Water Resource Management in Western Rajasthan: Challenges and Strategies Review

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Received 25.01.2025 **received in revised form** 06.05.20225, **accepted** 06.05.2025
DOI: 10.47904/IJSKIT.15.1.2025.29-34

Abstract- The Western part of the state Rajasthan, is marked by its rain-less climate and limited water resources, faces significant challenges in water resource allocation policy. The western part of the state relies on ground water extraction, which decrease the water table. This article examines the current status of water resources, highlighting the reliance on traditional practices and the critical issues of water scarcity, over-extraction, and inadequate infrastructure. Climate change further exacerbates these challenges, impacting rainfall patterns and exacerbating drought conditions. To address these issues, the article proposes various management strategies, including groundwater recharge initiatives, promotion of sustainable agricultural practices, community engagement, investment in infrastructure, and stronger regulatory frameworks. By implementing these strategies, Western Rajasthan can enhance water availability and promote sustainable usage, securing vital resources for future generations.

Keywords– Water resource management, Western Rajasthan, Traditional practices, Climate change.

1. INTRODUCTION

The state of Rajasthan (Figure 1) covers an area of 3,42,000 km² (Largest state of the nation), deals with an adverse climatic conditions like: xeric climate, and thirsty land area. Annual rainfall varies widely across the state, ranging from 150 mm to 900 mm, with an average of 576 mm (Lowest in the India). Average annual rainfall in the western part of the state is lesser than 100 mm, The Jaisalmer district of the state is cited as the driest place in India**.** Temperatures fluctuate between 5°C and 45°C throughout the year. Agriculture in Rajasthan remains heavily reliant on rainfall, making the state particularly susceptible to water stress during droughts. Thus, ground water plays a vital role for the agricultural activities across the region [1-2].

The Western Rajasthan, a region marked by its Dry terrain and Inadequate water availability , presents a unique set of challenges for water resource management, as shown in Figure 2 and Figure 3 [3]. The harsh climate, characterized by limited rainfall and high temperatures, significantly impacts water availability, making it a critical concern for both agriculture and domestic use, as shown in Figure 4 [1,3]. The reliance on groundwater has become a primary source of sustenance for local communities, yet this dependence has led to serious sustainability issues, including declining water tables and increased competition for limited resources [3]. Low rainfall adversely affects the ground water table, especially in regions where artificial water sources are unavailable, Like Jalore, Jhunjhunu, Jodhpur, Nagaur, Pali, and Sikar. Figure 4 shows the average annual rain fall for the various cities across the state [3].

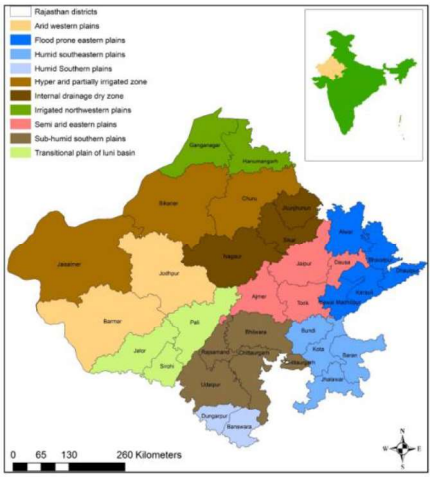

Figure 1: Rajasthan state with different agroclimatic zones. The inset shows the location of Rajasthan state in India [3].

The Ancestral Water handling methods, such as johads (Traditional water tanks) and step wells (Bawdi), have been essential in protecting the water and supporting local livelihoods [2,4-5]. However,

the growing pressures of population increase, agricultural demands, and climate change have undermined the effectiveness of these methods. Thus the more effective approaches are required for the efficient water management [2,6].

Water scarcity in Western Rajasthan is exacerbated by its geographical features, population growth, and agricultural demands. This region experiences the high evaporation rates (due to the hot climatic conditions, especially in the month of May and June) and limited rainfall (the Thar desert receives the lowest rainfall in India). Hence an effective water resource management plays a critical for the socioeconomic development [3,7]. Figure 4 shows the annual rainfall for all the district's headquarter of the state of Rajasthan. The average annual rainfall for all the district of the state are lesser than the average annual rainfall of the India (average annual rainfall of the India is 1190 mm).

Figure 2: Typical arid landscape of the western Rajasthan

Figure 3: Typical available scarce water resources in the western region of Rajasthan.

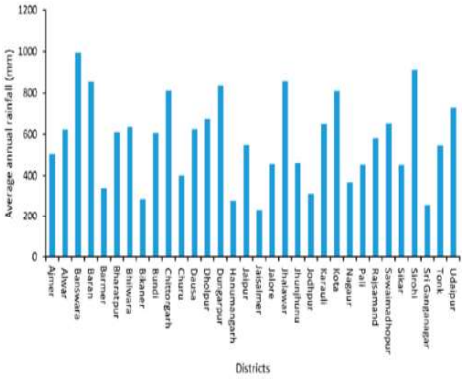

Figure 4: Typical average annual rainfall for all the district headquarters of Rajasthan [3].

This article aims to provide an overview of the current status of water resources in the Western Rajasthan, identify the key challenges faced, and explore potential strategies for improving water availability and promoting sustainable usage. By addressing these issues, we can work towards ensuring a resilient water future for the region, supporting both ecological balance and community needs.

2. CURRENT STATUS AND CHALLENGES OF WATER RESOURCES

Western Rajasthan's water resources are critically influenced by its arid climate and geographical conditions, [7-8] as shown in Figure 1 and Figure 2. Understanding the current status of these resources is essential for addressing the challenges faced by the region.

2.1 Groundwater Reliance

Groundwater serves as the primary source of water for both agricultural and domestic use in the Western Rajasthan. The majority of farmers depend on borewells and tube wells for an irrigation, which has led to significant over-extraction. Many districts report alarming declines in groundwater levels, with some areas experiencing drops of several meters per year. This depletion threatens not only agricultural productivity but also the availability of drinking water for local populations. Table 1 demonstrates the current situation of groundwater in the state. Groundwater availability is highly sensitive, depending upon the hydrological conditions. The limited groundwater resources of the state are overexploited due to excessive irrigation and industrial activities [2-4].

2.2 Surface Water Sources

Surface water is limited in the region, primarily due to infrequent and uneven rainfall patterns, as shown in Figure 4. Seasonal rivers and lakes are often dry for extended periods, and existing reservoirs are

frequently insufficient to meet the demands of agriculture and households. During monsoon months, excess runoff can lead to flooding in some areas, but this is not harnessed effectively for long-term storage due to inadequate infrastructure.

Table 1: Groundwater status of the state Rajasthan (2011) [3].

Parameters	No. of Block
Over Expoloited (> 100%)	172
Critical (90 % - 100 %)	25
Semi Critical (70% - 90%)	20
Safe (< 70 %)	24
Saline water block	2
Total	243

2.3 Traditional Water Management Practices

Despite modern challenges, traditional water management systems play a vital role in water conservation. Structures such as johads (check dams) and anicuts are still used in some communities to capture and store rainwater, shown in Figure 5 [2]. However, these practices often lack widespread adoption and investment, limiting their effectiveness in addressing the region's water needs.

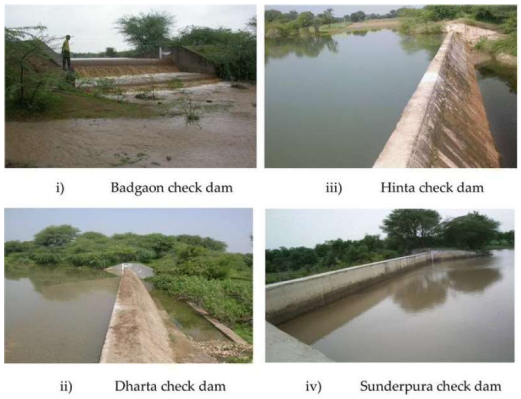

Figure 5: Check dam structures in the state of Rajasthan during the monsoon [2].

2.4 Water Quality Concerns

In addition to quantity, water quality poses significant issues. Groundwater contamination from agricultural runoff, salinity, and other pollutants affects drinking water safety. High salinity levels in certain areas further complicate agricultural practices, impacting crop yields and soil health [3].

2.5 Impact of Climate Change

The effects of climate change are increasingly evident in Western Rajasthan, with erratic rainfall patterns and rising temperatures further straining water resources. Droughts are becoming more frequent and severe, exacerbating water scarcity and threatening local communities' livelihoods [4].

2.6 Water Availability

The region experiences low and erratic monsoon rainfall, averaging between 100 to 500 mm annually, which is insufficient to meet the demands of its population and agriculture. Groundwater is the primary source of water for drinking and irrigation. However, many areas are facing alarming rates of depletion due to over-extraction [5].

2.7 Socio-Economic Factors

Rapid population growth increases water demand, placing additional stress on already limited resources. Access to water is often inequitable, with rural communities facing greater challenges in securing reliable and safe water sources compared to urban areas.

2.8 Infrastructure Challenges

The region suffers from insufficient water supply and distribution infrastructure, leading to significant water losses. Aging infrastructure and lack of investment hinder effective water management and distribution.

3. WATER RESOURCE MANAGEMENT IN WESTERN RAJASTHAN: STRATEGIES

From above stated conditions (from section 2) efficient water resource management is much needed for the overall development of the western region of the state. Here are the key points to achieve the optimal water management [6 &7].

3.1 Rainwater Harvesting

3.1.1 **Traditional Methods:** Rainwater harvesting is a sustainable practice that involves collecting and storing rainwater for later use, shown in Figure 6. It can provide numerous benefits, such as reducing reliance on municipal water supplies, lowering water bills, and decreasing stormwater runoff. Rajasthan has a rich heritage of water conservation methods, such as Tanka, Kund water, sarover, Baori, and Beri. These structures are designed to collect and store rainwater during the monsoon, making it available during dry periods [8].

Figure 6: Traditional methods of water harvesting in western Rajasthan.

3.1.2 Modern Rainwater Harvesting:

Urban areas, government buildings, and private institutions have adopted more modern rainwater harvesting systems to recharge groundwater levels

and reduce dependency on external water sources [9].

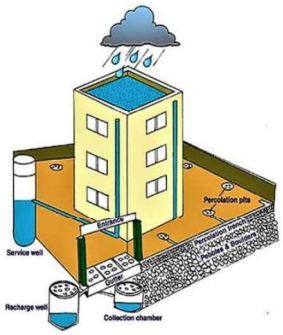

Figure 7: New methods of water harvesting in western Rajasthan.

3.2 Water Conservation and Efficient Use

3.2.1 Micro-irrigation Systems: Techniques like **drip irrigation** and **sprinkler irrigation** can help reduce water wastage in agriculture, which is a major consumer of water in Rajasthan, as shown in Figure 8. It is more popular technique in major part of Thali area (Part of Bikaner and Naguar) [10].

Figure 8: New methods of water harvesting in western Rajasthan.

3.2.2 Crop Diversification: Encouraging farmers to grow drought-resistant crops (e.g., millet, pulses, and oilseeds) reduces the water demand, as these crops require less irrigation.

3.2.3 Water-Efficient Appliances: The adoption of water-efficient devices like low-flow taps, showerheads, and toilets can reduce domestic water consumption [10].

3.2.4 Water Treatment and Recycling: Reusing treated wastewater for non-potable uses (e.g., irrigation, industrial processes) can alleviate pressure on freshwater sources [11].

3.2.5 Water-Efficient Farming Practices: Promoting soil moisture management, mulching, and timely irrigation can enhance water-use efficiency. Methods like **Conservation Tillage** (reducing soil disturbance) also help in improving water retention in the soil [10].

3.2.6 Public Awareness Campaigns: Educating citizens on the importance of water conservation, promoting water-saving techniques, and fostering a culture of responsible water use can have a significant impact on overall consumption patterns.

3.2.7 Smart Water Management Systems: IoT (Internet of Things)-enabled sensors and smart meters can help in real-time monitoring of water levels, consumption, and leaks, enabling better control over water resources [11-12].

3.2.8 River Linking Projects: Though controversial and complex, interlinking rivers or linking water surplus areas to drought-prone regions could provide a solution to address regional water shortages. In Rajasthan, such projects could help balance water availability across different areas [13].

3.3 Sustainable Groundwater Management

3.3.1 Regulation of Groundwater Extraction: In many parts of Western Rajasthan, groundwater levels are declining rapidly due to over-extraction for agriculture and domestic use. Implementing groundwater usage regulations and monitoring is critical to preventing further depletion.

3.3.2Artificial Recharge of Groundwater: Constructing recharge wells, percolation tanks, and ponds can help replenish groundwater aquifers, improving long-term water availability [14].

3.4 Role of Policy Formulation and Regulation

Governmental bodies play an important role in the water resource management. For the effective utilization of the available water resources strict and transparent governmental policies as well as the bodies, are required. Following governmental bodies can play an important role in the improvement of water resource availability [15-16].

3.4.1 Ground Water Year Book – Rajasthan

The **Ground Water Year Book – Rajasthan,** published by the Central Ground Water Board (CGWB), Ministry of Jal Shakti, provides comprehensive data on groundwater resources in Rajasthan. This report includes insights into water level trends, aquifer characteristics, groundwater quality, and regional hydrogeological assessments [15].

3.4.2 Infrastructure Development

- **Indira Gandhi Canal Project (IGCP)**

A landmark government initiative to bring water from the Sutlej and Beas rivers to the arid zones of Western Rajasthan, aiding irrigation and drinking water supply [15-16].

- **Construction of Reservoirs and Check Dams**

To conserve rainwater and reduce dependency on groundwater.

- **Revival of Traditional Water Systems**

Government-supported restoration of tankas, kunds, baoris, khadins, and johads to promote sustainable local water storage [17].

3.4.3 Financial Support and Subsidies

- **Subsidies for Drip and Sprinkler Irrigation**

To promote efficient irrigation practices among farmers.

- **Grants for Water Harvesting Structures**

Support to build rooftop rainwater harvesting systems in urban and rural households [17-18].

- **Mgnrega**

Often used to create or restore water conservation infrastructure, especially in rural areas [19].

3.4.4 Awareness and Capacity Building

- **Public Awareness Campaigns**

Promoting water conservation, efficient irrigation, and behavioural change in water usage.

- **Training Programs**

For farmers, engineers, and local bodies on watershed development and best practices [20].

4. CONCLUSION

Water plays a crucial role into the overall development of the region, especially in the desert areas like Thar desert (Western Rajasthan). The Jaisalmer district headquarter in the Rajasthan is considered as the lowest rainfall receiving area in the India. The presence of water resource through out the year in the any region plays an important role for the socioeconomic developmental activities. It becomes a great challenge for the arid areas like western Rajasthan.

Effective blueprints are required to ensure water availability for agricultural, domestic, and industrial needs. The region can combine traditional water conservation practices, modern technologies, and policy reforms to address its water crisis. Key strategies such as rainwater harvesting, efficient irrigation systems, groundwater recharge, and the promotion of water-efficient practices can help optimize water use and improve resource availability. Additionally, community participation and public awareness are crucial in fostering sustainable water management practices at the grassroots level. Government support through legislation, financial incentives, and infrastructure development is vital to drive long-term solutions. Technological innovations like remote sensing, smart water management systems, and desalination offer promising avenues to improve water resource management, particularly in urban and industrial contexts. Moreover, integrated approaches like Integrated Water Resource Management (IWRM) and possible projects like river linking could offer broader, region-wide solutions. In conclusion, addressing the water challenges of Western Rajasthan requires a holistic, multi-pronged approach, balancing immediate needs with long-term sustainability. By combining policy, technology, and community-driven initiatives, the region can work towards ensuring water security for its population, agriculture, and economic development in the face of an unpredictable climate.

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