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Water Resource Management in Mehsana: Strategies, Challenges, and Sustainable Approaches

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ABSTRACT

The concern of water resource management is relevant to the Mehsana district of Gujarat because of factors such as semi-arid climate, increased industrialization, and rising agriculture requirements. The focus of this paper is the details of current practices for water management, issues that affect its provision, and the use of sustainable practices for water management in the future. Overusing the resource for purposes such as irrigation also reduces the groundwater table's discharge rate, thus reducing water availability in the area. Moreover, threats from industrial effluent and water pollution by high fluoride levels affect the communities' health. To overcome these problems, integrated water management measures like rainwater harvesting, efficient micro irrigation, and aquifer recharge structures have been developed. The water availability has been improved by government schemes like Saurashtra Narmada Avtaran Irrigation (SAUNI) Yojana and check dam construction. Despite this, some problems are related to the effective implementation of the regulations, mobilization of the community, and water usage issues by agriculture and industry.

INTRODUCTION

Water is the lifeblood of humanity and the environment, acting as the essential element for all living organisms. Water is a renewable yet finite resource, embodying the cyclical balance of evaporation and precipitation. This simple abstraction has deepened the existence of human history, interweaving for a long time in traditions and religions. However, innovative mechanisms derived from complex scientific understandings have been devised to unlock its potential and mitigate its danger, supporting urban expansion and agricultural intensification. The incessant growth in population, scientific developments, and urban complexity have led to innumerable challenges in the face of water. The side effect of development is the increased domestic, industrial, and agricultural activities that have generated wastewater and polluted river basins, forcing governments to seek technological solutions for treatment and purification. Agriculture remains the dominant freshwater consumer, occupying a significant proportion in various sectors. Hosting farms within the urban sphere has elicited another set of complex interrelationships with local environmental loss (M. Singh et al., 2013). The artemia plant constitutes an astonishing 70% of water intake, while table beef takes nearly 15,000L of water to produce one kilogram. This ubiquitous livelihood group has been the initial victim of state policies that have led to the large-scale nationalization of land, forcing a plethora of small agriculture holders to revert to the urban scenario. Water pollution has flowered from intensive industrial activities in numerous cities, both state-owned and private, which have jeopardized the populace in terms of consumption and habitat. The preeminent cause of swung groundwater levels has been allocated to the intensification of commercial irrigation, undermining water availability for local marginal agriculture holders. Moreover, the syncretism of rapid urban growth forces them to opt for healthy water polluted with heavy metals. The rise of rampant agricultural activities heavily dependent on pesticides, fungicides, and herbicides appears to have proliferated in the city districts. Exacerbating is that the illegal trash dumping of hazardous materials is correlated in proximal adjacency with economically disempowered localities, acting as a direct feeder to the prolonged water spillover in localities (D Clark, 2019).

Overview of Water Resources in Mehsana

Sustainable water resource management is a challenge for any urban area. As annual rainfall in the Mahesana district (about 750 mm) is confined to a period from June to September, Mehsana Urban Development Authority (MUDA) and other urban local bodies only during that time primarily rely on the limited rainfall, surface water sources like reservoirs, tanks, and kunds. The substantial dependence on rainfall, visible effects of climate change, and land-use alterations in the district environment affect the movement, storage, quality, and availability of ground and surface water resources (Venu Menon, 2007). Limited availability of good quality water resources challenges equitable distribution between domestic and industrial uses. Farmers, who rely heavily on groundwater, compete with urban citizens for it.

Initially, the Mehsana district, comprising <20 Urban Local Bodies (ULBs) covering an 841 sq. km area, depended on kunds and tanks for drinking and irrigation. The technical know-how that evolved "by default" was unique to the arid zone. Roof-top harvesting of runoff from 160–200 sq. km of land replaced groundwater extraction for domestic use in the rest of Gujarat and the rest of India. Both tanks and kunds had recharge wells at their base. Tanks were usually larger (5,000–50,000 m3), whereas kunds varied from 10 m3 to a few 100 m3. Thus, managed groundwater from a tank was better quality and had a lower iron concentration than a kund. Such ground treatment schemes typically followed a 3–to 5-day regular cleaning of all open wells. Water Towers were also created. Gazdhar kunds (earthen embankment) with a triangular section were typical of the area. Runoff was rainwater harvested. Flushing of open wells (and then cleaning kunds) continued for about 30–35 years after installation of 1st tank in the taluka in 1988. At its peak, clean water was provided to almost 50,000 people from June to October. The moveable population of Mehsana town, primarily transients, was attracted to the world's largest electric fair. If people fall ill regularly when they consume water, they naturally try to replace a water source.

Current Water Management Practices

This section provides a comprehensive overview of the current issues and problems associated with water resource management in Mehsana. The existing system of irrigation and related issues and problems, such as the system of drinking water supply, water issues, and the current management planning, are analyzed and presented below. The subsequent section deals with the problems and obstacles encountered in the services.

The system comprises three supply modes: underground water, canals, and check dams. Under the existing system, the latter two supply modes have been widely used for agriculture. The study's results on the effectiveness of the existing irrigation system found that the most traditional and customary field bunding/mudbandi was the most effective practice in conserving water resources, followed by tree-making and following cultivated fields. It also positively impacts the crop yield increase to the extent of its effectiveness in conserving water resources. However, farmers have not extensively adopted these effective field water conservation practices. The primary reason for the narrow adoption is the absence of an extension in which the training on water management might be included (Dhaoui, 2013). Any operation and hand pump construction also negatively impact the effectiveness of these conservation practices. Observing farmers' opinions from the group discussion, it is found that the reasons for the inability to perform the practices are primarily environmental and external ones that the farmers would not overcome. One of the long-standing traditional accessories of the check dam construction has a detrimental impact on the water and soil conservation of the dam's catchment area.

3.1. Irrigation Systems

Irrigation is a critical component in Indian agrarian practices. In Mehsana, a district located in the dry land of Gujarat state, irrigation is even more crucial due to erratic monsoon patterns. Groundwater is the primary water source, but many wells have drying problems, and water tables have continually decreased. Aquifers like Mehsana show annual depletion (Schultz & De Wrachien, 2002). Irrigation systems vary in Mehsana. Traditional methods, such as the Nadi and Subasa systems, have been practiced for years. However, they are not very efficient systems. With these systems, water is available whenever released into the canal, irrespective of soil need.

Farmers typically practice flood irrigation, which results in much water runoff, seepage, and wastage. Consequently, the systems are neither valuable nor helpful in terms of water conservation. In the case of problematic water distribution in canals, water tends to move towards the locality where the canal passes and thus tends to increase the water table at a faster rate. As a result, many wells, which are located near canals, face water logging problems. On the other hand, the wells have to be more profound due to the demand for water from wells due to the drying of other wells in the region. The cost of motor installations would become non-affordable for some small and medium farmers. Farmers' traditional attitude towards agriculture and technology also contributes to the limited adoption. With conventional technology, most farmers practice flood irrigation, which typically has an efficiency level of about 25 to 30%. However, implementing this system costs farmers in several ways compared to the traditional method. First, from an investment point of view, the cost is beyond the capacity of small and marginal farmers. Second, in terms of high-value crops, the installation of this system is still beyond farmers' awareness. Third, out of 251 operates, 20 operators belong to the socially disadvantaged caste group and are landless. A local NGO has thus encouraged farmers to prefer this system. Research has shown that declining water tables significantly impact agriculture and society. Farmers' education and increasing awareness of higher irrigation efficiency and financial assistance availability can increase drip and sprinkler technology installation. The disparities in irrigation efficiency levels across different crops might significantly impact crop productivity. The enforcement of drip and sprinkler technology should follow stricter conditions.

3.2. Drinking Water Supply

In Mehsana, mechanisms for ensuring potable drinking water differ by neighborhood. Like other cities in Gujarat, several neighborhoods in Mehsana rely on the town municipal corporation's potable drinking water supply. While public taps are the primary sources of potable water, water is transported in cans or buckets from public taps to homes. Several households, however, continue to rely on private or de facto community taps for drinking/cooking water. With a motorized pump regulated by the municipal water supply, twice daily municipal water supply can reach the neighborhood (Spross, 2015).

Compared to most of Mehsana's neighborhoods, the most densely settled locale where many challenges confront potable water access, the compound is low. The neighborhood's lowland status renders it one of the most flood-prone neighborhoods in the town. In the rainy season, standing water is present in much of the neighborhood and flows into homes and communal, natural groundwater waste sinks on the neighborhood's western edge. The least populated homes are located in the streambed's dry quarters, with the most bore-well facilities. In most localities, multi-storied dwelling units possess built-in overhead tanks to store potable water, providing a reserve for when municipal water supply is not forthcoming. The high density of residents within low-income families is not afforded the space to build overhead tanks, and the majority are required to store potable water. One man was accustomed to purchasing cans and stated, "... about twice a week, the sour taste of water from public taps makes him somewhat sick." The transaction to privatized bottled water makes an alternative access point for potable water available. It is speculated that as potable water sources are fixed and less in number compared to the high population number, contamination is more likely to happen. This may underlie the complaint regarding the changing taste in water, perhaps due to pipe contamination often reported by those tap users. Municipal water supply, the primary source of potable drinking water in the town, is sporadic and inadequate, often occurring once or twice a day. When tap sources more frequently run dry in the summer, municipal water does not come at all for days/weeks. In the neighborhood's absence of a regular municipal water supply, all-time under-construction facilities are being installed. In order to cope with the irregular municipal supply and for augmenting their physical storage and reserve, the neighborhood residents complained that during periods when the municipal supply was out of order for two to three days, the private suppliers who provide drinking water door-to-door with the aid of camel-based carts and tankers, temporarily filled water from other resources including tap stands where they suspect it to be contaminated.

Challenges in Water Resource Management

As one of the key natural resources, water plays a vital role in the sustenance and nourishment of human life. Water resource management is thus an essential aspect of the development planning of any region to keep up with its safe yield potential. Water resource management requires data and information and depends on the needs, objectives, and priorities of the management objectives and their capacity (Venu Menon, 2007).

The current picture shows significant challenges to water resource management in Mehsana. The overview underscores the pressing need to address these challenges and the complexities raised by their interactions. As a rapidly developing city with an expanding industrial base, Mehsana is facing severe water stress concerning the quality and availability of water. The over-extraction of groundwater, mainly for industrial and agricultural uses, has led to a critical water balance that has become a significant challenge for sustainable water development. Industrial and agricultural pollution of groundwater is alarming, and the release of untreated water significantly impacts the health and ecosystem of Mehsana. The already polluted surface water is also being used for irrigation, raising a critical public health concern. Although the surface water bodies in Mehsana (mainly small ponds, lakes, and canals) are a better prospect for water resource recharge, managing these water bodies, particularly regarding soil erosion from surrounding barren land, remains a neglected issue.

Water, the elixir of life, is becoming the most precious scarce commodity. Groundwater usage in Mehsana is primarily for agricultural purposes and industries, though in many villages, it is used for drinking water; it is being exploited recklessly through tube-wells, causing the water table to drop rapidly. Mehsana poses a challenge in groundwater recharge. The fall in the water table led to water depletion in the dug wells. This was accentuated by poor rainfall. In the first year of post-monsoon, the Gross Irrigated Area (GIA) is more than the annual recharge.

4.1. Groundwater Depletion

Groundwater is being over-exploited at an unsustainable rate in the Mehsana District and the surrounding district of North Gujarat. It may not surprise the government officers, NGO activists, and farmers, but it is now widely accepted that there are high groundwater extraction rates in the district beyond the natural replenishment rate, and a critical situation is developing. This section will critically evaluate the nature and extent of the problem and review current government regulations, their efficacy, and community responses.

The fact that groundwater was being depleted at an unsustainable rate was first noted a few years ago. Studies demonstrated the comparison of recharge rates to those of extraction and showed a marked imbalance, with the latter exceeding the former. Between the publication of the two sets of data, more detailed reports have been produced, emphasizing the deteriorating situation. The paper will also explore the causes and consequences of this depletion and how it can be reduced and reversed. The adverse effects of this include damage to the subsoil and agrarian structure, which leads to increased soil erosion and salinity and a general decline in the fertility of the land; a general lowering of the water table and a resultant decline in agricultural outputs (focus on paddy and horticultural crops); a decrease in the availability and quality of drinking water; and a reduction in the biological diversity of ecosystems and consequently a decline in their productivity and resilience to natural or artificial disasters. This decline is particularly acute in areas that suffer from poor rainfall and is manifest in underdeveloped societies (Venu Menon, 2007).

Furthermore, with these favorable conditions for developing tubewells and pumpsets, there has been an unprecedented and continuing increase in their number. With the growth in the number of wells and an increase in the lifting capacity of the pumps, there has been a parallel increase in groundwater extraction. While these problems are common to most of Gujarat, their degradation rates differ.

Mehsana District, in particular, has been more prone to the ill effects of groundwater depletion, with borewells running dry and aquifers suffering from widespread salinity and related water quality problems. A combination of erratic monsoon rains with devastating floods and droughts, rapid agricultural expansion, increased water demands due to increased population, and government policies towards improved and more remarkable water resource development is having a profound adverse impact. There is a clear need to address this issue at an early juncture, not simply from a concern for the sustainability of the resource but crucially for the potential of conflict over access to water resources, which could have long-term implications for inter-regional and intra-regional politics.

4.2. Pollution

The critical issue of water pollution as a challenge in water resource management is discussed. The pollution describes the contamination of water bodies. It changes the natural characteristics of water. The physical, chemical, or biological alteration impairs the water quality and reduces the water's fitness for any particular purpose ((N) Thyagaraju, 2016). Water gets polluted when the pollutants are released into the bodies of water without adequate treatment to remove the harmful compounds. The sources of water pollution are broadly classified as point sources and nonpoint sources. There are prominent sources of water pollution in Mehsana district. It identifies the sources that contribute to the contamination of water in Mehsana. The consequences of water pollution on human health, biodiversity, and overall environment are also discussed. The government's success in eradicating water pollution and its persistent challenges are discussed. The section further examines the efforts of the community at the local level to prevent water pollution. The impacts of water pollution on the tourism industry and the economy are also discussed.

Pollution is prevalent with alarming proportions in the Mehsana district. The primary sources of water contamination are irrigation return flow and surface runoff. The farming sectors heavily depend on chemical fertilizers and pesticides, which drain into water bodies. Untreated effluents from industries and untreated sewage are also disposed of in surface water resources. There is serious and growing concern about excessive exploitation of groundwater leading to water shortages and declining quality. High concentrations of nitrate, chloride, fluoride, and TDS are observed. The storage of water in Tank's lakes, near the urban area under the command of these projects, has serious consequences on the health of the local people. The increased pollution is detrimental to human health and essential to the rarest biodiversity and ecosystems. Environmental pollution is more local and has broader implications. Polluted water is a reservoir of several species of pathogenic microorganisms and is a dark source of waterborne diseases, and the defection ranges from minor diarrhea to even life-threatening cholera and hepatitis. Many regulatory measures have been taken to sort out the pollution. Various programs have been implemented to create environmental awareness from the grassroots level, where the rural populace is more vulnerable, and to build institutional capacities. Ensuring the participation of people and the non-governmental sector is key to the success of any program. Recognizing this truth, a massive number of surveillance and check mechanisms for monitoring water quality have been launched. Integrated Participation in the management of water uses is essential.

Sustainable Approaches

Irrigation systems in Mehsana have significantly increased the income of the small and marginal farmers, but at the same time, several problems have cropped up regarding waterlogging and salinization. Therefore, efficient regional and local groundwater management is essential for sustainable agriculture. The awareness and vigilant efforts within the community to accept contemporary water management practices are the primary prerequisites for ensuring this long-term sustainability. This paper elucidates the generally accepted and localised good practices for secure management of the water resources available to the community to meet the demands of potable water and agriculture. Mehsana lies in a semi-arid region where drinking water and water for irrigation are needed. People widely depend on bore wells and tankers for their daily water needs. The level of the water table is getting lower at an alarming rate. Due to the excessive use of non-renewable groundwater, many parts of Mehsana's urban and rural development block face an acute shortage of potable and irrigation water. Hence, the whole community of Mehsana should come forward with a sense of single nationality to tackle the current water crisis with available resources so that the future generation can meet their needs, too (Thuy Lan Chi et al., 2015). Here, emphasis is given to two major sustainable water resource management approaches, which Mehsana and its people can adopt to save and conserve their available water resources. The first issue addresses the suitability of various treatment technologies and, hence, the feasible application for communities with limited resources. In its absence, the integration of traditional methods at the household level to treat the ground or rainwater, along with its proficient use, is presented. The second issue describes the expedient and efficient practice of rainwater harvesting, which could serve as an option to face the problem of declining water table and assist in monsoon failure.

5.1. Rainwater Harvesting

Water resource management is a growing challenge with rapid urbanization and rising water demand in Mehsana. Past water policies and the existing systems' inadequacy have failed to meet growing urban demand. Groundwater pumping, following the introduction of deep tube wells, has led to declining water levels and saltwater intrusion. This has been further exacerbated by increasing demand from industries and agriculture and the growing urban population. These factors have put enormous pressure on water resources, and diversifying and developing new water sources has become crucial (Thuy Lan Chi et al., 2015). This research investigated current water issues in Mehsana and strategies for the sustainable management of water resources, focusing on the economic, technical, and social benefits of one of the most promising water alternatives - rainwater harvesting.

The successful implementation of rainwater harvesting systems as a sustainable approach to supplementing water resources in water-stressed environments was examined. The quality of harvested rainwater was investigated through a case study of the Mehsana taluka, located in the semi-arid region of north Gujarat, India. Financial and technical implications and the public perspective of rainwater harvesting systems in water-stressed areas are addressed. A major problem in water supply is the fluctuation in extraction and quality of water resources. Therefore, a rainwater harvesting system is essential to overcome current and future water resources. Harvested rainwater in Mehsana taluka, one of the water-stressed areas in the country, was deemed an alternative drinking water resource. These systems have unproven benefits, such as reducing runoff, percolation to groundwater recharge, and preventing soil erosion (A. Appiah et al., 2017). However, the feasibility of collected water for drinking is still under investigation. The quality of drinking rainwater is essential for community acceptability and health impacts. A local water quality index (LWQI) was developed to evaluate rainwater quality. Furthermore, a sensitivity analysis method for the LWQI system was proposed to determine its robust performance. Through various case studies, understanding and modeling the LWQI system and research findings on different water disposal methods were proposed to address these questions.

5.2. Reuse and Recycling of Water

Before its treatment and disposal, wastewater is collected in a combined sewer system in Mehsana and most other cities. In some of the city's residential areas, individual waste lines for storm and waste water may be found. The plant has reduced pollution by collecting domestic wastewater for timely treatment. Part of the settlement system is effective in its operation. However, partially or due to the absence of systematic, efficient, timely cleaning (in some areas), pollution is a significant contributor. The public awareness path was to be conducted to discard the waste in dustbins meant for waste materials separately. The cooperation is solicited through citizen volunteers to procure effective and satisfactory implementation results and further aid the natural living habitat.

CONCLUSION

The descriptive analysis of existing practices in water resource management (WRM) in Mehsana demonstrates the implications of economic development on the qualities and uses of water while also indicating the multiscalar complexity of WRM in the global-local nexus. It is argued that the challenges of water resource management in Mehsana are rooted in the migratory epoch of modernity. The widespread privatization of water resources in different places can be explained by their global-local contingency that connects their overarching resource deployment strategies with local forms of accumulation (M. Singh et al., 2013). Therefore, the strategic analysis of potential approaches to sustainable WRM is grounded in a place-specific perspective. It is maintained that successful strategies for addressing water scarcity may rest upon site-specific analysis both to apprehend the qualitative specificity of local environments and to decode the force behind multilocally contested geographical processes. The advocacy for more holistic and cooperative work in the local approach calls attention to the learning, sociocultural, and experimental dimensions of water use in different places, including Mehsana, which are frequently abandoned in global approaches to the privatization of common resources (Kanjere et al., 2014).

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