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Climate Change and Disaster Vulnerability in Jhunjhunu District

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Abstract: ***Jhunjhunu is a district in northeastern Rajasthan, lying in a semi-arid to arid zone. It is already facing weather extremes, water scarcity, agricultural distress, and fragile ecosystems. This paper examines: climate trends in Jhunjhunu (temperature, rainfall), the types of disasters and climate hazards to which it is vulnerable; how socio-economic conditions affect vulnerability; how well (or poorly) the district is adapting; and what policy, planning, and community-level interventions might reduce disaster risk. Key findings include increasing variability in rainfall, frequent meteorological droughts, groundwater stress, heat extremes, and high sensitivity due to dependence on rainfed agriculture. The adaptive capacity is constrained by limited water infrastructure, uneven socio-economic development, and weak institutional mechanisms. The paper concludes with recommendations for improving resilience: better water management (rainwater harvesting, recharge), more climate-smart agricultural practices, early warning systems, capacity building, and integrating climate risk into local planning.***

Keywords: Climate Change, Disaster Vulnerability, water scarcity, agricultural distress, and fragile ecosystems.

1. INTRODUCTION

Jhunjhunu district is in northern Rajasthan, situated in a semi-arid to arid climatic zone. It experiences extremes of temperature, scanty and erratic rainfall, high evaporation, frequent droughts. Agriculture, livelihoods, water resources and health are strongly impacted by climate variability. Climate change is projected to exacerbate extremes (heat waves, erratic rainfall, droughts), which will increase vulnerability in regions like Jhunjhunu. Understanding vulnerabilities is important for planning resilient development.

2. METHODOLOGY / DATA SOURCES

Key data sources for this study include:

1. Rainfall data from ICAR (Central Arid Zone Research Institute) and district/tehsil level rainfall records (1901-2005, and up to 2011).

2. Meteorological drought inventories.

3. Groundwater studies (quality, overexploitation) in Jhunjhunu.

4. Socio-economic and demographic data (population, agriculture dependency, literacy, water access).

5. Studies of rainfall spatial and temporal patterns using GIS methods.

3. CLIMATE TRENDS & HAZARDS

3.1 Temperature

Surveillance and reports show very high maximum temperatures in summer, cold winters, with large diurnal ranges. Jhunjhunu block experiences hot summers (up to ~48°C), winters can go down to ~1-2°C.

Rising temperature trends are reported for western Rajasthan (which includes Jhunjhunu) — increasing temperature amplifies evapotranspiration, raising water demand, increasing heat stresses.

3.2 Rainfall: Amount & Variability

Annual rainfall in Jhunjhunu district lies roughly between 400-560 mm in many tehsils, with ~24-32 rainy days per year.

The monsoon (June-September) contributes the major share. Seasonal rainfall in this period varies between ~343-477 mm depending on tehsil.

High coefficient of variation in rainfall (~37-44%) meaning the rainfall is erratic.

Extreme rainfall events occur: for example, 1-day maxima in various return periods: up to ~281 mm in Khetri for 100-yr return period; other tehsils have high one-day events.

3.3 Droughts & Dryness

Meteorological droughts are frequent. Between 1901-2005, about 34 out of 105 years had droughts in the district.

Different tehsils show differing drought frequencies: In some places drought occurs roughly once every 3-4 years. For example, Khetri, Chirawa etc.

Recent studies confirm persistent drought risk in Jhunjhunu although among districts in Rajasthan it sometimes has lower frequency than the worst cases.

3.4 Groundwater and Water Resources

Groundwater is the main source of water for drinking, irrigation in many parts of the district.

Overexploitation is evident. Many areas have low groundwater potential, water levels dropping. Blocks like Surajgarh, Buhana, etc, depend heavily on groundwater with limited recharge.

Water quality issues are present: salinity, fluoride, contamination, diseases.

3.5 Other Hazards

Heat waves: Very hot summers cause stress especially for vulnerable populations (elderly, outdoor workers).

Possible flooding / house damage: Instances of heavy rain causing house collapse during heavy rainfall in recent years (e.g. rain-related structural collapse) in Jhunjhunu.

Land degradation: due to overuse of groundwater, reduction of pasturelands, increase of wasteland, reduction of fallow/grazing lands.

4. VULNERABILITY ASSESSMENT

A useful framework divides vulnerability into three components: exposure, sensitivity, and adaptive capacity.

4.1 Exposure

1. Exposure to climate hazards: droughts, heat extremes, erratic rainfall (both deficit and heavy events), water scarcity.

2. Geographic exposure: Certain tehsils (blocks) — e.g., parts that are more arid, or block with lower rainfall (north-eastern, western), rocky terrain (Khetri, parts of Udaipurwati) limit water retention and increase exposure.

3. Socio-economic exposure: Large share of population depends on agriculture (especially rainfed, or on limited irrigation). Any variation in climate directly affects livelihoods.

4.2 Sensitivity

Sensitivity refers to how severely people / systems respond to exposure.

Agriculture: Crops sensitive to timing & quantity of rainfall. Many farmers rely on monsoon; droughts or delayed rains severely cut yields.

Water dependence: High dependence on groundwater and limited surface water. Water quality issues increase health sensitivity.

Demographics: High population in rural villages, and households with limited resources. Vulnerable groups (women, small farmers, landless laborers) are more sensitive.

Infrastructure: Housing quality may be poor (e.g. non-engineered housing), so heavy rain can cause damage. Health infrastructure limited.

4.3 Adaptive Capacity

Adaptive capacity refers to the ability to adjust, cope, or recover.

Strengths:

1. Some local initiatives and awareness (e.g., rainwater harvesting in various parts of Rajasthan) could be adapted here.

2. Some irrigation infrastructure, agricultural extension services.

Weaknesses:

1. Limited access to water storage and recharge structures; groundwater overexploitation with inadequate regulation.

2. Low income, small land holdings, limited assets, often lacking access to formal credit or insurance.

3. Knowledge limitations, e.g. limited access to early warning, limited technical capacity in agriculture to shift crop patterns, or adopt climate smart agriculture.

4. Institutional constraints: local governance may be under-resourced; disaster preparedness plans may not be well developed at block/village

5. CASE STUDIES / EMPIRICAL FINDINGSU

5.1 Rainfall Spatial–Temporal Patterns (2024 study)

A recent study (2024) using GIS (qGIS) over 22 years observed that rainfall amount shows an increasing tendency while number of rainy days increases slowly. Blocks like Khetri receive the highest average rainfall, Jhunjhunu block among the lowest.

The spatial variation is important: south and south-eastern parts have relatively more rainfall; north-eastern and western parts are drier. This has implications for groundwater recharge, agriculture, water availability.

5.2 Groundwater Impact Study (2023)

A study titled "CLIMATE CHANGE IMPACT ON GROUNDWATER RESOURCES IN DISTRICT JHUNJHUNU" shows that groundwater is critical; quality is deteriorating partly due to climate variability, human extraction, and that recharge is insufficient in many areas.

5.3 Rainfall & Drought Characteristics

Based on historical rainfall data (tehsil-wise, 1901-2005), the district has had meteorological droughts in about one third of the years.

Extreme one-day rainfall events: Though rare, such events present risk of flash flooding, runoff, erosion, damage to infrastructure.

6. IMPACTS

Some of the impacts already manifesting (or likely to manifest) in Jhunjhunu:

Water scarcity: Reduction in dependable water supply, depletion of groundwater, more stress on aquifers.

Agricultural losses: Lower yields due to droughts and erratic rainfall; crop failures; possibly shift in cropping patterns; reduced income for farmers.

Health impacts: Heat stress, waterborne diseases due to poor water quality; malnutrition if food insecurity increases.

Economic impacts: Reduced livelihoods, increased migration, increased costs for water (transport, deeper wells).

Environmental degradation: Land degradation, degradation of soil quality, loss of green cover, desertification process.

7. DISCUSSION: RISK & VULNERABILITY IN COMPARATIVE PERSPECTIVE

Compared with some of the most arid districts in Rajasthan (e.g., Jaisalmer, Barmer), Jhunjhunu is less extreme in terms of drought frequency but still highly vulnerable.

The district appears in "very high risk" in certain climate vulnerability/risk assessments of districts by central government sources.

The exposure is increasing (temperature, rainfall variability), while adaptive capacity is not keeping pace, especially for poorer and remote areas.

8. POLICY, PLANNING AND INSTITUTIONAL CONTEXT

State government programs: Rajasthan has several water conservation, afforestation, and soil conservation programs. In addition, tree planting and "green" missions are underway.

Land use regulations, agricultural extension services, groundwater regulation: these exist but enforcement and investment vary.

Disaster management: Rajasthan State Disaster Management Authority has frameworks, but district-level preparedness, early warning, infrastructure to cope with extreme events needs strengthening.

9. STRATEGIES & RECOMMENDATIONS

To reduce vulnerability and build resilience, the following strategies are suggested:

Strategy Key Actions

Water Resource Management Expand rainwater harvesting (village ponds, tanks, johads), roof rainwater harvesting. Recharge structures in aquifer depletion zones. Regulate groundwater extraction; mapping of critical zones. Improve surface water storage (check dams, percolation ponds).

Agriculture & Livelihoods Promote drought-tolerant and heat-resistant crop varieties; shift cropping calendars if needed. Mixed cropping, crop diversification; water-efficient irrigation (drip, sprinkler). Strengthening farmers' access to extension, climate advisory services. Insurance schemes for crop failure.

Early Warning & Disaster Preparedness Better weather forecasting, local scale warnings. Awareness programs for farmers, community training in handling extreme heat, drought, heavy rainfall events. Infrastructure resilient to extremes (housing, roads).

Health & Social Safety Nets Strengthen health services for heat stress and waterborne illnesses; ensure water quality; community awareness on hygiene. Social protection for vulnerable groups (poor, women, landless).

Ecosystem Restoration & Land Management Afforestation, especially native drought-resilient species. Soil conservation, preventing erosion. Conserving pasture lands and checking land degradation. Harnessing traditional practices.

Institutional & Policy Measures Integrate climate risk into district planning (e.g. Disaster Management Plans, Land Use Plans). Allocate budget for adaptation. Encourage participatory planning involving local communities. Strengthening capacity of block/village level institutions.

10. CHALLENGES AND RESEARCH GAPS

Data Gaps: More recent, high resolution climate data; better soil moisture, groundwater level monitoring; more frequent assessments of exposure and sensitivity at sub-block level.

Attribution of extreme events: Need better work to ascertain how much of observed trends (rainfall extremes, heat waves) are due to anthropogenic climate change vs natural variability.

Behavioral & Socio-cultural aspects: Understanding how local beliefs, practices, awareness affect adaptation.

Economic analysis: Costs of adaptation vs cost of inaction. What are threshold impacts on livelihoods or migration?

Policy implementation: Evaluating which policies have been effective, what are bottlenecks (financial, institutional, social) in implementing adaptation / resilience projects.

11. CONCLUSION

Jhunjhunu district is facing significant vulnerability to climate change and associated disasters. Though perhaps not as extreme as some desert districts, its exposure (to drought, rainfall variability, heat) and sensitivity (agriculture dependence, water scarcity, socio-economic constraints) are high, while adaptive capacity remains relatively low in many localities. Without concerted efforts in planning, infrastructure, community capacity building, and ecosystems management, the risks will increase. Conversely, with targeted adaptive strategies, there is scope to build resilience, improve livelihoods, and reduce disaster fragility.

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