverse scenarios and requirements, the Act empowers the state government to formulate implementation rules and offers flexibility in granting exemptions under specific circumstances.

In summary, the Uttar Pradesh Groundwater (Management and Regulation) Act of 2019 represents a substantial stride in addressing the challenges arising from unchecked groundwater exploitation, dwindling water levels, and contamination. Through the establishment of a structured framework for responsible groundwater management, the Act endeavors to ensure water security for both urban and rural areas. Moreover, its overarching goal is to safeguard the environment while promoting equitable access to this indispensable resource. (U.P. Act No. 13 2019)

UTTAR PRADESH GROUND WATER (MANAGEMENT AND REGULATION) RULES, 2020

Core principles play a pivotal role in shaping well-crafted public policies regarding water resources. These principles provide the bedrock for achieving consistency in approaches when dealing with the planning, development, and management of water resources. The fundamental tenets are delineated as follows:

1. **Integrated and Environmentally Sound Perspective:** Effective planning, development, and management of water resources should be underpinned by holistic and environmentally sustainable viewpoints. These perspectives should encompass state and national contexts while factoring in the human, social, and economic requisites. This ensures a judicious and conscientious utilization of resources.
2. **Equity and Social Justice:** The principle of equity and social justice should guide the allocation of water resources. This principle guarantees the fair distribution of water resources, taking into account the diverse needs of various societal segments.
3. **Informed Decision Making and Good Governance:** Informed decision-making is of paramount importance in attaining goals related to equity, social justice, and sustainability. Thus, it is imperative to uphold practices of good governance that facilitate well-informed decisions for the greater benefit of the community.
4. **Community Resource and Public Trust Doctrine:** It is crucial to treat water as a communal asset held in trust by the state in adherence to the public trust doctrine. This approach seeks to realize equitable and sustainable development, as well as ensuring food security and livelihood opportunities for all.
5. **Right to Safe Water and Sanitation:** Unrestricted access to safe and hygienic drinking water and sanitation services is an inherent human right necessary for a dignified and fulfilling life. Consequently, these essentials should hold precedence over other water uses.
6. **Balancing Human Needs and Economic Considerations:** Beyond the primary requirement of safe drinking water and sanitation, it is prudent to consider water as an economic commodity to incentivize resource conservation and efficient utilization.
7. **Ecological Considerations:** Acknowledging water's vital role in maintaining ecosystems, ecological factors should be thoughtfully integrated into water management decisions.
8. **River Basin as a Planning Unit:** All facets of the water cycle, encompassing evapotranspiration, precipitation, runoff, rivers, lakes, soil moisture, and groundwater, are interconnected. Thus, the river basin should serve as the foundational hydrological unit for planning endeavors.
9. **Integrated Approach to Quantity and Quality:** The interrelation between water quality and quantity

underscores the need for a comprehensive management approach. This entails integrating wider environmental management strategies, including economic incentives and penalties, to curtail pollution and wastage.

10. **Addressing Climate Change Impact:** It is imperative to account for the influence of climate change on water resource availability while making well-informed water management decisions.

To sum up, these guiding principles constitute a framework for shaping effective policies related to water resources. By aligning policies with these principles, governments can secure the sustainable, equitable, and efficient use of water resources, concurrently ensuring environmental preservation and meeting society's indispensable needs (Khan et al. 2021).

SUGGESTIONS AND RECOMMENDATIONS

- **Review of methodology:** The management of groundwater is solely dependent on the available data of groundwater assessment. However, methodologies used for the collection of valid data are crucial for monitoring, implementation, and decision-making.
- **Mapping of aquifers:** Aquifer mapping and groundwater quality assessment at proper scale in every identified hydro-geological block is important for further management of aquifers.
- **Domestic water security:** Prioritization and management of domestic groundwater security by applying proper strategies suggested by government authorities or legal frameworks.

CONCLUSION

The therapeutic options operate according to physics and chemistry principles. As a result, maintaining a set of predetermined operating parameters is crucial to maintaining their efficiency. This would require competent technical personnel, which is largely lacking, for system operations as well as routine maintenance. To be efficient and cheap, most of the drinking water treatment technologies must be tested in local communities. It is crucial that water pipes do not cross sewage or are not immersed in sewage places in communities where clearer water delivery networks provide clean drinking water. There is a chance that sewage will mingle with pipe water in the communities because the sewage channels are open. Despite the overwhelming effort, we hope that one day, all rural regions will have subsurface drainage systems that will lessen the number of organic particles that might contaminate groundwater.

Rural water supply programs are now being conducted in rural regions under the Water and Sanitation Department. The program's goals are to offer access to clean drinking water through tap connections and to ensure that every home builds a latrine to prevent open defecation. Talking specifically about U.P. (our case study) and the legal dimensions, then, the legalities of groundwater have not been addressed in the Bill. This also reflects the need to relook at the laws and policies from a state-specific lens.

Common people are reporting the poor quality of the water. Institutions and civil society must be reinforced so they can react swiftly to issues with water quality. This is made possible by increased awareness of the types of groundwater pollution, the potential dangers to groundwater quality in their area, the degree of susceptibility, the negative impacts of utilizing polluted water, and feasible preventive actions. In turn, they could exert pressure on the line agencies to deliver. Strengthening civil society organizations is crucial since groundwater quality fluctuations are frequently erratic. Because of the high expenses and technical expertise required, it is very challenging for monitoring agencies to set up an intricate network of WQM stations. Additionally, people's willingness to pay for water is closely correlated with their knowledge of and awareness of the negative effects of consuming contaminated or polluted water. By creating a crucial database on groundwater quality, reputable and technically proficient NGOs may significantly contribute to the development of civil society.

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