



Climate Change Impact and Assessment on Four-Footed Wild Mammals and their Conservative Habitats from the Dry Command Area at Kotri downstream, Sindh, Pakistan

Original Article

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Abstract

An ecological evaluation of habitats for small four-footed wild mammals has been carried out in the Kotri downstream area. The primary focus was on the command area of the Indus River downstream from Kotri. This evaluation looked at the biological, chemical, and physical elements that affect the ecosystem's health. Samples were collected from designated sampling locations. Water quality measurements revealed air temperatures ranging from 9 to 38°C and water temperatures from 9 to 34°C. Air humidity levels varied between 24 and 70%, while wind speeds ranged from 22 to 27, and light levels fluctuated between 9 and 21, with wet conditions spanning 19 to 80. The pH of the water ranged from 7.7 to 8.6, with salinity levels between 0.00 and 0.01 ppm. Optical density (OD) was between 1.2 and 5.9 mg/L, with total dissolved solids (TDS) ranging from 160 to 292 mg/L in the Indus River. The outcome of the water and dry belt of Indus River quality samples revealed the appropriateness in supporting the growth, dispersal, production and reproduction of the terrestrial and especially small wild mammals which are found within the Kotri downstream dry belt region. There were 10 species of forfeited wild mammals. *Herpestes edwardsii*, *Hystrix indica*, *Funambulus pennant*, *Paraechinus micropus*, *Rattus rattus*, *Oryctolagus cuniculus*, *Vulpes bengalensis*, *Canis aureus indicus*, *Sus scrofa*, and *Felis silvestris*, which was a specialty, but as the flow of the Indus slowed down, they lost their heritage.

Keywords: Climate Change Impact, Assessment, Conservation, Habitats, Wild Mammals.



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Introduction

A wildlife survey of fauna, and conservation and habitat of wild mammals in the Indus River Kotri downstream dry command area, covers about 157 kilometers between Kotri and its delta, where it enters the sea. The Indus stream water is a valuable asset in horticulture, animals, fisheries, home supply, drinking water, contemporary use and maintaining the ground water spring (Kerr *et al.*, 2025). This freshwater also dilutes sea water and allows few young animals to survive. Freshwater forestalls develop sustaining a salt blockade into the ground and, later, enhancing soil fertility. The delta of Sindh, the seventh largest in the world, provides fertile ground to production and rearing thousands of sea life, approximately as a birth cradle. Internationally, the Indus delta is rated highly regarded due to its high efficiency, i.e., its capability to transform over brilliant energy into biomass that sustains the vocation requirements of more than a section of 1,000,000 people. It presupposes the important role in developing the mangrove ranger service and in conserving a vast number of lots of sediment, silicate, iron, phosphorus, calcium carbonates, in this way maintaining the marine mudflat areas (Salik, Hashmi, Ishfaq, & Zahdi, 2016). Climate change is a slow or rapid change in the environmental conditions that is drastically changing the life and livelihood of people and the biodiversity in addition to raising the sea levels and the seawater temperature to change the wind and rain patterns. Although the warming of the earth surface is slowly melting the glaciers and raising the sea levels, seawater is also heating up to change the wind and rain patterns. Consequently, the occurrence and severity of cyclones along the Sindh coast have increased at an unprecedented rate in the first 20 years of the 21st century (Masson-Delmotte *et al.*, 2021). The studies have demonstrated that numerous life and livelihood changes are taking place due to natural climatic changes, pollution, overexploitation of natural resources and scarcity of fresh water at Sindh coastline in Pakistan. The sharp interest in limiting to save lives and livelihoods is also much needed by the state, research institutes, NGOs and general population (Hafeez *et al.*, 2023). The wildlife of the region has been devastated by climate change and other problems. The first and proposed one is the benchmark and preliminary that may be useful and worthy to the future planning, development, conservation and adaptation front to face the future adversities of climate change patterns alongside solution responses (Qureshi, Jhala, Yadav, & Mallick, 2023).

Methods and Materials

Study Area

The bridge is a total of 1,948 feet/594 m long. The foundation below low water is 49 to 60 feet/15-18 m. Kotri Bridge (25deg22'19.94 northern latitude and 68deg18'46.26 eastern longitude). It is the command of the Indians river and has abundant flora and fauna. Data collection of population of wild mammal conservation, habitat protection and assessment of pollution impact and observations of climate change phenomenon of Station wise were collected and preserved as follows: Water samples were also taken to determine the quality, mammal presence and ecological relevance, and the climate impact conditions of the Kotri downstream command area (Reboussin *et al.*, 2018).

Figure 1

Map of Research Area, Kotri Bridge, Hyderabad, Sindh, Pakistan



Environmental Parameters

To measure water variables, physical and chemical variables, water samples were taken. Some of the parameters could be considered on the spot and some others were studied in the laboratories. The temperature of air and water (oC) was measured using digital thermometer model CE TP101. Wild mammal's samples were sampled and counted in the dry belt of the Indus River. The samples were stored and collected as per the normal practices as explained by (Sikes, Schiraldi Jr, & Williams, 2019). The test parameters of water quality were done at the spot e.g. pH and temperature. Temperature and humidity were tested using the total dissolved solids (TDS) and the conductivity bridge WTW320 A. The pH of the water was measured with the help of the HM Digital Meter model SB1500pro. Salinity of water was measured with the assistance of the HM Digital Meter model SB1500pro. The humidity was determined using HC digital meter. The humidity measures the level of vapor water in the air. Relative humidity is used to measure how much water is in the air compared to the maximum number of vapors of the water (moisture). The warmer the temperature, the greater the amount of water vapors the air can hold and it was measured using the clock/humidity HTC-1 (McLean *et al.*, 2016).

Assessment of Wild Mammals

Confirmation and availability of four-footed wild animals were done through a series of interviews, which were organized at the local level in Bagri, Qulee, Menghwars, Mallah and natives, in the study area. The help of animal traps made locally was used to collect and identify the forefeet of mammals, squirrels, nevla, jackals, foxes and other rabbits, pigs and deer. Confirmations were made, and the animals remained alive and were gathered at the special request of the survey team. The inhabitants of the Indus River Kotri commanding area that are residing in the upper part of freshwater deltaic zone of the Indus River in the commanding area of Naibaran, Oonger, Sondha, and Chatto Chand riverine areas. Some of the animals available in houses and farms of the communities that were gathered in local catching activities were also photographed as hobby and sales animals (Sikes, Care, & Mammalogists, 2016).

Results and Findings

Physiochemical and water quality parameters

The Indus River requires its physical and chemical properties that sustain the biodiversity of the river like the temperature of the air and water, moisture, and acidity, the level of salts and gases, to support the development, production and survival of the biota in the water environment (Allan, 2011).

Table 1

Physical parameters of the area supporting small mammals Kotri downstream command area, Sindh, Pakistan

Parameters	Summer	Autumn	Winter	Spring	Mean	ST/DEV
Temperature of Air °C	38	31	9	15	23.25	13.52467
Humidity %	24	65	70	61	55	20.99206
Wind action km /H	27	26	22	19	23.5	3.696846
Light SI	19	21	9	13	15.5	5.507571
Drought %	20	25	10	12	16.75	6.994045
Wet %	80	73	19	21	48.25	32.75541

Table 2

Water quality parameters of the area supporting small mammals in the Kotri downstream command area, Sindh, Pakistan

Parameters	Summer	Autumn	Winter	Spring	Mean	ST/DEV
Temperature of water °C	34	31	9	17	22.75	11.78629
pH of water	7.7	7.8	8.0	8.6	8.025	0.403113
Salinity of water ppm	0.0	0.0	0.0	0.01	0.003333	0.005774
OD mg/L	5.8	5.6	1.5	1.6	3.625	2.397742
TDS mg/L	160	180	270	292	225.5	65.22525

Table 3

Seasonal population of wild mammals recorded from the Kotri downstream command area, Sindh, Pakistan

Scientific name	Autumn	Winter	Spring	Summer	Mean	ST/DEV
<i>Herpestes edwardsi</i>	67	212	226	216	180.25	180.25
<i>Hystrix indica</i>	1	1	2	2	1.5	1.5
<i>Funambulum pennanti</i>	270	216	243	212	235.25	235.25
<i>Paraechinus micropus</i>	8	5	10	9	8	8
<i>Rattus rattus</i>	229	194	235	213	217.75	217.75
<i>Oryctolagus cuniculus</i>	21	32	51	95	49.75	49.75
<i>Vulpes bengalensis</i>	3	4	2	1	2.5	2.5
<i>Canis aureus indicus</i>	1	2	7	5	3.75	3.75
<i>Sus scrofa</i>	6	21	18	19	16	16
<i>Felis silvestris</i>	1	0	3	3	1.75	1.75

Temperature of Air °C

Air temperature was observed seasonally in the correct way and temperature of air in summer was highest (38degC), minimum low temperature of air in winter was 9degC and high temperature was determined. (Table 1) (Liu, Tan, Yu, & Wang, 2023). The effects of temperature on the wild mammals Climate The temperature of air have significant role to play, and it is the dominant force of the biodiversity; some of the wild mammals rely on the breeding seasons, hence temperature is the most significant ecological factor of life (WWF Pakistan and International Union for Conservation of Nature (IUCN 2000).

Humidity

The humidity of the atmosphere was observed seasonally in different seasons; in all seasons correctly, the minimum humidity was observed in the summer (24deg), and the maximum in the winter (70deg) (Table 1). The most significant aspect of ecology is humidity. Large amounts of humidity may provide the right environment for species that are specific to moist environments like amphibians, some

species of reptiles, and some insect species. The presence of high humidity may facilitate growth of organisms. It is crucial to understand its impact to conserve and manage biodiversity in different habitat, which is most appropriate in development of insects (Yu, Zhang, Li, Zhao, & Kang, 2013).

Wind

The average measure of wind action was taken in all seasons of the downstream command area and was measured using the anemometer (19-27 km/h). Wind is the primary physical parameter of an ecosystem, and it indirectly and directly impacts on the mammal in terms of their survival, distribution, and behavior. The strong winds cause the heating to become more demanding in cold weather and in hot weather the cooling is provided by the convection because of the strength of winds. It also changes the vegetation cover and prey distribution, which influences the living environment of mammals and their food indirectly. Strong winds may cause habitat destruction, decrease the access of shelters, and force out mammals (Voigt *et al.*, 2018).

Light

There is a common ecological unit of measurement called lux meter, which is used to measure light. Light may change natural habitat, decrease the availability of shelter, displace mammal populations by disrupting feeding, breeding, and movement behavior (Hoffmann, Muttarak, Peisker, & Stanig, 2022).

pH

pH was also observed in this kind of study. It is of immense importance in ecology. It was noted that the overall range which was taken in different stations was 7.4-8.6. The lowest pH of 7.4-8.6 was measured at all 5 stations in different seasons of autumn through summer. On the one hand, the highest pH of 8.6 was measured at these in-season springs. It is observed that the pH was low during cold seasons, and maximum during hot seasons. (Table & Fig 2). It is noted that pH transparent climate effects on biodiversity occur in all the stations before, during, and after monsoon season. Although it was observed that it has no significant impact on stations 1 and 5 having the lowest and highest pH respectively, the aquatic life is in favor. Demonstrate the beneficial climate effect of pH on all the wild mammals (Sharma, Sharma, & Soni, 2023).

Dissolved oxygen (DO)

Measuring the value of dissolved oxygen seasonally is done in this research. The minimum ratio of dissolved oxygen (2.1 mg/L) was obtained at station 1 during summer and the maximum ratio of dissolved oxygen (5.9 mg/L) was obtained during winter. Observation of the trend of dissolved oxygen is also important. It has an inverse relationship with change of temperature. (Table & Fig. 2). Value of dissolved oxygen in all the stations was between 2.1 and 5.9. Dissolved oxygen requirement is usually not more than 10mg/L. Thus, Dissolved oxygen value of all the stations indicates that all the stations are conducive living places of all aquatic organisms (Vandewalle *et al.*, 2010).

Total dissolved solids (TDS)

This paper demonstrates that no more difference in all seasons existed in 2021-2023 in terms of content of TDS. The lowest (170 mg/L) was in autumn and highest (261mg/L) in spring. Whereas... it could be because of evaporation less. The peak value was during spring whereas the minimum value was during autumn. (Table 2 & Fig. 2) On the whole, the threat of climate change on the Kotri downstream to Khober Creek wild mammals is very high. The Kotri downstream in the Indus River had water shortfall. There are other environmental aspects that need critical intervention that would decrease heat, preserve and recuperate habitats and encourage conservation activities with the aim of saving wild mammals and ecosystem operations. The Kotri in the downstream of the Indus River is home to squirrels, rabbits, foxes, jackals, pigs, deer, and blue cows, which were reported in the commanding area. The wildlife in most of the wildlife was, however, seldom because of

hunting of, especially deer, rabbits, and pigs. Animals emerge in the early morning and late evening hours where they come out by their nests and shelters to get food. The communities of the villagers occasionally hunt and eat these animals as food besides selling and using the money to earn a living. There are members of society who are keeping these animals in their different homes as hobbies. The mentioned animals were locally found in the homes of the community members (Benyus, 2010).

Herpestes edwardsii (Indian grey mongoose)

This is what is locally referred to as a Nour or a novella and is also referred to as the Indian grey mongoose. The species is usually found in the marshy regions of the Indus River at the lower end of a large variety. The present study survey found this species visually in most of the sampling stations. This species normally favors the thick marshy areas.

Hystrix indica (Indian Crested Porcupine)

The animal is locally called 'Suua' or 'Serhh' and it is one of the common animals found in the wild areas of Thar desert, Kohistan region and Riverine region. The Indian crested porcupine frequently usually happened within the commanding region of Kotri down the Indus River. Its spines are also gathered in the dykes and a marshy land, which signifies the existence of the animal.

Tachyglossus aculeatus (Short-Beaked Echidna)

The short-beaked echidna is locally called Jhaaha. It commonly occurs in the muddy- marshy areas among the herbs in dry localities and sands fragments in the bed of the Kotri downstream region of the River Indus. An animal is heavily furred and spined and possesses a certain snout and tongue which entraps his food.

Tamias striatus (Squirrel)

Tamias genus is a species of eastern chipmunks that belong to the family of the squirrels. It has one living species, which is found in gardens, parks, fruit trees and the agriculture fields around Sindh. The study area also has the same species being collected and observed.

Rattus rattus (Semi-Aquatic Rodent)

Rattus rattus is a big herbivorous rodent that is semi-aquatic. It inhabits sandy burrows and expanses of water on the banks of the Indus River. It preys on river vegetation stems at times found in the nebulous vegetation. The rat was noted in the dead form in the vegetable crop field on the bank of the Indus River close to the Sonda site. This was identified in the laboratory using the taxonomic keys of Robert.

Oryctolagus cuniculus domesticus (Rabbit)

According to the local language, *Oryctolagus cuniculus domesticus* rabbit is referred to as Saaho or as Kharghosh. It can be found in the wild places in the riverbed as well as in the sandy places in most houses in the villages. The villagers are mostly using dogs and traps to captivate the animal. According to the communities in the survey period, the wild riverine rabbit is tastier when compared to the domestic rabbit (Weinstein *et al.*, 2021).

Vulpes bengalensis (Indian Fox)

It is also known as Indian fox; the fox inhabits the rueful areas in Pakistan, India, Bangladesh and Nepal. Such fox was widespread in Indus River, river Nara canal, Ashro Thar and Tharparkar area of Sindh. This is a generalist feeder animal.

Canis aureus indicus (Golden Jackal)

It is a golden jackal which is widespread in Pakistan, India, Bhutan, Burma and Nepal. This is the jackal species that is prevalent in the Indus River basin in Kotri downstream. This is nocturnal and is primarily nocturnal in nature.

Hyelaphus porcinus (Indian Hog Deer)

This is a deer that is commonly referred to as Indian hog deer. The small deer that is native to them. It is a deer inhabiting India, Pakistan and Bangladesh and resembles the bara Singha so considered by the local people of the region. This species is commonly occurring in Tharparkar, Thana Boola Khan and the Khirthar mountain location and has also been reported at the bed of the Kotri downstream river Indus as well.

Antelope cervicapra (Black Buck)

This is a species of animal that is popularly referred to as the nilgai (blue bull). It is popularly known in Sindh province as Rojh. The colour of the body is brown slightly with white shade. Their diet is herbivorous, so it can hardly be found in the grassland region of the Indus River Kotri at low stages in the wild. Houses of the natives of the Taluka of Tando Muhammad Khan also had most of the animals.

Boselaphus tragocamelus (Blue Bull)

This is a species of animal that is popularly referred to as the nilgai (blue bull). It is popularly known in Sindh province as Rojh. The color of the body is brown slightly with white shade. Their diet is herbivorous, so it can hardly be found in the grassland region of the Indus River Kotri at low stages in the wild. Houses of the natives of the Taluka of Tando Muhammad Khan also had most of the animals.

Sus scrofa davidi (Wild Boar)

The Suar animal is a wild boar that is native to Pakistan, India and Iran. The color is light brown. This mammal is hardly found in the Indus River Kotri commanding area. The pigs are, however, also happening during the agricultural lands in bulk form during the flooding time mainly in the early morning time.

Figure 2

Mammals occur in Indus River Kotri downstream, Sindh, Pakistan





Discussion

The research studies the climate impact on wild mammals and all four seasons of the study area and gives physical chemical and biological status of Kotri downstream. The seasonal variations in Kotri Barrage discharge demonstrate the holistic association that is existent between natural and human system, and this can be the reason why the holistic analysis of water management and environmental protection is pertinent in sustaining the ecosystem of Indus River delta. The temperature was measured in summer at the air temperature and the change between summer and spring temperature in temperature under temperature, 26 -30 o C. Temperature Climate change impact on the wild mammals. Temperature is one of the ecological factors of air that are relevant. Air temperature, is noteworthy and it is the primary movement of the wild mammal(Braunstein, Bennett, Voigt, & Oosthuizen, 2023). Temperature is most pertinent ecological aspect of life as it is a factor that would rely on the biodiversity that is concerned with moderate temperature

Amphibian Reptiles Birds and some Mammals breeding cycles. Government of Pakistan (Songer *et al.*, 2012). Water temperature. The minimum low temperatures of air (during winter and high temperature) were taken downstream at the Kotri (Table 1) at 9o C -34 o C. The whole biodiversity is affected by temperature climate. Temperature is also a significant variable in the water ecology. Temperature of water forms significant contributor of biodiversity in water. Humidity in Air during high in winter (20- 59deg) and low in summer (40- 45) it began to decrease in high temperature and increase in low temperature or during rainy season or under the influence of the supply of the water (Table 2). Salinity Variations and Seasonal Impact. Had the lowest (0.0 mg/L) salinity, which is attributed in Tables 2. Climatic Effect to Salinity and Aquatic Life. The criterion that was used in the study was to understand the impact of the climate on the salinity and what would be the result of this impact on aquatic biodiversity. It had a low impact on aquatic biodiversity. It was carried out to understand the effect of the climate on the salinity and the subsequent impact on mammals. PH water levels are significant ecological research because they seriously affect biodiversity. In this study, PH was measured in five stations throughout the various seasons such as winter to summer. The lowest and highest PH values were 7.4 and 8.6 respectively with the lowest value obtained during cold seasons and highest value obtained during hot seasons. Specifically, the greatest pH was recorded in the spring in the fifth station which was 8.6. These observations show that the seasonal climate in water has a direct impact on the pH of water, which, in its turn, has an impact on aquatic and terrestrial wildlife (Sharma *et al.*, 2023).

Climatic Effect to Salinity and Aquatic Life. The criterion that was used in the study was to understand the impact of the climate on the salinity and what would be the result of this impact on aquatic biodiversity. It had a low impact on aquatic biodiversity. It was carried out to understand the effect of the climate on the salinity and the subsequent impact on mammals. PH water levels are significant ecological research because they seriously affect biodiversity. In this study, PH was measured in five stations throughout the various seasons such as winter to summer. The lowest and highest PH values were 7.4 and 8.6 respectively with the lowest value obtained during cold seasons and highest value obtained during hot seasons. Specifically, the greatest pH was recorded in the spring in the fifth station which was 8.6. These observations show that the seasonal climate in water has a direct impact on the pH of water, which, in its turn, has an impact on aquatic and terrestrial wildlife (Singh *et al.*, 2024). The reduced DO levels in the summer may cause stress to aquatic life, especially the sensitive species, and the high levels in the winter may encourage more diverse and flourishing ecosystem.

Constant assessment and evaluation of the DO trends are required in preserving the aquatic biodiversity as well as regulating the impact of climate variability on the aquatic environment. The experiment shows that the Total Dissolved Solids (TDS) was not significantly different among seasons. The lowest TDS concentration was found to be 170mg/L in autumn with the highest being 261mg/LL in spring. Such seasonal variation in the TDS level can be explained by the lowered rates of evaporation. Wild mammals are largely threatened by climate change, which is a significant problem in some regions such as the Kotri downstream command area. Reduction of the water flow in Indus River south of Kotri is a severe problem. The impacts of water scarcity are observed on the whole ecosystem, endangering species and their habitat. Answer this, immediate steps must be taken. Climate action, conserving and restoring habitats, and encouraging conservation are necessary measures to reduce global temperatures. *Herpestes edwardsii*, *Hystrix indica*, *Funambulus pennant*, *Paraechinus micropus*, *Rattus rattus*, *Oryctolagus cuniculus*, *Vulpes bengalensis*, *Canis aureus indicus*, *Sus scrofa*, *Felis silvestris*. This is supported by the fact that the Kotri downstream area of Sindh, Pakistan has a high level of biodiversity and ecological value because it harbors many different species of plants (Gleason & Cronquist, 1963).

Conclusion

The present research was conducted in Kotri command area. We carefully examined the temperature and pH, salinity, total dissolved solids, dissolved oxygen and the effect of climate on the wildlife in these localities. The sample was taken every season. The current study reported how climatic conditions affected small wild fauna in warm and cold season. Their figures were however very high during good weather conditions. There is a limited number of wild faunas that was consistently recorded in the existing study. The study showed that large percentage of the water flows through the Kotri bed which is located below the Indus River. Water circulation has a positive impact on both plants and animals. The government should also think of putting measures in place and should closely observe the right amount of water being discharged by the river Indus because the river is an essential resource to the flora and fauna. They can be found in the downstream command zone of Kotri even to the delta. Lack of fresh water to fulfill the demand.

Recommendations

Referring to the results and aim of the research entitled Climate Change Impact and Assessment on Four-Footed Wild Mammals and Its Conservative Habitats in the Dry Command Area at Kotri Downstream, Sindh, Pakistan, one can make several major recommendations that can guarantee the efficient preservation and management of mammalian fauna and their habitats when the climatic conditions are altered. It is suggested that special attention must be paid to preservation and conservation of the vital habitats, especially, the riparian areas, patches of vegetation, and small perennial or seasonal water bodies, which act as a crucial refuge to wildlife in times of severe drought or heat waves. There should be an attempt to replenish the native vegetation and control land degradation by implementing afforestation and habitat restoration initiatives that increase food supply and shelter to the mammals. The ecological corridors between fragmented habitats are important to ensure that wildlife moves, exchanges genes, and adapts to the changing environment. Also, better management of water resources must be put in place in conjunction with irrigation and environmental authorities to avoid the overly diversion of water, saline accumulation and desiccation of habitat. Ecological monitoring using camera trapping, remote sensing and community-based reporting must be done regularly to monitor the changes in populations and to detect the initial stress factors in the wildlife due to climatic changes. It is also desirable to involve the community hence awareness campaigns and participatory conservation strategies are to be encouraged among the locals, farmers and herders to curb the human-wildlife conflict and promote the sustainable utilization of the land. The policy interventions should promote the conservation of the habitats by providing climate-smart planning, integrating biodiversity conservation in regional developments projects and implementation of wildlife protection legislation.

The collaboration between research institutions and conservation organizations is necessary to come up with adaptive management and carry out long-term research on the ecology of species, their climate resilience, and the recovery of their habitats. All these recommendations will help reduce the negative effects of climate change on the four-footed

wild mammals as well as enhance the resilience of the ecosystem and the sustainable preservation of the biodiversity in Kotri downstream dry command area in Sindh, Pakistan.

Future Studies

It would be advisable in future research that long-term and large-scale research be done to follow the population dynamics, behavioral adaptations and genetic diversity of the four-footed wild mammals to current climate change in the Kotri downstream area. An improved toolkit to be adopted in future research ought to incorporate remote sensing, GIS-based habitat modeling, and environmental DNA (eDNA) analysis to detect species and determine habitat suitability changes in the upcoming climate projections. The temporal extension of the data collection in the various seasons and years would be beneficial in the determination of the migration patterns, breeding time of species and how they survive under changing temperature and water scarcity. More research is also required into the cumulative impacts of anthropogenic stressors, such as land-use change, agricultural and pollution on mammalian habitats to create overall conservation baselines. Co-operation among ecologists, climatologists, hydrologists, and local communities will be necessary to come up with multidisciplinary measures that will connect ecological data with both climatic and hydrological models. However, in the future, it is necessary to conduct scientific studies on the performance of conservation interventions, experiment with adaptive management approaches, and suggest climate resilience models of wildlife conservation by region. Research on the socio-economic aspects of conservation, especially the perception of the community, livelihood base and sustainable co-existence patterns would contribute immensely to the combination of both human and wildlife requirements. All in all, the net objective of future research studies should be to develop predictive frameworks and policy-based statistics that can be used in proactive conservation planning and the long-term survival of wild mammal populations in the advent of more severe climate change in Sindh, Pakistan.

Declarations

Ethical Approval and Consent to Participate: This study strictly adhered to the Declaration of Helsinki and relevant national and institutional ethical guidelines. Informed consent was not required, as secondary data available on websites was obtained for analysis. All procedures performed in this study were by the ethical standards of the Helsinki Declaration.

Consent for Publication: Here, we, the authors, give our consent for publication.

Availability of Data and Materials: Data will be provided upon written request from the corresponding author.

Competing Interest: The authors state that there exists no conflict of interest between the co-authors on the publication of the given research paper. The content, expression of findings, and inferences of the research have been mutually agreed upon by all the authors.

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Authors' Contribution: The manuscript was prepared and analyzed by all authors equally, with no one being left out when it came to conception and design as well as experimentation. Both authors were actively involved in the research process, and both read and signed the final version of the paper, before submitting it.

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