

Climate Resilience and Social Equity: Mitigation and Adaptation Strategies for Deprived Communities in Rajasthan

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Abstract

Rajasthan's arid and semi-arid environments are among the most climate-stressed landscapes in India. Rising temperatures, increasing heatwave frequency, erratic monsoon behaviour, and chronic groundwater depletion intersect with socio-economic deprivation to intensify risks for Scheduled Castes, Scheduled Tribes, landless agricultural labourers, pastoralists, smallholders, and women. This paper examines climate change mitigation and adaptation strategies in Rajasthan through the integrated lenses of climate resilience and social equity. Drawing on policy analysis, secondary statistics from national and state reports, and regional case insights, the study evaluates the effectiveness of renewable energy expansion, watershed development, climate-smart agriculture, livelihood diversification, and social protection mechanisms. While Rajasthan has made notable progress in solar energy deployment and water conservation initiatives, benefits remain unevenly distributed due to institutional fragmentation, limited access to climate finance, gendered constraints, and information gaps. The paper argues that resilience outcomes depend on inclusive governance, targeted finance for the poorest, decentralized renewable systems with local employment, and the integration of traditional ecological knowledge. An equity-centered framework is proposed to align mitigation and adaptation with climate justice, thereby supporting sustainable development pathways for deprived communities in Rajasthan.

Keywords: Climate resilience; Social equity; Climate change; Deprived communities; Rajasthan; Mitigation; Adaptation

1. INTRODUCTION

Climate change poses an unprecedented threat to both natural ecosystems and human societies, particularly in regions characterized by ecological fragility and socio-economic deprivation. Rajasthan, India's largest state by geographical area (342,239 km²), exemplifies this vulnerability due to its arid climate, limited water resources, and heavy dependence on climate-sensitive livelihoods such as agriculture and pastoralism. The state covers about 10% of India's land area but receives only 1% of its water resources, with over 60% of its area classified as desert or semi-desert (Government of Rajasthan, Rajasthan State Action Plan on Climate Change 2022).

Deprived communities in Rajasthan experience the impacts of climate change more intensely because of structural inequalities, limited adaptive capacity, and restricted access to resources. Rising temperatures, erratic rainfall, prolonged droughts, and increasing heatwaves exacerbate poverty, food insecurity, migration, and health risks. For instance, Rajasthan has experienced over 15 drought events from 1995

to 2020, more than any other state in India, affecting agricultural output and livelihoods (Government of Rajasthan, Rajasthan State Action Plan on Climate Change 2022). Addressing climate change in such a context requires strategies that integrate mitigation and adaptation with social equity.

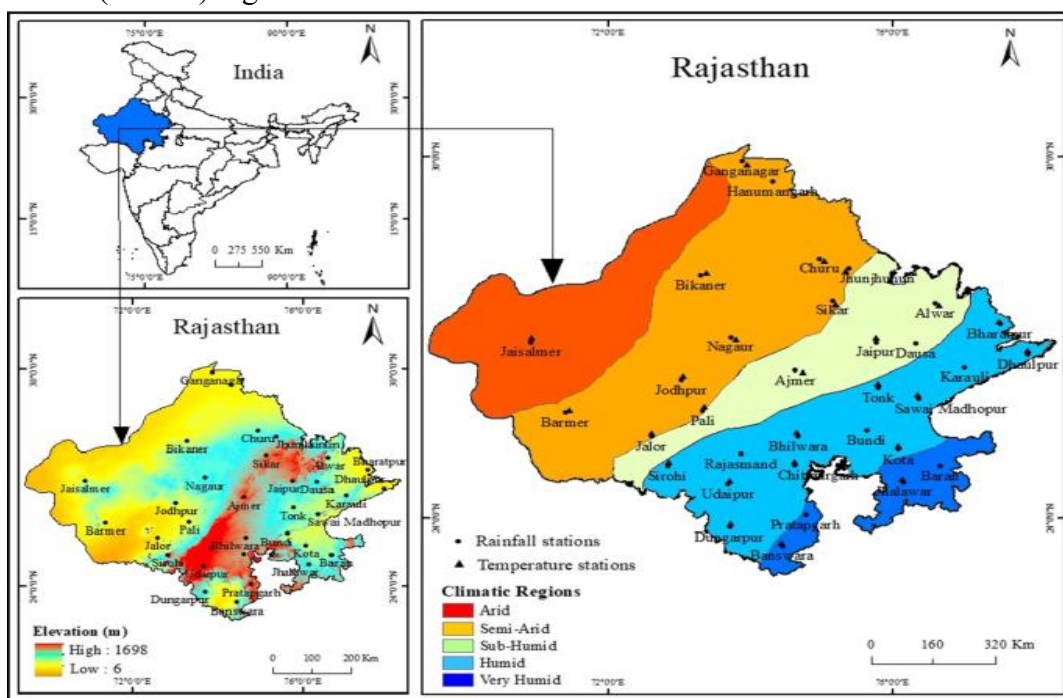
This paper aims to analyse climate change mitigation and adaptation strategies in Rajasthan with a special focus on deprived communities, emphasizing the need for inclusive, justice-oriented climate action. It draws on statistical data from sources like the India Meteorological Department (IMD) and government reports, incorporating diagrams and maps to illustrate trends and spatial distributions.

2. Climate Change and Socio-Economic Vulnerability in Rajasthan

2.1 Climatic Characteristics

Rajasthan’s climate ranges from extremely arid in western districts (e.g., Jaisalmer, Barmer) to semi-arid in the eastern plains (e.g., Jaipur, Kota). Average annual rainfall is low (around 500-600 mm statewide) and highly variable, making agriculture precarious. Western Rajasthan receives less than 300 mm annually, while eastern parts get up to 800 mm (Government of Rajasthan, Rajasthan State Action Plan on Climate Change 2022). Climate change projections indicate rising average temperatures by 2.43°C to 4.27°C in maximum values and 0.23°C to 1.42°C in minimum values from 2071-2100 (Bajracharya et al. 100; also see Government of Rajasthan, Rajasthan State Action Plan on Climate Change 2022), more frequent heatwaves, declining groundwater levels, and increased rainfall variability, further intensifying ecological stress.

In the Banas River Basin, annual rainfall is projected to decrease under RCP4.5 and RCP8.5 scenarios, with mild droughts occurring most frequently, followed by moderate and severe ones. A persistent 12-year drought is estimated from 2024 to 2035 at SPI-9 and SPI-12 scales. In Ganganagar district, analysis of 122 years of data identified 46 moderates to severe drought events at the 3-month scale and 32 at the 12-month scale, with the longest lasting 21 months (2000-2002) (Frontiers in Climate study). The map below illustrates Rajasthan's climatic zones, highlighting arid (western), semi-arid (central), and sub-humid (eastern) regions.



Recent rainfall variability over Rajasthan, India

Temperature trends show an increase in mean temperatures, with the northeast and northwest regions experiencing a 2.6°C rise. The diagram below depicts seasonal temperature and rainfall trends in Udaipur district, representative of southern Rajasthan, showing Sen's slope values for different seasons.

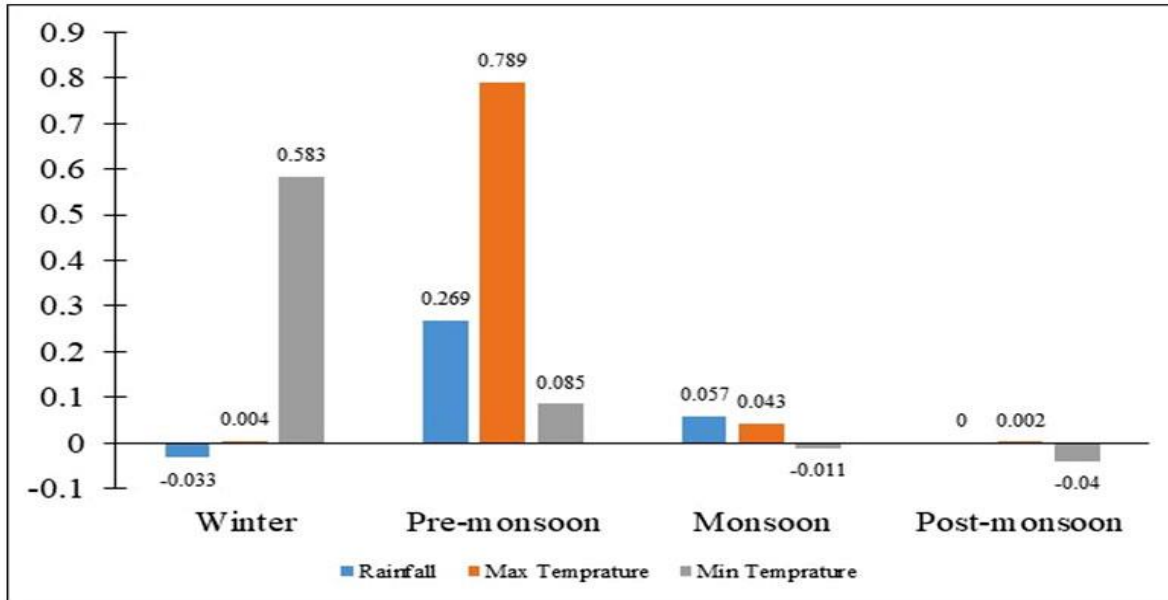


Fig. 3 Sen's slope values for different seasons

2.2 Deprived Communities and Differential Vulnerability

Social vulnerability in Rajasthan is shaped by caste, class, gender, and livelihood patterns. Scheduled Tribes (STs) constitute 13.5% of the population and depend heavily on forests and rain-fed farming in southern and southeastern Rajasthan. Scheduled Castes (SCs) make up 17.8%, often landless labourers lacking assets and secure employment. Pastoral communities face shrinking grazing lands, while women bear disproportionate burdens related to water collection, food security, and health (Singh 221–239).

According to the 2011 Census, 14.7% of Rajasthan's population lives below the poverty line, with rural poverty at 16% and urban at 11%. Poverty declined from 34% in 2004-05 to 15% in 2011-12, but micro-level analysis reveals high concentrations in pockets, often overlapping with SC/ST populations. The Nat community, a de-notified tribe classified as SC, faces severe deprivations, with high illiteracy (female literacy at 20-30%) and economic marginalization. Gender disparities amplify vulnerability; low-caste women experience greater discrimination, independent of socio-economic status (Singh 221–239).

Sahariya tribal women, for instance, face poverty, poor economic conditions, and cultural barriers, limiting access to education and healthcare. In slum areas like Jaisalmer, 60-70% of dwellers are from disadvantaged castes, reinforcing entrenched inequalities. SC/ST households show higher multidimensional poverty, with lower health, education, and empowerment indicators.

3. Climate Change Mitigation Strategies in Rajasthan

3.1 Policy Framework

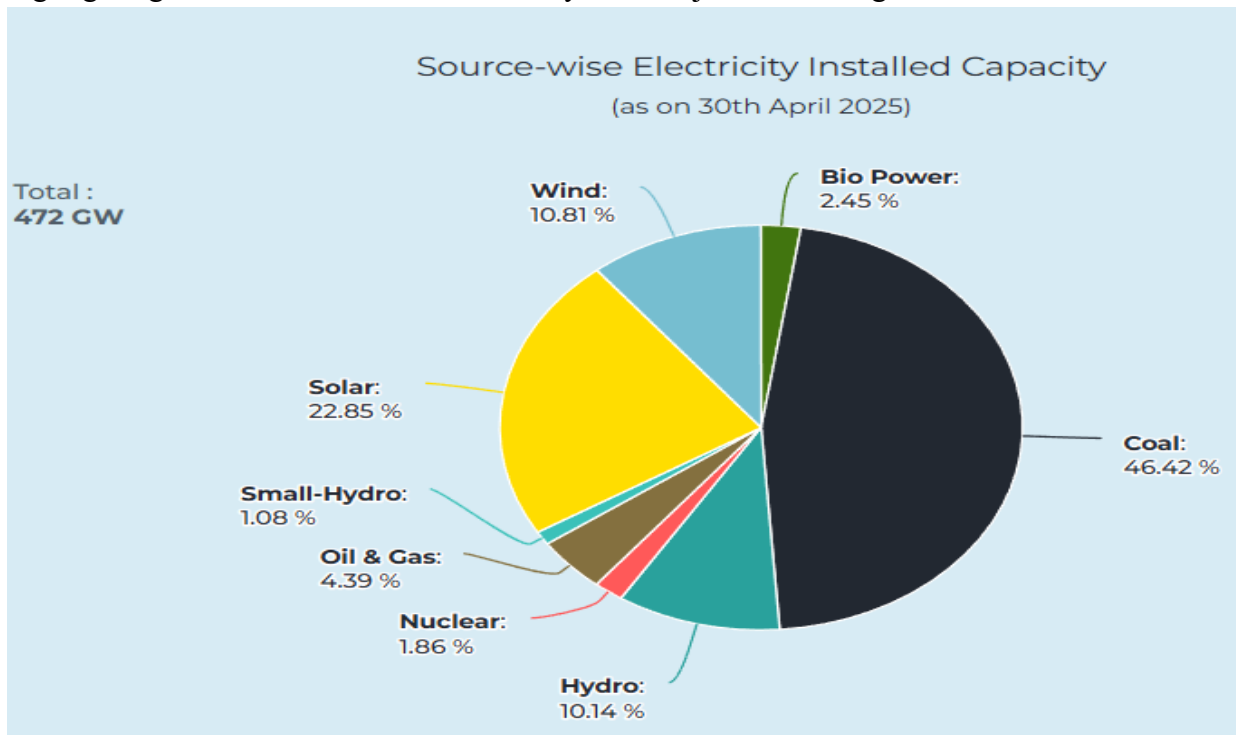
India's National Action Plan on Climate Change (2008) provides the overarching framework for mitigation and adaptation. Rajasthan's State Action Plan on Climate Change (2019, updated 2022)

emphasizes renewable energy development, water conservation, and sustainable land use (Government of India; Government of Rajasthan, Rajasthan State Action Plan on Climate Change 2022).

3.2 Renewable Energy and Equity

Rajasthan has emerged as a national leader in solar energy production, with renewable energy accounting for 20.3% of installed power capacity (total 37,818 MW as of June 2025). In 2024, solar reached over 50% of installed capacity (30.31 GW renewable total), dominating at 76% of renewables (Ministry of New and Renewable Energy). However, transmission constraints affect 4,300 MW of solar capacity, leading to curtailment. While large-scale solar parks contribute to emission reduction, their social benefits for deprived communities remain limited. Greater emphasis is needed on decentralized solar solutions, local employment, and energy access for marginalized households. Financial health of DISCOMs poses barriers to equity.

The pie chart below shows India's source-wise electricity installed capacity (as of April 2025), highlighting Solar's 22.85% share nationally, with Rajasthan leading.



3.3 Sustainable Land and Agricultural Practices

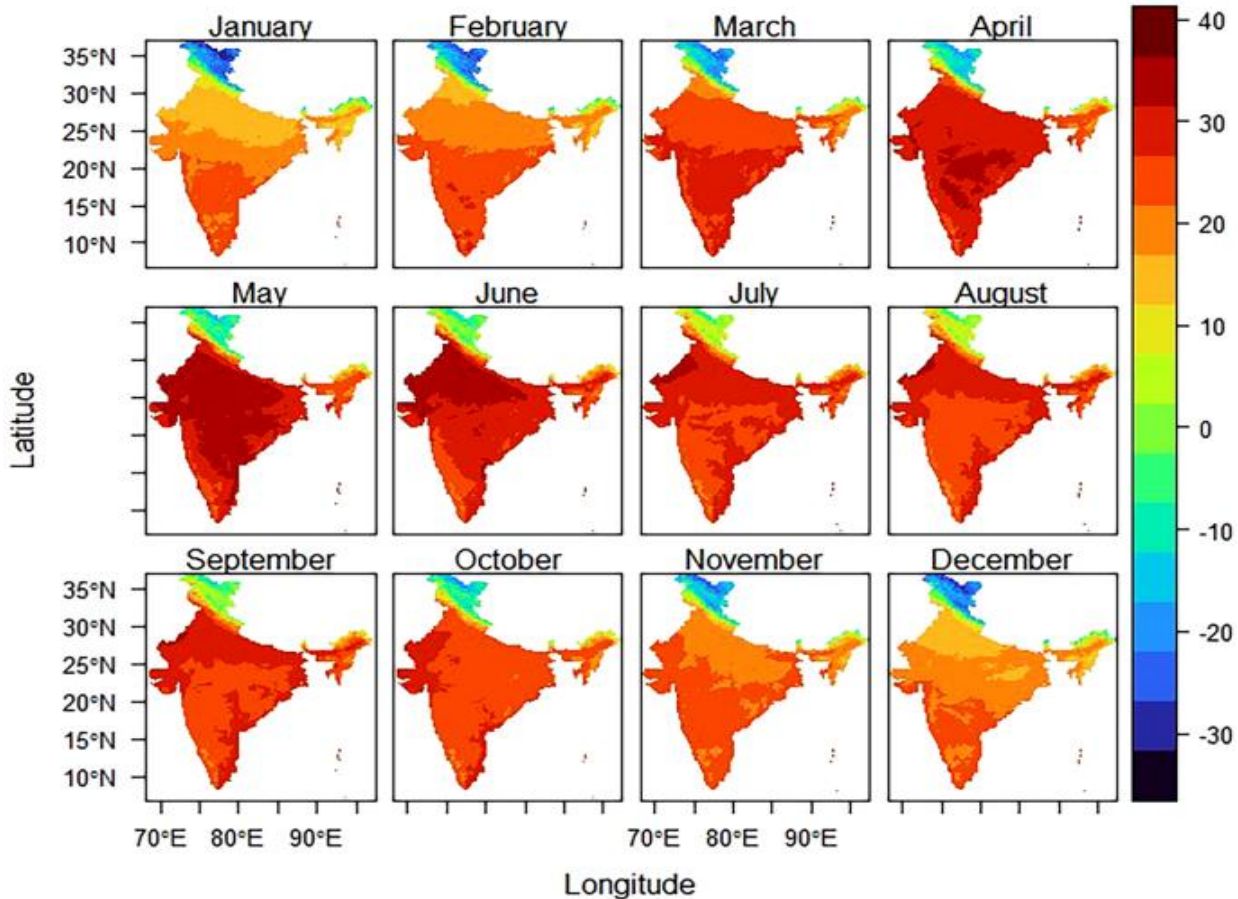
Mitigation measures such as watershed development, afforestation, and soil conservation contribute to carbon sequestration and ecosystem stability. However, small and marginal farmers (over 70% of holdings <2 ha) often lack access to technology, extension services, and financial support necessary to adopt these practices effectively. Dryland regions face frequent crop failures, with risks increasing under climate scenarios (Kumar and Sharma 512–526).

4. Adaptation Strategies for Deprived Communities

4.1 Water Resource Management

Community-based watershed management, rainwater harvesting, and revival of traditional systems like johads and baoris enhance water security and adaptive capacity, particularly in drought-prone regions. In

Rajasthan, johads have recharged aquifers, transforming drylands. MGNREGS supports these efforts, prioritizing water harvesting and soil moisture conservation, reducing vulnerability to rainfall variability. Over 60% of MGNREGS works focus on water-related infrastructure, improving drinking water and irrigation security (Government of Rajasthan, Rajasthan State Action Plan on Climate Change 2022). The map below shows drought frequency across India, with Rajasthan highlighted as a high-risk area.



4.2 Livelihood Diversification

Diversifying livelihoods through skill development, micro-enterprises, and non-farm employment reduces dependence on climate-sensitive sectors and enhances resilience among deprived households. MGNREGS provides 100 days of wage employment, aiding income security.

4.3 Social Protection Mechanisms

Government programs such as MGNREGS play a crucial role in providing income security during climate-induced livelihood disruptions. Strengthening these safety nets through climate-responsive planning can significantly enhance resilience. Impacts include reduced farm production vulnerability.

4.4 Health and Heatwave Adaptation

Increasing heat stress requires targeted adaptation measures including early warning systems, public awareness campaigns, and access to healthcare for vulnerable populations. Rajasthan recorded over 700 heatwave events in the past five decades, with heat-related mortality rising (Limaye). A single five-day heatwave causes ~30,000 excess deaths nationally, with Rajasthan among the worst-affected states. Districts like Jaipur and Churu face 180+ additional deaths per event. Indigenous practices, such as using wet cloths and staying indoors, aid adaptation (Council on Energy, Environment and Water).

The graph below illustrates potential evapotranspiration trends under temperature rise scenarios in Jodhpur, indicating increased water stress.

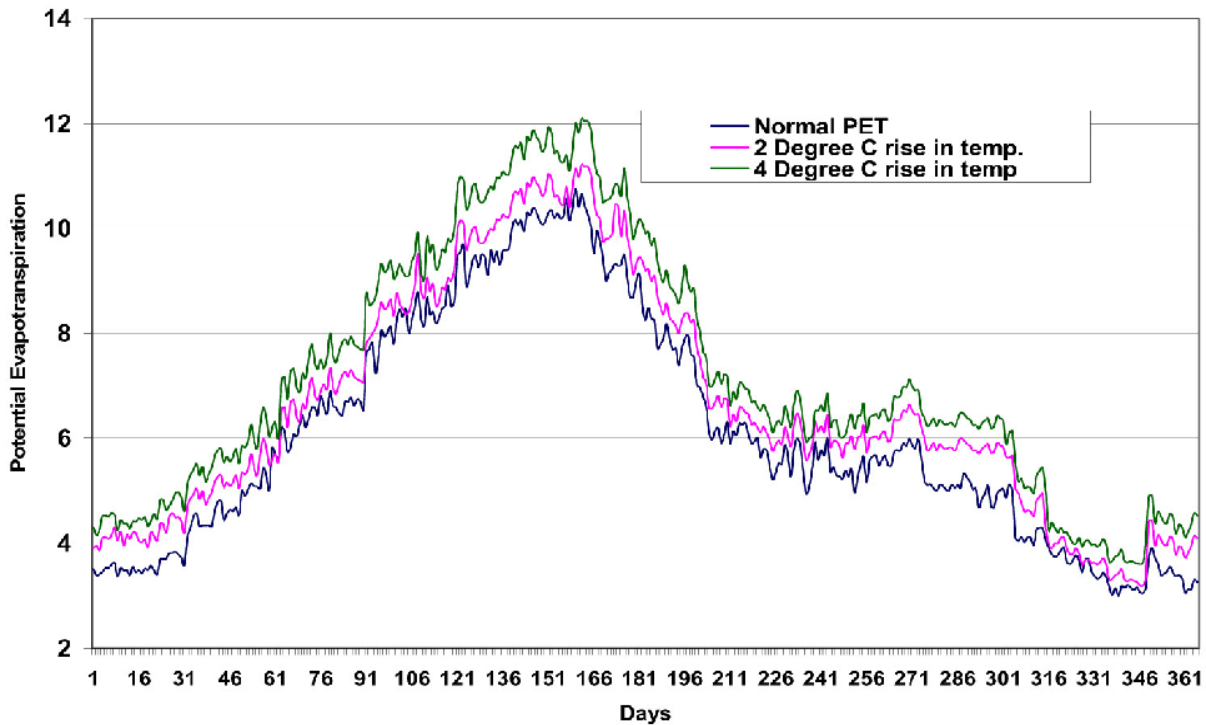


Fig. 4 Daily Potential Evapotranspiration at Jodhpur

5. Challenges in Implementing Inclusive Climate Strategies

Despite progressive policies, challenges persist due to institutional fragmentation, limited climate finance access, lack of participatory planning, gender inequality, and inadequate dissemination of climate information among deprived groups. Infrastructure deficits and talent outmigration exacerbate issues, as per Groundwater Department data (Government of Rajasthan, Rajasthan Climate Change Policy 2023).

6. Pathways toward Inclusive Climate Resilience

To build real climate resilience in Rajasthan—especially for deprived communities—we must follow practical, fair, and people-centered pathways. Here are the key ones I strongly believe in:

- **Strengthening participatory governance at local levels:**

Climate action will only work if people at the village and panchayat level are truly involved in planning and decision-making. Programs like Mukhyamantri Jal Swavlamban Abhiyan (MJSA) have already shown success when villagers take full ownership of water conservation and self-reliance efforts. In places like Alwar, Inclusive Climate Action Centres are helping communities lead their own climate planning. When women and marginalized groups actively participate, risk assessments become more accurate, adaptation plans become stronger, and local voices—especially from SC/ST communities and women—are finally heard. This makes policies more democratic and effective.

- **Prioritizing deprived groups in climate finance and insurance schemes:**

The most vulnerable people—women, small and marginal farmers, tribal families—suffer the heaviest losses from heatwaves, droughts, and crop failures. We need to give them first priority in climate finance, subsidies, and insurance. Schemes like SEWA’s Women’s Climate Shock Insurance in Rajasthan and nearby states have already paid out automatically to over 46,000 women in 2024 when temperatures crossed 41–46°C (Self-Employed Women’s Association and Climate Resilience for All). Such

parametric insurance (quick payouts based on weather triggers) can protect income and prevent families from falling deeper into poverty or migrating. Both central and state governments should expand subsidized, targeted insurance for the poorest households so they are not left behind.

- **Promoting decentralized renewable energy with community ownership:**

Rajasthan is already a solar leader, but big solar parks often benefit companies more than local people. Instead, we should focus on decentralized solutions—rooftop solar panels, solar pumps for farmers, community microgrids, and small grid-connected projects. The PM-KUSUM scheme is helping, and villages like Lakshmipura-Jharla have shown how solar microgrids can give reliable power while letting the community manage and own the system. The Rajasthan Integrated Clean Energy Policy 2024 supports rooftop solar with net metering, off-grid solutions, and local generation. This reduces transmission losses, creates jobs in villages, and ensures poor households get clean, affordable energy without depending on unreliable grids (Ministry of New and Renewable Energy).

- **Integrating traditional knowledge with scientific planning:**

Our ancestors in the Thar desert developed brilliant water-harvesting systems—johads, baoris, tankas, kunds, and khadins—that still work perfectly in dry conditions. They collect rainwater, recharge groundwater, and reduce evaporation. Organizations like Tarun Bharat Sangh have revived thousands of johads in Alwar, turning dry areas green again by combining villagers' traditional wisdom with modern science (Tarun Bharat Sangh). When we blend this local knowledge into government programs like MJSA or watershed projects, we get sustainable, low-cost solutions that communities trust and maintain themselves. This approach strengthens ecological balance and builds long-term resilience.

- **Adopting gender-responsive and socially inclusive climate policies:**

Women in Rajasthan carry the heaviest burden—fetching water, managing household food security, and dealing with health impacts—yet climate policies often ignore gender differences. The Rajasthan State Action Plan on Climate Change talks about inclusion, but we need to go further: make policies truly gender-responsive and even gender-transformative. This means designing projects that reduce women's labour load (e.g., climate-smart agriculture tools that need less manual work), increasing women's participation in decision-making, and addressing caste and class barriers. When policies empower women and marginalized groups instead of treating everyone the same, inequalities decrease and overall community resilience grows stronger (Singh 221–239).

These pathways connect climate action with social justice. By combining local participation, traditional wisdom, modern technology, and fair resource distribution, we can help deprived communities in Rajasthan become more resilient and secure for the future. This is not just theory—it is the practical way forward.

7. Conclusion

Climate resilience in Rajasthan cannot be achieved without addressing social inequities that amplify vulnerability. Integrating mitigation and adaptation strategies with social justice is essential for protecting deprived communities from climate risks. Inclusive climate governance, equitable resource distribution, and community-centered planning are vital for building long-term resilience and sustainable development in Rajasthan.

In conclusion, as someone who has studied the geography and lived realities of Rajasthan for many years, I firmly believe that true climate resilience in our state cannot be built unless we directly confront and reduce the deep social inequities that make vulnerability so much worse for deprived communities.

Rajasthan is already one of the most climate-vulnerable states in India—ranked high in national assessments for exposure to extreme heat, prolonged droughts, erratic rainfall, and water scarcity (Council on Energy, Environment and Water). Recent data from 2024–2025 shows this clearly: Rajasthan had some of the most intense heatwaves on record, with temperatures crossing 50°C in places like Churu and Sri Ganganagar, leading to hundreds of heat-related deaths and illnesses across the country, many in our rural and poor areas (Limaye). Heat stress has intensified sharply in northwestern states like ours, with more very warm nights, higher humidity in traditionally dry cities like Jaipur, and frequent power outages, water shortages, and agricultural losses affecting small farmers, landless labourers, pastoralists, Scheduled Castes, Scheduled Tribes, and especially women who bear the extra burden of fetching water and managing household survival during crises.

These climate shocks hit deprived communities hardest because of existing inequalities—limited access to land, credit, education, healthcare, early warning systems, and alternative livelihoods. In rural Rajasthan, where most people depend on rain-fed agriculture and livestock, even a single bad season can push families into debt, malnutrition, migration, or deeper poverty. National surveys from 2025 show that majorities of Indians, including in our state, have personally experienced severe heatwaves (over 70%), droughts and water shortages (around 52%), agricultural pests, and related hardships, with high worry levels about food security, extinctions, and famines (Yale Program on Climate Change Communication). Rajasthan stands out with the highest number of highly vulnerable districts in many studies, and our rural populations face a dual burden: climate change plus lack of awareness, resources, and proper scheme implementation.

Simply putting up solar parks or building more check dams is not enough if the benefits bypass the neediest. Mitigation efforts—like expanding renewables and sustainable land practices—must reduce emissions while creating local jobs and energy access for marginalized households. Adaptation strategies—community watersheds, johads revival, livelihood diversification, MGNREGS-linked safety nets, and heat action plans—only succeed when they are designed with equity at the core, prioritizing women, small farmers, tribals, and SC/ST groups.

The way forward is clear: we must integrate mitigation and adaptation strategies tightly with social justice. This means inclusive climate governance where panchayats, women’s groups, and deprived communities have real decision-making power; equitable distribution of resources, climate finance, subsidies, and insurance (like parametric heat/drought payouts that reach the poorest first); and community-centered planning that blends our rich traditional knowledge (johads, tankas, pastoral practices) with modern science and technology.

Rajasthan’s recent steps—like the Green Budget 2025–26 allocating thousands of crores for sustainability, renewables, and climate resilience, plus initiatives for a Climate Change Centre of Excellence—give hope, but implementation must focus on justice and inclusion to make a real difference (Government of Rajasthan Finance Department). Only then can we protect the most vulnerable from escalating risks, prevent further erosion of livelihoods, and build long-term resilience that supports sustainable development for all.

In the end, climate resilience in Rajasthan is not just about surviving hotter summers or drier monsoons—it is about ensuring that no one is left behind in the face of these changes. By putting social equity first, we can transform vulnerability into strength, creating a more just, resilient, and prosperous future for our deprived communities and the state as a whole. **This is not an option; it is essential.**

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