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Ecoclimatic and floral Assessment in the Beed area of Churu District, Rajasthan

Mukesh Kumar Meena[1], Naveen Kumar[2]

[1]Department of Botany, Govt. Lohia College, Churu
[2]R.N. Ruia Govt. College, Ramgarh Shekhawati, Sikar

Abstract
This study examines the ecoclimatic factors and floral diversity in the Dabla Beed and Ratan Nagar Beed areas of Churu District, Rajasthan. Climatic data for 2019 and 2020, obtained from the Meteorological Department, Jaipur, were analyzed alongside field surveys conducted across different seasons. Results showed extreme temperature variations, with summer highs exceeding 50°C and winter lows dropping below -1.5°C. Relative humidity varied seasonally, with the lowest levels in pre-monsoon months and peaks during the monsoon. Rainfall predominantly occurred between June and September, influencing the growth of xerophytes, thorn forests, drought-resistant shrubs and seasonal grasses. The study underscores the importance of climate-adaptive strategies for biodiversity conservation in this arid region.

Keywords: Ecoclimatic factors, floral diversity, Churu District, Arid vegetation, Climate adaptation

Introduction:

Nature, in its infinite generosity, has always provided for the fundamental needs of all living beings, while inherently resisting the fulfillment of excessive human greed. Over countless millennia, this natural equilibrium has nurtured an intricate web of life, meeting essential requirements for human survival. The preservation of biodiversity, therefore, becomes a crucial responsibility to avoid the irreversible loss of this natural heritage. At the heart of Earth's vitality lies the diversity and coexistence of life—a complex, interwoven system essential for the survival and evolution of all organisms (Tilman, 2000). This diversity serves as a foundational pillar that supports ecological stability, growth and resilience. Yet, this priceless natural wealth is increasingly threatened by the relentless growth of human populations and the ensuing environmental degradation.

Biodiversity, as a concept, encapsulates the vast spectrum of natural variations present within ecological systems. It encompasses the diverse forms of flora, fauna, microorganisms, their genetic makeup and the dynamic ecosystems they collectively build. The present biodiversity represents the outcome of billions of years of evolutionary processes, shaped by natural forces and increasingly altered by anthropogenic activities. This intricate biological network underscores humanity's dependence on nature's delicate balance. While approximately 1.2 million species have been scientifically documented—primarily consisting of smaller organisms such as insects—estimates from the United Nations Environment Programme (UNEP) suggest a much broader range, estimating the existence of 9 to 52 million species globally. Nevertheless, many scientific studies converge on a more conservative estimate of around 13 million species(Mora et al., 2011).

This study delves into the significant influence of ecoclimatic variables on the floral diversity of Churu District, a region nestled within the vast expanse of the Thar Desert in Rajasthan. Unlike the more forgiving climates of temperate and tropical regions that foster rich biodiversity, the Churu District presents a landscape shaped by arid conditions. Here, extreme temperatures, scant rainfall and rapid evaporation impose formidable challenges to plant survival, distinguishing this region from other global biomes.

The impact of climate on plant distribution and diversity is a well-established phenomenon, observable across ecosystems from the lush Amazon rainforest to the frigid Arctic tundra. Each biome showcases a distinct set of climatic conditions that have driven the evolution of specialized plant adaptations. In the Churu District, the unforgiving desert environment—with its limited annual precipitation and significant diurnal temperature variations—acts as a natural filter, allowing only the most resilient species to thrive.

The primary objective of this study is to investigate the intricate relationship between ecoclimatic variables and floral diversity within the Churu District. Specifically, we aim to analyze how factors such as temperature fluctuations, precipitation patterns and humidity levels shape the survival strategies employed by native plant species. Through this analysis, we seek to uncover the adaptive mechanisms that enable flora to persist in such harsh environmental conditions.

Furthermore, this research endeavors to position Churu's ecoclimatic context within a broader global perspective, offering insights into how climate variations influence biodiversity across diverse habitats worldwide. By understanding the ecological strategies adopted by desert flora, we hope to contribute valuable knowledge to biodiversity conservation efforts, emphasizing the importance of tailoring strategies to specific climatic conditions. This study underscores the necessity of integrating ecoclimatic insights into conservation frameworks to ensure the sustainable preservation of Earth's rich biological diversity (Khan & Singh, 2010; Kundu et al., 2014; Sweta&Dharmveer, 2018).

Materials and Methods:

Climatic Data Collection

The climatic data utilized in this study, including temperature, relative humidity and rainfall patterns, were obtained from the Meteorological Department, Jaipur, Rajasthan. The data covered the years 2019 and 2020, providing comprehensive insights into the ecoclimatic conditions influencing the floral diversity of the Dabla Beed and Ratan Nagar Beed areas in Churu District. The recorded parameters included monthly minimum and maximum temperatures, relative humidity levels and rainfall measurements. These meteorological records served as a fundamental basis for understanding seasonal and interannual climatic variations in the study area.

Floral Survey and Field Studies

Regular field surveys were conducted throughout the study period to document the floral diversity in the selected study sites. The surveys were carried out in different seasons to capture the dynamic changes in vegetation composition across varying climatic conditions. Systematic observations were made to identify plant species, assess their abundance andanalyze their ecological adaptations to the local climate. The surveys involved:

1. **Site Selection:**
Two prominent areas, Dabla Beed and Ratan Nagar Beed, were selected as representative study sites based on their ecological significance and distinct floral composition within the Churu District.

2. **Survey Methodology:**
Quadrant sampling and line transect methods were employed to record the floral diversity. Surveys were conducted across multiple seasons—summer, monsoon and winter—to observe temporal variations in species distribution and abundance.

3. **Identification and Documentation:**
Plant species were identified using standard floras and taxonomic keys. Photographic documentation and herbarium specimen collection were conducted to support the identification process. Plant species were categorized into groups based on their ecological strategies, including xerophytes, seasonal grasses, thorn forests and drought-resistant shrubs.The integration of meteorological data with field survey findings provided a holistic understanding of the region's floral diversity and the climatic factors driving these ecological patterns. The results from this study serve as a foundation for formulating effective conservation strategies tailored to the arid environment of Churu District.

Results and Discussions:

1. Temperature

The examination of ecoclimatic parameters is instrumental in deciphering the environmental conditions influencing vegetation diversity and the overall biodiversity within specific locales. This study focuses on the assessment of temperature fluctuations in the Dabla Beed Area and Ratan Nagar Beed Area of Churu District, Rajasthan, India, throughout the years 2019 and 2020. The documented temperature shifts offer a comprehensive overview of the seasonal and yearly temperature trends which are pivotal in defining the local climate, thereby affecting myriad ecological processes.

Upon analyzing the maximum temperature trends within the study period, a clear seasonal pattern emerges. In 2019, Churu encountered its peak maximum temperature in June (50.8°C), with May and April also experiencing exceedingly high temperatures, peaking at 48.5°C and 44.5°C, respectively. These summer months (April to June) consistently faced extreme temperatures surpassing the 40°C mark, indicating a substantial heat stress that could markedly influence the local flora and fauna. The year 2020 followed a similar trajectory, with May reaching the zenith at 50°C, while April and June saw maximum temperatures of 43.1°C and 46.3°C, respectively. This consistency in high temperatures during the summer underscores the critical heat stress conditions prevalent in the Dabla Beed and Ratan Nagar Beed areas.

The range of temperatures throughout the study years highlighted noteworthy variations. In 2019, the lowest minimum temperature was recorded in January (-1.1°C), signifying the cold winter conditions typical of this desert region. February and December also noted minimum temperatures nearing the freezing point. Conversely, 2020 saw its coldest minimum temperature in December (-1.5°C), with January and February again showcasing cold temperatures, emphasizing the occurrence of chilly winters in both the Dabla Beed and Ratan Nagar Beed areas.

Such temperature dynamics depict the quintessential climatic pattern of these areas, characterized by intensely hot summers and significantly cold winters. The elevated maximum temperatures during summer could potentially lead to heightened water stress, affecting plant growth and productivity adversely. On the flip side, the notably low minimum temperatures in winter could impact the survival and dormancy phases of native plant species accustomed to the regional climatic norms. Grasping these seasonal and annual temperature trends is crucial for evaluating the ecological compatibility of the Dabla Beed and Ratan Nagar Beed areas for diverse plant species and for gauging their potential adaptability to climatic shifts. It furnishes essential insights for the conservation of biodiversity and the formulation of strategies aimed at mitigating the ramifications of extreme temperatures on the local ecosystems.

Table 1 Temperature (^{O}C) of Churu district in years 2019 and 2020

S. No.	Months	2019		2020	
		Minimum	**Maximum**	**Minimum**	**Maximum**
1	January	-1.10	31.60	1.80	27.40
2	February	4.40	30.10	4.50	34.10
3	March	7.70	42.00	11.10	35.40
4	April	15.90	44.50	16.50	43.10
5	May	21.60	48.50	20.00	50.00
6	June	23.00	50.80	19.50	46.30
7	July	23.70	45.50	21.80	44.90
8	August	24.80	39.80	22.50	41.10
9	Sept	24.10	43.30	21.80	41.40
10	October	15.40	39.00	12.20	40.90
11	November	10.30	37.50	4.10	35.20
12	December	-0.06	26.20	-1.50	33.60

Churu's temperature extremes, vegetation in the area has adapted to endure the harsh climatic conditions. The potential vegetation types include:

- ⇒ **Xerophytic Vegetation:** Plants that have adapted to survive in an environment with little liquid water. They have specialized features like thick, waxy leaves to minimize water loss, deep root systems to access groundwater and small leaf surfaces to reduce transpiration. Examples include *Opuntiaficus-indica*, *Euphorbia caducifolia*, *Aloe vera* and*Calotropisprocera.*
- ⇒ **Thorn Forests:** Comprising mainly small trees and bushes armed with thorns to deter herbivores and minimize water loss. *Acacia* and *Prosopis* (Mesquite) are common genera found in these

habitats, offering resilience to both high and low temperature extremes. For example, *Acacia nilotica, Prosopisjuliflora, Ziziphusnummularia*and*Capparis decidua*

⇒ **Seasonal Grasses:** Grass species that thrive during the brief monsoon season, completing their life cycle quickly before the return of arid conditions. These grasses can survive in dormant states during the dry and cold months. For example, *Cenchrusciliaris, Dactylocteniumaegyptium, Cenchrussetigerus*and*Chlorisbarbata*

⇒ **Drought-Resistant Shrubs:** Shrubs like *Calotropisprocera* and *Euphorbia* that can withstand dry conditions and are well-suited to the fluctuating temperatures of Churu, offering forage and shelter to local fauna.

In summary, the temperature analysis for the Dabla Beed Area and Ratan Nagar Beed Area from 2019 and 2020 underscores the occurrence of high maximum temperatures during the summer months, with readings soaring above 40°C and cold winters marked by sub-zero minimum temperatures. These observations are fundamental to our comprehension of the local climate's influence on vegetation types and biodiversity, underscoring the necessity for adaptive management and conservation tactics to bolster the resilience and sustainability of ecosystems within these regions of Churu District.

2 Relative humidity (%)

The relative humidity in Churu throughout 2019 and 2020 exhibited significant monthly variations, with both years showing a trend of minimum humidity reaching its lowest during the pre-monsoon period (April and May) and maximum humidity peaking during the monsoon months (July to September). In both years, January started with a wide range of humidity (21% to 100% in 2019 and 26% to 100% in 2020), indicating possible dew formation or fog in the mornings and extremely dry conditions during the day.

The months of February to April showed a gradual decrease in minimum relative humidity, reaching the lowest in May for both years, with 6% in 2019 and 9% in 2020. This significant drop in moisture levels corresponds to increased water stress for plants, potentially impacting germination rates, growth and productivity of both natural vegetation and agricultural crops in Churu.

During the summer months, particularly in June, there was a noticeable increase in humidity levels, which can be attributed to the onset of the monsoon season. The maximum humidity levels in June 2020 reached up to 94%, a substantial increase from the 88% in 2019, indicating more moisture in the air which could temporarily relieve the plants from the intense heat and dry conditions experienced in the previous months.

The monsoon period (July and August) consistently showed high maximum relative humidity levels of 100% in both years, reflecting the significant impact of monsoonal rains on the region's climate. This increase in atmospheric moisture is essential for the survival and proliferation of plant species in Churu, promoting lush growth and helping in the replenishment of groundwater levels.

Post-monsoon months (September to November) demonstrated a gradual decrease in humidity levels, with October 2020 showing a notably lower maximum relative humidity (65%) compared to

2019 (85%). This decrease in moisture levels indicates the onset of drier conditions, preparing the vegetation for the approaching winter.

Table 2 Relative humidity (%)Churu district in years 2019 and 2020

S. No.	Months	2019		2020	
		Minimum	Maximum	Minimum	Maximum
1	January	21	100	26	100
2	February	15	100	11	97
3	March	14	100	19	100
4	April	10	97	18	86
5	May	6	79	9	86
6	June	8	88	16	94
7	July	29	100	29	100
8	August	38	98	46	100
9	September	33	88	25	97
10	October	26	85	16	65
11	November	30	100	15	96

The variations in relative humidity in Churu have profound implications for local vegetation types. During the low humidity months, xerophytic plants, such as cacti and succulents, which are adapted to conserve water, thrive. These plants have features like thick cuticles, reduced leaf surfaces and specialized photosynthetic processes to minimize water loss.The higher humidity levels during the monsoon support a wider variety of plant species, including annual herbs and grasses that complete their life cycles quickly, taking advantage of the brief period of increased water availability. This seasonal burst of greenery provides essential forage for local fauna and replenishes the seed bank for the next growing season.

Understanding the relative humidity patterns and their impact on local ecosystems is crucial for developing effective conservation strategies and sustainable agricultural practices in Churu. It highlights the need for water conservation measures during the dry months and the importance of preserving natural vegetation that supports the ecological balance in this arid region.

3 Rainfall

The annual rainfall data for the Churu area during the years 2019 and 2020 provides a clear picture of the precipitation patterns in this arid region of Rajasthan, India. Such information is crucial for understanding the environmental conditions that influence the local ecosystem, including vegetation types, biodiversity and agricultural practices.

In 2019, the rainfall in Churu showed considerable variability across the months, with the majority of the precipitation occurring during the monsoon season (June to September). The highest maximum rainfall recorded was in August at 21.4 mm, closely followed by November at 22.7 mm and June at 18.9 mm. These figures indicate that while the monsoon season brings the most significant amount of rainfall, occasional post-monsoon showers contribute to the annual precipitation as well. Notably, the beginning of the year and the post-monsoon months witnessed minimal rainfall, with October showing no rainfall at all. The sparse distribution of rainfall outside the monsoon months highlights the challenging dry conditions prevalent in Churu for the majority of the year.

The year 2020 witnessed a somewhat different rainfall pattern, with June and July experiencing significantly higher maximum rainfall amounts of 63.6 mm and 56.7 mm, respectively. This increase during the early monsoon months suggests a more concentrated period of rainfall in 2020 compared to 2019, which could have implications for groundwater recharge and the timing of agricultural activities. March and April of 2020 also saw slightly higher rainfall than in the previous year, indicating variability in pre-monsoon showers. However, similar to 2019, the latter part of the year, particularly from September to December, experienced minimal to no rainfall, reinforcing the arid nature of the region.

Table 3Rainfall (mm)Churu district in years 2019 and 2020

S. No.	Months	2019		2020	
		Minimum (mm)	Maximum (mm)	Minimum (mm)	Maximum (mm)
1	January	0.60	0.60	0.40	5.60
2	February	0.10	1.30	0.00	0.00
3	March	0.20	1.60	0.40	14.20
4	April	0.40	9.40	0.60	8.00
5	May	3.60	14.80	0.40	10.20
6	June	0.80	18.90	1.00	63.60
7	July	0.20	18.90	0.30	56.70
8	August	0.40	21.40	0.20	33.00
9	September	0.20	2.50	0.20	14.60
10	October	0.00	0.00	2.20	2.20
11	November	0.20	22.70	0.00	0.00
12	December	0.20	5.00	0.00	0.00

The rainfall patterns in Churu across 2019 and 2020 have significant implications for the region's vegetation and agricultural practices. The bulk of rainfall during the monsoon months supports the growth of monsoon-dependent crops and replenishes soil moisture, which is critical for sustaining the natural vegetation and agricultural lands. However, the extended dry periods necessitate efficient water management strategies to support both natural ecosystems and agriculture.

Given the arid climate of Churu, vegetation in the area is adapted to survive with minimal water. The predominant plant types include xerophytic species, drought-resistant shrubs and seasonal grasses that can quickly capitalize on the brief rainy season to complete their life cycles. These adaptations are crucial for maintaining biodiversity in such a challenging environment.

Analyzing the annual rainfall for Churu during 2019 and 2020 underscores the variability and unpredictability of precipitation in arid regions. The data highlights the essential role of the monsoon season in sustaining the local ecosystems and the agricultural economy. Understanding these patterns is vital for developing adaptive strategies to manage water resources efficiently, ensuring the sustainability of both natural and human-modified landscapes in the Churu area. This analysis not only provides insights into the immediate ecological and agricultural implications but also contributes to long-term planning for climate resilience and biodiversity conservation in the face of changing global climate patterns. The diverse range of plant species identified in the Churu area, spanning across various families from Acanthaceae to Zygophyllaceae and even encompassing Gymnosperms like *Ephedra foliata* from the Gnetaceae family, illustrates the remarkable adaptability and resilience of flora in arid and semi-arid ecosystems. The correlation between the prevailing weather conditions in Churu, characterized by extreme temperature fluctuations, scarce rainfall and varied relative humidity levels and the vegetation types highlights the ecological strategies employed by these plants to thrive under such challenging conditions.

The temperature in Churu varies dramatically, with summer months reaching highs above 40°C and winter months dropping to sub-zero temperatures. This extreme variability necessitates specific adaptive strategies among local plant species. For instance, the annual herb *Blepharissindica* and *Peristrophebicalyculata* have life cycles that allow them to complete their growth and reproduction within the brief, milder periods before the harsh summer or winter extremes set in. Perennial species like *Calotropisprocera* and *Neriumindicum* exhibit structural adaptations such as thick cuticles, reduced leaf area and deep root systems, minimizing water loss and accessing deep soil moisture to withstand high summer temperatures.

Relative humidity in Churu shows significant seasonal variation, dropping to very low levels in the pre-monsoon months, which emphasizes the importance of drought-resistant features among local flora. Species such as *Trianthemaportulacastrum*and *Zaleyaredimita* demonstrate succulence and water storage capabilities that enable them to survive periods of low atmospheric moisture. Their physiological and morphological adaptations, such as crassulacean acid metabolism (CAM) photosynthesis, allow them to minimize water loss while maximizing carbon dioxide uptake during the cooler nighttime.

Annual rainfall in Churu is minimal and highly variable, with a significant proportion occurring during the monsoon months. This erratic precipitation pattern shapes the distribution and abundance of various plant species. The annual herbs and grasses, including species from the Amaranthaceae family like *Amaranthushybridis*and *Celosia argentia*, exploit the brief wet season for rapid growth and reproduction, employing strategies like seed dormancy to survive the dry periods. Trees such as *Tecomellaundulata* and *Capparis decidua* are deep-rooted, tapping into the subterranean water reserves to sustain themselves throughout the year, regardless of surface water availability.

The monsoon season, occurring from July to mid-September, brings a brief respite from the intense heat, accounting for approximately 73 percent of Churu's annual rainfall. The mean annual rainfall, based on data collected from 1956 to 2016, stands at 413.61 mm, highlighting the scarcity of precipitation in the area. However, rainfall variability is significant, with data from different decades showing considerable fluctuations: from 1986 to 1995, the average annual rainfall was 364.4 mm with a coefficient of variation (CV) of 31.21 percent; from 1996 to 2005, it increased slightly to 408.5 mm with a CV of 39.68 percent; and from 2006 to 2016, the average further rose to 463.0 mm with a CV of 32.05 percent. Such variability underscores the unpredictable nature of rainfall in Churu, ranging from a meager 20.3 mm in 1918 to an unprecedented 1036.0 mm in 1978 (Nain et al., 2021), indicating the vast inter-annual variations in precipitation the region experiences.

The plant species diversity within the Churu area, underpinned by their specialized adaptations to the local climate, underscores the ecological value and fragility of this region. Conservation efforts must prioritize the maintenance of natural habitats and the ecological processes that support this biodiversity. Sustainable land use practices, water conservation measures and protection against overgrazing and deforestation are crucial to preserving the unique plant life adapted to Churu's challenging environment.

Conclusion:

In conclusion, the vegetation types in the Churu area are a testament to the intricate relationship between climate and biodiversity. The adaptive strategies of these plants not only enable their survival and proliferation under extreme weather conditions but also play a vital role in the stability and productivity of the ecosystem. Understanding these dynamics is essential for developing effective conservation strategies that ensure the resilience of these ecological communities in the face of ongoing climate change.

References:

1. Khan, J. B., & Singh, G. P. (2010). Ethno-medicinal active plants for treating cold and cough in the vicinity of Nahargarh Wildlife Sanctuary, Jaipur, India. *Our Nature*, *8*(1), 225–230.
2. Kundu, A., Dutta, D., Patel, N. R., Saha, S. K., & Siddiqui, A. R. (2014). Identifying the process of environmental changes of Churu district, Rajasthan (India) using remote sensing indices. *Asian Journal of Geoinformatics*, *14*(3), 14–22.
3. Mora, C., Tittensor, D. P., Adl, S., Simpson, A. G. B., & Worm, B. (2011). How many species are there on Earth and in the ocean? *PLoS Biology*, *9*(8), e1001127.
4. Nain, V. K., Nain, D., Nain, S. K., & Nehra, A. K. (2021). Study Of Rainwater Of District Churu: A Review. *Journal of Survey in Fisheries Sciences*, 130–140.
5. Sweta, &Dharmveer, S. (2018). Study of Phytodiversity in Sahwa and Taranagar Area of Churu District, Rajasthan. *Innovation the Research Concept*, *3*(2).
6. Tilman, D. (2000). Causes, consequences and ethics of biodiversity. *Nature*, *405*(6783), 208–211.