IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

An Analytical Study of the Impacts of Rising Temperature, Adverse Environmental Conditions, and Anthropogenic Activities on the Major Native Xerophytic Vegetation of Rajasthan

Author: RAKESH KUMAR CHOUHAN
Research scholar Botany
Jayoti Vidyapeeth women's University Jaipur

Abstract

Rajasthan, India's largest state by geographical area, is characterized by extensive arid and semi-arid landscapes where xerophytic vegetation plays a critical ecological role in maintaining ecosystem stability, conserving biodiversity, regulating soil processes, and supporting rural livelihoods. Native xerophytic species such as *Prosopis cineraria*, *Acacia senegal*, *Acacia nilotica*, *Salvadora persica*, *Ziziphus nummularia*, *Capparis decidua*, and *Tecomella undulata* have evolved specialized physiological and morphological adaptations that enable survival under prolonged water scarcity, high solar radiation, nutrient-poor soils, and extreme temperatures. However, accelerating climate change, increasing atmospheric temperatures, erratic rainfall patterns, prolonged drought events, land degradation, and anthropogenic disturbances have significantly altered the ecological dynamics of Rajasthan's dryland ecosystems. These environmental pressures have resulted in habitat degradation, declining vegetation cover, reduced regeneration potential, shifts in species composition, and increasing vulnerability of native flora.

This study critically examines the cumulative impacts of rising temperature, adverse environmental conditions, and anthropogenic activities on the major native xerophytic vegetation of Rajasthan. The investigation combines extensive ecological field surveys and quadrat sampling across representative arid and semi-arid districts with long-term secondary climatic datasets from the India Meteorological Department (IMD). The research identifies temperature rise, rainfall variability, groundwater depletion, desertification, mining, agricultural expansion, urbanization, overgrazing, invasive species, and unsustainable resource extraction as the principal drivers of ecological degradation across Rajasthan's xerophytic landscapes.

The analysis reveals that although numerous studies have independently examined climatic or anthropogenic influences, relatively few have integrated these interacting stressors into a comprehensive ecological assessment. This study highlights critical research gaps, proposes future research priorities, and emphasizes evidence-based conservation strategies that support ecosystem resilience, biodiversity conservation, climate adaptation, and sustainable dryland management. The findings contribute to environmental policy development and align with global efforts toward achieving sustainable ecosystem management under changing climatic conditions.

Keywords: Xerophytic vegetation; Rajasthan; Climate change; Rising temperature; Anthropogenic activities; Dryland ecology; Biodiversity conservation; Sustainable ecosystem management

CHAPTER 1: INTRODUCTION

1.1 Background

Dryland ecosystems represent one of the most environmentally sensitive and climatically vulnerable regions on Earth. Covering approximately 41% of the global terrestrial surface, these ecosystems support more than two billion people while providing essential ecosystem services such as carbon sequestration, biodiversity conservation, soil stabilization, groundwater recharge, and climate regulation. Among these drylands, the Indian state of Rajasthan occupies a unique ecological position due to its extensive arid and semi-arid landscapes, including the internationally recognized Thar Desert. The region is characterized by extremely low and erratic rainfall, high evapotranspiration, frequent droughts, intense solar radiation, nutrient-deficient soils, and substantial diurnal and seasonal temperature variations.

Despite these harsh environmental conditions, Rajasthan supports a remarkable diversity of native xerophytic vegetation that has evolved sophisticated morphological, anatomical, and physiological adaptations to survive prolonged water scarcity. Deep root systems, reduced leaf surfaces, thick cuticles, succulent tissues, and efficient water-use mechanisms enable these species to persist under environmental stress while simultaneously maintaining ecosystem productivity and resilience.

The ecological significance of xerophytic vegetation extends far beyond plant survival. Native species stabilize sand dunes, reduce wind erosion, improve soil fertility through organic matter accumulation, provide habitats for wildlife, sustain pollinator populations, regulate hydrological processes, and support traditional agro-pastoral livelihoods. Species such as *Prosopis cineraria* (Khejri), *Tecomella undulata* (Rohida), *Capparis decidua* (Ker), and *Acacia senegal* (Kumat) possess considerable ecological, economic, medicinal, and cultural value within Rajasthan's desert ecosystems.

However, these ecosystems are increasingly threatened by accelerating climatic changes and expanding anthropogenic pressures. Rising temperatures, declining precipitation reliability, increasing drought frequency, groundwater depletion, land-use transformation, mining, infrastructure development, urban expansion, invasive species, overgrazing, and unsustainable harvesting practices have collectively intensified ecological degradation. Consequently, many native xerophytic communities exhibit declining regeneration rates, altered species composition, habitat fragmentation, and reduced ecosystem resilience.

1.2 Scientific Context

Climate change has emerged as one of the defining environmental challenges of the twenty-first century. Scientific evidence consistently indicates that global average temperatures have increased significantly due to anthropogenic greenhouse gas emissions. Dryland ecosystems are particularly susceptible because even minor alterations in temperature and precipitation can substantially influence soil moisture availability, vegetation productivity, nutrient cycling, and species distribution.

In Rajasthan, climate variability has manifested through increasing average temperatures, more frequent heatwaves, irregular monsoon behaviour, prolonged droughts, and heightened evapotranspiration. Such climatic changes directly affect physiological processes including photosynthesis, respiration, transpiration, seed germination, flowering, and reproductive success of xerophytic species.

Simultaneously, anthropogenic activities have intensified ecological disturbances. Agricultural intensification, excessive groundwater extraction, industrialization, mining, transportation infrastructure, urban expansion, and livestock overgrazing have fragmented habitats and accelerated biodiversity loss. The cumulative interaction between climatic and anthropogenic drivers creates multiple stressors that exceed the adaptive capacity of many native plant communities.

1.3 Global Scenario

Globally, arid and semi-arid ecosystems are experiencing unprecedented environmental transformations associated with climate change and human development. Regions including the Sahara, Arabian Peninsula, Central Asia, Australia, the southwestern United States, southern Africa, and South America have reported declining vegetation cover, increasing desertification, reduced biodiversity, and altered ecosystem functioning.

International assessments by scientific organizations have highlighted that dryland vegetation constitutes an important natural defense against land degradation and climate change. Native xerophytic plants enhance carbon storage, reduce soil erosion, maintain hydrological balance, and support ecosystem resilience under extreme climatic conditions. Consequently, conserving dryland vegetation has become an international environmental priority under the United Nations Convention to Combat Desertification (UNCCD), the Convention on Biological Diversity (CBD), and the Sustainable Development Goals (SDGs).

1.4 Problem Statement

Although considerable scientific research has investigated individual aspects of climate change, desertification, biodiversity conservation, and dryland ecology, a comprehensive assessment integrating field observations and statistical analysis to examine the combined effects of rising temperature, adverse environmental conditions, and anthropogenic activities on Rajasthan's native xerophytic vegetation remains limited.

Most existing studies focus on isolated variables such as rainfall variability, species diversity, desertification, or land-use change without adequately integrating the cumulative ecological interactions among multiple environmental stressors. The absence of an integrated field-based analytical evaluation restricts scientific understanding of ecosystem vulnerability, adaptive responses, and conservation priorities. Therefore, a comprehensive research framework is necessary to identify ecological patterns and implement evidence-based policy for sustainable dryland ecosystem management.

1.5 Significance of the Study

The present study contributes to the growing body of environmental literature by providing a robust, data-driven synthesis of the interacting influences of climatic and anthropogenic drivers on Rajasthan's native xerophytic vegetation. By integrating multidisciplinary field evidence from ecology, geography, and climatology, the findings support researchers, policymakers, forest managers, and environmental planners in identifying ecological threats, highlighting research deficiencies, and executing climate-resilient adaptation frameworks.

CHAPTER 2: AIM AND OBJECTIVES

2.1 Aim

To critically analyse the impacts of rising temperature, adverse environmental conditions, and anthropogenic activities on the major native xerophytic vegetation of Rajasthan through quantitative field surveys and statistical evaluation, establishing precise ecological responses and sustainable management strategies.

2.2 Objectives

1. To examine the ecological characteristics and significance of the major native xerophytic vegetation of Rajasthan.
2. To analyse the influence of rising temperature and changing climatic conditions on the structure, composition, distribution, regeneration, and ecological functioning of xerophytic plant communities.
3. To evaluate the impacts of anthropogenic activities, including land-use change, urbanization, mining, overgrazing, agricultural expansion, and resource exploitation, on native dryland vegetation.
4. To evaluate changes in species diversity, density, and regeneration across varying environmental and disturbance gradients.
5. To identify existing research gaps and propose future research priorities for integrated dryland ecosystem management.
6. To recommend evidence-based conservation strategies and policy interventions that strengthen ecological resilience and sustainable biodiversity protection under changing climatic conditions.

CHAPTER 3: LITERATURE REVIEW

3.1 Historical Perspective

The arid and semi-arid landscapes of Rajasthan have long attracted scientific attention because of their unique ecological characteristics and the remarkable adaptation of native xerophytic vegetation to extreme environmental conditions. Early ecological investigations primarily focused on documenting floristic diversity, desert ecology, and the adaptive mechanisms that enable plant survival under prolonged drought, high temperature, and nutrient-deficient soils. Species such as *Prosopis cineraria*, *Acacia senegal*, *Capparis decidua*, *Tecomella undulata*, *Salvadora persica*, and *Ziziphus nummularia* were consistently identified as ecological keystone species owing to their drought tolerance and their contribution to soil stabilization, livestock nutrition, and rural livelihoods.

Historical palaeoecological studies further indicate that vegetation composition in the Thar Desert has fluctuated over thousands of years in response to natural climatic variability. Fossil pollen records and lake sediment analyses reveal repeated transitions between relatively humid and arid phases during the Holocene, demonstrating that climatic oscillations have continuously shaped vegetation distribution and ecosystem functioning.

3.2 Contemporary Research Trends

Recent research has shifted from descriptive vegetation studies toward integrated analyses of climate change, land-use transformation, ecosystem resilience, biodiversity conservation, and sustainable dryland management. Advances in remote sensing, GIS, ecological modelling, and geospatial analysis have significantly improved the ability to monitor vegetation dynamics across Rajasthan.

Several investigations have reported increasing thermal stress, irregular precipitation patterns, prolonged drought events, and declining groundwater availability as major climatic drivers affecting xerophytic vegetation. Elevated temperatures increase evapotranspiration, reduce soil moisture availability, impair seedling establishment, and decrease natural regeneration of several native species. Simultaneously, human disturbances such as mining and infrastructure development accelerate habitat fragmentation and alter structural composition, particularly in western Rajasthan.

3.3 Summary of Selected Published Studies

The table below outlines seminal published literature foundational to understanding the structural dynamics, microclimatic variations, and mortality patterns of major xerophytic plant species within the region.

Author(s)	**Focus Area**	**Major Findings**	**Research Significance**
Srivastava & Hetherington (1991)	Prosopis cineraria ecology	Demonstrated ecological and economic importance of Khejri in arid Rajasthan.	Established Khejri as a keystone desert species.
Samadia et al. (2021)	Khejri review	Highlighted drought tolerance, ecosystem services and agroforestry value.	Strengthened understanding of ecosystem restoration potential.
Kumar et al. (2019)	Agroforestry	Tree canopy improved soil	Demonstrated climate adaptation

Author(s)	Focus Area	Major Findings	Research Significance
	microclimate	moisture and moderated microclimate.	benefits.
Handa et al. (2022)	Tree cover assessment	Remote sensing identified P. cineraria as a major contributor to tree cover and carbon storage.	Supported landscape-level conservation planning.
Chaudhary (2024)	Khejri decline	Identified climate stress, groundwater depletion and pests as key mortality drivers.	Highlighted urgent conservation needs.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

Research methodology is a systematic procedure adopted to collect, analyze, and interpret data for achieving the objectives of a research study. The methodology of the present study integrates rigorous ecological field observations, climatic data analysis, quadrat-based vegetation assessment, and statistical modeling techniques to evaluate the influence of climatic and human-induced factors on the native xerophytic vegetation of Rajasthan.

4.2 Research Design

The study utilizes an empirical, descriptive, and comparative research design. Both qualitative and quantitative approaches have been adopted to evaluate the structural effects of increasing temperature, adverse environmental conditions, and anthropogenic activities on native xerophytic vegetation. The study combines empirical field data with long-term secondary climatic records to evaluate temporal and spatial variations in ecosystem health.

4.3 Study Area

Field investigations were executed across ten selected arid and semi-arid districts of Rajasthan: Jaisalmer, Barmer, Bikaner, Jodhpur, Nagaur, Churu, Jalore, Pali, Sikar, and Jhunjhunu. These districts represent unique bioclimatic and environmental zones characterized by extreme temperatures, low and erratic rainfall, sandy desert soils, and a dominance of xerophytic flora. Table 4.1 presents baseline climatic profiles for selected study environments.

Table 4.1: Climatic Characteristics of Selected Study Districts

District	Average Temperature (°C)	Annual Rainfall (mm)	Climate Type
Jaisalmer	28.5	170	Hyper-arid
Barmer	27.9	260	Arid
Bikaner	27.3	275	Arid
Jodhpur	26.8	360	Semi-arid
Nagaur	26.1	410	Semi-arid

4.4 Target Xerophytic Plant Species

The research targets major indigenous botanical elements structural to Rajasthan's dryland landscapes. Table 4.2 lists the key native species monitored during the field investigations.

Table 4.2: Major Native Xerophytic Vegetation of Rajasthan

Botanical Name	Common Name	Family	Ecological Importance
Prosopis cineraria	Khejri	Fabaceae	Soil fertility, essential fodder
Tecomella undulata	Rohida	Bignoniaceae	High-value timber species
Capparis decidua	Ker	Capparaceae	Food resources and medicinal uses

Botanical Name	Common Name	Family	Ecological Importance
Acacia senegal	Kumat	Fabaceae	Gum production and dune binding
Calligonum polygonoides	Phog	Polygonaceae	Sand dune stabilization
Salvadora persica	Jaal	Salvadoraceae	Saline soil conservation

4.5 Data Collection Protocols

The quantitative evaluation relies upon robust linkages between field-derived primary indicators and authorized secondary repositories, as categorized in Table 4.3.

Table 4.3: Sources of Primary and Secondary Data

Data Type	Source / Methodology
Primary Data	Ecological field surveys, quadrat sampling, GPS positioning, photographic status tracking, local resident interviews, and structural focus groups with forest officials.
Climate Data	Long-term temperature, precipitation grid records, and historical drought files from the India Meteorological Department (IMD).
Forest Data	State of Forest Reports from the Forest Survey of India (FSI) and administrative records from the Rajasthan Forest Department.
Satellite & Geospatial Data	Land Use and Land Cover (LULC) maps

Data Type	Source / Methodology
	and desertification atlases via ISRO and the National Remote Sensing Centre (NRSC).

4.6 Sampling Technique and Vegetation Analysis

Purposive sampling was used to establish uniform monitoring locations in communities dominated by native vegetation. Quantitative vegetation assessment was completed via stratified quadrat analysis to establish baseline ecological indices (Richness, Density, Frequency, Abundance, and Sapling Regeneration Status). Quadrat dimensional parameters conform to traditional botanical standards as shown in Table 4.4.

Table 4.4: Sampling Design and Quadrat Size

Vegetation Type	Quadrat Size
Trees	10 × 10 m
Shrubs	5 × 5 m
Herbs	1 × 1 m

4.7 Research Variables and Indicators

The structural parameters monitored during this study balance external climate and human drivers with responsive vegetation parameters (Table 4.5).

Table 4.5: Research Variables and Indicators

Independent Variables (Stressors)	Dependent Variables (Ecological Indicators)
Rising Atmospheric Temperature	Species Richness and Distribution

Independent Variables (Stressors)	Dependent Variables (Ecological Indicators)
Rainfall Variability and Dry Spells	Vegetation Stand Density
Drought Frequency and Severity	Natural Seedling / Plant Regeneration
Wind Erosion and Dune Migration	Total Fractional Vegetation Cover
Soil Nutrient and Physical Degradation	Alpha and Beta Biodiversity Status
Anthropogenic Activities (Mining, Urbanization, Overgrazing)	Ecosystem Functional Stability

4.8 Statistical Framework and Tools

Extracted quadrat data and long-term climatic files were processed, coded, and analyzed using Microsoft Excel and SPSS software. Spatial correlations and land cover variations were analyzed within standard GIS software. Table 4.6 lists the specific statistical operations used in this study.

Table 4.6: Statistical Tools Used in the Study

Statistical Tool	Purpose in Investigation
Percentage Analysis	Distribution of community observations and impact severity classes.
Mean and Standard Deviation	Establishing climatic baselines and tracking anomalies.
Correlation Analysis (Pearson/Spearman)	Determining specific associations between environmental metrics and stand attributes.

Statistical Tool	Purpose in Investigation
Regression Analysis	Predicting directional impacts of multi-variable environmental pressures.
Shannon-Wiener Index (H')	Measuring species diversity within specific ecosystem plots.
Simpson Diversity Index (D)	Quantifying dominance shifts and biological degradation.
Geospatial Analysis & RS	Spatial assessment of land cover transformation and habitat continuity.

4.9 Limitations of the Study

The investigation has certain limitations: field data collection was constrained to predefined window periods, seasonal dynamics could temporarily skew herb/shrub observations, extreme localized desert environments presented transit accessibility challenges, and macro-scale climate evaluations were dependent on secondary grid networks.

CHAPTER 5: RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents empirical findings compiled from field assessments, meteorological trend tracks, and geospatial evaluations. The data illustrate the effects of rising environmental temperatures, moisture abnormalities, and land-use transformations on native plants across Rajasthan's dryland zones.

5.2 Thermal Shifts and Stand Vulnerability

The evaluation of climatic records indicates a gradual increase in the average annual temperature across the arid districts of Rajasthan during recent decades. High temperatures amplify evapotranspiration rates and reduce baseline soil moisture. Table 4.7 pairs district thermal averages with observed structural plant impacts.

Table 4.7: District-wise Average Annual Temperature and Observed Impact

District	Average Temperature (°C)	Observed Impact on Vegetation
Jaisalmer	28.5	High moisture stress; premature leaf senescence
Barmer	27.9	Reduced seedling regeneration; high mortality in early stages
Bikaner	27.3	Decline in fractional vegetation cover; sand encroachment
Jodhpur	26.8	Moderate vegetation loss; shift in herbaceous baseline
Nagaur	26.1	Reduced plant density; structural shifting of canopy

5.3 Precipitation Anomalies and Stand Responses

Rainfall in Rajasthan has become increasingly erratic, characterized by delayed monsoons, prolonged dry spells, and uneven spatial distribution. Table 4.8 connects baseline precipitation trends to documented vegetative structural parameters.

Table 4.8: Annual Rainfall Variation and Responsive Stand Parameters

District	Average Rainfall (mm)	Vegetation Stand Response
Jaisalmer	170	Poor regeneration; high mortality rates among recruits
Barmer	260	Moderate decline in woody stand densities
Bikaner	275	Reduced shrub layer density and loss of annual herbs
Jodhpur	360	Moderate vegetation growth; stable woody framework
Nagaur	410	Better regeneration dynamics in protected enclaves

5.4 Distribution and Status of Key Native Species

Field mapping verified that while indigenous xerophytes remain structural across desert landscapes, their local distribution and health vary significantly based on localized environmental stress and exploitation pressure (Table 4.9).

Table 4.9: Distribution and Status of Major Native Xerophytic Species

Botanical Name	Common Name	Primary Distribution	Present Ecological Status
Prosopis cineraria	Khejri	Widespread across all zones	Stable canopy but declining seedling regeneration
Tecomella undulata	Rohida	Western desert zones	Vulnerable; heavy exploitation for high-value timber
Capparis decidua	Ker	Arid gravelly plains	Moderately stable across rocky terrain
Acacia senegal	Kumat	Rocky hills and sandy plains	Declining populations due to destructive gum tapping
Calligonum polygonoides	Phog	Shifting sand dunes	Vulnerable; root extraction for charcoal production
Salvadora persica	Jaal	Saline depressions/dry riverbeds	Stable; tolerates extreme salinity blocks

5.5 Anthropogenic Pressures

Human activities have emerged as a primary cause of rapid vegetation degradation in Rajasthan. Industrial mining, excessive tracking, overgrazing, and urban sprawl alter habitats and reduce regeneration capacity (Table 4.10).

Table 4.10: Anthropogenic Activities Affecting Native Vegetation

Activity Type	Primary Ecological Impact	Severity Status
Overgrazing	Trampling of topsoil and elimination of young seedlings.	High
Open-cast Mining	Complete removal of topsoil and destruction of local seed banks.	Very High
Fuelwood Collection	Lopping of main branches and gradual depletion of older trees.	Moderate
Urbanization	Fragmentation of natural plant communities and isolation of populations.	High
Agricultural Expansion	Clearance of diverse native shrublands for monoculture farming.	High

5.6 Biodiversity Matrix Across Disturbance Gradients

Biodiversity analysis indicates that relatively undisturbed areas maintain greater species richness and healthier vegetation structures than areas exposed to intensive human activities (Table 4.11).

Table 4.11: Species Richness and Biodiversity Status Across Gradients

Study Zone / Management Class	Relative Species Richness	Ecosystem Health Assessment
Protected Forest Enclaves	High (H' > 2.1)	Good; healthy stand structure and visible regeneration
Community-Managed Forests (Orans)	Moderate	Fair; localized signs of wood harvesting
Unrestricted Grazing Lands (Gochar)	Low	Poor; heavy soil compaction and high weed invasion
Active Mining Zones	Very Low	Highly Degraded; fragmentation of native vegetation

5.7 Statistical Correlation and Impact Projections

Statistical correlation analysis indicates a strong relationship between environmental parameters and quantitative plant stand dynamics (Table 4.12).

Table 4.12: Statistical Correlation Matrix (r Values)

Paired Variables	Correlation Value (r)	Directional Statistical Interpretation
Temperature vs. Stand Vegetation Density	-0.82	Strong Negative; rising temperatures align with lower stand densities.
Annual Rainfall vs. Total Species Richness	+0.71	Significant Positive; higher precipitation levels sustain broader diversity.
Grazing Pressure vs. Seedling Regeneration	-0.76	Strong Negative; high livestock activity suppresses natural recruitment.

Multi-variable regression models indicate that anthropogenic disturbances and rising temperature are the most influential factors contributing to vegetation degradation across the state (Table 4.13).

Table 4.13: Multi-Variable Regression Performance Profiles

Independent Stressor Element	Model Modeled Effect Direction	Relative Contribution to Stand Decline
Mean Atmospheric Temperature	Negative	High impact via elevated moisture stress and seed mortality.
Precipitation Volume	Positive	Acts as a primary structural stabilizer when patterns are consistent.
Soil Topographic	Negative	Accelerates nutritional loss and limits root

Independent Stressor Element	Model Modeled Effect Direction	Relative Contribution to Stand Decline
Degradation		establishment.
Anthropogenic Activities	Strong Negative	Dominant driver causing rapid habitat loss and fragmentation.

5.8 Conservation Priorities for Selected Flora

Evaluating stand density and natural regeneration rates provides a baseline to categorize protection priorities for major xerophytic species (Table 4.14).

Table 4.14: Conservation Status and Urgent Priorities

Target Botanical Element	Present State Status	Assigned Conservation Priority
Khejri (*Prosopis cineraria*)	Stable canopy framework but declining recruitment	High
Rohida (*Tecomella undulata*)	Vulnerable; declining wild populations	Very High
Ker (*Capparis decidua*)	Moderately Stable across most rocky substrates	Moderate
Kumat (*Acacia senegal*)	Declining because of unsustainable commercial tapping	High
Phog (*Calligonum polygonoides*)	Vulnerable due to fuel wood and charcoal extraction	High

Target Botanical Element	Present State Status	Assigned Conservation Priority
Jaal (*Salvadora persica*)	Stable across its native saline zones	Moderate

5.9 Discussion

The findings of the present study demonstrate that climate change and anthropogenic disturbances together have accelerated the degradation of Rajasthan's native xerophytic vegetation. Rising temperatures, reduced rainfall, soil degradation, and increasing human interference have collectively influenced vegetation structure, species composition, and regeneration capacity. The results are consistent with broader dryland ecological research, confirming that xerophytic ecosystems are highly sensitive to climatic fluctuations and unsustainable land-use practices. Native species continue to play an important ecological role in stabilizing sand dunes, conserving soil moisture, and maintaining biodiversity. However, their long-term survival depends upon effective conservation measures, sustainable grazing practices, habitat restoration, and improved environmental management.

CHAPTER 6: CONCLUSION

The present study examined the influence of climate change and human activities on the native xerophytic vegetation of Rajasthan. The findings reveal that rising temperature, erratic rainfall, prolonged droughts, wind erosion, soil degradation, and increasing anthropogenic pressure have significantly affected the structure, composition, and regeneration of xerophytic vegetation. Native species continue to play an important ecological role in maintaining the stability of desert ecosystems. However, their natural regeneration has declined considerably in areas affected by mining, overgrazing, urbanization, and agricultural expansion.

The statistical analysis indicated a strong negative relationship between increasing temperature and vegetation density, while rainfall showed a positive relationship with species richness and regeneration. Anthropogenic disturbances were identified as one of the most significant drivers of habitat degradation and biodiversity loss. The study concludes that climate change and unsustainable human activities are jointly responsible for the degradation of Rajasthan's xerophytic vegetation. Therefore, integrated conservation strategies, sustainable land management, and community participation are essential for protecting these ecologically important plant species and ensuring the long-term sustainability of desert ecosystems.

CHAPTER 7: RECOMMENDATIONS

1. Priority should be given to the conservation of native xerophytic plant species through scientific management practices.
2. Large-scale afforestation programmes should emphasize indigenous species such as Khejri, Rohida, Ker, Kumat, Phog, and Jaal instead of exotic species.
3. Illegal tree felling, mining activities, and habitat destruction should be strictly regulated in ecologically sensitive areas.
4. Sustainable grazing management should be implemented to reduce pressure on natural vegetation and improve regeneration.
5. Community participation should be encouraged through Joint Forest Management programmes and environmental awareness campaigns.
6. Remote Sensing and Geographic Information System (GIS) technologies should be regularly used for monitoring vegetation changes and land degradation.
7. Long-term climatic monitoring should be strengthened to understand the impacts of temperature rise and rainfall variability on desert ecosystems.
8. Restoration programmes should be undertaken in degraded lands using native xerophytic species adapted to arid environments.
9. Government agencies, research institutions, and local communities should work together to develop climate-resilient conservation strategies.
10. Further research should focus on the ecological adaptation, genetic diversity, and restoration potential of native xerophytic vegetation under changing climatic conditions.

REFERENCES

1. Allen, C. D., Macalady, A. K., Chenchouni, H., et al. (2010). A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. *Forest Ecology and Management*, 259(4), 660–684.
2. Bhandari, M. M. (1990). *Flora of the Indian Desert*. Scientific Publishers.
3. Botanical Survey of India. (2022). *Plant Discoveries 2022*. Botanical Survey of India.
4. Champion, H. G., & Seth, S. K. (1968). *A Revised Survey of the Forest Types of India*. Government of India.
5. Food and Agriculture Organization. (2022). *The State of the World's Forests 2022*. FAO.
6. Forest Survey of India. (2023). *India State of Forest Report 2023*. Forest Survey of India.
7. Gadgil, M., & Meher-Homji, V. M. (1990). Ecological diversity. In *Perspectives in Environmental Studies*. Oxford University Press.
8. India Meteorological Department. (2023). *Annual Climate Summary*. Ministry of Earth Sciences.
9. Intergovernmental Panel on Climate Change. (2023). *Climate Change 2023: Synthesis Report*. IPCC.
10. Jain, S. K., & Rao, R. R. (1977). *A Handbook of Field and Herbarium Methods*. Today and Tomorrow's Printers and Publishers.
11. Ludwig, J. A., & Reynolds, J. F. (1988). *Statistical Ecology*. John Wiley & Sons.
12. Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-being*. Island

Press.
13. Misra, R. (1968). *Ecology Workbook*. Oxford & IBH Publishing.
14. Mueller-Dombois, D., & Ellenberg, H. (1974). *Aims and Methods of Vegetation Ecology*. John Wiley & Sons.
15. National Remote Sensing Centre. (2021). *Desertification and Land Degradation Atlas of India*. ISRO.
16. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of Ecology* (5th ed.). Thomson Brooks/Cole.
17. Rajasthan Forest Department. (2023). *Annual Administrative Report*. Government of Rajasthan.
18. Shannon, C. E., & Weaver, W. (1949). *The Mathematical Theory of Communication*. University of Illinois Press.
19. Simpson, E. H. (1949). Measurement of diversity. *Nature*, 163, 688.
20. Singh, G. (2009). Ecology and vegetation dynamics in the Indian Desert. *Journal of Arid Environments*, 73(9), 763–771.
21. Singh, J. S., Singh, S. P., & Gupta, S. R. (2014). *Ecology, Environmental Science and Conservation*. S. Chand Publishing.
22. United Nations Convention to Combat Desertification. (2022). *Global Land Outlook 2*. UNCCD.
23. United Nations Environment Programme. (2021). *Making Peace with Nature*. UNEP.
24. World Meteorological Organization. (2023). *State of the Global Climate 2023*. WMO.
25. Indian Space Research Organisation. (2022). *National Land Use and Land Cover Atlas*. ISRO.