



ISSN Print: 2664-9926
 ISSN Online: 2664-9934
 NAAS Rating (2026): 4.82
 IJBS 2026; 8(8): 49-55
www.biologyjournal.net
 Received: 10-05-2026
 Accepted: 14-06-2026

Gaurav Jangid
 Zoology Department,
 University of Technology,
 Jaipur, Rajasthan, India

Deepika Yadav
 Zoology Department,
 University of Technology,
 Jaipur, Rajasthan, India

Manvi Malwal
 Botany Department, Post
 Graduate Government College
 for Girls, Sector 11,
 Chandigarh, India

Long-term Climate Variability and Potential Vulnerability of Mammalian Diversity in the Shekhawati Region of Rajasthan, India

Gaurav Jangid, Deepika Yadav and Manvi Malwal

DOI: <https://www.doi.org/10.33545/26649926.2026.v8.i8a.977>

Abstract

The Shekhawati region of northeastern Rajasthan contains a diverse mammalian assemblage surrounded within an arid to semi-arid landscape. This study integrates a historical climatic assessment for Churu, Sikar and Jhunjhunu with a previously documented mammalian inventory to establish a quantitative climate-fauna baseline for conservation planning. Annual records for 1981-2025 were analysed for mean temperature, rainfall, relative humidity and wind speed using five-year period means, five-year moving averages and linear regression. Mann-Kendall and Sen's slope statistics were additionally used to assess monotonic trends. The mammalian diversity comprised 40 species belonging to 8 orders, 20 families and 31 genera. Rodentia was the richest order (14 species), followed by Carnivora (9) and Chiroptera (8). Mean temperature showed weak, non-significant positive linear slopes in all three districts. In contrast, rainfall increased significantly in Churu (3.714 mm year⁻¹), Sikar (5.028 mm year⁻¹) and Jhunjhunu (4.533 mm year⁻¹). Relative humidity increased significantly in all districts, whereas wind speed declined significantly. Mann-Kendall results corroborated the rainfall, humidity and wind-speed trends. The 2021-2025 period recorded particularly high rainfall and humidity relative to earlier five-year periods.

Keywords: Climate variability, mammalian diversity, arid ecosystem, rainfall trend, relative humidity, wind speed, biodiversity conservation, Shekhawati, Rajasthan, climate vulnerability

Introduction

Climate variability is a major factor of ecological structure and function. It plays a key determining role in drylands where water availability constrains primary productivity and propagates through food webs. Climate change can affect organisms through physiological stress, shifts in resource availability, habitat suitability, phenology, distribution and ecological interactions (Bellard *et al.*, 2012; IPCC, 2022) ^[1, 8]. Broad-scale assessments have documented coherent climate-associated changes in species distributions and biological timing. It also emphasized that local responses are mediated by land use, habitat condition and other anthropogenic pressures (Parmesan and Yohe, 2003) ^[19].

Arid and semi-arid ecosystems are subtle to changes in rainfall amount, timing and atmospheric moisture. Rainfall influences soil moisture, vegetation productivity, surface-water availability and prey resources, potentially affecting herbivores and predators. Rajasthan has climatic variability significantly across space and through time. Earlier studies have reported significant spatial heterogeneity in temperature and precipitation trends across Rajasthan (Sharma *et al.*, 2021; Porwal & Choudhary, 2023) ^[26, 20].

Shekhawati area is comprised of Churu, Sikar and Jhunjhunu districts. It contains sandy and desertic landscapes, agricultural plains, scrub, grassland, settlements and localized foothill habitats. Previous studies have reported that irrigation, agriculture, mining, urbanization, transportation and habitat degradation as important pressures on animal biodiversity (Dev and Singh, 2016) ^[4]. The present study addresses this gap by linking the mammalian assemblage with long-term climatic variability. The objectives of the present study were to enumerate 1981-2025 trends in mean temperature, rainfall, relative humidity and wind speed. The five-year climatic variability and evaluation of monotonic trends is also carried out. It also undertaken to study the mammalian biodiversity and feeding composition.

Corresponding Author:
Manvi Malwal
 Botany Department, Post
 Graduate Government College
 for Girls, Sector 11,
 Chandigarh, India

Study area

The Shekhawati region is in northeastern Rajasthan and forms part of the broader arid and semi-arid landscape associated with the Thar Desert. The supplied faunal study describes the region as extending approximately from 27°24' to 29°02' N and 73°04' to 76°05' E, covering about 27,529.44 km². The region has strong seasonal contrasts, with hot summers and relatively cool winters, and includes extensive sandy areas and dunes in the north-western sector. Agricultural expansion, irrigation, mining, roads and urbanization have modified habitats across the region.

Materials and methods

In the present study, the annual climatic observations for Churu, Sikar and Jhunjhunu (1981-2025) were carried out. Four climatic variables were analyzed such as annual mean temperature (°C), annual rainfall (mm), relative humidity (%) and mean wind speed (m s⁻¹). Long-term meteorological data for the Shekhawati region were obtained from the India Meteorological Department (IMD), Pune. Annual observations were summarized into nine five-year periods (1981-1985 through 2021-2025), and centred five-year moving averages were calculated. Linear regression was fitted with year as the predictor. Slope, R² and p-value were reported. Mann-Kendall (MK) statistics were calculated using the sign of all pairwise temporal differences, with tie correction in the variance. Sen's slope was estimated as the median of all pairwise slopes. A two-sided p<0.05 criterion was used for statistical significance. Mammalian diversity analysis was carried out through surveys to document the presence and abundance of key species, using techniques such as transect walks, quadrat sampling, and camera trapping.

Results

Mean temperature varied substantially among years, but linear trends were not significant. Slopes were +0.00418 °C year⁻¹ for Churu (R²=0.008, p=0.554), +0.00245 °C year⁻¹ for Sikar (R²=0.002, p=0.751), and +0.00242 °C year⁻¹ for Jhunjhunu (R²=0.002, p=0.746). Mann-Kendall tests were also non-significant. Thus, the available annual mean-temperature series does not support a statistically significant monotonic warming trend over 1981-2025. Rainfall increased significantly in all three districts. Linear slopes were 3.714 mm year⁻¹ in Churu (R²=0.130, p=0.015), 5.028 mm year⁻¹ in Sikar (R²=0.172, p=0.005), and 4.533 mm year⁻¹ in Jhunjhunu (R²=0.160, p=0.007). Mann-Kendall tests were significant in Churu (Z=2.553, p=0.011), Sikar (Z=2.729, p=0.006) and Jhunjhunu (Z=2.651, p=0.008). Sen's slopes were 4.148, 5.244- and 5.000-mm year⁻¹, respectively. Relative humidity increased significantly in all districts. Linear slopes were +0.269, +0.249 and +0.235 percentage points year⁻¹ for Churu, Sikar and Jhunjhunu, respectively (all p<0.001). Mann-Kendall Z values were 5.412, 4.227 and 4.075, respectively, with p<0.001 in all cases. Sen's slopes were +0.273, +0.275 and +0.265 percentage points year⁻¹. Wind speed showed significant declines in all districts. Linear slopes were -0.00452 m s⁻¹ year⁻¹ in Churu, -0.00445 m s⁻¹ year⁻¹ in Sikar and -0.00549 m s⁻¹ year⁻¹ in Jhunjhunu (all p<0.001). Mann-Kendall Z values were -3.527, -3.798 and -4.107, respectively. Sen's slopes were approximately -0.00400, -0.00400 and -0.00526 m s⁻¹ year⁻¹. The 2021-2025

period had the highest rainfall among the nine five-year periods in each district: 615.6 mm in Churu, 750.8 mm in Sikar and 715.6 mm in Jhunjhunu. The same period also had the highest five-year relative humidity averages: 43.4%, 47.0% and 46.6%, respectively. In the present investigation, mammalian diversity contained 40 species, 8 orders, 20 families and 31 genera. Rodentia was the richest order with 14 species, followed by Carnivora with 9 species, and Chiroptera with 8 species. Artiodactyla contributed 3 species. Insectivora and Primates each contributed 2 species. Pholidota and Lagomorpha each contributed one species.

Discussion

The principal climatic signal in the Shekhawati dataset is a shift in hydroclimatic conditions rather than a statistically significant increase in annual mean temperature. Rainfall and relative humidity increased significantly across all three districts. The wind speed declined across all three districts. Earlier studies on Rajasthan climatic reported substantial heterogeneity among climatic variables and locations (Sharma *et al.*, 2021; Porwal and Choudhary, 2023) [26, 20].

The rainfall increase may alter water availability and dryland primary productivity. The improved rainfall can increase forage and seed resources and thereby influence herbivorous and granivorous mammals. However, the ecological outcome depends on rainfall timing, runoff, soil retention, agricultural land use and habitat connectivity. Increased rainfall therefore cannot be equated automatically with improved mammalian habitat quality.

The strong increase in relative humidity may influence evaporative demand and local microclimatic conditions. Such changes could be relevant to bats and small mammals, particularly through insect abundance, roost conditions and water availability. Nevertheless, the present study did not measure bat activity, insect abundance or microclimate and therefore does not demonstrate these mechanisms.

The decline in mean wind speed is another important environmental signal. Wind affects evapotranspiration, aeolian transport and surface conditions in sandy environments. A decline in annual mean wind speed may therefore alter some local habitat processes.

The mammalian diversity was dominated by rodents, carnivores and bats. These groups potentially respond to climatic variability through different pathways. Herbivores may respond primarily through vegetation and water resources. The rodents may respond through seed availability, soil conditions and vegetation cover. The carnivores may respond indirectly through prey and water; and insectivorous bats may respond through insect resources and roost microclimate. These pathways are consistent with the broader understanding that climate can affect biodiversity through resource and habitat mechanisms (Bellard *et al.*, 2012) [1]. The presence of species with different ecological strategies suggests that climate variability is unlikely to produce a uniform response across the assemblage. Generalist species associated with human-modified habitats may be relatively buffered. The desert-adapted or habitat-specialist species may be more dependent on combinations of vegetation, soil and water conditions. There should be an integrated climate-wildlife monitoring and conservation programme across Churu, Sikar and Jhunjhunu.

Table 1: Taxonomic composition of the mammalian inventory

Order	Families	Genera	Species	Species (%)
Rodentia	3	10	14	35.0
Carnivora	5	6	9	22.5
Chiroptera	6	6	8	20.0
Artiodactyla	1	3	3	7.5
Insectivora	2	2	2	5.0
Primates	1	2	2	5.0
Pholidota	1	1	1	2.5
Lagomorpha	1	1	1	2.5

Table 2: Five-year climatic averages for Churu, Sikar and Jhunjhunu during 1981-2025

District	Period	Mean T (°C)	Rainfall (mm)	RH (%)	Wind (m s ⁻¹)
Churu	1981-1985	26.28	468.2	32.0	2.22
	1986-1990	26.92	326.0	31.6	2.3
	1991-1995	26.6	402.0	33.2	2.22
	1996-2000	26.84	378.4	33.2	2.3
	2001-2005	27.26	380.0	33.2	2.22
	2006-2010	27.2	424.2	37.0	2.16
	2011-2015	26.2	468.6	38.8	2.16
	2016-2020	26.86	445.4	38.2	2.02
	2021-2025	26.78	615.6	43.4	2.14
Sikar	1981-1985	25.62	505.8	37.4	2.32
	1986-1990	26.24	366.0	33.2	2.36
	1991-1995	25.9	488.8	35.8	2.3
	1996-2000	26.08	418.6	35.4	2.36
	2001-2005	26.48	386.8	34.6	2.3
	2006-2010	26.58	450.6	38.6	2.24
	2011-2015	25.36	543.6	41.6	2.22
	2016-2020	26.26	500.6	40.4	2.16
	2021-2025	25.96	750.8	47.0	2.2
Jhunjhunu	1981-1985	25.76	517.4	37.6	2.2
	1986-1990	26.32	371.6	33.4	2.24
	1991-1995	25.96	479.6	35.4	2.16
	1996-2000	26.3	427.8	35.4	2.24
	2001-2005	26.64	420.4	35.0	2.12
	2006-2010	26.7	474.6	38.8	2.14
	2011-2015	25.62	539.0	41.2	2.08
	2016-2020	26.32	511.2	40.0	1.98
	2021-2025	26.04	715.6	46.6	2.04

Table 3: Linear, Mann-Kendall and Sen's slope trend statistics during 1981-2025

District	Variable	Linear slope/year	R ²	Linear p	MK Z	MK p	Sen slope/year	Sen/decade
Churu	Mean temperature	+0.00418	0.008	0.5542	0.334	0.739	0.000	0.000
Sikar	Mean temperature	+0.00245	0.002	0.7514	0.176	0.860	0.000	0.000
Jhunjhunu	Mean temperature	+0.00242	0.002	0.7459	0.098	0.922	0.000	0.000
Churu	Annual rainfall	+3.714	0.130	0.0151	+2.553	0.0107	+4.148	+41.48
Sikar	Annual rainfall	+5.028	0.172	0.00458	+2.729	0.00635	+5.244	+52.44
Jhunjhunu	Annual rainfall	+4.533	0.160	0.00656	+2.651	0.00803	+5.000	+50.00
Churu	Relative humidity	+0.269	0.547	<0.001	+5.412	<0.001	+0.273	+2.73
Sikar	Relative humidity	+0.249	0.372	<0.001	+4.227	<0.001	+0.275	+2.75
Jhunjhunu	Relative humidity	+0.235	0.347	<0.001	+4.075	<0.001	+0.265	+2.65
Churu	Wind speed	-0.00452	0.255	<0.001	-3.527	<0.001	-0.004	-0.040
Sikar	Wind speed	-0.00445	0.285	<0.001	-3.798	<0.001	-0.004	-0.040
Jhunjhunu	Wind speed	-0.00549	0.327	<0.001	-4.107	<0.001	-0.00526	-0.053

Table 4: Mammalian diversity and potential climate-response pathways

No.	Order	Family	Common name	Full scientific name	Abundance	Foraging	Potential pathway
1	Insectivora	Erinaceidae	Indian hedgehog	<i>Paraechinus micropus</i>	C	O	Potentially sensitive to aridity/vegetation-resource changes
2		Soricidae	Asian house shrew	<i>Suncus murinus</i>	VC	O	Potentially responsive to moisture and prey availability
3	Chiroptera	Pteropodidae	Indian flying fox	<i>Pteropus medius</i>	C	F	Potentially linked to fruiting vegetation and water
4		Megadermatidae	Greater false vampire bat	<i>Megaderma lyra</i>	VR	C	Potentially linked to insect/prey availability and roost microclimate
5		Rhinolophidae	Blyth's horseshoe bat	<i>Rhinolophus lepidus</i>	R	I	Potentially linked to humidity, insects and roost microclimate
6			Greater mouse-tailed bat	<i>Rhinopoma microphyllum</i>	C	I	Potentially linked to insects and roost microclimate
7			Lesser mouse-tailed bat	<i>Rhinopoma hardwickii</i>	C	I	Potentially linked to insects and roost microclimate
8		Emballonuridae	Egyptian tomb bat	<i>Taphozous perforatus</i>	R	I	Potentially linked to insects and roost microclimate
9		Vespertilionidae	Common pipistrelle	<i>Pipistrellus pipistrellus</i>	C	I	Potentially linked to insect availability and microclimate
10			Asiatic yellow house bat	<i>Scotophilus heathi</i>	C	I	Potentially linked to insect availability and microclimate
11	Primates	Cercopithecidae	Northern plains gray langur	<i>Semnopithecus entellus</i>	R	H	Potentially linked to vegetation and water availability
12			Rhesus macaque	<i>Macaca mulatta</i>	R	H	Generalist; habitat and water resources likely important
13	Carnivora	Canidae	Golden jackal	<i>Canis aureus</i>	R	C	Potentially buffered by dietary generalism; prey/water changes may matter
14		Canidae	Red/desert fox	<i>Vulpes vulpes</i>	C	C	Potentially sensitive to prey and thermal/habitat conditions
15		Viverridae	Small Indian civet	<i>Viverricula indica</i>	VR	O	Potentially linked to cover, prey and water availability
16		Herpestidae	Small Indian mongoose	<i>Herpestes javanicus</i>	R	C	Potentially linked to prey availability and habitat structure
17			Indian gray mongoose	<i>Herpestes edwardsii</i>	C	C	Potentially linked to prey availability and habitat structure
18			Ruddy mongoose	<i>Herpestes smithii</i>	R	C	Potentially linked to prey availability and habitat structure
19		Felidae	Desert cat	<i>Felis lybica</i>	R	C	Potentially sensitive to prey, habitat and water conditions
20			Jungle cat	<i>Felis chaus</i>	VR	C	Potentially linked to wetlands/vegetation and prey
21		Ursidae	Sloth bear	<i>Melursus ursinus</i>	-	O	Potentially sensitive to habitat and seasonal food availability
22	Artiodactyla	Bovidae	Nilgai	<i>Boselaphus tragocamelus</i>	VC	H	Potentially linked to rainfall-mediated forage and water
23			Blackbuck	<i>Antelope cervicapra</i>	C	H	Potentially linked to grassland productivity and water
24			Indian gazelle/chinkara	<i>Gazella bennettii</i>	C	H	Potentially sensitive to dryland forage and water availability
25	Pholidota	Manidae	Indian pangolin	<i>Manis crassicaudata</i>	VR	I	Potentially sensitive to soil conditions, prey and habitat disturbance
26	Lagomorpha	Leporidae	Indian hare	<i>Lepus nigricollis</i>	R	H	Potentially linked to vegetation productivity and cover
27	Rodentia	Sciuridae	Northern palm squirrel	<i>Funambulus pennantii</i>	VC	H,G	Potentially linked to vegetation and human-modified habitats
28		Muridae	Black rat	<i>Rattus rattus</i>	VC	O	Generalist; likely relatively resilient to climatic variability
29			Kutch rat	<i>Cremnomys cutchicus</i>	C	O	Potentially linked to vegetation/soil conditions
30			House mouse	<i>Mus musculus</i>	VC	O	Generalist; potentially buffered by human-associated habitats
31			Phillips' mouse	<i>Mus phillipsi</i>	R	O	Potentially linked to dryland vegetation and soil conditions
32			Flat-haired mouse	<i>Mus platythrix</i>	R	O	Potentially linked to vegetation and soil conditions
33			Rock/Sadhu mouse	<i>Mus saxicola</i>	R	O	Potentially linked to rocky habitat and resource availability

34		Bush rat	<i>Golunda ellioti</i>	C	O	Potentially linked to vegetation cover and soil moisture
35		Soft-furred field rat	<i>Millardia meltada</i>	R	O	Potentially linked to crop/grass resources and moisture
36		Indian desert gerbil	<i>Meriones hurrianae</i>	VC	O	Desert-adapted; potential sensitivity to extreme resource variability
37		Indian gerbil	<i>Tatera indica</i>	VC	O	Potentially linked to rainfall-mediated food and soil conditions
38		Hairy-footed gerbil	<i>Gerbillus gleadowi</i>	R	O	Desert-adapted; potential sensitivity to resource and habitat changes
39		Baluchistan gerbil	<i>Gerbillus nanus</i>	R	O	Desert-adapted; potential sensitivity to resource and habitat changes
40	Hystriidae	Indian crested porcupine	<i>Hystrix indica</i>	R	O	Potentially linked to vegetation, soil and water availability

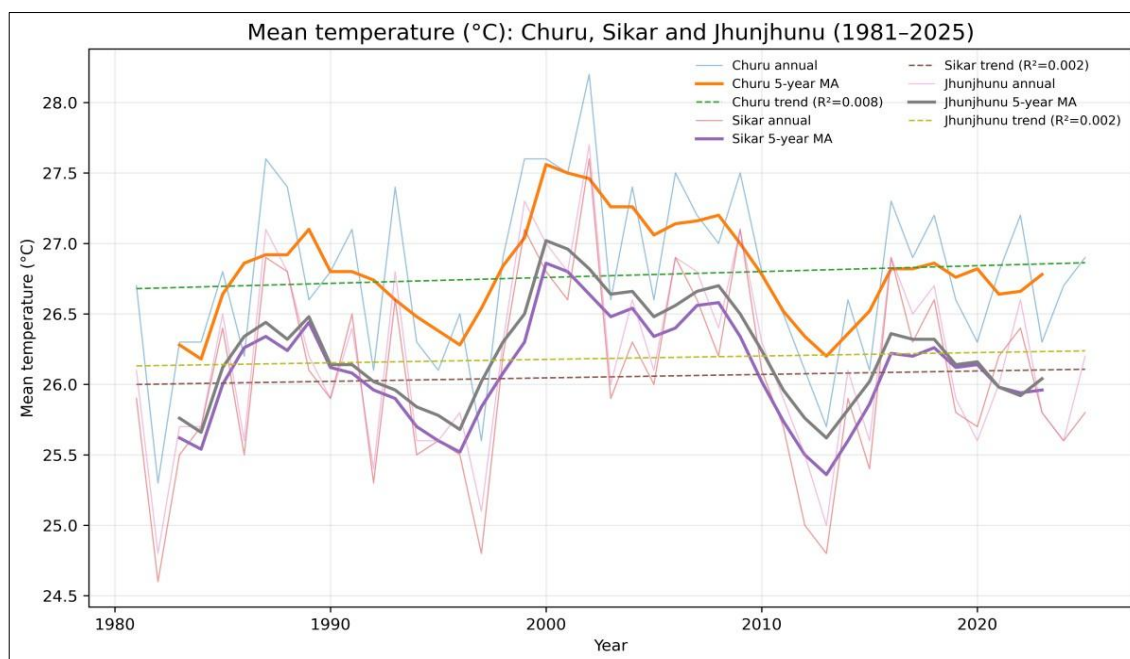


Fig 1: Annual mean temperature, five-year moving average and linear trend for Churu, Sikar and Jhunjhunu, 1981-2025

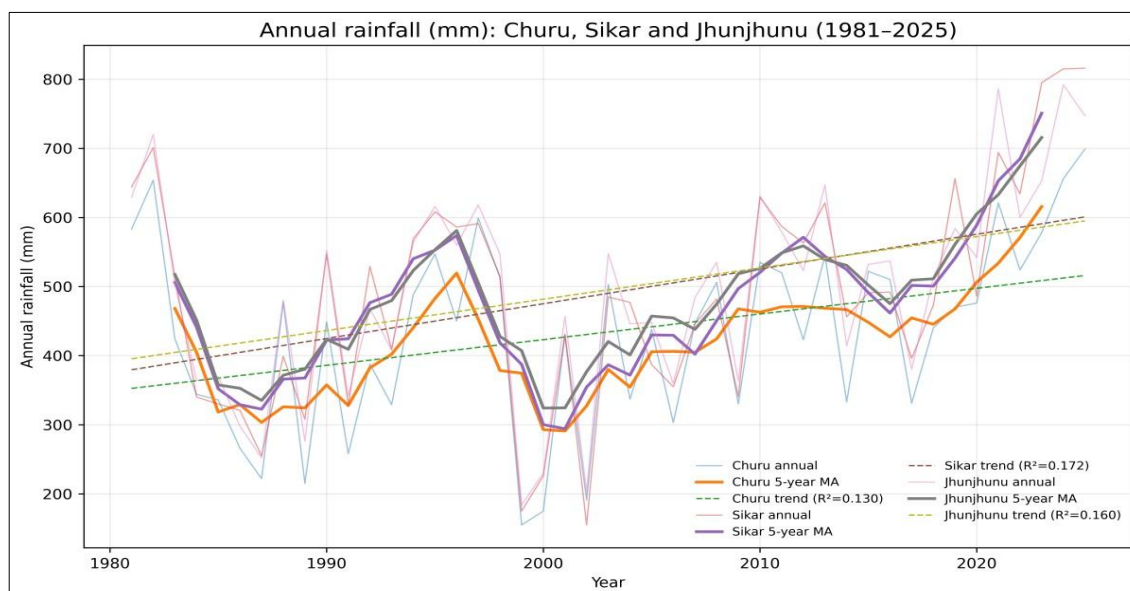


Fig 2: Annual rainfall, five-year moving average and linear trend for Churu, Sikar and Jhunjhunu, 1981-2025

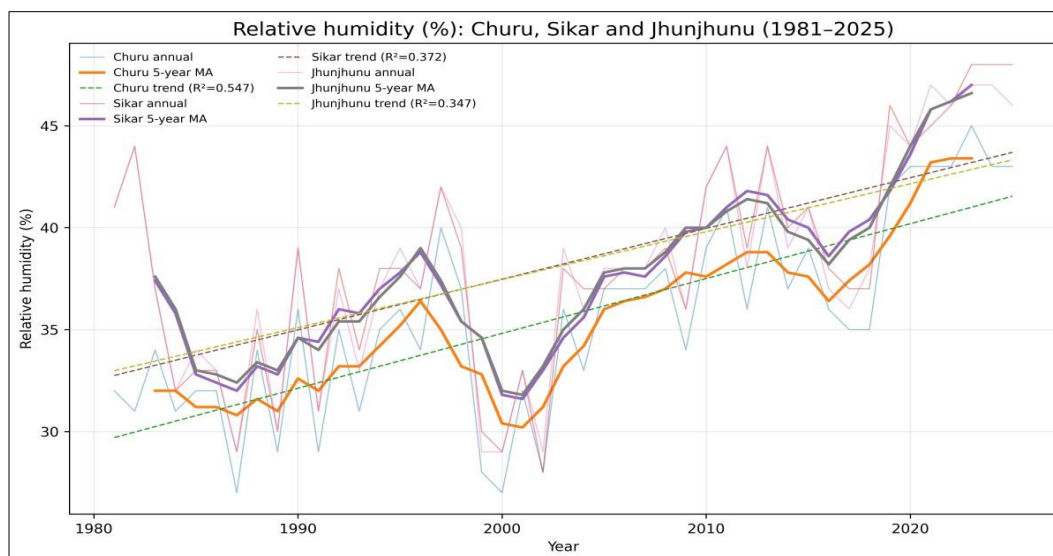


Fig 3: Annual relative humidity, five-year moving average and linear trend for Churu, Sikar and Jhunjhunu, 1981-2025

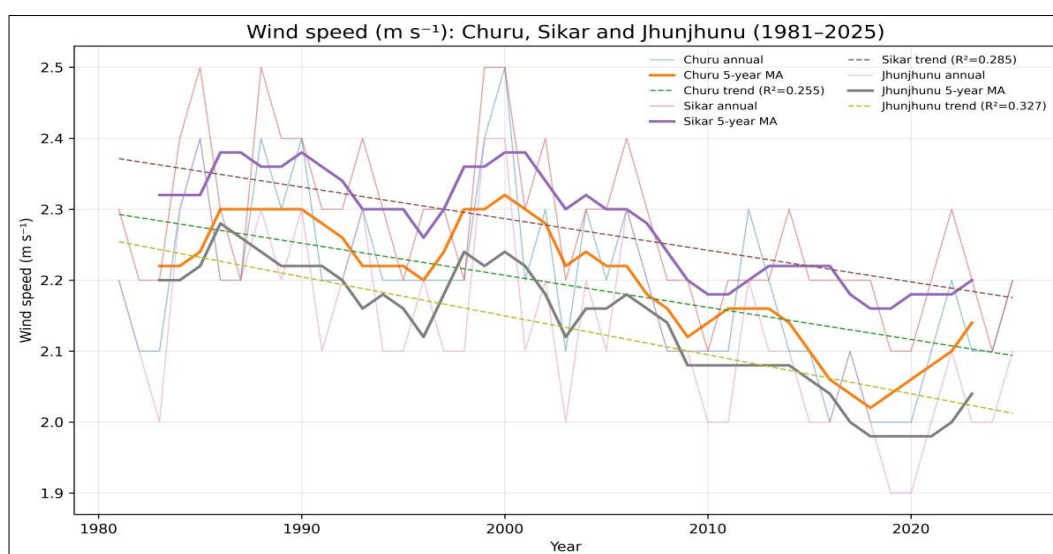


Fig 4: Annual wind speed, five-year moving average and linear trend for Churu, Sikar and Jhunjhunu, 1981-2025

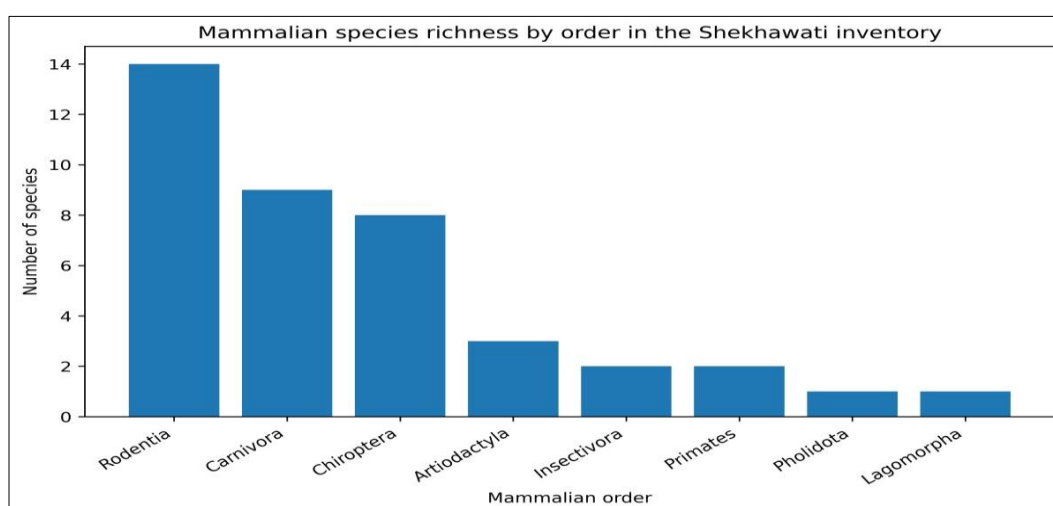


Fig 5: Mammalian species richness by order in the Shekhawati inventory

Conclusion

Shekhawati experienced significant long-term increases in rainfall and relative humidity and significant decreases in wind speed during 1981-2025. The annual mean temperature showed weak, non-significant positive trends.

The 2021-2025 period was particularly wet and humid relative to the earlier five-year periods. The mammalian diversity comprised 40 species across 8 orders, with rodents, carnivores and bats.

References

- Bellard C, Bertelsmeier C, Leadley P, Thuiller W, Courchamp F. Impacts of climate change on the future of biodiversity. *Ecol Lett*. 2012;15:365-377.
- Beyer RM, Manica A. Historical and projected future range sizes of the world's mammals, birds, and amphibians. *Nat Commun*. 2020;11:5633.
- Briscoe NJ, Morris SD, Mathewson PD, Buckley LB, Jusup M, Levy O, Maclean IMD, Pincebourde S, Riddell EA, Roberts JA, Schouten R, Sears MW, Kearney MR. Mechanistic forecasts of species responses to climate change: The promise of biophysical ecology. *Glob Change Biol*. 2023;29:2979-2995.
- Dev K, Singh P. Mammalian diversity of Shekhawati region in arid zone of Thar Desert, India. *Int J Fauna Biol Stud*. 2016;3(5):16-22.
- Forest Survey of India. India State of Forest Report 2023. New Delhi: Ministry of Environment, Forest and Climate Change, Government of India; 2024.
- Fuller A, Mitchell D, Maloney SK. The physiological challenge of climate change for free-living terrestrial mammals. *Annu Rev Physiol*. 2026;88:1-20.
- IPBES. Global assessment report on biodiversity and ecosystem services. Bonn: IPBES Secretariat; 2019.
- IPCC. Climate change 2022: Impacts, adaptation and vulnerability. Cambridge: Cambridge University Press; 2022.
- IPCC. Climate change 2023: Synthesis report. Geneva: Intergovernmental Panel on Climate Change; 2023.
- Krishnan R, Sanjay J, Gnanaseelan C, Mujumdar M, Kulkarni A, Chakraborty S, editors. Assessment of climate change over the Indian region: A report of the Ministry of Earth Sciences (MoES), Government of India. Cham: Springer; 2020.
- Lamba A, Zeng Y, Sreekar R, Rege A, Teo HC, Koh LP. Anchoring India's umbrella species to biodiversity and climate gains. *Conserv Lett*. 2026;19(3):e70059.
- Leclerc C, Courchamp F, Bellard C. Future climate change vulnerability of endemic island mammals. *Nat Commun*. 2020;11:4943.
- Mitchell D, Snelling EP, Hetem RS, Maloney SK, Strauss WM, Fuller A. Revisiting concepts of thermal physiology: Predicting responses of mammals to climate change. *J Anim Ecol*. 2018;87(4):956-973.
- National Tiger Conservation Authority, Wildlife Institute of India. Status of tigers, co-predators and prey in India, 2018. New Delhi: Government of India; 2019.
- National Tiger Conservation Authority, Wildlife Institute of India. Status of tigers, co-predators and prey in India, 2022. New Delhi: Government of India; 2023.
- Pacifici M, Foden WB, Watson JEM, Butchart SHM, Kovacs KM, Scheffers BR, Hole DG, Rondinini C. A framework for the identification of hotspots of climate change risk for mammals. *Glob Change Biol*. 2017;23:2492-2501.
- Pacifici M, Rondinini C, Rhodes JR, Burbidge AA, Cristiano A, Watson JEM, Woinarski JCZ, Di Marco M. Global correlates of range contractions and expansions in terrestrial mammals. *Nat Commun*. 2020;11:2840.
- Pacifici M, Visconti P, Butchart SHM, Watson JEM, Cassola FM, Rondinini C. Species' traits influenced their response to recent climate change. *Nat Clim Change*. 2017;7:205-208.
- Parmesan C, Yohe G. A globally coherent fingerprint of climate change impacts across natural systems. *Nature*. 2003;421:37-42.
- Porwal V, Choudhary MP. Investigating variations and trend analysis for temperature and precipitation as a result of climate change in Rajasthan, India. *J Clim Change*. 2023;9(3):33-40.
- Rajasthan State Biodiversity Board. Biodiversity of Rajasthan. Government of Rajasthan; 2026.
- Rajasthan State Biodiversity Board. Threatened species of Rajasthan. Government of Rajasthan; 2026.
- Rawat M, Dookia S. Climate change and anthropogenic pressures on the Great Indian Bustard's habitats in the Thar Desert of Rajasthan, India. *Biol Forum Int J*. 2025;17(12):31-38.
- Santini L, Cornulier T, Bullock JM, Palmer SCF, White SM, Hodgson JA, Bocedi G, Travis JMJ. A trait-based approach for predicting species responses to environmental change from sparse data: How well might terrestrial mammals track climate change? *Glob Change Biol*. 2016;22(7):2415-2424.
- Scheffers BR, De Meester L, Bridge TCL, Hoffmann AA, Pandolfi JM, Corlett RT, Butchart SHM, Pearce-Kelly P, Kovacs KM, Dudgeon D, *et al*. The broad footprint of climate change from genes to biomes to people. *Science*. 2016;354(6313).
- Sharma SK, Sharma DP, Sharma MK, Gaur K, Manohar P. Trend analysis of temperature and rainfall of Rajasthan, India. *J Probab Stat*. 2021;2021:6296709. doi:10.1155/2021/6296709.
- Singh AP, Sharma LK, *et al*. Dryland refuge at risk: Climate and land-use change impacting habitat of chinkara on the Indian subcontinent. *J Wildl Manage*. 2026.
- Snook RR, Bretman A, Dougherty LR, Fricke C, *et al*. The consequences of rising temperatures for animal fertility. *Nat Rev Biodivers*. 2026;2:225-241.
- Theodoridis S, Fordham DA, Brown SC, Li S, Rahbek C, Nogués-Bravo D. Evolutionary history and past climate change shape the distribution of genetic diversity in terrestrial mammals. *Nat Commun*. 2020;11:2557.
- Urban MC, Bocedi G, Hendry AP, Mithoub JB, Pe'er G, Singer A, Bridle JR, Crozier LG, De Meester L, Godsoe W, *et al*. Improving the forecast for biodiversity under climate change. *Science*. 2016;353(6304):aad8466.
- Wildlife Institute of India. Status of tigers, co-predators and prey in India, 2022. New Delhi: National Tiger Conservation Authority & Wildlife Institute of India; 2023.
- Wildlife Institute of India. Status of leopards in India, 2022. New Delhi: National Tiger Conservation Authority & Wildlife Institute of India; 2024.
- Williams JW, Ordonez A, Svenning JC. A unifying framework for studying and managing climate-driven change in biodiversity. *Nat Clim Change*. 2021;11:259-270.
- WWF. Living Planet Report 2024: A system in peril. Gland: World Wide Fund for Nature; 2024.
- Zubair AA. Marine mammals of the Indian Ocean: Diversity, distribution and climate change vulnerability: A review. *Uttar Pradesh J Zool*. 2026;47(1):193-209.