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13

RAINWATER HARVESTING IN PUNJAB: MITIGATING DECLINING WATER TABLES

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Abstract: *The essential element of that is crucial for survival is water. But the 21st century has its own challenges; despite the progress it has made in making life smoother. The present water crisis, which is affecting the globe from various angles, requires urgent attention from academia for policy inputs and from the government for implementation. The Indian state of Punjab, which is dependent solely on agriculture, is finding it difficult to maintain the groundwater levels. They are dropping beyond the renewal capacity. In this tumultuous situation, the most appropriate solution that presents itself is to tap the falling precipitation. The present paper is an attempt to show how rainwater harvesting can work well in the state of Punjab. The various aspects related to water table depletion and its causes, such as over-extraction for intensive agriculture, are examined. Then, the paper sheds light on historical methods for water conservation that were employed by our ancestors and explores how these traditional strategies can still be effective. The potential of traditional systems, combined with modern methods, is currently needed to correct the water balance of underground aquifers. Hence, all of that has to be seen in a holistic scenario, which this paper is an attempt towards.*

Keywords: Declining Water Tables, Rainwater, Harvesting, Traditional Approaches

Introduction

Water being a mobile fluid is consistently changing form in the water cycle. It falls as a downpour and should be caught for meeting the current shortage of this scarce resource. Therefore, rainwater harvesting comes as a viable option. The draining of water underground in the villages occurs all alone because of the accessibility of huge open spaces yet in the urban communities, large-scale development from solid concrete pretty much rules out any water saturating ground. So, there is a need to make way for more permeability and reduce the concretization to the extent possible (Lancaster, 2019). The water from rain for the most part goes squandered in the event that it is not collected as expected here. In water reaping frameworks, there is a collection of water falling as precipitation. The most widely recognized technique utilized for the collection of water is rooftop conservation. The roof catchment gathers water falling on the roofs of the spaces like schools, workplaces, or houses which can then be utilized for different purposes. It very well may be a source of different errands in the routine existence of individuals or it tends to be utilized for artificial re-energizing of the underground springs. There are multiple approaches to allowing the water to arrive at the underground aquifers, these incorporate digging wells or bore wells. The customary frameworks of water collection like the lakes and wells should be restored. The top of different structures in the area can be used as run-off space to catch water. The rural people can also be encouraged to build some structures for harvesting rainwater which can be maintained at absolute minimum costs but with more human sweat (Lancaster, 2019).

There are two different ways of water harvesting but before that, there are some criteria upon which the selection of the site is based. These are the climatic conditions, socio-economic conditions of the area, and already existing infrastructure (Krishan, 2011). The first is through the roof framework and the other is through the surface catch. In the housetop collection of water, the roofs are utilized as an immediate source of collection of water, and the water is then sent into a water tank. The construction style of the roof and its catchment area are some of the factors that contribute to the amount of captured water. In the surface flow capture the water can be gathered from the immense open spaces. This should be possible just with the assistance of the local area in general. The water gathered in this manner is mostly used for the artificial re-energizing of groundwater and also can be a source of agriculture (Oweis, 2012). The requirement for water harvesting has arisen because of the current peculiarity of industrialization, urbanization, and broad water-utilizing present-day ways of life.

Water harvesting can be advanced as a legitimate answer to the water crisis in the country. There are a few advantages connected to the system. The principal advantage clearly will be the greater availability of water all through the year for different purposes even in the non-rainy season. The circumstance of dry season can likewise be managed on the off chance that the local area at large will have stores of water from the preceding rains. The water bills will likewise drop helping the consumer at the lower level of pay. The act of water harvesting is very climate friendly in which the artificial recharge of the groundwater advances the wellbeing of the underground water reserves. One of the main roundabout advantages of this protection adds up to gender equality. Frequently in regions confronting a lack of water, the ladies of the family are water transporters. The women travel a significant distance to bring water for the family frequently undermining their wellbeing and paying the opportunity cost of using that time in the useful works for their self-improvement. In the event that there will be stores to be utilized by individuals in the midst of a dry spell, the women can draw in their time in some productive venture. This will clearly improve their status in the public arena and will likewise make them autonomous bosses of their own fates. So clearly advancing water harvesting in the areas confronting water deficiency will add to women's empowerment. Likewise, the system of rainwater harvesting is generally cost-effective. It is simply a one-time investment; the support cost is extremely low. The artificial re-energizing of groundwater through the engaged mediation of rainwater conservation can work on the fertility of the soil and improve its fertility in the non-rainy season. In that season another exercise like mulching on selected spots can also help reduce loss of soil moisture (Lancaster, 2019).

The growing populace on our planet spurs an interest in additional resources among which is water. The looming warning of the world to be battling water wars is a serious concern.

India is likewise traveling in its direction toward this water crisis. The easiest accessible source of water in India is groundwater. The groundwater can be handily taken advantage of with regards to accessibility and furthermore is monetarily doable to tap it. Be that as it may, the overreliance on it has added to subsiding water tables and this accompanies heaps of adverse results going from social to financial. In a recent judgment in the Westend Green Farms, case by NGT it has been clearly instructed that the stakeholders need to be mindful of the groundwater extraction and the authorities need to be strict to make sure that the rules are followed (Westend Green Farms Society v. Union of India & Ors, 2017). The water demand in India is growing. To satisfy this consistently expanding demand for water there is a requirement for tapping the precipitation with the assistance of appropriate strategies. Of the 400 mm of precipitation got by India just half is usable representing the geological and different constraints. Around 37 percent of the freshwater from downpours, snow, or icy masses lands back into the oceans because of the shortfall of storage capacity in India. The amount of rainfall varies across time and space due to the variation in the geography of the country. The main reason for scarcity in most of the country is not the variation in rainfall, but rather the lack of proper management. Meghalaya is a prime example of this, as it receives one of the highest amounts of rainfall in India amounting to 11000 mm but still experiences water shortages during the winter months (Rain Water Harvesting and Conservation Manual, 2002). This highlights the absence of infrastructure to collect and store the rainwater, as well as the inadequate management of water resources.

India, despite being fortunate enough to receive one of the highest levels of rainfall in the world, is currently facing a significant water crisis. Despite being one of the wettest regions on the planet, the country lacks a comprehensive water management policy, resulting in the wastage of its abundant water resources. India possesses various sources of fresh water, including snow, rainfall, and glaciers, which necessitate proper storage facilities to ensure their efficient utilization. Without adequate infrastructure for water storage, substantial quantities of usable freshwater are lost to the seas. Consequently, there is an urgent need to develop a suitable policy for managing the nation's water resources. The combination of a growing population and modern lifestyles has led to an increased demand for water, posing a major challenge. Furthermore, the availability of water decreases significantly during non-rainy seasons, exacerbating the issue. Also, the vast topographical expanse coupled with variability in the rainfall poses an intrinsic challenge for tapping this resource (Barron, 2009).

This situation necessitates the implementation of various water conservation measures. The primary objective is to conserve water while also instigating a shift in people's behavior to prioritize the preservation of this invaluable resource in their daily activities. India has a rich heritage of water harvesting, evident in the historical water structures such as the bathing ghats at Mohenjo-Daro or Dholavira. These structures reflect the wisdom of the early inhabitants of this land. The state of Rajasthan, located in the Thar desert, boasts remarkable water harvesting structures, including *jhaalaras* and others (Agarwal & Narain,1999). The ruling elite recognized their responsibility to construct such structures for the region. There are some outstanding examples of the involvement of civil society in the construction of water structures for public use. One such example is Tarun Bhagat Sangh which has worked on this issue in villages and constructed more than 2,500 johads in the area (Sharma, 2002). It is imperative to enhance water harvesting efforts with the collective involvement of the community.

Declining Groundwater Tables of Punjab

The recent report from the central groundwater board has revealed that a significant number of blocks in Punjab, specifically 114 out of 150, are experiencing overexploitation of groundwater. This report provides valuable insights into the state of Punjab's aquifers (Central Groundwater Board, 2014). Recognizing the existence of this problem is the initial step towards finding a solution. The overexploitation of groundwater in Punjab has been an ongoing issue for a considerable period of time. The implementation of agricultural policies has played a significant role in the unsustainable extraction of groundwater. Various factors have contributed to the depletion of groundwater reserves, with the foremost being the shift in cropping patterns from traditional maize to wheat and paddy. Paddy cultivation, in particular, has been identified

as a major contributor to groundwater consumption in Punjab. During the early years of India's independence, when food security was a pressing concern, policies were implemented to promote the growth of wheat and rice. The government took several measures to incentivize the production of these crops. However, the present era is witnessing the environmental repercussions of these actions.

Table 01: Shifting of the crop pattern table

Year	Rice (in million hectares)	Wheat (in million hectares)
1970- 71	390	2299
1990-91	2015	3273
2011- 12	2826	3910

Source: Statistical Abstract of Punjab, various issues

The state of Punjab has played a significant role in contributing a substantial portion of foodgrains to the national reserves, thus earning the reputation of being India's bread basket. Traditionally, the cultivation of rice and wheat, which were not well-suited for this region, began to be practiced here. The table provided illustrates the growth in the cultivation area of rice and wheat from 1970 to 2012. In 1970, the cultivation area for rice was only 390 million hectares, while for wheat it was 2299 million hectares. However, these figures have consistently increased over time, reaching 2826 million hectares for rice and 3910 million hectares for wheat in 2012. Consequently, the cultivation area for maize, which was previously compromised to accommodate the production of rice and wheat, has experienced a decline.

Table 02: Cropping Intensity

Years	Cropping Intensity
1970- 71	140
1980- 81	161
1990-91	178
2000- 01	186
2011-12	190

Source: Statistical Abstract Punjab, various issues

The table presented above illustrates the cropping intensity in the state of Punjab, which has exhibited growth over the specified period. Specifically, the cropping intensity increased from 140 in 1970 to 190 in 2011-12. Cropping intensity refers to the level of productivity derived from a particular plot of land within a given year by farmers. Higher values of cropping intensity indicate greater productivity and more extensive utilization of the land, which can lead to the depletion of land and water resources.

Table 03: Net irrigated Area (Percent)

Year	Percentage of net irrigated area to net sown area
1970-71	71
1980-81	81
1990-91	93
1999-00	94

Source: Statistical Abstract of Punjab, Various Issues

The table presented above illustrates the percentage of net irrigated area in relation to the net sown area. It is evident that the net irrigated area in Punjab has experienced an increase. Punjab is recognized as one of the most heavily irrigated provinces in India. Specifically, the net irrigated area rose from 71 percent in 1970-71 to 94 percent in 1999. It is commonly argued that the cultivation of paddy, a crop that dominates Punjab's agriculture, is unsuitable for the region. Paddy cultivation requires a significant amount of water, and flood irrigation is typically employed throughout the country, including Punjab. However, Punjab, being semi-arid due to its proximity to the Thar desert, receives less rainfall compared to other regions where rice is traditionally grown, such as West Bengal and Orissa. Despite this, farmers in Punjab have turned to paddy cultivation due to its profitability, supported by government procurement operations and market assistance measures. However, it should be

noted that Punjab is not naturally suited for paddy cultivation, leading farmers to rely on groundwater extraction by deepening bore wells. Consequently, the shift in irrigation infrastructure reflects a decline in groundwater levels, rendering the situation unsustainable. The majority of farmers, regardless of farm size, have installed groundwater extraction devices, indicating a widespread reliance on this resource. However, this raises concerns about the viability of such practices in the future.

The profitability of paddy cultivation has incentivized farmers in Punjab to continue growing this crop. Government support measures, such as minimum support prices and free electricity for farming operations, have played a significant role in its growth. The state government of Punjab provides substantial electricity subsidies for farming activities, which, while beneficial for social welfare, further encourages paddy cultivation. These subsidies are primarily used to power pumps for groundwater extraction. To replenish the aquifers in Punjab, power reforms are necessary. In the year 2010-11, the Punjab government incurred a subsidy of 3.20/kwh for supplying electricity to farmers. The central region of Punjab, which is experiencing a significant decline in water levels, operates approximately one million electricity-operated tube wells. Urgent attention is required to address the issue of subsidy funding, and electricity charges should be linked to usage. This approach would encourage farmers to adopt better water management practices. The government could promote alternative irrigation methods, such as sprinklers and drip irrigation, by withdrawing the subsidy provided for free electricity. This not only saves government funds but also contributes to environmental sustainability. Farmers in Punjab need to be convinced that they can cultivate alternative crops without compromising their financial gains. Traditional crops suitable for the region, such as maize, should be reintroduced. However, farmers will only shift to other crops if they prove to be profitable. Therefore, it is crucial to develop policies that make the cultivation of alternative crops lucrative for farmers. Even if the immediate elimination of paddy cultivation is not feasible, transitioning to rice varieties that require less water should be considered. Additionally, the Punjab Preservation of Subsoil Water Act, 2009, recommends measures such as sowing paddy after a specific date in May. Implementing this practice could result in significant water savings at the community level.

Water Harvesting Traditions in the Country

Throughout history, the people of India have demonstrated a strong awareness of the importance of water conservation. This can be seen in the ancient practice of constructing lakes and other water bodies, which dates back to the time of the *Mauryas*. The existence of Sudarshan Lake, as evidenced by epigraphical records of its construction and subsequent repair, further confirms the Indians' knowledge and implementation of water conservation techniques. Although many traditional rainwater conservation methods have fallen out of use, some continue to be practiced in peripheral regions and they need to be practiced in consonance with modern methods (World Water Council, 2000). For instance, in hilly areas like Uttarakhand and Himachal Pradesh, rainwater is collected in *chuptyaulas* and simars for various purposes such as bathing, drinking, livestock care, and even religious rituals. Similarly, in mountainous depressions, *chaals* and *khaals* are utilized to collect rainwater, forming small lakes or ponds of local significance. In the Gangetic regions of Uttar Pradesh and Bihar, wells are commonly dug to meet water needs, as the water table is relatively shallow and easily accessible. Rajasthan, being a desert area, has its own unique rainwater harvesting structures known as *kunds*. These *kunds* are specifically designed to collect the limited rainfall in the region. The Thar desert, in particular, features two types of rainwater preservation structures: *beris* and *tankas*. Beris are reservoirs dug into the ground and coated with clay to collect water, while tankas are more commonly used and serve multiple purposes. To maintain hygiene, tankas are often protected from grazing cattle, and people are prohibited from wearing shoes in the vicinity. Tankas are a common sight in many households, with wealthier families lining them with mortar, while others may rely on more rudimentary forms of construction or depend on communal facilities.

In Punjab, the village ponds serve as the primary means of collecting rainwater for direct use, although wells are also utilized for artificial recharge. The scarcity of water at the

village level necessitates the restoration of these water bodies. Village ponds capture runoff and often provide irrigation for farmers with limited resources. Given the state's significant water crisis, it is imperative to conserve water comprehensively. To achieve this, village ponds must be reevaluated as a water source, and policies should be implemented to restore their multifunctional role, encompassing environmental preservation, enhancing the scenic beauty of villages, and facilitating various village activities, including animal care. However, a major challenge in cleaning these ponds is that they are now being treated as sewers, with all the village's sewage being discharged into them. Furthermore, the Punjab government has not allocated any funds for the desilting of village ponds. Consequently, these structures have fallen into disuse and are no longer able to meet the water demands of the villagers, despite once being a significant water source. It is crucial for the government to allocate funds for their regeneration. Additionally, the rural population, comprising diverse sections, has different expectations regarding the use of pond water. While marginal and poor farmers are somewhat willing to utilize the water for irrigation, wealthy and resourceful farmers are skeptical due to concerns about pollution. Therefore, apart from government investment in restoration, it is essential to find common ground among the various stakeholders in the village to address their respective interests and prioritize what they consider most relevant.

Rain Water Harvesting in the Present Scenario in Punjab

The Punjab Municipal Building Bye Law is a comprehensive set of regulations established by the state government to govern construction activities in urban areas. These laws include a dedicated chapter on rainwater collection, emphasizing the importance of conserving rainwater through suitable technologies. (Punjab Municipal Building Bye-Laws, 2018) The objective of rainwater conservation is highlighted, stating that it can be used directly or indirectly. Direct usage involves various household tasks, kitchen gardening, and toilet flushing, although it is not recommended for drinking purposes due to impurities. To make rainwater suitable for drinking, it must undergo purification processes (Kinkade-Levario, 2007). The laws also emphasize the indirect use of rainwater to recharge underground aquifers in Punjab. Compliance with these regulations is mandatory for buildings with an area of 100 square meters or more. They must incorporate rainwater harvesting structures during construction. While any rainwater harvesting project is installed it is a must to calculate the water budget which is the probable amount that can be stored in a water tank. Only when these criteria are met can the buildings be granted service connections in accordance with the rules. Various techniques, such as roof catchments, downpipes, filter chambers, and storage tanks, are mentioned as means of rainwater harvesting (Rain Water Harvesting and Conservation Manual, 2002). The laws justify the necessity of implementing such regulations in urban areas, as opposed to rural areas where groundwater recharge occurs naturally. Urban areas, being more congested, experience higher rates of evapotranspiration. Therefore, specific laws for rainwater conservation are necessary in these areas. The laws specify that up to 55,000 liters of rainwater can be conserved per 100 square meters per year, with the exact amount depending on the size of the plot. Open spaces within the district, such as parks or grazing grounds, can also be planned for conservation measures in collaboration with resident welfare associations. The responsibility for implementing these provisions lies with the municipal corporations, who should appoint individuals who are well-versed in the interpretation of these bye-laws to oversee rainwater harvesting cells within the district. The authority should issue no-objection certificates only after thorough scrutiny and compliance, ensuring that the property is eligible for a service connection. It is crucial to diligently monitor these rainwater harvesting structures to ensure their effectiveness.

Table 04: Average Rainfall in Punjab

Year	Rainfall
1970	672.3
1980	739.1
1990	754.6
2000	391.9
2010	472.1

Source: Punjab.data.gov.in

The pattern of rainfall in Punjab is inconsistent. Some years' experience abundant rainfall, while others have a deficit compared to the average. The monsoon months in the state are from July to September during which the state gets most of its precipitation which averages around 648.8 mm (Central Groundwater Board, 2014). The rainfall data for the years 1970, 1980, 1990, 2000, and 2010 have been recorded (Government of Punjab, 2020). Both Punjab and the country as a whole do not exhibit a consistent trend in rainfall.

Conclusion

The depletion of underground water in Punjab has been a recurring concern raised by both government and non-government organizations. The severity of the issue is emphasized by the central groundwater board, which states that a majority of water blocks in Punjab have been excessively exploited. This decline in water tables can be attributed to the prevalent cropping pattern that heavily favors water-intensive crops such as wheat and paddy. The irrigation requirements for these crops are substantial, and government policies, such as minimum support prices and free electricity for farming operations, further incentivize their cultivation. Consequently, farmers have abandoned traditional crops that were more suitable for the local environmental conditions. To address this issue, it is necessary to discourage the growth of paddy or restrict its cultivation after a certain date, as stipulated by government regulations. Additionally, the adoption of sprinklers or drip irrigation methods can help reduce water demand. However, it is crucial to not only focus on reducing water demand but also increase water supply. Therefore, water conservation efforts in all forms are essential, and rainwater harvesting emerges as a viable solution. Despite Punjab not being one of the highest rainfall-receiving regions in the country, the collected precipitation can be conserved for use during non-rainy seasons or for groundwater recharge. Rainwater can be collected using a combination of traditional and modern techniques, tailored to the specific environmental conditions of each area. For instance, in rural areas, the revival of traditional ponds known as "shapad" in Punjabi can serve as an optimal solution for rainwater collection to meet the various needs of villagers. In urban areas where community participation may be limited, strict enforcement of rainwater harvesting regulations can ensure that all buildings have appropriate structures in place. However, the success of conservation efforts relies on the complete adoption of these practices by the community. Therefore, it is imperative to raise awareness among the general public.

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