ALVAN JOURNAL OF SOCIAL SCIENCES (AJSS)
FACULTY OF SOCIAL AND MANAGEMENT SCIENCES
ALVAN IKOKU FEDERAL UNIVERSITY OF EDUCATION, OWERRI
https://www-ajsspub-org.b12sites,com https://www.ajsspub2.org
E- ISSN: 3043 – 5463 ISSN: 1595 – 5842 VOULUME 2, ISSUE 2, 2025

RESEARCH ARTICLE

ROLES OF INNOVATIVE TECHNOLOGIES IN COMBATING CLIMATE-DRIVEN ENVIRONMENTAL CRIMES IN ENUGU STATE, NIGERIA

NNEKA NKIRU AMAECHI-ANI

Department of Sociology/ Psychology, Godfrey Okoye University, Ugwuomu Nike, Enugu State

ABSTRACT

This study examines the role of innovative technologies in combating climate-driven environmental crimes in Enugu State, Nigeria. The state has witnessed an increase in environmental crimes such as illegal deforestation, sand mining, bush burning, and improper waste disposal, largely driven by climate change which results in land degradation, water pollution, flood, erosion and biodiversity loss. The limitations of manual surveillance and weak monitoring have created a gap which innovative technologies can help to bridge, this gap is what this study intends to fill. This study addresses climate-driven environmental crimes, focusing on Mobile Environmental Reporting Applications, Artificial Intelligence (AI), drone surveillance, Geographic Information Systems (GIS) and Surveillance Cameras. Environmental Governance Theory was adopted as theoretical framework. With sample size of 200 respondents, the study gathered qualitative data from oral interviews with community stakeholders, environmental and law enforcement officers and quantitative data through structured questionnaires across selected communities in Enugu State. Findings show that although some innovative technologies are being used in Enugu, their application and collaboration between agencies is still limited which slows down the effective use of technology in environmental protection. The study concludes with recommendations for training, investment in digital crime-fighting tools and collaborations to ensure sustainable environmental protection.

Keywords: Climate change, environmental crime, environmental agencies, innovative technologies, Law enforcement agencies.

Corresponding Author

Nneka Nkiru Amaechi-Ani: Email Address: nnekameche@gmail.com
Telephone Number: +2348036731242

Received: 7/6/2025; **Revised:** 21/7/2025; **Accepted:** 26/7/2025; **Published:** 30/7/2025

ALVAN JOURNAL OF SOCIAL SCIENCES (AJSS)
FACULTY OF SOCIAL AND MANAGEMENT SCIENCES
ALVAN IKOKU FEDERAL UNIVERSITY OF EDUCATION, OWERRI
https://www-ajsspub-org.b12sites,com https://www.ajsspub2.org
E- ISSN: 3043 – 5463 ISSN: 1595 – 5842 VOULUME 2, ISSUE 2, 2025

1.0. INTRODUCTION

Climate change has become an increasing threat and most pressing global challenge of the 21st Century; its impact is felt not only in changing weather patterns, but also in the increase of environmental crimes (Adeleke, 2024). Environmental crimes are illegal activities that harm the natural environment, this include illegal mining, oil bunkering, bush burning, sand excavation, illegal logging/deforestation, pollution, desert encroachment, wildlife trafficking and unregulated waste dumping. In many cases, climate change makes these crimes worse, for example, deforestation contributes to rising temperatures, while gully erosion caused by heavy rains leads to land degradation and displacement of people (Intergovernmental Panel on Climate Change (IPCC, 2023). Nigeria, as the largest economy in Africa**,** heavily depends on natural resources such as crude oil, forests, and minerals**.** In Nigeria, climate-driven environmental crimes have become a growing concern and are becoming more prevalent due to the increasing pressures of climate change (Adeoti, 2021). These severe environmental challenges occur as a result **of** unsustainable resource exploitation and weak environmental governance which puts the lives of Nigerians at risk directly and indirectly.

In Enugu State, which lies within the southeastern region of Nigeria, climate change is increasingly linked with environmental crimes. Issues like deforestation in rural areas**,** illegal sand mining in Udi and Awgu**,** bush burning in Nsukka and gully erosion in parts of Nkanu and Aninri are major concerns. These crimes are driven by population growth, poverty, lack of enforcement, and weak environmental education (Agbo & Eze, 2023). Additionally, rainfall patterns in Enugu have become more irregular, leading to soil erosion and making farmlands more vulnerable. The natural vegetation, which once acted as a barrier against flooding and erosion, is rapidly disappearing. In response to these challenges, the use of innovative technologies has gained attention as a modern approach to environmental protection. Technologies such as drones**,** Geographic Information Systems (GIS)**,** remote sensing**,** satellite imagery**,** AI-based surveillance systems**,** and mobile environmental reporting apps are helping to monitor, detect, and control illegal activities affecting the environment (Nwankwo & Uche, 2022). These technologies allow for quicker responses, real-time data gathering, better decision-making, and stronger environmental management. However, in Enugu State, the use of these technologies is still limited due to financial, technical, and institutional challenges (Nwankwo & Uche, 2022). Many local environmental agencies lack the training and equipment to deploy these tools effectively. Despite these challenges, there is a growing awareness of the importance of modern technologies in curbing environmental crimes that are worsened by climate change (Barigbon, 2023). This research, therefore, seeks to explore the current use of innovative technologies in combating environmental crimes in Enugu State, identifying key barriers and suggesting effective ways to improve their adoption for better environmental protection. The limitations of manual surveillance and weak monitoring have created a gap which innovative technologies can help to bridge, this is the gap which this study intends to fill.

ALVAN JOURNAL OF SOCIAL SCIENCES (AJSS)
FACULTY OF SOCIAL AND MANAGEMENT SCIENCES
ALVAN IKOKU FEDERAL UNIVERSITY OF EDUCATION, OWERRI
https://www-ajsspub-org.b12sites,com https://www.ajsspub2.org
E- ISSN: 3043 – 5463 ISSN: 1595 – 5842 VOULUME 2, ISSUE 2, 2025

1.1. Statement of the Problem

Enugu State is increasingly affected by environmental crimes, many of which are made worse by the impacts of climate change. Illegal activities such as deforestation, sand mining, bush burning, and unregulated waste disposal are now common in both urban and rural areas of the state. These activities have led to soil degradation, water pollution, biodiversity loss, increased flooding, and worsening gully erosion. The effects are more severe during the rainy season, which has become more intense and unpredictable due to climate change. Despite the existence of environmental protection laws and agencies in Enugu State, enforcement remains weak. Many crimes go unreported or unchecked due to poor surveillance, lack of manpower, and limited access to data. For example, illegal mining activities continue in parts of Udi and Awgu, often unnoticed until serious damage has been done. Similarly, gully erosion has swallowed roads, farmlands, and homes in communities like Nsukka and Nkanu East, yet local response systems are slow due to lack of information.

Modern technologies have the potential to address these challenges by offering tools for real-time monitoring, early warning systems, data collection, and improved decision-making. However, their usage in Enugu State remains low. Most local environmental agencies still depend on manual methods of inspection and reporting. Even where technologies exist, they are underutilized due to poor technical skills, low awareness, and insufficient funding. The limitations of manual surveillance and weak monitoring have created a gap which innovative technologies can help to bridge; this is the gap which this study intends to fill.

1.2. Purpose of the Study

1. To identify the major climate-driven environmental crimes occurring in Enugu State.
2. To examine how innovative technologies are being used to detect and prevent these crimes in Enugu State.
3. To suggest ways of improving the use of technology to protect the environment in Enugu State.

1.3. Research Questions

i. What are the common climate-driven environmental crimes in Enugu State?

ii. In what ways are innovative technologies being used to combat these environmental crimes in Enugu State?

iii. How can the use of innovative technologies be improved to better protect the environment in Enugu State?

ALVAN JOURNAL OF SOCIAL SCIENCES (AJSS)
FACULTY OF SOCIAL AND MANAGEMENT SCIENCES
ALVAN IKOKU FEDERAL UNIVERSITY OF EDUCATION, OWERRI
https://www-ajsspub-org.b12sites,com https://www.ajsspub2.org
E- ISSN: 3043 – 5463 ISSN: 1595 – 5842 VOULUME 2, ISSUE 2, 2025

2.0. CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1.1. Conceptual Framework

Climate change refers to long-term alterations in temperature, precipitation, wind patterns, and other elements of the Earth's climate system (Barigbon, 2023). These changes can be driven by natural processes such as volcanic eruption, solar variations and human activities such as industrial emissions, deforestation, and pollution. The Intergovernmental Panel on Climate Change (IPCC, 2023), defines climate change as, a change in the state of the climate that can be identified by using statistical tests, changes in the mean and the variability of its properties which persists for an extended period, typically decades or longer. These gases trap heat in the Earth's atmosphere, leading to global warming and shift in climate patterns. Climate change acts as a catalyst for environmental crimes by intensifying resource scarcity, environmental degradation, and socio-economic vulnerabilities (Barigbon, 2023).

Climate-driven environmental crimes refer to illegal activities that contribute to or exacerbate environmental degradation which directly impacts on climate change (Manbe & Ebonyi, 2019). Globally, these activities have severe socio-economic and environmental consequences, threatening biodiversity, public health, and sustainable development. These environmental changes have far-reaching consequences, including resource scarcity, habitat destruction and environmental degradations which are closely linked to a rise in environmental crimes, as individuals and criminal networks exploit natural resources for financial gain (Manbe and Ebonyi, 2019).

Innovative technologies refer to new, creative, or significantly improved tools, systems, methods, or devices that are designed to solve specific problems more efficiently and effectively than traditional methods. Innovative technologies have become useful in tackling environmental crimes globally. GIS and satellite imagery allow governments to track land use changes and detect illegal activities. Drones provide aerial surveillance in hard-to-reach areas, making it easier to monitor forest areas and mining sites. Mobile apps have been used in some African countries such as Kenya and Ghana to report illegal dumping and forest encroachment by local residents. In Nigeria, however, the application of these tools is still limited. A study by Nwankwo and Okafor (2020) noted that while remote sensing and GIS are used in flood and erosion monitoring in Anambra and Imo States, such tools are rarely applied in Enugu due to lack of skilled personnel and poor infrastructure. When properly applied, these technologies can strengthen environmental governance, improve accountability and help respond more effectively to the growing threats of climate-driven crimes (Agbo & Eze, 2023).

Environmental crimes are illegal activities that harm the environment and contribute to ecological degradation (Barigbon, 2023). Enugu State has experienced serious environmental challenges in recent years. According to the Enugu State Ministry of Environment (2021), gully erosion affects over 250 communities across the state. Illegal sand mining continues in

ALVAN JOURNAL OF SOCIAL SCIENCES (AJSS)
FACULTY OF SOCIAL AND MANAGEMENT SCIENCES
ALVAN IKOKU FEDERAL UNIVERSITY OF EDUCATION, OWERRI
https://www-ajsspub-org.b12sites,com https://www.ajsspub2.org
E- ISSN: 3043 – 5463 ISSN: 1595 – 5842 VOULUME 2, ISSUE 2, 2025

areas such as Oji River, Awgu, and Udi, often carried out without environmental impact assessments. Bush burning and deforestation in Nsukka and Nkanu regions have reduced vegetation cover, contributing to soil erosion and poor air quality. These environmental problems are often unregulated, with low public awareness and limited enforcement. Alongside these, climate change is increasingly linked to environmental crimes, which are illegal activities that cause significant harm to ecosystems, biodiversity, and natural resources (Adeleke, 2024). These impacts are increasingly evident across the world, including Nigeria and Enugu State particularly. As natural resources become depleted, individuals and criminal networks exploit these conditions to engage in illegal activities (Nwankwo & Uche, 2022).

Environmental agencies and law enforcement agents in Enugu State play crucial roles in regulating environmental practices and addressing climate-related crimes. The Enugu State Ministry of Environment is the main state agency which serves as the central coordinating body for environmental policy formulation, climate adaptation strategies, and the enforcement of environmental laws. However, despite their mandate, studies show that these agencies often operate with limited access to advanced tools like GIS, drones, and satellite mapping that could help in proactive environmental monitoring (Agbo & Eze, 2023). The Enugu State Waste Management Authority (ESWAMA) **is** responsible for managing solid waste and controlling open dumping and burning, especially in urban centers like Enugu metropolis. Yet, the absence of smart waste tracking systems and real-time reporting tools has hindered swift response and offender identification (Adeoti, 2021).

Similarly, the Forestry Department had been instrumental in addressing illegal logging and deforestation. Nigeria Erosion and Watershed Management Project (NEWMAP) Enugu State chapter is a World Bank-supported project, working with Enugu State government – responsible for integrating climate resilience and community participation among local residents and handling gully erosion control, especially in affected local governments like Agbani, Nsukka etc. but their efforts are largely manual and reactive rather than data-driven or technology-supported. State Emergency Management Agency (SEMA) – they have the responsibility of managing environmental disasters (flooding, landslides, windstorms), they also support climate-related emergency responses.

Law enforcement agencies such as the Nigeria Police Force (Enugu Command) and the Nigeria Security and Civil Defence Corps (NSCDC) assist in environmental protection by arresting individuals involved in environmental crimes. However, according to Umeh (2022), these agencies often lack environmental intelligence tools, such as mobile-based reporting systems, surveillance drones, and AI-powered environmental monitoring dashboards that could enhance detection, evidence gathering, and prosecution of offenders.

From a criminological perspective, effective enforcement of environmental laws requires timely and accurate information, community participation, and transparent monitoring which

innovative technologies can enable. Technologies such as Geographic Information Systems (GIS), drone surveillance, remote sensing, and mobile environmental alert applications can empower these agencies to detect illegal activities in real-time, analyze environmental changes spatially, and forecast future risks (Eze & Chukwu, 2022). Onyema and Ugwu (2024) admit that without technological tools, enforcement remains slow, underfunded, and heavily dependent on physical patrols, which are prone to delay and corruption. Therefore, this study builds upon existing knowledge by exploring how these environmental and law enforcement institutions in Enugu State can adopt and integrate innovative technologies into their operations to improve surveillance, enhance early warning systems, and increase successful prosecutions of climate-related environmental crimes.

2.1.2. Climate Change and the rise of Environmental Crimes

Climate change has increasingly become a major driver of environmental crimes across the globe, especially in developing regions where enforcement of environmental regulations remains weak (NEMA, 2021). In Nigeria, and particularly in Enugu State, the intersection of climate variability, population pressure, and inadequate environmental governance has resulted in a range of environmental crimes that contribute to environmental degradation and compound climate risks (Nwankwo & Okeke 2023).

Illegal Deforestation

One of the most persistent climate-driven environmental crimes in Enugu State is illegal deforestation. Many rural and semi-urban areas, including Udi, Awgu, and parts of Nsukka, are experiencing the rampant felling of trees for timber, firewood, and charcoal production. This activity often occurs without authorization from forestry or environmental agencies. As noted by Eze and Chukwu (2022), uncontrolled tree harvesting contributes significantly to forest loss, increased surface temperatures, loss of biodiversity, and soil erosion. The removal of tree cover in forest ecosystems also reduces carbon sequestration potential, thereby accelerating the impact of global warming.

Sand and Gravel Mining

Sand mining, particularly along riverbanks in areas like Emene, Abakpa, and Nike, is another prevalent environmental crime. This practice is driven by the demand for construction materials and often goes unregulated. Umeh (2022) observed that illegal sand mining not only alters the course of rivers and depletes aquatic habitats but also contributes to localized flooding and erosion, especially during the rainy season. Such activities are usually climate-aggravated, as erratic rainfall patterns increase the vulnerability of exposed riverbanks.

Bush Burning and Agricultural Fires

Bush burning remains a traditional method for land clearing, especially in Nsukka and other agrarian communities. However, this practice has evolved into an environmental crime due to

ALVAN JOURNAL OF SOCIAL SCIENCES (AJSS)
FACULTY OF SOCIAL AND MANAGEMENT SCIENCES
ALVAN IKOKU FEDERAL UNIVERSITY OF EDUCATION, OWERRI
https://www-ajsspub-org.b12sites,com https://www.ajsspub2.org
E- ISSN: 3043 – 5463 ISSN: 1595 – 5842 VOULUME 2, ISSUE 2, 2025

its harmful contributions to greenhouse gas emissions, destruction of soil nutrients, and loss of animal habitats (Onyema & Ugwu, 2024). Recurrent burning worsens air quality and triggers seasonal health crises, especially respiratory issues during dry seasons.

Improper Waste Disposal and Open Burning

Urban and semi-urban communities like Ogui, New Haven, Maryland and Abakpa are burdened with the challenge of illegal dumping and open burning of solid waste. Poor waste management systems, coupled with population growth, have led many residents to dispose of waste in drainage channels and public spaces, often resorting to open incineration. According to Onyishi and Mbah (2022), such practices emit black carbon and methane, both potent climate pollutants. They also block waterways, increasing the frequency and severity of urban flooding during heavy rains.

Industrial Pollution and Chemical Waste Dumping

Industrial hubs in Emene and 9th Mile area of Enugu state, engage in the unregulated disposal of waste chemicals and oils into water bodies or nearby soils. These activities lead to long-term pollution and the destruction of freshwater ecosystems. A study by Adebayo and Taiwo, (2021) link industrial pollution to the rising incidence of skin diseases, waterborne illnesses, and climate-sensitive health conditions in Enugu State.

Encroachment and Poor Urban Planning

As climate events force rural-urban migration, urban expansion in areas like Trans Ekulu, GRA, and Thinkers Corner has led to unregulated housing developments on wetlands and floodplains. Building on these ecological zones without appropriate drainage planning has increased the incidence of flash floods and urban heat islands (Umeh, 2022). This form of land encroachment is often aided by corrupt land officers and absence of government enforcement, amounts to a significant environmental crime under Nigerian environmental law.

2.1.3. The Role of Innovative Technologies in Addressing the Problem

Environmental crimes linked to climate change, such as illegal deforestation, illegal sand mining, open waste burning, and land encroachment, have intensified across sub-Saharan Africa in recent decades, particularly in urbanizing regions like Enugu State, Nigeria (NEMA, 2021). These crimes not only degrade natural ecosystems but also worsen the effects of climate change by increasing carbon emissions, disrupting natural water cycles, and reducing climate resilience (Onyema & Ugwu, 2024). In response to these challenges, innovative technologies have gradually been adopted to play vital roles in detection, monitoring, and prevention efforts.

ALVAN JOURNAL OF SOCIAL SCIENCES (AJSS)
FACULTY OF SOCIAL AND MANAGEMENT SCIENCES
ALVAN IKOKU FEDERAL UNIVERSITY OF EDUCATION, OWERRI
https://www-ajsspub-org.b12sites,com https://www.ajsspub2.org
E- ISSN: 3043 – 5463 ISSN: 1595 – 5842 VOULUME 2, ISSUE 2, 2025

Geographic Information Systems (GIS) and Remote Sensing

GIS and remote sensing technologies offer real-time spatial data for monitoring land use patterns, vegetation cover, and water body dynamics. In Enugu State, these tools are increasingly used by researchers and state agencies to identify environmental violations such as illegal deforestation and land encroachment (Nwankwo & Okeke, 2023).

Satellite imagery and aerial mapping have helped expose unsanctioned tree felling in Udi and Nsukka forest reserves. According to Nwankwo and Uche (2022), GIS tools have enabled policy makers to map erosion-prone zones and predict flood plains, thereby enhancing enforcement strategies and climate adaptation planning.

Drones (Unmanned Aerial Vehicles)

Drones have proven to be effective surveillance tools in the fight against environmental crimes in Enugu State, especially in areas that are physically inaccessible to environmental task forces. These devices are used to monitor large forest reserves and riverine areas where activities such as illegal charcoal production, land clearing, and open dumping occur. NGOs like the Enugu Green Coalition have partnered with local communities to deploy drones for monitoring bush burning activities, especially in dry seasons when the risk of wildfire is high (Onyishi & Mbah, 2022). The real-time data collected through drone surveillance helps both the Ministry of Environment and local enforcement agencies gather visual evidence and make swift decisions, thereby improving the prosecution of offenders. However, the effectiveness of drone surveillance remains limited due to lack of skilled personnel and insufficient equipment across enforcement bodies (Umeh, 2022).

Mobile Environmental Reporting Applications

Mobile-based environmental reporting applications allow citizens to participate in crime detection by reporting infractions using smart phones. Although still underdeveloped in Enugu State, there is growing potential to adapt platforms similar to “EcoReport” or “GreenCheck” for local use. These applications could allow users to geo-tag incidents of illegal dumping, tree felling, or pollution and forward them to relevant agencies such as the Enugu State Waste Management Authority (ESWAMA) and the Forestry Commission. According to Aroh and Edeh (2022), citizen participation through mobile reporting platforms can significantly strengthen environmental surveillance systems and reduce enforcement gaps caused by underfunded government agencies. Integrating such platforms with local environmental education campaigns could enhance their adoption and effectiveness.

Environmental Data Dashboards and Early Warning Systems

The use of digital dashboards and early warning systems is gradually emerging in environmental planning and disaster risk reduction in Enugu State. These tools aggregate climate-related data such as rainfall intensity, river overflow levels, and air quality indexes. With support from the Nigerian Meteorological Agency (NiMet), the state now has access to

ALVAN JOURNAL OF SOCIAL SCIENCES (AJSS)
FACULTY OF SOCIAL AND MANAGEMENT SCIENCES
ALVAN IKOKU FEDERAL UNIVERSITY OF EDUCATION, OWERRI
https://www-ajsspub-org.b12sites,com https://www.ajsspub2.org
E- ISSN: 3043 – 5463 ISSN: 1595 – 5842 VOULUME 2, ISSUE 2, 2025

predictive models that can forecast flood-prone periods and erosion likelihood (Aroh & Edeh, 2022). By integrating this information into environmental crime prevention strategies, agencies can proactively target areas most vulnerable to waste dumping, open burning, and illegal building on wetlands. For instance, the Enugu Urban Planning Authority has started using such systems to guide urban land use and issue alerts when zoning violations are detected in climate-sensitive areas (Onyishi & mbah, 2022).

Surveillance Cameras and Internet of Things (IoT) Sensors

Emerging smart technologies like CCTV surveillance and IoT-based sensors are gaining attention as tools for real-time detection of environmental crimes. In Enugu's commercial zones such as Ogbete and Artisan Market, the state government has begun experimental use of surveillance cameras to monitor waste disposal behavior and unauthorized activities along river channels. The devices possess very high capabilityrecord 24/7 footage that can be used to identify perpetrators and improve transparency in enforcement operations. IoT sensors, although not yet widely deployed, hold great promise for monitoring water quality, air pollution, and soil contamination in industrial areas such as Emene and 9th Mile. As noted by Onyema and Ugwu (2024), IoT devices can serve as early detectors of chemical leaks or burning pollutants, providing instant alerts to emergency responders.

Artificial Intelligence (AI) and Predictive Modeling

Artificial Intelligence (AI) and machine learning algorithms are being applied experimentally in climate risk assessments and environmental crime detection. These technologies analyze large datasets—including social media activity, land use patterns, and weather data—to predict where environmental crimes are likely to occur. According to research by Nwankwo and Okeke (2023), AI tools could be used in Enugu to identify illegal mining hotspots and simulate the environmental impacts of unregulated construction. AI use is still at an early stage in the region, collaboration with academic institutions like the University of Nigeria, Nsukka has opened doors for research-driven integration of such tools into state environmental planning.

Smart Waste Management Systems

Innovative tools such as GPS-enabled waste collection tracking and digital route mapping are helping to improve waste disposal services in parts of Enugu Metropolis. ESWAMA, in partnership with local ICT firms, is testing smart tracking tools to monitor the movement and disposal behavior of waste contractors. This helps to discourage illegal dumping in drainage systems and open spaces—common causes of climate-related flooding. Furthermore, digital systems that record waste generation by households and businesses are being introduced to support recycling and enforce pollution taxes (Onyema & Ugwu 2024). These efforts represent a significant step towards integrating circular economy principles in urban waste management.

ALVAN JOURNAL OF SOCIAL SCIENCES (AJSS)
FACULTY OF SOCIAL AND MANAGEMENT SCIENCES
ALVAN IKOKU FEDERAL UNIVERSITY OF EDUCATION, OWERRI
https://www-ajsspub-org.b12sites,com https://www.ajsspub2.org
E- ISSN: 3043 – 5463 ISSN: 1595 – 5842 VOULUME 2, ISSUE 2, 2025

2.1.4. Advancement in the Use of Innovative Technologies for Environmental Protection

Innovative technologies play a pivotal role in modern environmental protection strategies, especially in regions facing persistent climate-driven environmental crimes like Enugu State. However, the effective use of these technologies depends not only on their availability but also on institutional readiness, technical capacity, public engagement, and supportive policies (Eze & Chijioke, 2020).

Capacity Building and Institutional Strengthening

One of the major limitations to the optimal use of innovative tools in Enugu State is the lack of technical skills among enforcement personnel. Studies have shown that when environmental officers are not adequately trained in using tools such as GIS mapping, drone surveillance, satellite imagery, and mobile data applications, the tools become underutilized (Adebayo & Taiwo, 2021). Effective environmental monitoring requires regular staff training and professional development. Building local capacity through collaboration with tertiary institutions such as the University of Nigeria Nsukka (UNN) and Enugu State University of Science and Technology (ESUT) can enhance data interpretation and technological deployment (Eze & Chijioke, 2020).

Public Awareness and Grassroots Digital Inclusion

Environmental governance is most effective when it is inclusive. As Nwankwo and Okeke (2023) noted, grassroots communities often lack awareness of how to engage with digital platforms, which weakens public reporting of environmental crimes. Integrating local communities into environmental surveillance efforts—through mobile apps, SMS-based systems, and community radio alerts—can significantly increase public participation in environmental protection. This is particularly useful in reporting crimes like illegal logging, sand mining, and bush burning in rural and semi-urban areas.

Government Funding

Limited funding has been identified as a key constraint to the use of digital tools in environmental enforcement (Adebayo & Taiwo, 2021). For Enugu State to improve its use of innovative technology, there must be targeted budget allocations to acquire and maintain tools like air quality monitors, water testing devices, and real-time surveillance drones. Moreover, the establishment of public–private partnerships (PPPs) can help drive innovation and investment in green technology solutions tailored to local environmental issues (Okonkwo & Dike, 2023).

Inter-Agency Collaboration and Data Sharing

Fragmentation among environmental and law enforcement agencies in Nigeria, including those in Enugu State, often results in poor coordination and information gaps (NEMA, 2021). To overcome this, researchers advocate the creation of central digital platforms where

ALVAN JOURNAL OF SOCIAL SCIENCES (AJSS)
FACULTY OF SOCIAL AND MANAGEMENT SCIENCES
ALVAN IKOKU FEDERAL UNIVERSITY OF EDUCATION, OWERRI
https://www-ajsspub-org.b12sites,com https://www.ajsspub2.org
E- ISSN: 3043 – 5463 ISSN: 1595 – 5842 VOULUME 2, ISSUE 2, 2025

agencies such as Enugu State Ministry of Environment, ESWAMA and the Nigerian Police can share geospatial data, environmental alerts, and enforcement reports. According to Obi and Uzochukwu (2022), such integrated platforms enhance the capacity of the state to respond swiftly to emerging environmental threats.

Legal and Policy Frameworks for Environmental Governance

For technology to thrive in the environmental sector, the legal environment must evolve. Unfortunately, current environmental regulations in Enugu State do not adequately recognize the role of digital evidence such as drone footage or satellite data in prosecuting environmental crimes. Enacting state-level policies that mandate the use of tech-based reporting and monitoring systems will institutionalize innovation and strengthen environmental law enforcement (Edeh & Ibe, 2021).

Smart Monitoring and Early Warning Systems

Modern technology offers real-time protection through smart environmental monitoring centers. These centers, equipped with Internet of Things (IoT devices), AI cameras, and climate sensors, can monitor air pollution, deforestation patterns, illegal mining activity, and flood risks. Establishing such centers in Enugu's urban and vulnerable zones will greatly improve early warning and disaster response (Chinedu et al., 2023).

2.2. Theoretical Framework

This study is anchored on the Environmental Governance Theory (EGT**),** which offers a comprehensive lens for understanding how environmental challenges, particularly those linked to climate change and human misconduct, can be addressed through cooperative efforts, policy frameworks, and the strategic use of modern technologies. Environmental Governance Theory explains how institutions, communities, and governments interact in managing environmental issues, particularly in contexts where the natural environment is under threat from exploitation, negligence, or climate-induced changes. The theory shifts the focus from top-down government regulation to a more inclusive and participatory system that encourages collaboration among multiple stakeholders**,** such as the government, local communities, non-governmental organizations, private actors, and international partners. It also advocates for the use of scientific knowledge and technology in environmental decision-making and enforcement.

The theory helps explain why poor enforcement of environmental policies**,** lack of public participation and weak use of modern technologies contribute to the persistence of these environmental crimes. It also supports the argument that the integration of ICT tools**,** community-based environmental reporting systems and satellite-based monitoring can significantly strengthen the environmental protection landscape in Enugu state.

ALVAN JOURNAL OF SOCIAL SCIENCES (AJSS)
FACULTY OF SOCIAL AND MANAGEMENT SCIENCES
ALVAN IKOKU FEDERAL UNIVERSITY OF EDUCATION, OWERRI
https://www-ajsspub-org.b12sites,com https://www.ajsspub2.org
E- ISSN: 3043 – 5463 ISSN: 1595 – 5842 VOULUME 2, ISSUE 2, 2025

3.0. MATERIALS AND METHODS

This study employed a descriptive survey design**,** suitable for gathering both qualitative and quantitative data on climate-driven environmental crimes and the use of innovative technologies to combat them in Enugu State. This research was carried out in Enugu State, focusing on six communities namely: Ogui, Emene, Abakpa, Awkunanaw, Maryland and Thinkers Corner, across Enugu North, South, and East Local Government Areas. These areas were chosen due to their exposure to environmental crimes such as illegal deforestation, bush burning, sand mining, and waste dumping. A sample size of **200 respondents** was selected out of the population of 1016 people.

Purposive sampling was used to select key stakeholders such as government officials, environmental workers, and traditional/community leaders because of their specific knowledge about the subject. Simple random sampling was also used to select ordinary residents and market traders, ensuring equal chances of participation and reducing bias. A structured questionnaire was one of the instruments for data collection, containing both closed- and open-ended questions. Oral interview was another data instrument, conducted with selected officials such as environment and law enforcement officers, local government officials and community/traditional leaders to enrich the data. Quantitative data were analyzed with frequencies and percentages while Qualitative responses were analyzed and interpreted using thematic analysis according to the important themes of the research questions.

4.0. RESULTS AND DISCUSSIONS

Result for research question one indicates that majority of the respondents representing 82% believe that the common climate-driven environmental crimes in Enugu State is frequent illegal deforestation in their communities, especially for firewood and charcoal. In collaboration with qualitative findings, some traditional leaders and residents from Udi and Nsukka reported that deforestation was driven by youth engaging in charcoal business for survival. Environmental officers as well expressed concern that open forest and waste burning contributes to rising air pollution which worsens seasonal flooding and affects the lives of individuals directly and indirectly.

These findings are explained in line with studies by Nwankwo and Uche (2022), who link these crimes to climate risks like erosion, poor air quality, and biodiversity loss. They stated that those crimes are largely economic, driven by poverty, lack of awareness, and weak enforcement by the government. Result for research question two indicates that more than half of the respondents representing 80% believe that they have not seen nor interacted with any digital platform for reporting crimes while 20% of the respondents state that they have

ALVAN JOURNAL OF SOCIAL SCIENCES (AJSS)
FACULTY OF SOCIAL AND MANAGEMENT SCIENCES
ALVAN IKOKU FEDERAL UNIVERSITY OF EDUCATION, OWERRI
https://www-ajsspub-org.b12sites,com https://www.ajsspub2.org
E- ISSN: 3043 – 5463 ISSN: 1595 – 5842 VOULUME 2, ISSUE 2, 2025

heard about innovative technologies such as drones or mobile reporting apps but have never seen it in use.

In collaboration with qualitative findings, An ESWAMA official confirmed that GPS tracking of waste trucks has been tested in parts of Enugu metropolis. A researcher from UNN noted that satellite images have been used to monitor encroachment and erosion zones but are rarely used by enforcement bodies. Community members, on the other hand, felt excluded from tech-based interventions, saying they lacked access to smart phones and training. The findings show low public engagement and limited use of innovative technologies in environmental enforcement, despite increasing awareness among professionals. This is explained in line with Onyema and Ugwu (2024), who argue that technological tools are under-utilized in Enugu State environmental agencies due to cost, lack of training, and limited infrastructure.

Result for research question three indicates that majority of the respondents representing 97% suggested so many ways to improve and protect the environment in Enugu state, such as training and equipping agencies with modern technologies, creating mobile apps for environmental crime reporting, community education and awareness campaigns, partnership with universities and **NGOs** to provide data and tools with stronger enforcement and prosecution of environmental offenders

These solutions were explained in line with the view of Aroh and Edeh (2022), who emphasized the need for community-driven and technology-supported environmental governance models. This will help people to be part of their environment, to protect and sustain it at both the state and local government level.

5.0. SUMMARY AND CONCLUSION

This study explored how innovative technologies are being used to combat climate-driven environmental crimes in Enugu State. It focused on environmental crimes such as illegal logging, deforestation, unregulated sand mining, bush burning, indiscriminate waste disposal, and water pollution, all of which are worsened by climate change and human activities. These environmental crimes not only damage the natural environment but also affect the health, safety, and livelihoods of the people in Enugu State. The study used both qualitative and quantitative methods. Interviews were conducted with officials from environmental and law enforcement agencies like the Ministry of Environment and ESWAMA, as well as community members. Questionnaires were also distributed to gather public opinion on the use of modern technologies such as GIS, drones, mobile apps, satellite monitoring, and environmental sensors. Findings showed that although some innovative technologies are being used in Enugu, their application is still limited. Challenges such as poor funding, lack of technical expertise, weak policies, poor public awareness, and minimal collaboration

between agencies are slowing down the effective use of technology in environmental protection.

In conclusion, innovative technologies offer powerful solutions for addressing climate-related environmental crimes in Enugu State. When effectively applied, tools like drones, GIS, mobile reporting apps and digital sensors can help detect, prevent, and respond to environmental crimes in real time. However, to fully benefit from these technologies, the government and relevant agencies must invest in training, infrastructure, and policy reforms. It is also important to create more awareness among the public, involve local communities, and promote cooperation between environmental and law enforcement agencies. By doing so, Enugu State can move toward a safer, cleaner, and more sustainable environment where technology plays a central role in protecting nature and improving people's lives.

Competing Interest

The authors have declared that no conflicting interest exist in this manuscript.

REFERENCES

Adebayo, M., & Taiwo, J. (2021). Digital innovation and environmental policy in Nigeria: Challenges and prospects. *Nigerian Journal of Environmental Management, 15*(2), 45 – 58.

Adeleke, A. (2024). Nigeria, Africa may lose $390b to environmental crime, mineral exploration. *The Guardian Nigeria*. Retrieved from https://guardian.ng/news/nigeria/nigeria-africa-may-lose-390b-to-environmental-crime-mineral-exploration/

Adeoti, J. O. (2021). Illegal mining and environmental degradation in Nigeria: The nexus and implications. *Journal of Environmental Studies, 15*(2), 45 – 60.

Agbo, S. I. & Eze, P. N. (2023). E-waste management in Nigeria: Challenges and prospects. *International Journal of Environmental Science and Technology, 20*(3), 1234 – 1245.

Aroh, C., & Edeh, A. (2022). Climate-induced migration and security risks in Southeast Nigeria. *Journal of Environmental Studies, 18*(3), 54–66.

Barigbon, C. B. (2023). State-corporate environmental crime and human security in the Niger Delta, Nigeria. *Journal of Global Social Sciences, 4*(14), 21–43.

Chinedu, A., Okpara, C., & Uche, P. (2023). Artificial intelligence and early warning systems for climate resilience in South-Eastern Nigeria. *Journal of Smart Environmental Research, 11*(1), 33–49.

Eze, C. & Chukwu, O. (2022). Illegal Logging and Climate Change in Nigeria: A Case Study of Enugu State. *African Journal of Environmental Research, 10*(2), 88–102.

Edeh, C., & Ibe, F. (2021). Legal frameworks for environmental technology adoption in Nigeria: A state-level analysis. *Law and Policy Review, 18*(3), 76–91

Eze, M. & Chijioke, N. (2020). University–government collaboration in environmental protection in Enugu State. *Journal of Applied Development Studies,* 9(1), 25 – 37.

Food and Agriculture Organization. (2021). *Global forest resources assessment 2020: Main report*. Rome: FAO.

Intergovernmental Panel on Climate Change. (2023). *Sixth assessment report*. Retrieved from https://www.ipcc.ch/report/ar6/

Interpol & UN Environment. (2019). *Strategic report: Environment, peace and security – A convergence of threats*. Retrieved from https://www.interpol.int/en/News-and-Events/News/2019/INTERPOL-and-UN-Environment-warn-of-convergence-of-environmental-crime-with-other-serious-crimes

Manbe, D. A., & Ebonyi, A. A. (2019). The nexus between climate change and criminality: The Nigerian experience. *International Journal of Research and Innovation in Social Science*, *3*(10).

NEMA (2021). *Report on Environmental Emergencies in Nigeria*. Abuja: National Emergency Management Agency.

Nwankwo, O., & Okeke, R. (2023). *Digital environmental governance and citizen participation in South-Eastern Nigeria*. *African Journal of Development and Public Policy*, *17*(2), 53-69.

Nwankwo, C. N., & Uche, C. U. (2022). Oil theft and pipeline vandalism in Nigeria: The human security implications. *African Security Review*, *31*(1), 50-65.

Obi, T., & Uzochukwu, I. (2022). The role of inter-agency coordination in environmental crime prevention. *Nigerian Journal of Public Safety*, *6*(2), 41–55.

Onyema, P., & Ugwu, L. (2024). Innovative surveillance tools for environmental crime prevention in South-East Nigeria. *Environmental Technology and Security,* 7(1), 33–50.

Onyishi, C. & Mbah, J. (2022). Solid waste disposal and air pollution in Enugu Metropolis. *Nigerian Journal of Public Health and Environment,* 16(4), 91–107.

Umeh, A. (2022). *Institutional weaknesses in enforcing environmental law in Enugu State. Nigerian Journal of Environmental Law and Policy, 5*(2), 60–78.