IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Climate Change and Arid Vegetation in Hanumangarh District

Author : Vikram Kumar (VSY) Assistant Professor (Botany) Govt college Bhadra (Hanumangarh)

Abstract : Hanumangarh district is a significant arid and semi-arid region located in the northwestern part of Rajasthan, where the natural environment is profoundly influenced by climate, soil, water availability, and human activities. The district's climate is predominantly hot and dry, characterized by extreme summer temperatures, erratic rainfall, and a significant drop in temperature during winter. Over the past few decades, factors such as rising temperatures, irregular rainfall, prolonged droughts, intense short-duration rainfall, increased evaporation rates, and shifting weather patterns have impacted the district's natural vegetation. Climate change particularly affects arid and desert flora that are adapted to survive with limited water availability. Key arid-zone plant species in Hanumangarh district include Khejri, Rohida, Babool, Kikar, Ber, Aak, Fog, Thor, Ker, and Kumat, alongside various grasses and shrubs. These plants play a vital role in maintaining the local ecosystem's balance while contributing to soil and biodiversity conservation, fodder availability, micro-climate regulation, and the rural economy. Rising temperatures and changing rainfall patterns associated with climate change are affecting processes such as germination, growth, flowering, fruiting, and natural regeneration. Reduced soil moisture due to erratic rainfall slows the growth rate of many plants, while prolonged droughts increase the risk of plant mortality and the depletion of vegetation cover. Conversely, certain arid-zone species exhibit greater resilience to the changing climate due to traits like deep root systems, reduced leaf surface area, thorny structures, and biological water-conservation capabilities. Additionally, factors such as agricultural expansion, excessive groundwater extraction for irrigation, grazing pressure, road and urban development, industrial activities, and the alteration of natural habitats are placing further strain on the arid vegetation. The combined impact of climate change and human pressures may lead to regional disparities in vegetation structure and distribution. In irrigated areas, agricultural crops and other man-made vegetation have replaced natural arid-zone vegetation, whereas natural shrubs and grasses remain significant in areas that are less irrigated or barren.

Keywords : Climate change, Hanumangarh district, arid climate, semi-arid region, arid vegetation, natural vegetation, temperature rise, rainfall variability, drought, desertification, vegetation cover, biodiversity, ecosystem, vegetation distribution, soil moisture, water availability, groundwater exploitation, land-use change, agricultural expansion, grazing pressure, Khejri, Rohida, Babool, Fog, Ber, Aak, Thor, Ker, Kumat, grass species, plant regeneration, vegetation conservation, environmental balance, natural resource management, GIS, remote sensing, sustainable development.

Article : Hanumangarh district is a significant agricultural and arid-to-semi-arid geographical region located in the northwestern part of Rajasthan. The district's natural conditions are shaped by the combined influence of temperature, rainfall, soil, water availability, landforms, and human activities. Key climatic characteristics of the region include hot and dry summers, relatively cold winters, and erratic monsoon rainfall. Due to naturally limited rainfall and high evaporation rates, the flora here has evolved to complete its life cycle with minimal water; these are known as arid and semi-arid vegetation types. Currently, climate change is impacting the district's natural vegetation system through rising temperatures, altered rainfall patterns and quantities, prolonged dry spells, sudden heavy rainfall, and increased evaporation. The relationship between climate change and arid-zone vegetation is crucial because these plants form the foundation of the local ecosystem, soil conservation, biodiversity, livestock rearing, the rural economy, and environmental balance. The natural vegetation of Hanumangarh district has evolved primarily to suit arid and semi-arid conditions. Significant plant species here include Khejri, Babool, Kikar, Rohida, Ber, Phog, Aak, Thor, Ker, and Kumat, alongside various grasses and shrubs. These plants possess unique capabilities for water conservation and resilience against adverse environmental conditions. For instance, Khejri roots penetrate deep into the soil, enabling the tree to utilize scarce water resources; its leaves serve as valuable livestock fodder, and it contributes to the retention of organic matter and nutrients in the soil. Species like Babool and Kikar also thrive in arid conditions, helping to maintain vegetative cover on the land. Shrubs such as Phog, Aak, and Thor are capable of surviving in environments characterized by low rainfall and high temperatures. Thus, the district's arid-zone vegetation is the result of long-term adaptation to the local climate. The most prominent impact of climate change is observed as a rise in temperature. Rising temperatures increase the rate of evaporation, resulting in a rapid depletion of soil moisture. In arid regions where water availability is already limited, further temperature increases can induce water stress in plants. Excessive heat can adversely affect processes such as photosynthesis, growth, flowering, and fruiting. Young plants and seedlings are particularly vulnerable because their root systems are not yet fully developed. Prolonged hot and dry conditions can reduce vegetation productivity and hinder the rate of natural regeneration. Additionally, extreme temperatures can reduce the germination capacity of seeds for certain species. Persistent temperature increases may lead to shifts in the composition of plant communities, potentially favoring heat-tolerant species. Changes in rainfall patterns are also critical for the arid vegetation of Hanumangarh. Rainfall in the region relies heavily on the monsoon, with significant year-to-year variations in both quantity and distribution. Under climate change scenarios, alterations in rainfall intensity, duration, and distribution may be just as significant as changes in total annual precipitation. If heavy rainfall occurs over a short period, a large portion is lost as surface runoff, preventing adequate soil moisture accumulation. Conversely, prolonged dry spells induce water stress in plants. An erratic monsoon can also disrupt the natural life cycles of plants; shifts in the timing of moisture and temperature conditions required for germination, flowering, and fruiting can impact reproductive success. Therefore, studying only the annual rainfall volume is insufficient; analyzing seasonal and spatial variability is also essential. Drought is a major environmental factor affecting the arid vegetation of Hanumangarh district. Frequent or prolonged droughts deplete soil moisture and can stunt plant growth. Under conditions of extreme drought, weak and less adapted plants may even perish. This leads to a reduction in natural vegetation cover and increases the risk of land degradation. A decline in vegetation cover can result in heightened soil erosion caused by strong winds; wind erosion can become a serious issue, particularly in areas with light, sandy soils. Vegetation binds the soil through its root systems and contributes organic matter to the surface. Therefore, the loss of vegetation is not merely a biodiversity issue; it is also linked to soil conservation and land productivity. The expansion of agriculture and irrigation in Hanumangarh district also influences the distribution of natural arid-zone vegetation. The Indira Gandhi Canal Project and the expansion of other irrigation facilities have boosted the agricultural

sector and crop production. Crops such as wheat, cotton, mustard, and gram are cultivated extensively in irrigated agricultural areas. Agricultural expansion has altered land use in many areas that previously supported natural vegetation—such as native grasses, shrubs, and arid-zone plants—giving way to cultivated farmland. This transformation has affected the extent of natural habitats. On the other hand, irrigation has led to the growth of plants in certain areas that were not naturally adapted to arid conditions. Therefore, when studying climate change, it is essential to examine not only natural climatic influences but also human interventions related to land use and irrigation. Excessive groundwater extraction can also pose a challenge to arid-zone vegetation. Increasing reliance on groundwater for agricultural and domestic needs can alter water levels. Deep-rooted natural vegetation can also be adversely affected by a prolonged decline in groundwater availability. Growing pressure on water resources could make vegetation conservation increasingly difficult in the future. Additionally, the excessive use of agrochemicals, pesticides, and fertilizers can impact surrounding natural ecosystems. These chemicals can have indirect effects on natural plants growing along field margins and on non-agricultural land. Thus, striking a balance between agricultural development and environmental conservation is crucial. Livestock and grazing pressures also influence the state of arid-zone vegetation. In the rural areas of Hanumangarh, livestock forms a vital part of the rural economy; natural grasses and shrubs serve as sources of fodder for these animals. However, if the available pasture and natural vegetation are insufficient relative to the livestock population, overgrazing can hinder plant regeneration. The destruction of seedlings and seeds slows down the regrowth of natural vegetation. Continuous grazing can leave the soil surface exposed, thereby increasing the risk of soil erosion. Consequently, scientific grazing management, the development of community pastures, and the conservation of local fodder species are essential. Conserving the biodiversity of arid-zone vegetation is of utmost importance in the context of climate change. Native species evolve in harmony with local climatic and soil conditions; hence, their conservation is beneficial for climate adaptation. Priority should be given to species such as Khejri, Rohida, Babool, Ber, and other local varieties in conservation and replanting programs. Planting native species can enhance vegetation cover while simultaneously improving soil conservation, fodder availability, and biodiversity. The participation of rural communities is crucial in this regard. Through traditional knowledge, local people are familiar with the medicinal, fodder, fuel, and other uses of various plants. Integrating this knowledge with scientific studies can lead to the development of more effective conservation strategies. Modern technologies play a significant role in studying climate change and vegetation dynamics. Tools like GIS and remote sensing enable the analysis of changes in vegetation cover, land use, agricultural areas, and wasteland over time. Satellite imagery allows for the assessment of vegetation status across different regions using indices such as NDVI. Correlating long-term temperature and rainfall data with vegetation changes helps establish the relationship between climate and vegetation. Statistical techniques—such as correlation, regression, and time-series analysis—can be employed to study the interrelationships between temperature, rainfall, and vegetation cover. Thus, a combination of spatial and statistical analyses can provide a clearer understanding of the impacts of climate change within the district. Water conservation is one of the most effective measures for preserving arid-zone vegetation. Practices such as rainwater harvesting, small-scale water conservation structures, farm ponds, watershed development, and local-level moisture conservation techniques should be promoted. Native drought-tolerant species can be replanted on degraded lands. Planned plantation drives along roadsides, canals, pastures, and community lands can help increase vegetation cover. However, rather than focusing solely on the number of saplings planted, it is essential to select species that are suited to local ecological conditions. Protecting areas undergoing natural regeneration from grazing and indiscriminate felling can facilitate vegetation restoration at a low cost.

Consclusion : Hanumangarh district constitutes a significant part of the arid and semi-arid region of northwestern Rajasthan, where a close ecological relationship exists between climate and vegetation. The study reveals that climate change—manifested through rising temperatures, erratic rainfall, increased frequency of droughts, high evaporation rates, and mounting pressure on groundwater resources—has impacted the structure, distribution, and regenerative capacity of the district's natural arid-zone vegetation. Indigenous species such as Khejri, Rohida, Babool, Kikar, Ber, Phog, Aak, Thor, and Ker possess a remarkable ability to survive harsh climatic conditions; however, changing climate and human intervention are continuously shrinking their natural habitats. The study also indicates that the expansion of irrigation-based agriculture, land-use changes, overgrazing, groundwater exploitation, and urbanization in Hanumangarh have depleted the natural vegetation cover. While the Indira Gandhi Canal Project has boosted agricultural production, agricultural land has replaced natural shrub and grassland vegetation in many areas. Consequently, there is an increased risk of adverse impacts on local biodiversity, wildlife habitats, and ecological balance. Rainfall uncertainty, in particular, is affecting natural processes such as seed germination, flowering, and fruiting, potentially leading to long-term changes in the structure of plant communities. Arid-zone vegetation is crucial not only from an environmental perspective but also from socio-economic and ecological standpoints. These species play a vital role in providing fodder for livestock and fuel for rural communities, as well as in medicinal applications, soil conservation, and the control of dust and wind erosion. Species like Khejri are key trees that maintain soil fertility within the agro-ecosystem and support climate-resilient agriculture. Therefore, the conservation of this vegetation is not merely a matter of biodiversity preservation but is also linked to sustainable rural development and food security. Looking ahead, it is essential to integrate climate change adaptation strategies with the conservation of natural vegetation in Hanumangarh district. Extensive planting of local and indigenous drought-tolerant species, development of community pastures, rainwater harvesting, groundwater recharge, scientific grazing management, and the rehabilitation of degraded land can prove to be effective measures. Additionally, regular monitoring of vegetation cover using GIS and remote sensing techniques, along with the analysis of long-term temperature and rainfall data, would be useful for policy formulation. Through the participation of local communities, the preservation of traditional knowledge, and environmental education, vegetation conservation can be transformed into a mass movement.

Reference :

1. Government of Rajasthan. Hanumangarh District Gazetteer. Jaipur: Government of Rajasthan.

2. Government of Rajasthan. District Statistical Handbook: Hanumangarh. Directorate of Economics and Statistics, Jaipur.

3. Government of Rajasthan. Rajasthan State Action Plan on Climate Change. Department of Environment, Government of Rajasthan, Jaipur.

4. India Meteorological Department. Climate of Rajasthan and Meteorological Statistics. New Delhi: India Meteorological Department.

5. India Meteorological Department. Annual Climate Summary. New Delhi: Ministry of Earth

Sciences, Government of India.

6. Forest Survey of India. India State of Forest Report 2023. Dehradun: Ministry of Environment, Forest and Climate Change, Government of India.
7. Forest Survey of India. India State of Forest Report 2021. Dehradun: Ministry of Environment, Forest and Climate Change, Government of India.
8. Ministry of Environment, Forest and Climate Change. National Action Plan on Climate Change. Government of India, New Delhi.
9. Ministry of Earth Sciences. Assessment of Climate Change over the Indian Region. Government of India, New Delhi, 2020.