

REMOTE SENSING AND ENVIRONMENTAL GEOGRAPHY IN NIGERIA: RELEVANCE, CHALLENGES AND PROSPECTS

¹Dr. Clarke Tarelayefa & ²Dr. Numoipre Inainfe

¹07060440235, Clarketare@gmail.com, ²08136458331, numoipreokwuwe@gmail.com

^{1&2}Department of Geography Education, Isaac Jasper Boro College of Education
Sagbama Bayelsa State, Nigeria

Abstract

This study examines the relevance, challenges, and prospects of remote sensing in environmental geography in Nigeria. Remote sensing has become an important tool for observing and analyzing environmental conditions without direct contact, while environmental geography provides a framework for understanding the interaction between human activities and the physical environment. The study reveals the usefulness of remote sensing in environmental monitoring, disaster management, urban planning, agriculture, and climate change studies across different parts of Nigeria, it also reveals challenges affecting its effective use, including high cost of technology, shortage of skilled personnel, poor data accessibility, inadequate funding, weak institutional coordination, and infrastructure limitations such as unreliable power supply and internet access. The study observes positive prospects such as technological advancement, increasing availability of satellite data, growing interest from government and private sector actors, expansion of training opportunities, and integration with Geographic Information Systems and artificial intelligence. The study concludes that remote sensing is highly valuable for environmental management in Nigeria and recommends increased funding, improved training, better data access policies, and stronger collaboration among stakeholders to enhance its effective application for sustainable development.

Keywords: *Remote sensing, Environmental geography, Disaster management, Urban planning and physical environment*

Introduction

The increasing pressure on the earth's surface from human activities and natural processes has made the need for accurate environmental information more urgent than ever before. Across the world, the ability to observe, measure, and understand environmental changes has moved from being a scientific interest to a practical necessity for planning and survival. In this regard, remote sensing and environmental geography have gained attention as valuable fields that support the monitoring and management of environmental resources. Their combined application offers a way to understand patterns of change over time and space, which is especially important in countries where environmental challenges are becoming more frequent and severe.

Remote sensing refers to the science of collecting information about the earth without direct contact, often through satellites, drones, and aerial sensors (Jensen, 2022). It allows researchers and decision makers to obtain data on land use, vegetation, water bodies, and atmospheric conditions from a distance. Environmental geography, on the other hand, focuses on the relationship between humans and their physical surroundings, with attention to how human actions influence natural systems and how environmental changes affect human well being (Campbell & Wynne, 2023). When these two fields are used together, they provide a structured approach for studying environmental conditions and changes in a way that is both systematic and evidence based.

Globally, the importance of remote sensing and environmental geography continues to grow due to rising concerns about climate change, resource depletion, and environmental hazards. Remote sensing has made it possible to track melting ice, monitor forest cover, assess air quality, and observe ocean conditions over long periods. At the same time, environmental geography provides

the framework for interpreting these observations in relation to human activities and policies (Campbell & Wynne, 2023). For instance, global efforts to monitor climate patterns rely heavily on satellite data, which helps scientists understand temperature changes and rainfall variations across continents (Hansen et al., 2023). This information supports environmental planning and policy decisions, showing how scientific tools can influence decision making at different levels.

In addition, the global use of remote sensing has improved disaster preparedness and response. Early warning systems for hurricanes, floods, and wildfires depend on satellite imagery and geospatial analysis (Weng, 2023). Environmental geography complements this by explaining the human factors that increase vulnerability, such as settlement patterns and land use practices (Campbell & Wynne, 2023). As a result, countries are better equipped to reduce risks and respond more effectively when disasters occur. Furthermore, remote sensing has become essential in agriculture, where it is used to monitor crop health, soil moisture, and weather conditions, thereby supporting food production and resource management.

While these applications are evident at the global level, their relevance is even more pronounced in Nigeria, where environmental challenges are closely linked to population growth, urban expansion, and resource use. Nigeria has experienced rapid urbanization, especially in cities such as Lagos, Abuja, and Port Harcourt, leading to increased pressure on land and infrastructure (Akinyemi & Adepoju, 2023). Remote sensing provides a reliable means of tracking these changes, while environmental geography helps to explain their causes and consequences. Together, they offer practical tools for planning and managing urban growth in a way that reduces environmental stress. Moreover, Nigeria's dependence on natural resources such as oil and agriculture makes environmental monitoring very important. Remote sensing can be used to assess changes in vegetation, detect oil spills, and monitor water bodies, which are essential for both economic activities and human survival (Oladipo, 2022). Environmental geography adds value by examining how these environmental changes affect livelihoods, health, and social stability. This combined approach is useful for policy makers who need accurate information to guide development decisions (Oladipo, 2022).

However, Nigeria faces several environmental issues that require urgent attention, and these issues further highlight the relevance of remote sensing and environmental geography. Flooding is one of the most common and destructive problems in the country. Seasonal floods affect many parts of Nigeria, especially coastal and riverine areas, leading to loss of lives, displacement of people, and damage to property (Adelekan, 2023). Poor drainage systems, unplanned settlements, and changing rainfall patterns contribute to this problem. Remote sensing allows for the mapping of flood prone areas and the monitoring of water levels, while environmental geography explains the human and physical factors that increase flood risks (Adelekan, 2023).

In a similar manner, deforestation remains a serious concern in Nigeria. Large areas of forest are cleared for agriculture, fuel wood, and urban development, which leads to loss of biodiversity and soil degradation (Olagunju, 2022). Satellite imagery has shown a steady decline in forest cover over the years, providing clear evidence of the scale of the problem. Environmental geography helps to connect this trend with population growth, poverty, and weak environmental policies, offering a deeper understanding of why deforestation continues despite its known effects (Olagunju, 2022). Oil exploration and production activities have resulted in frequent spills, which contaminate soil and water, destroy aquatic life, and affect the health of local communities (Nriagu et al., 2023). Remote sensing technologies can detect and monitor the spread of oil in water bodies and on land, making it easier to assess the extent of damage. Environmental geography complements this by examining the social and economic implications of oil pollution, including conflicts and loss of livelihood (Nriagu et al., 2023).

It becomes clear that the integration of remote sensing and environmental geography is not just desirable but necessary for Nigeria's development. The ability to generate accurate environmental

data and interpret it within a human context provides a strong basis for informed decision making. This is particularly important in a country where environmental problems are closely linked to economic activities and population pressures. By using these tools effectively, Nigeria can improve its capacity to manage natural resources, reduce environmental risks, and promote sustainable development. Therefore, this study seeks to examine the relevance of remote sensing in environmental geography within the Nigerian context, identify the key challenges that limit its effective use, and explore the prospects for its future development.

Literature Review

Remote Sensing

The ability to observe the earth from a distance has transformed how environmental information is gathered and understood in modern times. Remote sensing is defined as the science of acquiring information about objects, areas, or phenomena without direct physical contact, typically through the use of sensors mounted on satellites, aircraft, or drones (Jensen, 2022). These sensors capture data by detecting energy that is reflected or emitted from the earth's surface, which is then processed into images and datasets for analysis. Through this process, remote sensing provides a systematic way of studying environmental features such as vegetation, water bodies, soil conditions, and atmospheric elements. Remote sensing operates on the principle that different surfaces interact with electromagnetic energy in distinct ways. For instance, vegetation reflects energy differently from water or bare soil, which allows sensors to distinguish between these features (Campbell & Wynne, 2023). The data collected are often presented as digital images that can be interpreted visually or analyzed using computer software. This makes remote sensing a reliable tool for detecting patterns and changes over time. In addition, the repeated coverage of the same area enables the monitoring of gradual environmental changes, such as shifts in land use or variations in climate conditions (Weng, 2023).

Furthermore, remote sensing is valuable because it provides access to areas that may be difficult to reach through direct observation. It also allows for the collection of large amounts of data within a short period, which supports regional and global analysis. Advances in sensor technology and data processing have improved the accuracy and resolution of remote sensing data, making it more useful for research and decision making (Jensen, 2022). As a result, remote sensing has become widely applied in environmental studies, agriculture, urban planning, and disaster management, where timely and reliable information is essential.

Environmental Geography

A proper understanding of environmental processes requires attention to both natural systems and human activities, and this is where environmental geography becomes highly relevant. Environmental geography is a branch of geography that examines the interaction between humans and their physical environment, with a focus on how human actions influence natural systems and how environmental changes affect human well being (Castree, 2022). It brings together elements of physical geography and human geography to provide a comprehensive perspective on environmental issues. Environmental geography is concerned with studying spatial patterns and relationships in the environment. It seeks to explain why certain environmental conditions exist in specific locations and how these conditions change over time. For example, it can be used to analyze the effects of urban expansion on vegetation or the impact of agricultural practices on soil quality (Turner, 2023). By examining these relationships, environmental geography provides a deeper understanding of the causes and consequences of environmental problems.

In addition, environmental geography emphasizes the role of human decisions, policies, and economic activities in shaping environmental outcomes. It recognizes that many environmental challenges are linked to how resources are used and managed. As such, it supports the development

of strategies that aim to balance human needs with environmental protection. The field also makes use of scientific data and analytical methods to study environmental conditions, often drawing from tools such as remote sensing and field observation (Castree, 2022). This approach allows for a more informed and systematic analysis of environmental issues.

Moreover, environmental geography contributes to environmental planning and management by providing information that can guide decision making. It helps to identify areas that are vulnerable to environmental risks and suggests ways to reduce these risks. As environmental challenges continue to increase in many parts of the world, the importance of environmental geography becomes more evident, as it offers a structured way to understand and address these issues in both local and global contexts (Turner, 2023).

Geographic Information Systems (GIS)

The growing need to manage and analyze spatial data has led to the development of tools that can handle large amounts of location based information with accuracy and efficiency. Geographic Information Systems, commonly known as GIS, refer to computer based systems designed for capturing, storing, analyzing, and displaying spatial data (Longley et al., 2023). These systems allow users to work with data that are linked to specific geographic locations, making it possible to visualize patterns and relationships on maps. GIS plays an important role in environmental studies by providing a platform for integrating different types of data into a single system. For instance, it can combine information on land use, population, vegetation, and climate to produce maps and models that support analysis and decision making (Longley et al., 2023). This ability to integrate data from various sources makes GIS a powerful tool for understanding complex environmental issues. It also allows users to perform spatial analysis, such as measuring distances, identifying patterns, and examining relationships between different variables.

In addition, GIS supports the visualization of spatial information through maps and graphical displays, which makes it easier to communicate findings to a wider audience. This is particularly useful in planning and policy making, where clear and accurate information is required. GIS is often used alongside remote sensing, as it provides a means of organizing and interpreting the data obtained from satellite imagery (Weng, 2023). The combination of these tools enhances the ability to analyze environmental conditions in a systematic manner.

Furthermore, advances in computer technology have increased the accessibility and application of GIS in various fields. It is now widely used in urban planning, environmental management, disaster response, and resource allocation. The ability of GIS to handle large datasets and provide detailed spatial analysis has made it an essential tool for researchers and practitioners. When applied effectively, GIS supports better understanding of environmental processes and contributes to informed decision making in addressing environmental challenges.

Theoretical Framework **Systems Theory**

The study is anchored on Systems Theory, which was propounded by Ludwig von Bertalanffy in 1968. The theory explains the environment as a set of interconnected components that interact to form a unified whole. It assumes that changes in one part of the system can influence other parts, making it important to study environmental issues in a comprehensive manner. In environmental geography, Systems Theory provides a basis for understanding the relationship between human activities and natural processes, and how these interactions result in environmental outcomes such as flooding, deforestation, and land degradation (Meadows, 2008; Turner, 2023).

Furthermore, Systems Theory supports the use of remote sensing as a tool for observing and analyzing different components of the environment at the same time. Through satellite data and

spatial analysis, it becomes possible to monitor land use changes, vegetation patterns, and water systems, which are all parts of the environmental system (Jensen, 2022). This approach improves the understanding of how environmental problems develop and spread across space. For example, deforestation in one area may lead to soil erosion and increased flood risk in another area, which shows the connected nature of environmental processes (Weng, 2023). In addition, the theory explains the role of feedback within environmental systems. Human activities such as urban expansion and resource use can alter natural conditions, while environmental changes can also affect human livelihoods and settlement patterns (Turner, 2023). Remote sensing provides consistent data that make it possible to observe these interactions over time and support informed decision making. Therefore, Systems Theory is relevant to this study because it provides a clear framework for understanding how remote sensing can be applied to examine environmental relationships and support effective environmental management in Nigeria.

Relevance of Remote Sensing in Environmental Geography in Nigeria

The growing demand for accurate environmental information in Nigeria has made remote sensing an essential tool for understanding and managing environmental conditions. With increasing pressure from population growth, resource use, and changing climate patterns, the need for reliable data has become more evident. Remote sensing provides a practical means of observing environmental changes across large areas, while environmental geography offers a framework for interpreting these changes in relation to human activities. Together, they support informed decision making in various sectors of national development.

Environmental Monitoring

Remote sensing plays a major role in monitoring environmental conditions across Nigeria, especially in relation to deforestation, desertification, and erosion. Satellite imagery has been widely used to detect changes in forest cover in the southern and middle belt regions, where trees are often cleared for farming, fuel wood, and settlement expansion (Olagunju, 2022). This allows researchers to measure the rate of forest loss and identify areas that require conservation efforts. In northern Nigeria, remote sensing has been used to track the spread of desert conditions, particularly in states such as Borno, Yobe, and Sokoto, where reduced vegetation cover and soil degradation are common (Abubakar, 2023). Similarly, erosion mapping in southeastern states such as Anambra and Imo has benefited from satellite data, which helps to locate affected areas and assess the extent of damage (Eze & Okoye, 2022). These applications show how remote sensing supports continuous observation of environmental changes.

Disaster Management

Remote sensing is also important in disaster management, particularly in flood mapping and oil spill detection. Flooding has become a recurring problem in Nigeria, especially along the Niger and Benue river basins. Satellite images are used to map flood prone areas and monitor water levels during the rainy season, which helps in planning evacuation and response strategies (Adelekan, 2023). In cities such as Lokoja and Makurdi, remote sensing data have been used to assess flood extent and predict areas at risk. In the Niger Delta region, oil spill detection has been improved through the use of remote sensing technologies that can identify oil contamination on water surfaces and surrounding land (Nriagu et al., 2023). This makes it easier to respond quickly and evaluate the impact on local communities. These examples show how remote sensing contributes to reducing the effects of environmental hazards.

Urban Planning

The rapid growth of urban areas in Nigeria has made remote sensing a valuable tool for urban planning and management. Cities such as Lagos have experienced significant expansion over the years, leading to increased pressure on land, housing, and infrastructure. Remote sensing provides up to date information on land use changes, which helps planners monitor urban expansion and manage development more effectively (Akinyemi & Adepoju, 2023). For example, satellite data have been used to track the conversion of wetlands and open spaces into residential and commercial areas as in Lagos. This information supports planning decisions aimed at reducing congestion and improving living conditions. In addition, remote sensing helps to identify informal settlements and areas lacking basic services, which can guide urban development policies. The use of spatial data in this context improves the ability to manage growing cities in a structured manner.

Agriculture

Agriculture remains a major sector in Nigeria, and remote sensing has contributed to improving agricultural practices through crop assessment and drought monitoring. Satellite imagery is used to evaluate crop conditions, estimate yield, and monitor soil moisture levels in different parts of the country (Oladipo, 2022). This is particularly useful in regions where farming depends on rainfall, as it allows for early detection of stress conditions that may affect crop production. In northern Nigeria, where drought is a recurring issue, remote sensing has been used to monitor rainfall patterns and vegetation health, providing information that supports timely intervention (Abubakar, 2023). Farmers and agricultural planners can use this data to make informed decisions on planting and resource allocation. These applications show how remote sensing supports food production and resource management.

Climate Change Studies

Remote sensing also plays an important role in studying climate change by tracking environmental changes over time. Long term satellite data provide evidence of changes in temperature, vegetation cover, and water resources across Nigeria (Weng, 2023). This helps researchers understand how climate patterns are changing and how these changes affect different regions. For example, studies have shown shifts in rainfall patterns and increasing temperatures in parts of northern Nigeria, which have implications for agriculture and water availability (Hansen et al., 2023). In coastal areas, remote sensing has been used to monitor shoreline changes and rising sea levels, which pose risks to communities and infrastructure. By providing consistent and reliable data, remote sensing supports the study of climate related changes and their effects on the environment.

Challenges of Remote Sensing in Nigeria

Despite the growing importance of remote sensing in environmental studies, its effective use in Nigeria is still limited by several practical challenges. While the technology offers reliable means of collecting and analyzing environmental data, certain constraints reduce its full application across sectors. These challenges are linked to economic conditions, human capacity, institutional arrangements, and basic infrastructure, all of which affect how remote sensing tools are accessed and used in the country.

High Cost of Technology

One of the major challenges facing the use of remote sensing in Nigeria is the high cost of acquiring and maintaining the required technology. Satellite data, especially high resolution images, are often expensive and may not be readily available to local researchers and institutions (Jensen, 2022). In addition, specialized software used for processing and analyzing remote sensing data requires licenses that come at significant cost. Equipment such as high performance computers and data

storage systems also demand substantial financial investment. These costs make it difficult for universities, research centers, and government agencies with limited budgets to fully adopt remote sensing technologies. As a result, many institutions rely on outdated data or free sources that may not provide the level of detail required for advanced analysis (Weng, 2023).

Lack of Technical Expertise

Another major limitation is the shortage of trained personnel who can effectively handle remote sensing tools and interpret the data. Remote sensing requires knowledge in areas such as image processing, data analysis, and spatial interpretation, which are not widely available among professionals in Nigeria (Akinyemi & Adepoju, 2023). Although some universities offer courses in geospatial studies, the number of graduates with practical skills remains limited. This shortage affects both the public and private sectors, where there is a need for experts who can apply remote sensing in environmental management and planning. In many cases, organizations depend on a small number of specialists, which slows down project implementation and reduces efficiency. The lack of continuous training and skill development further worsens this challenge.

Poor Data Accessibility

Access to up to date and reliable data remains another issue affecting the effectiveness of remote sensing in Nigeria. Although there are global platforms that provide free satellite data, the availability of high quality and recent datasets is still limited in many cases (Campbell & Wynne, 2023). Some data sources require payment or special access, which may not be feasible for all users. In addition, there are challenges related to data sharing among institutions, as some agencies do not have clear systems for making their data available to others. This lack of coordination leads to duplication of effort and delays in research and decision making. Without easy access to current data, it becomes difficult to monitor environmental changes accurately or respond to emerging issues in a timely manner.

Inadequate Funding

Limited financial support is another factor that affects the use of remote sensing in Nigeria. Government investment in geospatial technology and environmental research is often insufficient, which restricts the ability of institutions to acquire equipment, purchase data, and support training programs (Oladipo, 2022). Many research projects depend on external funding, which may not be consistent or sufficient to meet long term needs. This situation affects the development of local capacity and reduces the ability to carry out large scale environmental studies. In addition, inadequate funding limits the maintenance and upgrading of existing facilities, leading to reduced efficiency in data processing and analysis.

Institutional and Policy Issues

The effectiveness of remote sensing in Nigeria is also influenced by institutional and policy related challenges. Although there are policies that support the use of geospatial data, their implementation is often weak due to lack of coordination among agencies and limited enforcement (Akinyemi & Adepoju, 2023). Different government bodies may operate independently without proper data sharing mechanisms, which reduces the overall effectiveness of remote sensing applications. In some cases, there is also a lack of clear guidelines on data management and usage, which creates uncertainty among users. These institutional gaps make it difficult to achieve a unified approach to environmental monitoring and planning.

Infrastructure Limitations

Basic infrastructure challenges further limit the use of remote sensing in Nigeria. Reliable electricity supply is necessary for operating computers, servers, and other equipment used in data processing, yet power outages are common in many parts of the country (Oladipo, 2022). In addition, stable internet access is required for downloading satellite data, accessing online platforms, and sharing information, but internet connectivity remains inconsistent in several areas. These limitations affect the speed and efficiency of data analysis and reduce the ability of researchers and institutions to work effectively. Without adequate infrastructure, even the available remote sensing tools cannot be fully utilized.

In summary, the challenges facing remote sensing in Nigeria are interconnected and continue to limit its effectiveness in environmental applications. High costs, shortage of skilled personnel, limited data access, weak funding, institutional gaps, and infrastructure problems all contribute to the slow adoption of this technology. Addressing these issues requires coordinated efforts that focus on improving capacity, increasing investment, and strengthening institutional frameworks to support the wider use of remote sensing in the country.

Conclusion

The discussion has shown that remote sensing remains highly relevant in environmental geography in Nigeria due to its wide range of applications in monitoring deforestation, desertification, and erosion, as well as supporting disaster management through flood mapping and oil spill detection. It also contributes to urban planning by tracking rapid city expansion, especially in Lagos, while aiding agriculture through crop assessment and drought monitoring, and supporting climate change studies by providing data on environmental changes over time. However, its effectiveness is limited by several challenges, including the high cost of technology, shortage of skilled personnel, poor access to up to date data, inadequate funding, weak institutional coordination, and infrastructure constraints such as unreliable power supply and internet access. Despite these issues, there are encouraging prospects, as technological improvements, increased data availability, growing involvement of government and private sector actors, expansion of educational programs, and integration with Geographic Information Systems and artificial intelligence continue to improve its application. Therefore, remote sensing remains important for environmental management in Nigeria, as it provides reliable information for planning, monitoring, and decision making. However, there is still a strong need for improved investment, capacity development, and institutional support to enhance its effective use for sustainable development in the country.

Recommendations

1. **Increase Funding for Geospatial Technologies:** Government and relevant stakeholders should allocate more funds for the purchase of satellite data, modern software, and high performance equipment.
2. **Promote Training and Education:** Efforts should be made to strengthen training and education in remote sensing and environmental geography across universities and research institutions and regular workshops and continuous professional development opportunities should also be encouraged to reduce the shortage of skilled personnel in the field.
3. **Improve Data Access Policies:** Government agencies and organizations should establish systems that promote data sharing among institutions and making up to date reliable satellite data that is more accessible in order to improve research quality and support timely environmental monitoring.
4. **Encourage Collaboration Among Stakeholders:** should be promoted among government agencies, academic institutions, and private sector organizations. Such partnerships can

improve resource sharing, technical support, and innovation in the use of remote sensing technologies.

References

- Adelekan, I. O. (2023). Flood risk management in Nigeria: Recent trends and policy implications. *Natural Hazards Review, 24*(2), 1–12.
- Akinyemi, F. O., & Adepoju, K. A. (2023). Geospatial technology and urban growth analysis in Nigeria. *Journal of Urban Planning and Development, 149*(1), 1–10.
- Campbell, J. B., & Wynne, R. H. (2023). *Introduction to remote sensing* (6th ed.). Guilford Press.
- Castree, N. (2022). *Environmental geography: A critical introduction* (2nd ed.). Wiley Blackwell.
- Eze, S. O., & Okoye, A. C. (2022). Gully erosion mapping and management in southeastern Nigeria. *Environmental Monitoring and Assessment, 194*(5), 1–15.
- Hansen, J., Sato, M., & Ruedy, R. (2023). Global temperature change and climate forcing. *Environmental Research Letters, 18*(4), 1–12.
- Jensen, J. R. (2022). *Remote sensing of the environment: An earth resource perspective* (3rd ed.). Pearson.
- Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2023). *Geographic information systems and science* (5th ed.). Wiley.
- Meadows, D. H. (2008). *Thinking in systems: A primer*. Chelsea Green Publishing.
- Nriagu, J. O., Udofia, E. A., Ekong, I., & Ebuk, G. (2023). Oil spill pollution and environmental impact in the Niger Delta, Nigeria. *Science of the Total Environment, 857*, 1–10.
- Oladipo, E. O. (2022). Environmental monitoring and sustainable development in Nigeria. *African Journal of Environmental Science and Technology, 16*(3), 120–130.
- Olagunju, T. E. (2022). Deforestation and environmental change in Nigeria. *Journal of Sustainable Forestry, 41*(6), 567–580.
- Turner, B. L. (2023). Sustainability and human environment interactions. *Annual Review of Environment and Resources, 48*, 1–25.
- Weng, Q. (2023). *Remote sensing and GIS integration: Theories, methods, and applications*. McGraw Hill.