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DEPLETION OF GROUND WATER RESOURCES : A CASE STUDY OF SOUTHERN RAJASTHAN

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Abstract

Groundwater extraction results in a multitude of positive outcomes for society as a whole. It is the principal source of drinking water for about half of the country's population as well as almost all of the country's rural citizens, and it provides around 50 billion gallons of water per day to support the nation's agricultural economy. In addition, it helps to sustain the nation's agricultural business. Ground-water depletion, which is a phrase that is usually characterized as a long-term fall in water-level produced by persistent ground-water pumping, is a serious issue that is associated with the utilization of ground water. Depletion of ground water is a phrase that is frequently described as a long-term decrease in water-level generated by persistent ground-water pumping. In a significant area of the United States, there is a shrinking pool of available ground water, which is a factor in the country's overall water crisis.

keywords: *ground water, resources,Rajasthan*

Introduction

A global "explosion" of groundwater development for urban, industrial, and agricultural supplies has occurred over the course of the previous half century as a direct result of the widespread availability of pumping wells. According to Shah et al. (2000), the total amount of groundwater extracted each year is between 750 and 800 km3. The use of groundwater has resulted in phenomenal economic advantages. On the other hand, groundwater supplies have been depleted in many locations to the point that well yields have declined, pumping costs have increased, water quality has worsened, aquatic habitats have been destroyed, and land has sank irrevocably. When water is extracted from an aquifer, it inevitably leads to the depletion of the groundwater supply, which is a natural and unavoidable result. Theis (1940) demonstrated that pumpage is originally generated from the withdrawal of water from storage, but that over time, this source of pumpage becomes progressively derived from decreasing discharge and/or higher recharge. When the new balance is attained, no further water will be drawn from storage since there will be no need for it. In the case of aquifers that are either fossilized or compacting, depletion practically represents permanent groundwater mining since recharging is either not possible or is unable to replace the pore spaces that have been drained. Head decreases that are both consistent and significant are an indicator of depletion in renewable aquifers. The extent of the issue has not been estimated on a worldwide scale; nevertheless, ongoing research conducted by the senior author suggests that around 700–800 km3 of groundwater has been extracted from aquifers in India over the 20th century. One of the better known instances is the 450,000 km2 High Plains aquifer system in the central United States. During the 20th century, the net quantity of water that was withdrawn from storage was more than 240 km3; this represents a loss of about 6% of the volume of water that was stored in the aquifer prior to the development of the area (McGuire et al. 2003). According to Dennehy et al. (2002), the use of groundwater for irrigation purposes has become either impossible or prohibitively expensive in some of the most depleted locations. The removal of the fresh groundwater that can be recovered with the least amount of effort might sometimes result in a residual supply that has a worse quality of water. This is because of induced leakage from the land surface, confining layers, or nearby aquifers that contain salty or polluted water. This is one of the reasons why this is happening. Seawater intrusion and upconing, which are both produced by head reductions in the aquifer, limit the amount of fresh groundwater that is accessible in coastal locations, which is where many of the major cities in the world are situated. This decreases the volume of fresh groundwater that is available. As global depletion proceeds, the repercussions it has are expected to become more severe, which will need an impartial appraisal of the issue and the potential remedies to it. In light of the rapidly changing physical and social situation, this paper investigates potential future approaches to assessing and controlling groundwater depletion.

1. Geographical Context: The region known as Southern Rajasthan is located in the western section of India, and it shares borders with the states of Gujarat and Madhya Pradesh. Jodhpur, Barmer, Jaisalmer, and Bikaner are some of the cities that may be found within this area. It is located in the Thar Desert, which is notorious for its dry environment and limited supply of water resources.
2. High Dependency on Groundwater: The population of southern Rajasthan depends largely on groundwater to meet their water requirements since there are not many surface water sources available (such as rivers and lakes) in that region. The most significant user of groundwater is the agricultural industry, followed by residential and commercial use. Rain-fed agriculture, which relies primarily on groundwater for irrigation, is the major form of crop production in this part of the world.
3. Over-Extraction and Declining Water Levels: Because of factors such as rising populations, greater agricultural production, and expanded industrial endeavors, there has been a substantial rise in the demand for groundwater over the course of many decades. Unfortunately, the pace of groundwater extraction has beyond the rate at which it can be naturally recharged, which has led to falling water levels. The usage of wells and tube wells, which are often dug deeper and equipped with more powerful pumps, is being done in order to reach water from lower aquifers, which exacerbates the issue of aquifer depletion.
4. Impact on Agriculture and Livelihoods: The falling groundwater levels have had a significant negative impact, both on agricultural output and on people's ability to make a living in southern Rajasthan. Farmers are experiencing difficulties such as decreased agricultural yields, rising expenditures associated with irrigation, and dependency on the unpredictable monsoons. Because the water table is falling, farmers are having to dig deeper wells and spend more money on water pumping, which is placing a burden on their finances.
5. Water Quality Issues: In addition to the issue of depletion, there is also a worry about the deteriorating quality of the water in the area. The water table falling causes a rise in the concentration of dissolved salts and minerals, which in turn causes an increase in the salinity of the water. since of this, the groundwater's appropriateness for irrigation is reduced since excessive salinity may be harmful to crops and lead to lower yields.
6. Government Initiatives: As a result of the government's realization of the gravity of the groundwater depletion issue, a number of steps have been made to address the matter. These efforts include the promotion of water conservation habits, the encouragement of the use of drip irrigation and sprinkler systems, the implementation of rainwater collecting methods, and the regulation of groundwater extraction via the construction of water meters and monitoring wells. These practices and systems may help reduce the amount of water that is wasted.

7. Community Participation: It is essential to include local people in environmentally responsible water management techniques. People have been educated via the establishment of awareness programs, training workshops, and farmer cooperatives in order to educate people on the effective use of water, crop choices, and water-saving practices. It is impossible for long-term conservation initiatives to be successful without the participation of local people and other stakeholders.
8. Future Challenges and Solutions: Despite the efforts that have been made to slow or stop the depletion of groundwater, there are still various obstacles that need to be overcome. Increasing public awareness, improving water usage efficiency, imposing stronger laws, and promoting alternate water sources like surface water reservoirs and wastewater recycling are some of the things that may be done in this regard. The use of sustainable agricultural methods, such as crop rotation and the development of drought-resistant cultivars, may also contribute to a reduction in the amount of water that is required. The depletion of groundwater supplies in southern Rajasthan is an urgent problem that will have significant repercussions for agriculture, people's means of subsistence, and the state's overall water security. To effectively address this issue, a multi-pronged strategy is required. This strategy must include environmentally responsible water management methods, active participation from the community, and strict adherence to government rules in order to guarantee the region's continued access to groundwater resources over the long term.
9. Research and Monitoring: In order to collect precise data on groundwater levels, quality, and recharge rates in southern Rajasthan, it is necessary to carry out extensive research and monitoring activities. This information may serve to provide direction for the decision-making process and contribute to the development of efficient strategies for water management. Monitoring groundwater extraction, water levels, and water quality metrics on a consistent basis may give insights into the changing dynamics of the aquifers and help identify regions of high stress. This can be accomplished via the use of hydrologic modeling.
10. Integrated Water Resource Management: It is very necessary to implement a holistic strategy for the management of water resources in order to ensure the sustainable use of groundwater. In order to do this, it is necessary to take into account the linkages that exist between surface water and groundwater, to encourage the concurrent use of water resources, and to put effective water allocation procedures into place. Plans for the integrated management of water resources may assist in optimizing water consumption, achieving a balance between the requirements of various industries, and minimizing the negative effects of groundwater depletion.
11. Rainwater Harvesting and Artificial Recharge: The groundwater reserves may be helped to be replenished if people are encouraged to use artificial recharge technologies and rainfall gathering techniques. Rainwater runoff may be collected by the construction of check dams, percolation tanks, and recharge wells, which then enables the captured water to permeate the earth and refill the aquifers. Taking these steps may assist increase the level of groundwater and maintain a sustainable water supply during times of low rainfall.
12. Water-Efficient Technologies and Practices: A large reduction in the demand for groundwater may result from the dissemination of water-saving technology and practices, especially in agricultural settings. Optimizing water utilization and reducing the amount of water that is lost may be accomplished through promoting the use of drip irrigation, sprinkler systems, and other precision farming methods. In addition, increasing water efficiency and decreasing dependency on groundwater for irrigation may be accomplished through encouraging the growth of drought-resistant crops and the use of crop rotation strategies.

13. Awareness and Education: It is essential to educate the people living in the surrounding areas about the significance of sustainable water management and the preservation of groundwater supplies. Individuals may be empowered to adopt habits that save water in their everyday lives, encourage responsible groundwater use, and build a feeling of collective responsibility towards the preservation of water resources via the implementation of educational campaigns, seminars, and training programs.
14. Policy and Governance: In order to successfully address the problems caused by groundwater depletion, it is vital to strengthen the policy frameworks and governance mechanisms that are already in place. The implementation of stronger controls on the extraction of groundwater, the guaranteeing of fair distribution of water resources, and the enforcement of sanctions for the unlawful extraction of water are all essential tasks. The creation of all-encompassing water management plans, the participation of all relevant parties, and the establishment of procedures for consistent monitoring and assessment may all help to the sustainable management of groundwater.
15. Regional Cooperation: The depletion of groundwater is not confined to the southern region of Rajasthan by any means. Collaborating with surrounding areas to share best practices, expertise, and experiences, as well as exchanging information and experiences, may lead to more efficient solutions. Through regional cooperation, transboundary water concerns may be addressed, sustainable water use can be promoted, and the availability of water resources for all stakeholders can be ensured for the long term. It is feasible to lessen the impact of the depletion of groundwater resources in southern Rajasthan by putting into action a mix of these measures and enlisting the participation of all of the key stakeholders. However, in order to solve this problem, it will need consistent work, careful planning over the long term, and a collective dedication to water conservation and environmentally responsible management techniques.

Groundwater depletion and global climate change

The hydrological systems of the planet will be significantly impacted by global climate change. Sea levels are rising because of both the melting of glaciers and the warming of the oceans. On the continents, we may anticipate a rise in both the frequency and intensity of floods and droughts. At the same time, increasing temperatures will cause winter snowpack to decrease and spring snowmelt to occur more quickly in mountainous regions. Depletion of groundwater may have a multiplicative effect on the effects of these changes if it is not managed in a regulated manner; on the other hand, such management can help reduce the severity of these effects. If we assume that the amount of groundwater that has been extracted over the previous century has been much more than what can be explained by steady increases in the amount of water that has been stored in the soil, natural channels and lakes, and the atmosphere, then the oceans will be the final destination for the groundwater that has been "lost." It is possible that the volume of groundwater depletion from storage will be so great on a global scale as to represent a contribution to the increase in sea level that can be measured. For instance, the total amount of water that was extracted from the High Plains aquifer throughout the 20th century contributed about 0.75 millimeters, or approximately 0.5%, to the recorded increase in sea level. A future sea-level rise may be slowed to some extent by taking measures to minimize the amount of groundwater that is extracted in the future and by increasing the amount of water that can be stored underground. Historically, the answer that civilization has taken to problems like as droughts and floods has been to collect surface water in reservoirs and then let it out only when necessary. However, there are not enough geologically acceptable areas for new dams, and people are becoming more conscious of the ecological repercussions of these dams, which will make it more difficult to respond to future hydrologic extremes, even while the frequency and severity of these extremes continue to rise. According to Service (2004), if temperatures continue to rise over the long term, there will be an increased need for water storage in preparation for a longer dry season. In some regions, an integrated solution may be reached by artificially recharging surplus runoff when it is available. This is possible in certain of these places. Therefore, depleted aquifers have the potential to be converted into subterranean "reservoirs," which may enhance the capacity of existing surface-water reservoirs to mitigate the effects of flooding and drought.

What are some effects of groundwater depletion?

When heavy pumping from an aquifer goes on for an extended period of time, there is the potential for negative impacts.

Issues with the water well Water wells are negatively impacted in three primary ways by falling groundwater levels. To begin, the height of the water must be increased so that it can reach the surface of the ground as the depth of the water grows. The amount of energy used to drive the pump rises in proportion to the increase in the lift distance. As a result, rising prices for electricity result from decreasing quantities of ground water. It is possible that using water for a certain purpose will no longer be practical from an economic standpoint due to the expenses associated with the energy required to do so. Second, there is the possibility that ground-water levels may drop below the bottom of the pumps that are now in use, which would need the costly modification of either lowering the pump, deepening the well, or digging a deeper replacement well. Third, there is a possibility that the output of the well will fall below rates that are useful.

Objectives

1. To get an understanding of the primary challenges presented by the scarcity of water in this region.
2. To get an understanding of the capabilities of riparian and agricultural communities with regard to their ability to adapt to climate change.
3. To gain an understanding of the role that rural communities in the project area play in the conservation and management of natural resources in a sustainable and equitable manner.

Database and methodology:

The current research used both elementary and secondary school students to compile its database of information. Numerous meetings with local authorities and nongovernmental organizations (NGOs) to collect data and information were held in this context. The author of this piece about the drought-affected region has participated in a great number of personal interviews. The information that was gathered was then assessed, analyzed, and explained in a clear way.

Study Area:

The Alwar district of Rajasthan is found in the state's north-eastern corner and stretches from north latitude 27 degrees 03' to north latitude 28 degrees 14' and from east longitude 76 degrees 07' to east longitude 77 degrees 13'.The total land area that it encompasses is 8720 square kilometers. Its width from east to west is around 110 kilometers, while its length from south to north is approximately 137 kilometers. About 2.45 percent of the total land area of the state is taken up by the district. The district contains a total of 1991 villages, and the population of rural areas was 30,18 lacs according to the 2011 census. The climate of the region may be described as semi-arid, with extremely hot summers (temperatures can reach up to 47 degrees Celsius) and very cold winters. The temperatures in the summer can reach up to 47 degrees Celsius.The south-west monsoon season often brings the most precipitation, which averages 631 millimeters. In the months of May and June, the rates of potential evaporation are at their highest. In the region under investigation, several traditional water collection methods have been put into practice, including the following: "Kui": in order to reduce the amount of water that is wasted, a tiny well known as kui or beri is built in close proximity to a water leaking as oozing tank. Its entrance is concealed by strips of wood, the majority of which are left in their natural state. The term "khadeen" refers to a building technique that may be used for a variety of purposes. The excess runoff from the upland and rocky surfaces is gathered in a khadeen that is next to the valley, and it is backed up against an embankment that has a masonry water barrier. The water that is allowed to pool in ia a khadeen contributes to the ongoing process of ground water recharge. The term "bawari" refers to step wells, which are also called "jhalara" in the area and are often built to collect rainwater. "Johad" is an Arabic word that refers to a dam that collects rainwater and then channels it into the earth in order to restock the supply of water that is found underneath.

A Johad In Gopalpura Village, In Alwar District

An overview of the transition from dry to rainy conditions: The crescent-shaped earthen dams known as 'johads' in Alwar were an important part of the city's long tradition of water conservation. These dams slowed the flow of water and enabled precipitation to seep into the ground below, therefore recharging subsurface aquifers. Alwar had a long and illustrious history of protecting its water resources.One of the most important contributions that Johad makes is meeting the need for water among cattle, and another contribution, which is of the utmost importance, is recharging ground water via the storage of water. This extended across a considerable distance in kilometers. When there is a prolonged period of drought, the capacity of the ground water reserve to meet the enormous demand for water increases. Because of the johads and the trees, it was feasible for water to be kept underground even when there was a drought in Alwar; this allowed the city to maintain its steady balance. By working together as a community, the villagers are essential in the process of building and maintaining the Johads. In earlier times, monarchs or other local authorities were responsible for providing funding for the building of Johads. Instead, they take a sixth share of the produce from the local inhabitants. The establishment of new forests is an additional significant aspect of community life because of the group's dependence on water. They have established rules for the felling of trees. In 1890, forests covered sixty percent of the earth's surface. Following the year 1940, local monarchs or rulers in the district of Alwar in Rajasthan sold the whole forest to loggers, which led to the beginning of the effects of deforestation. As a direct consequence of this, the negative impact on water, which is a natural resource, had a cascading effect on other natural resources. The depletion of natural resources has a direct correlation to the poverty of the surrounding communities. Topsoil became exposed owing to forest clearing. During the wet season, the topsoil that had been eroded ran down the slopes of the hill and into Johads. There were tens of thousands of Johads that were clogged up with silts. It was not successful in recharging the aquifers that were found at the bottom surface of Johads. The water table has to be lowered significantly. In earlier times, the people would work together to clear the silt from the Johads and then rebuild them. However, when the government took possession of the majority of the communal land to which the Johads belong, the villagers' enthusiasm began to wane. Manglo Patel, a resident of the community, was quoted as saying that "Village unity collapsed and people neglected their Johad structures," explaining that this was the case since Johads can only be created by groups and not by individuals. In this manner, one by one, Johads were rendered useless and wrecked. Around the year 1950, the government had erected tube wells that were powered by diesel engines. This was a result of the impact of contemporary technology. Getting water from tube wells became a lot less difficult as a result of technological advancements. As the water table continued to fall, the villagers were faced with the challenge of determining how far down they should dig in order to find water. The villagers were used to having easy access to water, which led to an easier way of life. But there came a day when they were unable to drill any farther. Water level had gone deep so far. As a natural and unavoidable fallout, wells went dry, and the streams and rivers in the area were completely devoid of water. The depletion of the aquifer was caused by a chain of vicious cycles that were interrelated with one another and reinforced one another. Due to a lack of available ground water, both the trees and the veggies perished. The slit deposition in Johads was hastened by the erosion of the soil. When there is less vegetation, there is less transpiration, which in turn leads to less precipitation. The duration of the monsoon season decreased from 101 days in 1973 to just 55 days in 1987. After the halt in irrigation-based farming, lands that had the potential to grow many crops were converted into land that could only produce a single crop. The outmigration of young males to cities like Delhi and Ahmadabad had begun to offer financial assistance for their families. Even the youngsters stopped attending to school in order to go two kilometres to a distant source of water. There just was not enough time in the day for women to contribute financially to their families via other means. The community institution came to a complete and utter halt. Story of a river that was reborn: in the years 1985 and 1986, one of the poorest districts in Rajasthan, Alwar, had one of the worst droughts in recorded history as a result of exceptionally low rainfall and extensive logging. The groundwater level dropped to a point where it was dangerously low compared to the average, and the district was designated as a "dark zone," which implies that any further extraction of ground water is prohibited entirely.

Community water management:

In 1985, Dr. Rajendra Sing, who was the director of an anonymous government organization known as Tarun Bharat Sangh, devised a revolutionary strategy to operate in the most impoverished area of Rajasthan, which was the Gopalpur hamlet located in the Alwar district. He had started the process of renovating Johads with the assistance of the local residents in the area. During the wet season of 1986, Johads once again began to get filled with water. After some time, the dry wells that were located in the area eventually become re-hydrated, and Goalpura reached its tipping point. The recovery of rivers resulted in the flourishing of aquatic life. The number of fish has increased. However, the government had granted fishing rights on rivers to private companies and individuals. The decision did not go down well with the villagers. They were the ones who put in the laborious effort to bring the rivers back to life. Because of the tension and conflict that arose as a result of this problem, a system for conflict resolution known as the Arawari River Parliament was established in the year 1999.

A Johad In Dry Season, In Alwar District

There were two MPs chosen from each of the 72 neighboring communities in the newly created parliament. Through the enactment of 11 laws, this legislature set out to accomplish its mission of regulating and safeguarding water use, and by extension, all areas of water management. The Arawari Parliament established a schedule of regular meetings, which led to the effective resolution of issues and the protection of water resources. However, since this parliament did not have any legal character, there were no legal duties as a result of the choices that it made. Despite this, the people of the hamlet were able to keep their parliament alive and operating well. Facilitators were provided by employees and colleagues of the Tarun Bharat Sangh organization. It was a narrative of triumph thanks to the contributions of the community. In order to improve the functioning of the 'Arawari Parliament, the Tarun Bharat Sangh formulated a legal plan that would be of assistance to Johadmanagement. However, the backing of the legislature is necessary in order to accomplish success in all aspects. Every single success paved the way for the next one. By the year 1996, Gopalpura had constructed nine johads, which covered a total area of 2,381 acres. As a result, the water table had risen from an average depth of 45 feet below the surface to a depth of 22 feet, and all of the wells contained water. As a consequence of this, fewer people using petrol pumps led to a reduction in the overall cost of fuel. The number of hectares devoted to wheat production increased from 33 to 108, and some agricultural areas began producing two crops each year. In addition to this, the people brought their forest resources back to life and reestablished their ancient gram sabha council. They levied a monetary penalty for each and every tree that was cut down. The effect of this success extended to the villages that were nearby, and the residents of those villages followed those old procedures of reviving johads. They too had success with those tactics. A new age starts with the enchantment of check dams: The community of Kohar, which is located in the Alwar area, did not get a lot of rain on a yearly basis, and around 78 percent of the water that was accessible was salty. The peasants not only had issues with regard to irrigation for agricultural purposes, but they also had challenges in arranging water for day-to-day operations; as a consequence, laege scale out migration was unavoidable. When the Sehgal Foundation finally made the decision in 2014 to come to this location, it was immediately confronted with this terrible predicament. The incredible outcome was accomplished by the organization by erecting a check dam in an effort to alleviate the severe water shortage. A check dam is a tiny barrier that is put across a constructed swale or drainage ditch. Check dams may be built out of rock, gravel bags, sand bags, fiber rolls, or other reusable goods. The effective slope of the channel is lowered by check dams, which in turn decreases the channel's flow rate. This method is ideal for a place like Kohar where members of the community may also be involved in the building of the dam since it needs little in the way of equipment, money, and large-scale labor. Check dams are ideal for this kind of construction. The locals have recently shown an interest in organic gardening and are even beginning to experiment with composting as a method of waste management. The construction of check dams helped alleviate the country's severe water shortage, which made all of this feasible.

Findings:

1. Efforts are made to organize rural communities in this project area for the purpose of integrated natural resource conservation and management.
2. Increased capability of riparian and agricultural communities to adapt to changing climatic conditions

Conclusion

The region known as Southern Rajasthan is located in the western section of India, and it shares borders with the states of Gujarat and Madhya Pradesh. Jodhpur, Barmer, Jaisalmer, and Bikaner are some of the cities that may be found within this area. It is located in the Thar Desert, which is notorious for its dry environment and few water supplies. Heavy Reliance on Groundwater As a result of the paucity of surface water supplies in the form of rivers and lakes, the people living in southern Rajasthan have to rely significantly on groundwater to fulfill their need for drinking water. The most significant user of groundwater is the agricultural industry, followed by residential and commercial use. Rain-fed agriculture, which relies primarily on groundwater for irrigation, is the major form of crop production in this part of the world. Ground-water depletion, which is a phrase that is frequently described as a long-term fall in water-level induced by persistent ground-water pumping, is a significant problem that is related with the usage of ground water.

Recommendations:

1. It is possible to create earthen dams and other small water collection systems. The amount of ground water that is recharged as a result of upstream irrigation will likewise grow.
2. In order to make the most efficient use of water, contemporary agricultural practices and irrigation methods will need to be used.
3. Crops with high water requirements should be avoided as much as possible. Farmers should have enough training to cultivate plants with minimal water requirements.
4. It is necessary to educate the people of the next generation and instill in them a connection to the johad, the forest, and the community as an essential step in the process of preserving the balance.

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