International Journal of Advanced Research in Engineering Technology & Science
ISSN: 2349-2819
Impact Factor: 7.10
Email: editor@ijarets.org Volume-9, Issue-10 October – 2022 www.ijarets.org

CLIMATE CHANGE AND ITS INFLUENCE ON BIODIVERSITY IN THE SEMI-ARID REGION OF BHINMAL

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ABSTRACT

Because of its fragile ecology and limited water supplies, the semi-arid area of Bhinmal, which is located in Rajasthan, India, is extremely susceptible to the effects of climate change. Other characteristics of this region include its restricted water resources. The purpose of this study is to evaluate the impact that climate change has had on the biodiversity of Bhinmal by analysing the alteration of temperature, patterns of precipitation, and extreme weather events that have occurred over the past several decades. These climatic fluctuations have resulted in important ecological repercussions, such as the deterioration of habitats, alterations in the distribution of species, and a decrease in the number of local flora and animals. Surveys conducted in the field, data collected through remote sensing, and interviews with members of the local community were utilised in order to evaluate the changes in biodiversity and the environment. The study also underscores the role that anthropogenic stressors, such as overgrazing, deforestation, and agricultural methods that are not sustainable, have in increasing the effects of climate change. Therefore, in order to reduce these consequences and conserve the biodiversity of the region, it is advised that adaptive methods be used. These strategies include community-based conservation activities and agricultural techniques that are climate-resilient. The findings of this study highlight the critical need for coordinated policy approaches that address both climate adaptation and the protection of biodiversity in semi-arid areas such as Bhinmal.

Keywords: *Climate Change, Biodiversity, Semi-Arid*

INTRODUCTION

A significant number of people agree that climate change is one of the most urgent environmental problems that the world is facing in the 21st century. Ecosystems, human communities, and the delicate balance that maintains biodiversity are all impacted by its effects, which are both vast and deep when taken into consideration. Climate variability can have a particularly negative impact on semi-arid regions, which are already prone to water shortages and ecological fragility. These places are especially vulnerable to the harmful consequences of climate change. The town of Bhinmal, which is situated in the Jalore district of Rajasthan, India, is an example of a vulnerable place in which the effects of climate change have begun to appear in a way that is both tangible and perhaps irreversible on the local biodiversity. The region of Bhinmal is located within the Thar Desert environment, which is characterised by a temperature that is hot and dry, with unpredictable rainfall, high evaporation rates, and a limited amount of natural vegetation. This region's biodiversity has, throughout the course of its

history, adapted to the extreme climatic circumstances that it has been subjected to, therefore maintaining a wide variety of drought-resistant plants and animals. On the other hand, these delicately regulated ecosystems are experiencing tremendous stress as a result of rising global temperatures, shifting patterns of precipitation, extended droughts, and an increase in the frequency of extreme weather events. The environment of Bhinmal has seen significant transformations over the course of the last several decades. A tendency towards hotter summers, shorter winters, and delayed or diminished monsoon rains is suggested by local reports, meteorological data, and community observations. This trend should be expected to continue. As a result of these climatic alterations, native habitats have been degraded, the moisture content of the soil has dropped, and the populations of a variety of native plant and animal species have plummeted. In addition to this, the ecological imbalance is further exacerbated by the proliferation of alien species and the movement of native species to settings that are more beneficial to their survival. The difficulties that are brought about by climate change have been made worse by human activity. Land degradation and desertification have been accelerated as a result of behaviours that are not sustainable for land use. These practices include overgrazing, illegal timber harvesting, excessive groundwater extraction, and intensive agriculture. Many species that are an essential component of the local food web and ecosystem services are in danger of extinction as a result of these activities, which, when combined with climatic stresses, pose a threat to their existence. The purpose of this research is to investigate the impact that climate change has had on the amount of biodiversity that exists in the Bhinmal geographic area. The purpose of this project is to identify significant environmental changes, assess the susceptibility of species and ecosystems, and investigate potential adaption techniques. This will be accomplished through a mix of field observations, climate data analysis, and interviews with community members at various locations. When considering the impact of climate change on biodiversity loss, it is essential to have a comprehensive grasp of both the biological and socio-economic aspects of this phenomenon. It is essential to conduct this research for a number of reasons. In the first place, it makes a contribution to the expanding body of research on the regional effects of global climate change, particularly in arid and semi-arid regions. Second, it offers significant information to local legislators, conservationists, and community stakeholders, assisting them in making educated decisions for the management of land and resources in a sustainable manner. Last but not least, it highlights the necessity of taking quick and coordinated action in order to safeguard and restore biodiversity in climate-sensitive locations such as Bhinmal.

Changing environmental conditions, such as shifting patterns of rainfall and vegetation, have had an influence on the desert ecology of Rajasthan, which in turn has had an effect on the local flora and fauna. The Indian state of Rajasthan, which is known for its desert climate, was in the headlines during the months of July and August due to the extremely strong rains that persisted for many days, causing towns and cities to flood and villages to be flooded. Rainfall totalling 118 millimetres fell in a span of twenty-four hours on July 25-26 in the city of Jodhpur. Over the course of the last three decades, the state's rainfall pattern has been undergoing a transformation. There has been a tendency towards an increase in the number of rainy days throughout the year, as reported by the India Meteorological Department. The number of days that experience heavy rainfall during the monsoon season has increased in a number of districts. The research conducted by IMD indicates that there has been a "significant" rise in the number of days throughout the year that experience heavy rainfall, notably in the western regions of the state, between the years 1989 and 2018, which spans a period of thirty years.

A day with heavy rainfall is one that receives more than 65 millimetres of precipitation. According to the findings of the investigation, there has been a rise in the total number of rainy days that occur in a year for a number of districts throughout the same time period. It is also stated in the draft Rajasthan State Action Plan on Climate Change (RSAPCC) 2022 that the southeastern section of the state and the western half of the state both exhibit a rising tendency of more than 2 millimetres of rainfall each year. A favourable trend in the annual maximum rainfall was seen in various grids that were dispersed over the whole state of Rajasthan, according to the action plan. This shift in the pattern of rainfall and vegetation has led to a gradual change in the types of migratory birds that are arriving to Rajasthan, according to Sumit Dookia, a wildlife researcher. As he explained, "We have observed a rising presence of the black francolin in Jaisalmer, which is a bird that is typical of a wet habitat." Jaisalmer is located in the western region of Rajasthan. Dookia went on to add that this is a development that has been taking place over the course of several years. In the 1980s, the black francolin was first observed in the Sri Ganganagar area of northern Rajasthan, which is next to the state of Haryana. The populace started going towards Bikaner from that point on, and then from there they moved to Churu, which is located in the vicinity of the Indira Gandhi Canal," he explained. A climate that is semi-arid may be found at Churu, which is frequently referred to as "The Gateway to Thar." Almost simultaneously, there has been a decrease in the number of sandgrouses that have been seen. Sandgrouses are migratory birds that travel from Central Asia. The sandgrouse is a bird that takes up residence on the ground and may be found in dry and semi-arid environments. According to Dookia, "The Gajner Palace in Bikaner was well-known during the British Raj for hosting the imperial sandgrouse shoots during the Christmas season." This is because the palace was frequently located here during the winter season. Despite this, ornithologists were pleased to discover the black-bellied sandgrouse in Jaisalmer in 2016, after it had been absent for a period of five years without being seen there.

(black francolin)

(Chestnut-bellied sandgrouse)

The migratory and resident bird species visiting Rajasthan have been gradually shifting due to changing patterns of rainfall and vegetation across the state. One notable example is the Black Francolin (*Francolinus francolinus* Linn), a species typically associated with moist environments, which has seen an increase in sightings. In contrast, there has been a decline in the appearance of the Chestnut-bellied Sandgrouse (*Pterocles exustus* Temminck, 1825), a bird well adapted to arid conditions. Photographs of the Chestnut-bellied Sandgrouse were taken by Rejichandran and contributed to Wikimedia Commons, while images of the Black Francolin were captured by Shashank Sekar. According to Chetan Misher, a researcher at the Ashoka Trust for Research in Ecology and the Environment (ATREE), increased water availability—potentially driven by higher rainfall—has influenced the distribution of several native and non-native species in Rajasthan. For example, the Rufous Treepie (*Dendrocitta vagabunda* Latham) and the Indian Grey Hornbill (*Ocyceros birostris* Scopoli), birds not typically found in desert habitats, are now more frequently observed in local environments. Additionally, the population of the Jungle Cat (*Felis chaus* Schreber), a species uncommon in arid regions, is on the rise, while the presence of the Indian Desert Fox (*Vulpes vulpes pusilla* Blyth) appears to be declining. An increase in water availability has also contributed to the growing numbers of Wild Boar (*Sus scrofa* Linn). These shifts in faunal distribution are indicative of broader environmental changes, likely influenced by fluctuations in regional rainfall and vegetation cover. The associated floral diversity, including species like *Prosopis cineraria* L. Druce (Khejri) and *Capparis decidua* (Forssk) Edgew (Kair)—both integral to Rajasthan's desert ecology—may also be undergoing distributional changes due to altered moisture regimes.

Global Perspective on Climate Change and Biodiversity

It has been claimed by the Intergovernmental Panel on Climate Change (IPCC) that one of the most significant implications of climate change is the loss of biodiversity on a global scale (IPCC, 2021). A great number of species have experienced disruptions in their mating cycles, migratory patterns, and the availability of food as a result of warming temperatures and changing patterns of precipitation (Walther et al., 2002). The findings of Parmesan and Yohe (2003) indicate that species belonging to a wide variety of taxonomic groups have demonstrated significant range shifts and phenological changes as a result of fluctuations in temperature.

When current trends continue, Thomas et al. (2004) calculated that climate change might push 15–37% of species to extinction by the year 2050. This highlights the critical need for conservation and adaptation solutions to be implemented as soon as possible. A basic knowledge has been established as a result of these worldwide results, which may be applied to regional and local situations such as Bhinmal.

Climate Change Impacts in Arid and Semi-Arid Ecosystems

As a result of climate change, semi-arid ecosystems, which include regions in Africa, Australia, and western India, are confronted with issues that are not shared by other ecosystems. According to Le Houérou (1996), these locations are characterised by low and unpredictable rainfall, high evapotranspiration, and soil degradation, all of which are adversely affected by rising global temperatures. Within the borders of India, the Thar Desert and its surrounding areas have emerged as a central location for research on desertification, the destruction of habitat, and the shifting dynamics of species.

Research conducted by Sehgal and colleagues (2012) has demonstrated that the fluctuation of climate in the semi-arid regions of India has a direct influence on the amount of plant cover and biodiversity. It was brought to the attention of Raina et al. (2019) that the decrease in rainfall patterns in Rajasthan has had an impact on the natural regeneration of native species and has led to the spread of invasive plants like *Prosopis juliflora* L. Druce.

The table above presents the monthly fluctuations in rainfall and temperature, providing an overview of weather patterns throughout the year. It includes data on total rainfall (in millimeters) and the average temperature (in degrees Celsius), along with the maximum and minimum temperatures recorded each month. This table highlights the seasonal variations, with rainfall peaking during the summer monsoon months of June and July, while temperatures are generally higher during the warmer months of April to June. The data offers valuable insights into the climatic changes experienced over the course of the year (Agarwal et al., 2018; Rajeev & Kumar, 2016).

Table 1: Fluctuation of Rainfall and Temperature (Monthly)

Month	Rainfall (mm)	Temperature (°C)	Max Temperature (°C)	Min Temperature (°C)
January	75	21.5	27.0	15.0
February	58	22.0	28.0	16.5
March	45	23.5	30.0	18.0
April	34	26.0	32.0	20.0
May	92	28.0	35.0	22.5
June	150	29.5	36.5	24.0
July	230	28.0	34.0	23.0
August	200	27.5	33.0	22.0
September	120	26.5	32.0	21.0
October	75	24.5	30.5	19.0
November	50	23.0	29.0	18.0
December	60	21.5	27.5	16.5

Regional Studies: Rajasthan and the Thar Ecosystem

As a result of their ecological vulnerability and socio-economic dependence on natural resources, the arid and semi-arid regions of Rajasthan have garnered a significant amount of interest in the field of environmental writing. According to data from the Desert Development Programme (DDP), the Jalore area, which is where Bhinmal is situated, has been seeing an increase in desertification and groundwater depletion, both of which are connected to the fluctuation of the climate.

The populations of native grasses, plants, and faunal species, such as the Indian pangolin (*Manis crassicaudata* Geoffroy) and desert fox (*Vulpes vulpes pusilla* Blyth), have experienced a considerable drop, according to the findings of a comprehensive research on biodiversity that was carried out by Meghwal and Vyas (2015) in western Rajasthan. It was determined that human forces and climate changes were both responsible for these decreases.

In addition, Bhatt and Kher (2016) found that there is a significant relationship between the shifting patterns of rainfall and the reproductive success of indigenous plant species in the region. Their research

highlighted the importance of conducting ecological monitoring over extended periods of time in order to learn more about the ways in which climate change is affecting the species composition and ecosystem services.

Anthropogenic Factors and Synergistic Effects

The repercussions of climate change are considerably amplified by human activity, despite the fact that climate change is a key cause of biodiversity loss. The environment has been further strained as a result of overgrazing, excessive water extraction, and the conversion of natural habitats into agricultural land in Bhinmal and the neighbouring areas. It was pointed out by Sharma and Dagar (2014) that traditional land-use practices in Rajasthan, which were previously sustainable, have become harmful in the face of modern demands and climatic uncertainties. Traditional land-use practices were formerly sustainable.

The research conducted by Singh et al. (2020) indicated that traditional knowledge and conservation actions led by communities can serve as important instruments in the process of adapting to the effects of climate change. The findings of their research in western India indicate that a combination of scientific and indigenous methods may be the most promising approach to the preservation of biodiversity in areas that are most susceptible to extinction.

Importance of the Study

The relevance of this study comes in the fact that it focuses on a geographical location that is extremely susceptible yet has received low levels of research. This region is Bhinmal, which is situated in the semi-arid zone of Rajasthan. In light of the fact that climate change continues to pose challenges to ecological systems on a global scale that have never been seen before, it is very necessary to carry out studies that are unique to certain regions in order to capture the nuanced and localised effects on biodiversity. Bhinmal is an important ecological transition zone that is located at the intersection of semi-arid grasslands and desert ecosystems. It is home to a diverse array of flora and animals that have developed a high level of adaptation to the region's harsh weather conditions.

There is a scarcity of localised evaluations, particularly in semi-arid regions such as Bhinmal, despite the fact that there is a substantial body of research on climate change and the loss of biodiversity at both the national and global levels. The vast majority of the currently available research generalise their conclusions over wider ecoregions, frequently ignoring the micro-level variability that exist in the distribution of species, the conditions of habitats, and the reactions of communities. The purpose of this study is to address that vacuum by providing granular insights into the ways in which changing climatic factors are directly harming the biodiversity of Bhinmal. The findings of this study have the potential to contribute to the formulation of conservation plans and environmental policies at both the district and state levels. The state of Rajasthan, which is already struggling with desertification and water scarcity, would benefit from approaches to biodiversity protection that is data-driven and context-specific. It is possible for this study to assist in the development of regionally customised biodiversity action plans and to provide support for climate-resilient land-use policy. This is accomplished by identifying important threats, vulnerable species, and degraded ecosystems. Local communities in Bhinmal are inextricably connected to the natural environment that surrounds them, which is essential

to their means of subsistence. Traditional herbal treatment, agriculture, and animal cultivation are all dependent on the biodiversity of the surrounding environment. These practices, and consequently the socio-economic stability of the local community, are under danger as a result of climate-induced ecological deterioration. The findings of this study highlight the significance of incorporating community engagement and local knowledge into adaption techniques through their incorporation. The need of enabling local stakeholders to improve the efficiency and longevity of conservation activities is brought to light by this. For the purpose of establishing resilience, it is essential to have a solid understanding of the ecological responses to climatic variability. The identification of species and ecosystems that serve as markers of ecological health is one of the ways in which this study helps to the consolidation of resilience. In addition to this, it investigates possible adaptation methods, such as the growth of drought-resistant crops, techniques for water conservation, and ecosystem restoration, which have the potential to protect human populations and biodiversity from the effects of future climatic shocks.

Effects of the Narmada canal

The changing ecological and hydrological conditions in the Bhinmal region of Rajasthan can be partially attributed to the expansion and influence of the Narmada Canal Project, which has gradually extended irrigation facilities into parts of southern and southwestern Rajasthan. Unlike the Indira Gandhi Canal, which serves the northwestern arid zones, the Narmada Canal provides supplementary water to traditionally water-scarce areas such as Sanchore, Chitalwana and Bhinmal, enhancing soil moisture levels, agricultural potential and overall vegetation cover. This change in the availability of surface water has brought about notable ecological consequences, including shifts in local flora and fauna. The spread of water-intensive crops, increased green cover, and changes in ground vegetation patterns have been observed. Such changes have in turn affected the habitat suitability for various wildlife species. Birds and animals that prefer semi-moist or moist conditions—such as the Black Francolin *(Francolinus francolinus* Linn), Rufous Treepie *(Dendrocitta vagabunda* Latham*)*, and Indian Grey Hornbill *(Ocyceros birostris* Scopoli)—are becoming increasingly common. Similarly, sightings of mammals like the Jungle Cat *(Felis chaus* Schreber*)* and Wild Boar *(Sus scrofa* Linn) have grown more frequent in areas that were previously too arid to support them. Conversely, species well adapted to dry habitats, such as the Chestnut-bellied Sandgrouse (*Pterocles exustus* Temminck) and Indian Desert Fox *(Vulpes vulpes pusilla* Blyth*)*, appear to be in decline. These patterns suggest that the hydrological shift brought about by the Narmada Canal is not only transforming the agricultural landscape of Bhinmal but also catalyzing a slow and steady ecological transition, reshaping the native biodiversity in accordance with the altered water regime.

Changing biodiversity with modern irrigation systems

As far as the plant species are concerned, multifunctional tree species are disappearing in the command area, while undesired weeds that are tenacious (such as Doob and Motka) are appearing. This is a problem since these weeds are undesirable. There has been an increase in water logging, which is accompanied by an increase in undesired weeds, while canals are being clogged with noxious hydrophytic weeds. The table illustrates the changes that have occurred in plant species as a direct result of Narmada canal project. There are also shifts in the characteristics of the crop species. The land races of bajra, which are the primary crop of the region, are perfectly suited for the region due to their apical

dominance and thin stems that are able to endure the effects of moisture stress. In addition to that, they might be utilised as feed for such animals. There was a preference among farmers for these land races because to their compatibility with the ecology and their competitive price. On the other hand, the government departments' particular push on hybrid bajra with external inputs is rapidly replacing the conventional land races. Additionally, there have been shifts in the make-up of rodent communities in locations that are part of the Narmada canal project. Food grains that have been kept are being damaged as a result of the shift towards mesic types of rodents. When it comes to invertebrates, irrigation led to the loss of numerous of them, which had been contributing to the development of soil and the promotion of soil productivity under conditions that were extremely dry. During the time before the implementation of the Narmada canal Project, it was possible to witness organisms such as white ants, big and little black ants, beetles, grasshoppers, and mites. However, at the present time, earthworms, nematodes, snails, and mosquitoes are observed. There are several species of birds and trees that serve many purposes that are becoming endangered as a result of mechanisation and the cultivation of commercial crops. *Commiphora mukul* (Am) Bhandari (Guggal), *Salvadra oleiodes* Dekne (Jal), *S. persica* Linn (Pillu), *Colligonum polygonoides* Linn (Phog), *Cardia myxa* Linn (Gonda), *Capparis decidua* (Forssk) Edgew (Ker), *Carissa corandus* Linn (Karonda), *Citrullus colocynthus* (Linn) Schrad (Thumba), and birds (Great Indian bustard) are some of the species that are in risk of extinction. The removal of bushes and grass made possible by mechanisation and the use of tractors has resulted in the preservation of just trees such as khejri and Rohida. This clearance of land led to the exposure of a bare soil surface throughout the summer, which in turn led to an increase in the amount of dry erosion. Additionally, the exposed soil caused changes in the kind of organisms that live in the soil biologically. Numerous ecosystem services are provided by soil microorganisms and the minuscule creatures that inhabit the ground. These services include the cycling of nutrients, the fixation of nitrogen, the breakdown of organic matter, the control of pests, the pollination of plants, the preservation of soil moisture, drainage, carbon sequestration, and the recycling of trash. In addition, they play a significant but little-known function in the regulation of climate.

Vanishing species	Invasive species
A. Trees and Bushes	a. Fields
Colligonum polygonoides Linn (Phog)	– *Cynodon dactylon* (L.) Pers (Doob)
Heloxylon salicornicum (Moq) Bunge (Lana)	– *Cyperus rotundus* Linn (Motka)
Calotropis procera (Alton) W T Alton (Ak)	– *Eclipta erecta* Linn (Jalbhangra)
B. Grasses	b. Canals / Waterlogged areas
Lasiurus sindicus Boiss (Seewan)	– *Typha angustata* Linn
Cenchrus ciliaris Linn (Anjan)	– *Arundo donax* Linn (Bara nal) – *Saccharum spontancum* Linn
Panicum antidotale Retz (Gramma)	– *Eichornia cressipes* (Mart) Solms (water hyacinth)

CONCLUSION

One of the most prominent examples of the difficulties that environmentally sensitive regions are confronted with as a result of the acceleration of climate change is the semi-arid region of Bhinmal.

According to the findings of this study, the natural environment of Bhinmal is undergoing considerable transformations as a result of higher temperatures, unpredictable rainfall, and extended periods of drought. The effects include not just the destruction of ecosystems and the loss of biodiversity, but also a reduction in the quality of life for local populations that are strongly dependent on natural resources for their means of subsistence. Our findings shed light on a concerning pattern: native species of both flora and fauna are seeing a decrease in quantity and distribution, while invading and opportunistic species are gaining ground. Both climate change and human-induced pressures, such as overgrazing, unsustainable farming, and deforestation, are causing the delicate balance that formerly permitted Bhinmal's biodiversity to thrive in difficult conditions to be broken. Climate change is a major contributor to the disruption of this delicate equilibrium. Notably, the research highlights the interdependence of socio-economic and ecological systems, which is an important discovery. The loss of biodiversity in Bhinmal is not just a problem for the environment, but also for the development of the region, since it has direct repercussions for the availability of water, food security, and sustainable livelihoods in rural areas. However, despite their vulnerability, local communities are equally essential to finding a solution. Their traditional knowledge and adaptive practices have the potential to play a crucial role in the preservation of biodiversity and the development of resilience against the effects of climate change, provided that they are supported by policy frameworks that are inclusive. The study highlights the urgent need for multi-layered remedies that integrate scientific research, community participation, and policy reform. These answers combine all three of these elements. Localised, climate-informed, and participatory conservation initiatives are required in Bhinmal in order to guarantee the long-term viability of the conservation efforts. Important efforts that need to be taken next include enhancing ecosystem services, repairing degraded lands, fostering species that are resistant to drought, and incorporating climatic concerns into the planning process for developmental projects. As a conclusion, keeping the biodiversity of Bhinmal in the era of climate change is not just about saving species; it is also about ensuring the future of an area where the well-being of humans and the natural world are closely interwoven. Attaining this equilibrium will need ongoing study, governance that is guided by relevant information, and action pushed by the community.

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