Journal of Science Research International (JSRI)
ISSN: 2456-6365 (Online)

OPEN ACCESS

APPLICATION OF ARTIFICIAL INTELLIGENCE IN ENVIRONMENTAL GEOGRAPHY: A GEOGRAPHICAL ANALYSIS

Ranjeet Baburao Pawar

Department of Geography,

Ajara Mahavidyalaya, Ajara, Kolhapur 416505, (M. S.) India.

**Corresponding author E-mail: ranjitpawar75@gmail.com*

Received: 15 January 2025	Revised: 13 February 2026	Accepted: 11 March 2026	Published: 28 March 2026

DOI: **https://doi.org/10.5281/zenodo.19273126**

Abstract:

In the twenty-first century, environmental systems are changing rapidly due to industrial growth, urbanisation, overuse of natural resources, and climate change. These complex and spatial processes require advanced technological tools beyond traditional research methods. Artificial Intelligence (AI) has become an important tool in environmental geography for analysing large spatial and temporal datasets. AI is widely used in satellite image analysis, remote sensing classification, climate prediction, biodiversity monitoring, land use assessment, and disaster management. Machine learning techniques help identify patterns, trends, and environmental risks more accurately and efficiently. This study examines the role and applications of AI in environmental geography. It highlights how AI improves prediction accuracy, supports scientific decision-making, and enhances sustainable development planning. However, concerns such as data bias, technological inequality, lack of transparency, and ethical issues must be addressed to ensure the responsible and sustainable use of AI in environmental management.

Keywords: *Artificial Intelligence, Environmental Geography, Geospatial Analysis, Climate Change, Sustainable Development, Machine Learning.*

1. Introduction

Environmental geography examines the interactions and interrelationships between human societies and natural systems within spatial and temporal contexts (1, 2). Environmental systems are continuously evolving due to both natural processes and anthropogenic activities. Issues such as global warming, climate change, deforestation, soil and water pollution, biodiversity loss, sea-level rise, and rapid urban expansion are complex and interconnected (3). Their impacts extend beyond local boundaries and are evident at regional and global scales.

Traditional statistical and linear analytical methods have contributed significantly to environmental studies; however, they possess limitations when dealing with extensive spatial and temporal datasets (4). Contemporary environmental research relies heavily on large volumes of data derived from satellites, climate models, sensor

networks, unmanned aerial vehicles (UAVs), and real-time monitoring systems (5). The analysis of such vast datasets necessitates advanced computational techniques.

In this regard, the integration of Artificial Intelligence, machine learning, deep learning, and Geographic Information Systems (GIS) has established a new foundation for environmental research (6). These technologies enable the identification of spatial patterns, generation of predictive models, assessment of environmental risks, and effective resource planning. AI has significantly enhanced climate analysis, land use studies, biodiversity mapping, and disaster early-warning systems, thereby making environmental decision-making more scientific and efficient (7).

2. Research objectives

The primary aim of this research is to examine the applications of Artificial Intelligence in environmental geography. The specific objectives are as follows:

i. To analyse the major applications, methodologies, and effectiveness of AI in environmental geography.
ii. To clarify the role of AI in environmental prediction and policy decision-making processes.
iii. To critically examine the technical limitations, data bias, lack of transparency, and ethical implications associated with AI.
iv. To propose a conceptual framework integrating geospatial technology and AI for sustainable environmental governance.

3. Research methodology

This research is based on a qualitative and analytical approach and relies mainly on secondary data available through internet-based academic sources. The study is conceptual in nature and focuses on understanding the applications of Artificial Intelligence in environmental geography through existing literature and digital information resources. Relevant information was collected from peer-reviewed academic journals, research articles, environmental reports, policy documents, and official publications available online. Important sources include the websites and digital databases of international organisations such as the Intergovernmental Panel on Climate Change (3) and the United Nations Environment Programme (8).

4. Major applications of artificial intelligence in environmental geography

In the study of environmental geography, Artificial Intelligence has emerged as an effective tool for data-based analysis, prediction, and policy-making. It helps analyse large amounts of environmental data related to space and time. By doing this, AI plays an important role in identifying patterns, trends, and possible risks in complex environmental processes (7).

4.1 Climate change and prediction

Climate change represents one of the most pressing global environmental challenges. Rising temperatures, irregular precipitation patterns, sea-level rise, and an increased frequency of extreme weather events require comprehensive long-term data analysis (3). AI analyses historical climate data, including temperature records, precipitation trends, greenhouse gas concentrations, and ocean temperature variations, in order to predict future climatic patterns.

It is particularly useful in forecasting extreme events such as cyclones, droughts, floods, and heat waves. These predictive capabilities support disaster preparedness and reduce potential human and economic losses. AI is also

applied in carbon emission mapping and climate risk assessment, thereby assisting policymakers in formulating sustainable development strategies (8).

4.2 Land use and land cover analysis

Land use and land cover changes provide direct evidence of human impacts on the environment. AI facilitates the automated analysis and classification of satellite imagery to detect changes over time (5). It enables the monitoring of deforestation, urban expansion, agricultural land transformation, desertification processes, and glacier retreat. Compared with traditional methods, AI offers greater speed, consistency, and accuracy (4). Such analysis supports urban planning, forest conservation, water resource management, agricultural planning, and climate adaptation strategies (6).

4.3 Biodiversity and ecosystem conservation

Biodiversity forms the foundation of ecological stability and sustainability. However, climate change, habitat destruction, pollution, and human activities pose significant threats to species and ecosystems (1).

AI-based image recognition systems analyse satellite imagery and camera trap data to identify and monitor wildlife populations. Acoustic monitoring techniques further allow the detection of species presence through sound analysis. Additionally, AI models can predict species distribution patterns based on climatic variables and land cover changes. This assists in identifying endangered species and prioritising conservation areas (2).

4.4 Disaster management

Natural disasters, including floods, landslides, wildfires, cyclones, and extreme rainfall events, are increasing in frequency and intensity due to climate change (3). AI supports the creation of risk maps through the integrated analysis of topography, soil characteristics, precipitation, temperature, vegetation cover, and human settlements. This enhances early warning systems and disaster preparedness planning. Following disasters, AI analyses satellite and drone imagery to assess infrastructure damage, agricultural loss, and environmental impact, thereby facilitating efficient relief and rehabilitation efforts (7).

4.5 Water resource management

AI is utilised to monitor water availability, groundwater levels, river flow patterns, and drought conditions. By analysing precipitation data, land use patterns, and climatic variables, AI supports sustainable water management and distribution planning (8).

4.6 Air pollution and urban environment

Rapid urbanisation has intensified air pollution and associated public health risks. AI predicts the Air Quality Index (AQI) by analysing data from pollution monitoring stations, including particulate matter, nitrogen oxides, sulphur dioxide, and ozone levels (7).

This enables authorities to implement preventive measures and issue public advisories. AI also identifies pollution hotspots by examining traffic density, industrial distribution, population concentration, and meteorological conditions. Furthermore, AI-based analysis of satellite imagery assists in studying the Urban Heat Island effect by identifying areas experiencing elevated temperatures due to reduced vegetation cover and dense construction (5).

5. Challenges and limitations of AI

Although AI has advanced environmental analysis from descriptive to predictive and prescriptive levels, several challenges remain:

- Data bias: Incomplete or unevenly distributed datasets may produce biased outcomes, particularly in regions with limited data availability.
- Technological inequality: Advanced computational infrastructure and skilled personnel are not equally accessible worldwide, leading to disparities in environmental governance.
- High energy consumption: Deep learning models require substantial computational power, potentially increasing energy use and carbon emissions (8).
- Lack of transparency: Certain AI models operate as 'black boxes', making their decision-making processes difficult to interpret and explain.
- To ensure responsible and sustainable use, international standards, ethical guidelines, and transparent operational frameworks must be developed (7).

Conclusion

Artificial Intelligence has emerged as a transformative tool in environmental geography. Its capacity to analyse extensive spatial and temporal datasets, identify patterns, and generate accurate predictions has significantly enhanced environmental research. AI has strengthened climate change analysis, biodiversity conservation, disaster management, land use monitoring, and urban environmental planning. It improves analytical precision, operational efficiency, and the scientific basis of decision-making (3).

However, concerns regarding data bias, technological inequality, energy consumption, and transparency must be carefully addressed. Ethical considerations, social equity, and accountability are essential for the sustainable application of AI. Artificial Intelligence does not replace environmental geography; rather, it functions as a supportive technological system that enhances geographical analysis. Through a human-centred approach, transparent methodologies, and sustainable policy frameworks, AI can contribute effectively to long-term environmental management.

References

1. Singh, S. (2015). *Environmental geography*. Prayag Pustak Bhawan.
2. Kumar, S., & Singh, R. (2018). *Environmental geography*. Rawat Publications.
3. Intergovernmental Panel on Climate Change (IPCC). (2023). *Climate change 2023: Synthesis report*. IPCC.
4. Bhatta, B. (2011). *Remote sensing and GIS*. Oxford University Press.
5. Reddy, M. A. (2014). *Geographical information systems and remote sensing*. B.S. Publications.
6. Roy, P. S., & Joshi, P. K. (2017). *Geospatial technology for environmental management*. TERI Press.
7. World Bank. (2021). *World development report 2021: Data for better lives*. World Bank.
8. United Nations Environment Programme (UNEP). (2022). *Emissions gap report 2022*. UNEP.