



**CHANGING CLIMATE AND BIODIVERSITY: A LATENT THREAT TO
RAJASTHAN'S TOURISM**

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***Abstract:** The Northwest Indian state of Rajasthan falls in the region of greatest climate sensitivity. It receives very little rainfall, the average of which is less than 75 Centimeters annually; hence, a large part is either arid or semiarid. Due to high temperatures and high evapotranspiration in most parts of the year, it has the maximum probability of occurrence of droughts in India. The severity of droughts is significant for the biodiversity i.e., Flora and Fauna of the region as many species have either become extinct or heading towards extinction. With global climate change, a rise of 20% in monsoon rainfall is projected for India, but a decreasing trend is projected for a large part of Rajasthan. In the future when temperature and evapotranspiration are predicted to increase with global climate change a slight variation could have a greater impact on the biodiversity of this region. The significance of biodiversity is crucial for the state's economy, which largely depends on protected area tourism as it provides a means of livelihood to a large portion of the population. Therefore, with global climate change, biodiversity protection is one of the most significant and major issues for future state policies and needs immediate concern.*

In light of the above facts, this paper will try to find the importance of biodiversity for the state of Rajasthan and future concerns of tourism.

***Keywords:** Climate Change, Biodiversity, Conservation,*

The History of the earth reveals that climate change is not a recent phenomenon as the planet has experienced glacial and interglacial periods in the past. According to Dash (2007) 'among the suggested causes of climate change, across different time scales, are changes in solar radiation and the earth's orbit, continental drift, polar wandering, mountain building, volcanic eruptions, changes in the carbon dioxide(CO₂) content of the atmosphere and changes in the heat stored by oceans'. On average, the global temperature rose by 0.74°C over the last hundred years (1906-2005), with more than half of this rise, 0.44°C, in the last 25 years (ICMOD, 2009). Recent data shows that the rate of change is expected to increase to about 2-5°C in the next 100 years (Groot, 1995; NIC, 2009). This is a matter of grave concern as the changes are comparatively significant as compared to warm periods experienced in the past and their impact on biodiversity may be larger. Apart from these, other factors which govern climate on earth are the complex interactions between the

hydrosphere, atmosphere and biosphere. The interactions and exchange of materials and energy between biotic and abiotic elements on earth go on naturally in the ecosystems till some interference is there. The interference may be due to increased human activity and increased use of resources. During the last 50 years, the levels of carbon dioxide have increased tremendously with the extensive use of fossil fuel on one hand and its lesser intake by reduced vegetation on the other. Vegetation acts as carbon dioxide sinks and Photosynthesis in plants maintain the proportion of this gas in the atmosphere. Due to large-scale deforestation all over the world and especially in the tropics in recent years, the amount of carbon dioxide gas has increased in the atmosphere. Apart from increases in carbon dioxide and consequent increases in temperature, other factors which enrich biodiversity are precipitation, humidity, and soil conditions. According to (Kellogg and Schware, 1982) present deserts or near-deserts would in some areas take a long time to become suitable for agriculture or grazing due to variations in water balance e.g., the Sahara and the Rajasthan Desert of India, would probably not revert for a long period of time to the more favorable soil conditions they apparently enjoyed in the Altithermal Period. Photosynthesis by green plants and respiration by both plants and animals is influenced by carbon dioxide levels and temperature. The variations in temperature, precipitation and the amount of carbon dioxide may affect the aging and dormancy period of plants and many phases in their life cycles like the timing of (de)foliation, leaf-burst, pollination and flowering, the timing of seed-setting and ripening, the length of the growing (or breeding) season, growth and the timing of migration (Groot, 1995). Increased levels of carbon dioxide may slow down seasonal senescence (aging) but may accelerate it due to higher temperatures (*ibid.*). A warm spell may affect the dormancy period of many plants and animals and reduce their fitness level. Their survival may become tough due to increased food requirements and adaptability. On one hand species with several life cycles per year e.g., weedy species, aphids like *Stellaria media*, *Poa annua*, *Senecio vulgaris* and *Capsella bursa-pastoris* may increase but on the other short-lived species may decrease, or outcompete (Ketner, 1990a cf. Groot, 1995). Similarly, the changes may affect the cycles of animals, especially birds as they have different breeding and wintering areas. The most significant changes can be felt by migratory birds which cover long distances, as their timing of migration and the routes are strongly influenced by weather conditions and climate. The various plant and animal interactions may cause a change in the ecosystem energy pyramid and thus the availability of food at various trophic levels. Variations in climate may lead to different zones of species distribution or a shift in flora and fauna e.g., a shift took place from grasslands to desert conditions in the Sahara Desert around 5000 years ago (Kellogg and Schware, 1982). Similarly, 'about 3,500 years ago the boundary between trees and the Arctic tundra in north-central Canada abruptly migrated southward about 300 to 400 kilometers, probably in response to increasing cold and more frequent forest fires that accompanied a general drying of the region and destroyed spruce forests' (*ibid.*). In Europe, a warming of (on average) 3⁰C roughly corresponds with a shift in bioclimatic zones of about 600 km in latitude or about 600 metres in altitude (Groot, 1995). With a latitudinal and altitudinal shift in climatic zones, the species with low migration rates

and low adjustment levels may become threatened by unfavorable conditions of a new environment.

Biodiversity simply means species¹ richness or variation within a species, among species and ecosystems. (IUCN 1993 cf. Jain and Garg, 1997) have defined biodiversity as 'the variability among living organisms from all sources including *interalia* terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part, which includes diversity within species (genetic diversity), between species (species diversity) and of ecosystems (ecosystem diversity)'. Tropical hot and humid regions have the richest biodiversity about 50% of the total which is estimated to be around 7 to 20 million. Biodiversity has ecological and economic importance for human beings. Various plants are used for extracting life-saving drugs like for malaria Quinine from Cinchona, for heart problems Digitalin from Foxglove, pain-relieving Morphine from Poppy plant, Sarpagandha for the treatment of hypertension and anti-cancerous drugs are made from Vinca, Vinblastin & Vincristin plants.

Biodiversity Conservation in India

India has rich biodiversity due to diverse physiographic and climatic conditions and hence it ranks sixth among the 12-mega biodiversity countries of the world (Mandal, 2003). A reference to biodiversity protection in India is found even in ancient hunter-gatherer societies which date back to about 6000 BC (*ibid.*). Efforts towards the conservation of biodiversity started after independence and got momentum during the 1970s. In 1970, the Indian Board for Wildlife drafted a National Wildlife Policy for seeking reasons for wildlife depletion and made specific recommendations for wildlife conservation in the country. Wildlife (Protection) Act in 1972 came with three categories of protected areas: national parks, sanctuaries and closed areas. Forest (Conservation) Act in 1980 regulated the diversion of forestland for non-forestry purposes. Various programmes like the India Eco-Development Project (IEDP) in 1994 and the initiation of major species conservation projects like Project Tiger, Elephant, Rhino, Asiatic Lion, Himalayan Musk Deer, Turtles and Crocodile are the consequences of these efforts.

For the conservation of wildlife both in-situ and ex-situ strategies have been adopted in India. Protecting an endangered species in its natural habitats like national parks and wildlife sanctuaries or the development of a network of protected areas comes under in-situ conservation. Conservation of genetic resources of species away from their area of origin or development is called ex-situ conservation like the collection of wild and domesticated organisms in botanical gardens and zoos, research centers, aquaria and other such locations. According to (EQUATIONS, 2009) India has a total of 650 Protected Areas (96 National Parks, 508 wildlife sanctuaries, 29 tiger reserves, 14 existing biosphere reserves and 3 conservation reserves) and an estimated 2 million of the world's conservation refugees.

¹A group of closely related structurally and functionally similar organisms which interbreed with one another in nature and not with organisms of another group. For more details please refer (Jain and Garg, 1997).

Importance of Biodiversity for Rajasthan

The state of Rajasthan is situated between 23° 3' N to 30° 12' N latitude and 69° 30' E to 78° 17' E longitude with two bio-geographic zones arid and semi-arid separated by 'The Aravalli Hills'. The total land area of the state is about 324,239 square kilometers, out of which about 198,100 square kilometers are arid. Apart from the area drained by the only perennial river Chambal, most of the area is rainfed. The Thar Desert spread over a two-thirds area of the state receives scanty rainfall and faces a high range of temperature, high wind velocity, and dry soil conditions. Out of the total area of the state, forests cover only about 37,638 square kilometers (9.56%) but are rich in biodiversity (Rajasthan State Forest Policy 2010). There are 2500 species of plants, 450 species of birds, 50 species of mammals, 20 species of reptiles and 14 species of amphibians besides numerous species of insects, butterflies, microflora and fauna (Rajasthan State Forest Policy 2010). Biodiversity has been conserved in the form of national parks, sanctuaries and medicinal plant conservation areas called *Orans* or *Dev Vans* and *Gauchars*. Currently, there are two national parks, 25 wildlife sanctuaries and two conservation reserves in the state covering almost all diverse ecosystems of the state and all species of flora and fauna which are part of these biodiversity-rich ecosystems (*ibid.*).

Biodiversity is very important for the state as it fulfills both natural and human demands. Various tribes of Rajasthan use a number of plants and animals for preparing medicines traditionally because western healthcare services are not accessible to poor people (Jain et al., 2008). Jain and his associates conducted a survey and found that tribal people cure ailments with two types of remedies i.e., *Shatriya* cured by plant-based and *Khatiyaby* animal-based remedies. Since the pastoral economy is the mainstay of people as the harsh climate and poor soil conditions do not permit prosperous agriculture and hence, biodiversity plays a significant role in sustaining the population. An example can be given of *Khejari* trees which are an important source of fodder and forage during lean periods as well as during droughts for the sustainability of camel and other livestock in arid regions on which a large population sustains directly or indirectly. Apart from helping in desert stabilization by acting as soil binders *Prosopis juliflora* and *Phogare* the major plants used for fuel by the people. Similarly, *Dhak* (*Butea monosperma*), *Dhawra* (*Annogeissus latifolia*), *Guggal* (*Commiphora wightii*), *Karaya* (*Stercularia aurens*), *Salar* (*Boswellia serrata*) trees are used by people for extracting gum.

Biodiversity is a major contributor towards protected area tourism which has a vital role in the state's economy like Kaoladeo National Park which is a major wintering area for large numbers of aquatic birds and around 370 species of birds from Afghanistan, Turkmenistan, China and Siberia, including the rare Siberian crane have enriched the beauty of this area and attracted a large number of tourists (UNEP). Apart from being one of India's main bird-watching sites, it has a unique assemblage of wetland species, and some 15 species of Ciconiformes nest in the heronry (*ibid.*). Due to their uniqueness, these areas offer ample opportunities for the growth of the tourism industry and diversification of traditional pastoral and dry farming pursuits.

The most important component of Rajasthan's biodiversity is the camel which is symbolic of Rajasthan and its culture and has been used for milk, wool, leather, transportation and a source of employment by the people for generations. It is profoundly integrated into the state economy and ecology that one can not imagine Rajasthan without deserts and camels. It has supported the survival of the Raika community, who are considered to be their guardians as they never raised them for their meat (LPPS, 2005).

Tourism in Rajasthan

Rajasthan has diverse tourist attractions like historical forts, palaces, architectural and heritage sites, temples, festivals, fairs and cultural events, wildlife safaris, nature parks and protected areas. The state attracts around 25% of the total international tourists and about 5% of the total domestic tourists (State of Environment Report for Rajasthan 2007). The state has two national parks, 25 wildlife sanctuaries and two Conservation Reserves created under the provisions of the Wildlife (Protection) Act, 1972 (Rajasthan State Environment Policy 2010). Several sanctuaries and nature parks of Rajasthan are now promoted for eco-tourism, wildlife safaris and adventure tourism. Wildlife sanctuaries like Darrah, Kumbhalgarh, Mount Abu, Phulwari Ki Nal, Bassi, Jawahar Sagar, Todgarh Raoli, Ramgarh, Sariska and National Chambal, and National parks like Keoladeo Ghana National Park, Desert National Park, Ranthambore National Park are important protected areas (http://www.rajasthantravelguide.com/rajasthan_tourism/park.html). The state has world heritage sites such as the Sambhar Lake, wetlands and sacred groves called 'orans'.

Tourism plays a significant role in the state economy and is largely responsible for the social conditions of people as it has promoted local handicrafts and culture, wherein 90% of the household income of artisans is attributed to sales from tourism (Rajasthan State Environment Policy 2010). Though agriculture and animal husbandry are the mainstay of livelihood but tourism acts as a supplement as it diversifies the local economy, particularly for a drought-prone area that cannot support good agriculture. The fastest-growing segment of the tertiary sector has been trade, hotels, and restaurants, which alone account for 15 percent of the Net State Domestic Product (*ibid.*).

Though the State of Environment Report for Rajasthan 2007 claims that 'in next 5 years the inflow of foreign tourists in Rajasthan is likely to increase by more than 4 times at the present rate' but facts point towards a decline as a major part of tourism in Rajasthan is based on the richness of biodiversity in protected areas and availability of rarest species therein. The growth of tourism requires growth in allied activities and infrastructure but a mismatch has led to a degradation of natural and human environmental conditions. A number of commercial establishments have grown in the immediate periphery of every protected area though Wild Life (Protection) Act 1972 disallows those (EQUATIONS, 2009). Large interference in their natural habitats has led biodiversity to degrade in protected areas. According to (Sahani, 2005) fast mechanization in agriculture and transport in recent years under rainfed cropping has caused more damage to the available natural fauna comprising of perennial pastures, *sewan (Lasiurus indicus)*, *dachab (Cyperus rotundus)* and *dhaman (Cenchrus setigerus)*, shrubs or bushes *pala (Ziziphus nummularia)*, *phog (Calligonum polygonoides)*, *senia (Crotalaria burhia)* and important fodder tree-like *khejari*

(*Prosopis cineraria*), etc. The major threats to wildlife species are habitat destruction from the clearing of forests, converting natural grasslands for agriculture, industry and human settlements, use of pesticides, hunting and poaching, the introduction of exotics, and lack of legislative support. Examples of exotic plant species responsible for the extinction of wild species are Hyacinth, Lantana, Eupatorium and Parthenium. The main causes of conflict in the protected areas, which comprise nearly a third of Rajasthan's forests, are undefined boundaries; inadequate relocation packages for the displaced communities; legal and ethical issues related to management plans and pressure of local communities, their livestock and crop damage by the wildlife.

Tiger habitats such as Ramgarh (Bundi), Bhainsrorgarh (Chittorgarh), Darrha (Kota) and Jamua Ramgarh (Jaipur) are degrading due to depleted prey base (Rajasthan State Forest Policy 2010). Similarly, the Great Indian Bustard and other fauna are following a decreasing trend and need conservation by increasing grasslands in Desert National Park Sanctuary (*ibid.*).

Another major concern is the adequate amount of water availability in sanctuaries and lakes which are the lifelines of tourism e.g., allocation of water for maintaining ecosystem services, especially in the Chambal River and the National Chambal Sanctuary which is the only 'Landscape Level Riverine Protected Area' in the country and also the only Tri-State Managed Riverine Protected Area. Similarly, deforestation in the catchment areas of lakes, increase in human settlements and pollution have choked them. For instance, Udaipur city which is highly dependent on its lakes as surface water resources and tourism may face miserable conditions in the future.

The camel which is an integral part of culture and economy and a vital component of the Biodiversity of Rajasthan for ages has come under "orphan commodity." This has become a serious issue when a decline of almost 50% is noticed in their population (LPPS, 2005). Thousands of female camels were sold for slaughter at Pushkar Fair in 2003 and their numbers decreased drastically from 756,088 in 1992 to 498,000 in 2003 (<http://www.indiaenvironmentportal.org.in/node/27554>). Experts from research institutions and non-government organizations from India, France, Germany, Kazakhstan, Oman, the United Arab Emirates and the UK in 'Mammaji-ki-dhuni Memorandum' tried to find out the reasons and solutions for this decline (*ibid.*). Shrinking of grazing areas, a decline in slow-growing *Acacia* trees and destruction of *Jal* plant, expansion of irrigation agriculture, alienation and neglect of community grazing lands, the establishment of wildlife sanctuaries and other reserved areas, disturbance in breeding areas and exclusion in government policies and development programmes were found to be major reasons for this decline (*ibid.*). Some of the camel breeding areas were either reduced by The Indira Gandhi Canal or turned into sanctuaries e.g., Kumbhalgarh. Decline in the camel population will affect a large number of poor families who depend on camels for their living especially the Raika community, who are considered to be their guardians traditionally.

Future Concerns for State Policies

Forest protection and biodiversity conservation are considered important components of forestry and according to Rajasthan state forest policy 2010, awards are given to people and organizations engaged in these activities but the facts narrate a different story. *Prosopis juliflora* and Phog which help in soil binding and stabilising the desert were cut in large numbers to supply fuelwood to neighbouring states for earning profits (Rajasthan state forest policy 2010). Similarly, large-scale degradation of Dhak, Dhawra, Guggal, Karaya, Salar, etc. caused by injuries during the extraction of gum has brought these trees into the category of threatened species.

With global climate change, a rise of 20% in monsoon rainfall is projected for India, but a decreasing trend is projected for a large part of Rajasthan (Singh et al., 2010). In the future when temperature and evapotranspiration are predicted to increase with global climate change a slight variation could have a greater impact on the biodiversity of this region. As a large part of Rajasthan is either arid or semi-arid with scanty vegetation a further reduction in forests will bring more desertification which may increase the intensity of forest fires and may add a large amount of carbon dioxide to the atmosphere.

Variations in climatic variables can cause shifts in forest types and diversity and can endanger the livelihoods of forest-dependent communities. A little increase in temperature in the state may affect a shifting in thermal zones and thus species composition, productivity, distribution and diversity which may further degrade the conditions of villages that are heavily dependent on forest resources.

Although Rajasthan is a drought-prone area, policymakers have favoured and subsidized irrigated agriculture in a big way. Already this has led to a depletion of groundwater supplies in many parts of the state. Over the last 20 years, one-crop rainfed agriculture was replaced with an irrigated two or even three-crop cycle which has further increased the demand for water. Reduced water availability in climate change scenarios will aggravate ground water depletion. The adversity may multiply in a climate sensitive state which already faces water scarcity as there is only one perennial river Chambal. Though ground water contributes 91% of drinking water, out of 237 blocks in Rajasthan, only 49 are safe in terms of ground water while 101 are critical and semi-critical and 86 are overexploited (Singh et al., 2010). Based on the WHO guidelines for drinking-water quality about 56% of the water sources are un-potable (*ibid.*). Further decrease in the amount of water in the future may outcompete many short-lived species essential for the economic and ecological sustainability of the state.

Climate change may affect protected area tourism by affecting biodiversity in areas already degraded due to human exploitation. A series of droughts in 2004, 2006 and 2007 in the state affected water availability in Keoladeo National Park and increased the growth of weed-like water hyacinth and knotweed which forced many birds to leave the area. It is the last known wintering ground in India of the western population of Siberian crane *Grus leucogeranus* whose number declined drastically and in 1996, only four birds wintered in the park whereas, in 1997 two adults and a young bird were seen (Milne, 1997 cf. UNEP).

Studies show that pesticide use in surrounding areas, heavy metal contamination, hunting by nomadic tribes and lack of suitable habitat have affected the migration pattern of Siberian cranes, which used to occur throughout the entire Indo-Gangetic plains of India but now they have deserted the area. Similarly, the extinction of the tiger (*Panthera tigris*) from two protected areas Sariska Tiger Reserve and Kailadevi Wildlife Sanctuary (Reddy, 2008) is an issue for the region's ecology and economy.

Though it is widely accepted that tourism has a negative impact on the environment and on indigenous & local communities but government policies promote it and especially in protected areas as ecotourism. The National Tourism Policy of 2002 clearly states – “wildlife sanctuaries and national parks need to be integrated as an integral part of the India tourism product, and priority needs to be given to the preparation of site and visitor management plans for key parks, after a prioritization of parks” (EQUATIONS, 2009).

Suggestions

- In future a slight variation in climatic variables may affect biodiversity which is very important for Rajasthan's ecology and economy and hence long-term solution should be made in advance for both economic and ecological gains.
- Rights of communities living in these areas should be protected and they should be integrated in the system in such a way that they themselves take the responsibility of conserving their environment.
- Traditional ecological knowledge of agricultural practices, crop varieties, animal breeds, and livelihood practices based on the management of agro-pastoral resources should not be banished as it could be effective in more arid and water scarcity conditions.
- Threatened species of flora and fauna should be given priority in policies and efforts should be done to increase their number by creating gene banks.
- People should be educated about conserving their environment and the intrinsic value of biodiversity.
- Drought-resistant species with the help of Biotechnology should be produced for desert stabilization and to support agriculture in a climate changed conditions.
- Since protected area tourism is a source of supplementing the economy its management should be such that resources are not stressed.

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