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Environmental Impacts of the 2021 Rainstorm in Oforola Ancient Kingdom, Imo State, Nigeria: A Qualitative Study

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Abstract:

- ***Background:***

Climate change has increased the occurrence of extreme weather events, including severe rainstorms that cause environmental damage and socioeconomic disruption, especially in vulnerable rural communities. This study explored the environmental impacts of the April 2021 rainstorm in Oforola Ancient Kingdom, Imo State, Nigeria.

- ***Methods:***

A qualitative descriptive design was used. Data were collected through semi-structured interviews with 68 affected residents, field observations of 34 households, and review of four documentary sources. Participants were purposively selected, and data were analyzed using Braun and Clarke's thematic analysis approach guided by the Sendai Framework for Disaster Risk Reduction.

- ***Results:***

The rainstorm caused extensive environmental and infrastructural damage. Two major themes emerged: environmental destruction and household resource losses; and infrastructure damage, displacement, and livelihood disruption. Participants reported flooding, environmental contamination concerns, destruction of vegetation and economic trees, loss of household resources, damaged residential buildings, electricity disruption, and livelihood challenges. Field observations confirmed substantial damage to homes, roads, electricity infrastructure, and vegetation, with approximately 50 residential buildings partially or completely affected.

- ***Conclusion:***

The April 2021 rainstorm significantly affected the environment, infrastructure, and livelihoods of residents in Oforola Ancient Kingdom. The findings highlight the vulnerability of rural communities to climate-related hazards and emphasize the need for climate-resilient infrastructure, improved disaster preparedness, environmental health surveillance, and community-based adaptation strategies.

Keywords: *Climate Change; Extreme Rainfall; Rainstorm; Environmental Impacts; Disaster Risk Reduction; Rural Nigeria.*

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I. INTRODUCTION

➢ *Climate Change and Increasing Extreme Weather Events*

Climate change has become one of the most significant environmental and public health challenges of the twenty-first century. The increasing concentration of greenhouse gases resulting from human activities, particularly fossil fuel combustion, deforestation, and land-use changes, has altered global climate systems, contributing to rising temperatures, changing precipitation patterns, and increased frequency and intensity of extreme weather events (Intergovernmental Panel on Climate Change [IPCC], 2023). Among these events, extreme rainfall, storms, and floods represent some of the most destructive climate-related hazards because of their capacity to rapidly transform ecosystems, damage infrastructure, disrupt livelihoods, and threaten human health.

The IPCC (2023) indicates that climate change is already influencing the frequency, intensity, duration, and spatial distribution of many extreme weather events. Increased atmospheric warming enhances the capacity of the atmosphere to hold moisture, thereby contributing to more intense precipitation events in many regions of the world. These changes have increased risks associated with flooding, soil erosion, infrastructure failure, ecosystem degradation, and displacement of vulnerable populations (Myhre et al., 2019; WMO, 2024).

Extreme weather events do not produce impacts through climatic hazards alone; rather, their consequences emerge from interactions between environmental hazards, human exposure, vulnerability, and adaptive capacity. Communities with weak infrastructure, limited disaster preparedness, poor environmental management, and high dependence on natural resources often experience disproportionate impacts from climate-related disasters (UNDRR, 2023). Therefore, understanding localized environmental consequences of extreme weather events is essential for strengthening disaster risk reduction and climate adaptation strategies.

➢ *Global Environmental Consequences of Extreme Rainstorms*

Extreme rainstorms are among the most damaging climate-related hazards globally due to their ability to cause rapid environmental transformation and widespread disruption of human activities. Heavy rainfall combined with strong winds can result in flooding, soil erosion, vegetation destruction, infrastructure damage, and contamination of water resources (World Health Organization [WHO], 2022). These environmental impacts often extend beyond immediate physical destruction, affecting public health, food security, economic stability, and community resilience.

Flooding associated with extreme rainfall can alter landscapes by increasing soil erosion, destroying vegetation, reducing agricultural productivity, and degrading ecosystems. In addition, floodwaters may transport waste materials, chemical pollutants, and pathogens into residential environments and water sources, increasing environmental health risks (Ahern et al., 2005; WHO, 2022). Communities with inadequate drainage systems and weak environmental management structures are particularly vulnerable to these secondary consequences.

The built environment is also highly affected by extreme rainfall events. Residential buildings, roads, bridges, electricity networks, and communication systems may experience structural failure due to excessive rainfall, flooding, and strong winds (Hallegatte et al., 2019). Damage to infrastructure can interrupt essential services, restrict mobility, delay emergency responses, and increase economic losses. The United Nations Office for Disaster Risk Reduction (UNDRR, 2023) identifies floods and storms as among the leading contributors to disaster-related economic losses worldwide.

In agricultural communities, extreme rainstorms may significantly affect livelihoods through destruction of crops, livestock, farmland, and economic trees. These impacts are particularly severe in rural areas where households depend heavily on environmental resources for food production and income generation (FAO, 2021). Consequently, extreme rainfall events represent not only environmental hazards but also threats to socioeconomic stability and sustainable development.

➢ *Environmental Vulnerability to Climate Hazards in Africa*

Africa remains one of the region's most vulnerable to climate-related environmental hazards despite contributing relatively little to global greenhouse gas emissions. This vulnerability is driven by multiple interacting factors, including dependence on climate-sensitive livelihoods, rapid population growth, poverty, inadequate infrastructure, weak environmental governance, and limited capacity for climate adaptation (IPCC, 2023).

Across the continent, increasing occurrences of floods, droughts, storms, and extreme rainfall events have resulted in widespread environmental degradation and socioeconomic disruption. The World Meteorological Organization (WMO, 2024) reported that climate-related hazards in Africa continue to affect ecosystems, agricultural systems, infrastructure, and human settlements, with vulnerable communities experiencing the greatest burden.

Agriculture remains one of the most climate-sensitive sectors in Africa. Changes in rainfall intensity and distribution influence crop productivity, soil conditions, water availability, and food security. Smallholder farmers are particularly vulnerable because agricultural production frequently depends on seasonal rainfall patterns and limited

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul969

access to climate adaptation resources (Serdeczny et al., 2017).

West and Central Africa have experienced increasing concerns regarding extreme rainfall variability, flooding, and environmental degradation. Nigeria, Ghana, Cameroon, and other countries have recorded increasing flood events associated with intense rainfall, inadequate drainage systems, urban expansion, and environmental mismanagement (Amoako & Inkoom, 2021; Nkwunonwo et al., 2020). Rural communities are especially vulnerable because many depend directly on forests, agricultural land, and natural resources while having limited access to disaster preparedness mechanisms.

➢ *Nigeria's Experience of Extreme Rainstorms and Environmental Damage*

Nigeria has experienced increasing environmental challenges associated with climate variability, including flooding, erosion, windstorms, and extreme rainfall events. These hazards have affected communities across different geographical regions, resulting in destruction of houses, agricultural losses, displacement, infrastructure damage, and disruption of economic activities (National Emergency Management Agency [NEMA], 2023).

The Nigerian Meteorological Agency (NiMet, 2023) has identified changing rainfall patterns and increasing climate variability as important contributors to rising disaster risks in Nigeria. Seasonal flooding and severe storms have become recurring environmental concerns, particularly in areas where drainage infrastructure, land-use planning, housing quality, and environmental protection systems remain inadequate.

Flood disasters represent one of Nigeria's most frequent climate-related emergencies. Major flooding events have affected millions of people, destroying homes, farmlands, transportation networks, and public infrastructure (NEMA, 2023). However, beyond large-scale disasters, localized rainstorms occurring at community levels also produce significant environmental consequences that are often poorly documented.

Rural communities in southeastern Nigeria are particularly vulnerable because livelihoods frequently depend on agriculture, vegetation resources, and informal economic activities. Damage to economic trees, crops, roads, electricity systems, and residential buildings can have long-term implications for household income, food security, and community development.

Despite increasing climate-related hazards in Nigeria, scientific documentation has focused predominantly on major floods and nationally recognized disasters. Smaller community-level events, particularly severe rainstorms, have received comparatively limited research attention. This creates gaps in understanding how localized environmental disasters affect rural communities and how residents perceive, adapt to, and recover from these events.

➢ *The 2021 Rainstorm Event in Oforola Ancient Kingdom*

On 8 April 2021, an unusually severe rainstorm accompanied by strong winds affected Oforola Ancient Kingdom in Owerri West Local Government Area of Imo State, Nigeria. The event resulted in extensive environmental and infrastructural destruction within affected communities. The storm caused damage to residential buildings, destruction of economic trees, disruption of electricity infrastructure, road damage, flooding, and loss of household resources.

The sudden occurrence of the rainstorm exposed existing vulnerabilities within the community, particularly weaknesses in housing structures, environmental management systems, and disaster preparedness mechanisms. Many residents experienced destruction of homes, loss of livelihood resources, and disruption of essential services.

Although community reports indicated substantial destruction following the event, limited scientific evidence exists regarding the environmental consequences of this localized disaster. Understanding community experiences is important because residents provide valuable information about environmental changes, damage patterns, recovery challenges, and adaptation strategies that may not be captured in official disaster records.

➢ *Environmental Impacts of Extreme Rainstorms*

- *Infrastructure and Housing Damage*

Infrastructure represents one of the most visible areas affected by extreme rainfall events. Strong winds and heavy rainfall can damage residential buildings, public facilities, roads, electricity systems, and communication networks. In vulnerable communities, inadequate construction standards and limited maintenance increase the likelihood of structural failure during extreme weather events (Hallegatte et al., 2019).

Housing destruction has significant social consequences because homes provide physical protection, security, and stability. Loss of shelter may result in temporary displacement, overcrowding, and increased dependence on emergency assistance. Rural communities with limited financial resources often face prolonged recovery periods following infrastructure damage.

- *Agricultural and Ecological Impacts*

Extreme rainstorms can produce substantial ecological consequences, including destruction of vegetation, loss of economic trees, soil erosion, and reduced agricultural productivity. In communities dependent on agriculture, these environmental losses directly affect household income and food security.

Economic trees provide important ecological functions, including erosion control, biodiversity support, and household economic benefits. Their destruction may therefore create long-term environmental and socioeconomic consequences beyond the immediate disaster period (FAO, 2021).

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul969

- *Water, Sanitation, and Environmental Health Risks*

Flooding and environmental destruction following severe storms can increase environmental health risks. Floodwater may contaminate water sources through transportation of waste, pathogens, and pollutants. Damage to sanitation systems may increase exposure to disease-causing organisms and create conditions favorable for outbreaks of water-related diseases (WHO, 2022).

Environmental health surveillance following disasters is therefore essential for identifying contamination risks, sanitation challenges, waste accumulation, and potential disease threats.

- *Livelihood Disruption and Socioeconomic Consequences*

Extreme rainstorms frequently affect household livelihoods through destruction of homes, agricultural resources, businesses, and income-generating assets. These consequences are particularly severe among households with limited financial reserves and few alternative livelihood opportunities.

The destruction of environmental resources may reduce household resilience and increase vulnerability to future climate hazards. Therefore, disaster recovery strategies must consider not only physical reconstruction but also restoration of livelihoods and community economic systems.

- *Research Gap*

Although previous studies have examined flooding, climate change, and disaster management in Nigeria, several knowledge gaps remain. Much of the existing evidence focuses on large-scale floods, economic losses, and national disaster trends, while localized environmental impacts of severe rainstorms remain insufficiently documented.

Furthermore, many disaster assessments rely on quantitative measurements, government reports, or remote databases, which may not adequately capture community experiences, perceptions of environmental change, and recovery challenges.

Specifically, limited scientific research has examined the environmental impacts of the April 2021 rainstorm in Oforola Ancient Kingdom. This study addresses this gap by exploring community experiences of environmental destruction, infrastructure damage, household resource losses, and livelihood disruption following the event.

- *Study Objective*

The objective of this study was to explore the environmental impacts of the April 2021 rainstorm in Oforola Ancient Kingdom, Imo State, Nigeria.

II. CONCEPTUAL FRAMEWORK

This study was guided by the Sendai Framework for Disaster Risk Reduction (2015–2030), developed by the United Nations Office for Disaster Risk Reduction (UNDRR). The framework explains that disaster impacts result from the interaction between hazards, exposure, vulnerability, and coping capacity, rather than from hazards alone (UNDRR, 2015).

The Sendai Framework emphasizes four priorities: (1) understanding disaster risk; (2) strengthening disaster risk governance; (3) investing in resilience; and (4) enhancing preparedness and recovery (UNDRR, 2015).

In this study, the April 2021 rainstorm was the climate-related hazard, while the extent of environmental damage depended on community exposure, infrastructure quality, livelihood dependence, and disaster preparedness. Thus, the observed impacts were shaped by both the storm and existing vulnerabilities.

➢ *Application to the Oforola Rainstorm*

The conceptual pathway illustrates how climate change contributes to extreme rainfall, which, when combined with community vulnerability (e.g., poor housing, inadequate drainage, reliance on agriculture, and weak infrastructure), leads to environmental and infrastructure damage such as flooding, vegetation loss, road and electricity damage, and destruction of homes. These impacts subsequently result in socioeconomic consequences, including livelihood disruption, reduced agricultural productivity, economic losses, limited access to essential services, and temporary displacement.

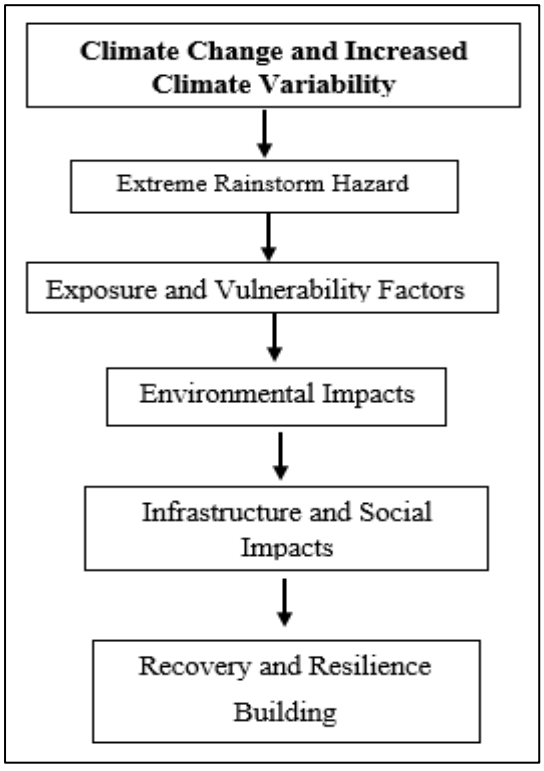

Fig 1 Conceptual Framework for Environmental Disaster Impacts Pathway.

➢ *Relationship Between the Conceptual Framework and Study Methods*

The Sendai Framework informed the development of the interview guide, field observation checklist, and analytical approach. Interview questions explored residents'

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experiences. During analysis, the framework guided interpretation of emerging themes by linking observed environmental damage with broader disaster risk concepts involving hazard exposure, vulnerability, impacts, and resilience.

➢ *Theoretical Contribution of the Framework*

Applying the Sendai Framework to a localized rural disaster provides important insight into how global disaster risk principles operate at community level. While climate hazards may be similar across regions, their consequences vary depending on local vulnerability conditions.

In Oforola Ancient Kingdom, the rainstorm acted as a triggering hazard, but the extent of environmental damage reflected underlying vulnerabilities related to rural infrastructure limitations, dependence on environmental resources, and limited disaster preparedness. Therefore, reducing future disaster impacts requires addressing not only climate hazards but also social, environmental, and structural vulnerabilities.

III. MATERIALS AND METHODS

➢ *Study Design*

This study employed a qualitative descriptive research design to explore the environmental impacts of the April 2021 rainstorm in Oforola Ancient Kingdom, Owerri West Local Government Area of Imo State, Nigeria. A qualitative approach was considered appropriate because the study aimed to understand residents' lived experiences, perceptions, observations, and interpretations of environmental destruction following the disaster.

Qualitative descriptive designs are useful for investigating real-world events where researchers seek to obtain detailed descriptions of participants' experiences without imposing complex theoretical interpretations (Sandelowski, 2000). This approach enabled the study to capture community-level evidence regarding flooding, destruction of vegetation, infrastructure damage, household resource losses, displacement, and livelihood disruption.

The study was guided by the Sendai Framework for Disaster Risk Reduction (2015–2030), which emphasizes that disaster impacts result from interactions between hazards, exposure, vulnerability, and adaptive capacity (UNDRR, 2015).

➢ *Study Setting*

The study was conducted in Oforola Ancient Kingdom, located in Owerri West Local Government Area of Imo State, southeastern Nigeria. Imo State is situated within Nigeria's humid tropical rainforest zone, characterized by high annual rainfall, fertile agricultural land, and communities that rely substantially on environmental resources for livelihoods.

Oforola Ancient Kingdom consists of rural settlements where residents engage primarily in agriculture, petty trading, small-scale businesses, and other environmentally dependent economic activities. The community contains residential areas surrounded by vegetation, farmland, and economic trees that contribute to household income and food security.

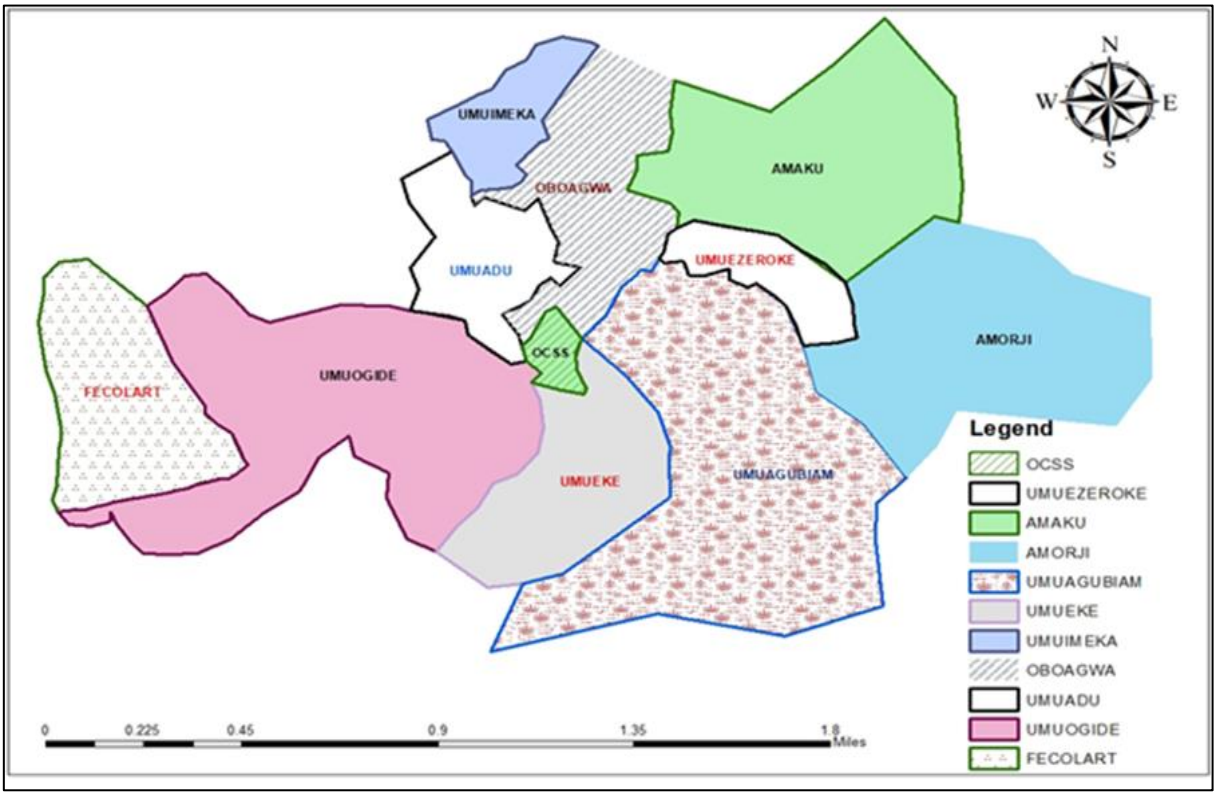

Fig 2 Oforola Ancient Kingdom Map Drawn with ArcGIS 10.8 and Field Coordinates for the Purpose of this Research in 2021 by the Corresponding Researcher.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul969

On 8 April 2021, a severe rainstorm accompanied by strong winds affected several villages within the kingdom. The most severely affected communities included Umueke, Umuagubiam and Umuogide. These villages experienced extensive environmental and infrastructural damage, including destruction of residential structures, fallen electricity poles, flooding, vegetation loss, and damage to household resources. The following figure 3 showed the map of affected villages.

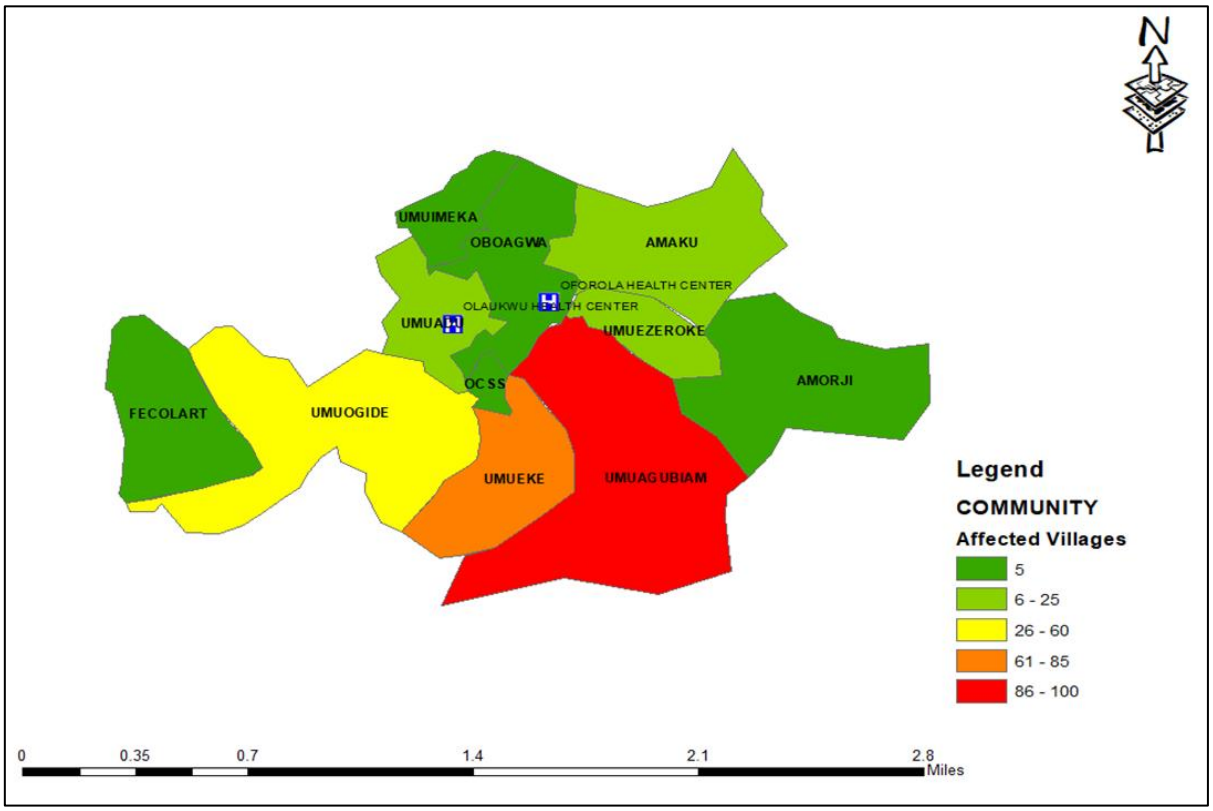

Fig 3 Location Map of the Most Affected Villages

Source: Developed by the corresponding author using GIS data for this study, highlighting the three study most affected villages by the April 2021 rainstorm: Umueke, Umuagubiam, and Umuogide.

➢ *Environmental Context of the April 2021 Rainstorm*

The April 2021 rainstorm occurred during Nigeria's early rainy season, a period associated with increasing atmospheric instability and frequent rainfall events in southeastern Nigeria. The storm was characterized by intense rainfall and strong winds that caused widespread environmental disruption within a short period.

The immediate environmental consequences included flooding of residential compounds, destruction of economic trees and vegetation, damage to residential structures, collapse of roofing materials, disruption of electricity supply, damage to transportation routes and destruction of household materials.

Field observations conducted after the event documented visible environmental changes, including damaged buildings, fallen trees, blocked movement routes, and disruption of community infrastructure as indicated on table 1.

Table 1 Observed Environmental and Infrastructure Damage Following the April 2021 Rainstorm

Damage Category	Observed Impact
Residential buildings	Partial and complete destruction of houses, damaged roofs and walls
Electricity infrastructure	Fallen electricity poles and interruption of power supply
Roads and transportation routes	Damage affecting movement and accessibility
Vegetation	Destruction of economic trees and vegetation cover
Household resources	Loss of documents, furniture, food items, electronics, and personal belongings
Environmental conditions	Flooding, water accumulation, and waste contamination concerns

➢ *Study Population*

The study population comprised residents of Oforola Ancient Kingdom who were directly affected by the April 2021 rainstorm. Participants experienced one or more impacts, including damage to homes, loss of household resources, agricultural destruction, environmental changes, infrastructure disruption, or livelihood losses. The study included 68 residents interviewed, 34 households assessed

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul969

through field observations, and four documentary sources reviewed. Although neighboring communities reported minor impacts, the greatest environmental damage occurred in Umueke, Umuagubiam, and Umuogide, which were selected as the primary study sites.

➢ *Sampling Strategy*

A purposive sampling technique was used to recruit participants with direct experience of the rainstorm and its environmental impacts. This approach was appropriate for selecting information-rich participants knowledgeable about disaster effects and recovery (Palinkas et al., 2015). Participants were selected based on residence in the affected communities, direct exposure to the rainstorm, experience of environmental or infrastructural damage, and involvement in recovery activities. Households included in field observations showed visible evidence of storm-related damage.

➢ *Inclusion and Exclusion Criteria*

Participants were eligible if they were residents of Oforola Ancient Kingdom during the April 2021 rainstorm, directly experienced environmental, structural, agricultural, or household losses, participated in recovery activities, and provided informed oral consent. Individuals were excluded if they were not residents during the event, were not directly affected, could not provide informed consent, or declined participation.

➢ *Data Collection Procedures*

Data were collected using two complementary methods**.**

- *Semi-Structured Interviews:*

Face-to-face interviews were conducted with 68 affected residents using an interview guide that explored environmental changes, damage to homes and infrastructure, vegetation and livelihood losses, flooding experiences, and recovery challenges. Interviews were conducted in participants' preferred language and documented for thematic analysis.

- *Household Field Observations:*

Structured observations were carried out in 34 affected households using an environmental damage checklist assessing building and roof damage, wall collapse, flooding, damage to electricity infrastructure, vegetation loss, and household resource destruction. These observations provided objective evidence to complement interview findings.

➢ *Data Analysis*

Data from interviews and field observations were analyzed using Braun and Clarke's (2006) six-phase thematic analysis. Researchers familiarized themselves with the data, generated initial codes, grouped related codes into themes, reviewed and refined the themes, defined and named the final themes, and presented the findings using narrative descriptions supported by participant quotations and field observations.

➢ *Trustworthiness*

The study's trustworthiness was ensured using the criteria proposed by Lincoln and Guba (1985). Credibility was enhanced through triangulation of interviews, field observations, and documentary evidence, supported by direct participant quotations. Dependability was achieved by systematically documenting data collection and analysis procedures. Confirmability was maintained by grounding findings in participants' accounts and observational evidence, while transferability was supported through detailed descriptions of the study setting, participants, and environmental context.

➢ *Ethical Considerations*

Ethical principles were observed throughout the study. Participants were informed about the study objectives, voluntary participation, confidentiality, and their right to withdraw at any time. Oral informed consent was obtained before data collection. To protect privacy, participant identities were anonymized, personal identifiers were excluded from reporting, and all data were securely stored and used solely for research purposes.

IV. RESULTS

➢ *Overview of Study Findings*

A total of 68 residents participated in the qualitative interviews, while 34 households were assessed through direct field observations. In addition, four documentary reports were reviewed to provide contextual evidence regarding the environmental consequences of the April 2021 rainstorm.

The findings demonstrated that the rainstorm produced extensive environmental and infrastructural consequences within Oforola Ancient Kingdom. Participants described widespread destruction affecting the natural environment, residential structures, household resources, and community services.

- *Thematic Analysis Generated Two Major Themes:*

✓ Environmental destruction and household resource losses
✓ Infrastructure damage, displacement, and livelihood disruption

These themes and their related subthemes are presented in table 2 below.

Table 2 Summary of Themes, Subthemes, and Representative Codes

Major Theme	Subtheme	Key Codes
Environmental destruction and household resource losses	Flooding and environmental contamination concerns	Floodwater, waste movement, water accumulation, environmental health risks
	Vegetation destruction and ecological losses	Economic trees, vegetation loss, agricultural damage

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul969

	Household resource destruction	Loss of documents, furniture, food items, personal belongings
Infrastructure damage, displacement, and livelihood disruption	Housing destruction and displacement	Collapsed structures, damaged roofs, temporary shelter, homelessness
	Electricity and transport infrastructure damage	Fallen poles, power interruption, road damage
	Livelihood disruption	Agricultural losses, reduced income, recovery challenges

➢ *Theme 1: Environmental Destruction and Household Resource Losses*

The April 2021 rainstorm resulted in significant environmental destruction across the affected communities. Participants reported that the storm altered their immediate surroundings through flooding, destruction of vegetation, loss of economic trees, and damage to household resources.

The environmental impacts affected both residential environments and livelihood-supporting resources, demonstrating the interconnected relationship between natural systems and household wellbeing in rural communities.

➢ *Subtheme 1.1: Flooding and Environmental Contamination Concerns*

Flooding was one of the most frequently reported environmental consequences of the rainstorm. Participants described how intense rainfall caused water accumulation within residential compounds, affecting household activities and damaging personal belongings.

Residents reported that floodwater entered homes and displaced household materials, including important documents, kitchen items, food supplies, and personal possessions.

- *One Participant from Umueke Explained:*

"All our documents are gone, most of them are agreements. We might not be able to recover some of the important documents again."*(Affected mother, Umueke)*

- *Another Participant from Umuagubiam Described the Effect of Floodwater on Household Materials:*

"The flood came and took our pots and plates away from our kitchen."*(Affected mother, Umuagubiam).*

Beyond physical damage, participants expressed concerns regarding possible environmental health risks associated with floodwater movement and waste accumulation.

- *A Young Resident from Umuagubiam Stated:*

"This flood can affect our health because it is circulating rubbish from places where people dump their refuse."*(Affected youth, Umuagubiam).*

These accounts indicate that flooding was perceived not only as an environmental event but also as a potential threat to household health and sanitation conditions.

➢ *Field Observation: Flooding and Environmental Damage*

- *Field Observation Findings*

Field observations confirmed widespread water accumulation in residential compounds following the rainstorm. Common environmental impacts included flooded household surroundings, damaged household property, water-destroyed documents, displaced furniture and domestic items, and destruction of surrounding vegetation. Researchers also observed significant damage to economic trees and vegetation, indicating potential long-term effects on household livelihoods and local ecological stability as seen on the following images in figure 4.

Fig 4 Flood Damage Observed in Residential Compounds Following the April 2021 Rainstorm.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul969

- *Subtheme 1.2: Vegetation Destruction and Ecological Losses*

Participants reported extensive destruction of vegetation and economic trees, including the uprooting and damage of trees used for food, income, shade, and environmental protection. The loss of these resources affected household livelihoods, especially among farming-dependent families, and raised concerns about reduced agricultural productivity, income loss, increased environmental vulnerability, and weakened ecological stability.

➢ *Field Observation: Vegetation Destruction and Ecological Losses*

Field observations supported these reports, showing visible damage to trees and vegetation across affected communities.

Fig 5 Destruction of Economic Trees in Affected Villages.

- *Theme 2: Infrastructure Damage, Displacement, and Livelihood Disruption*

Infrastructure destruction was one of the most severe impacts of the rainstorm, affecting residential buildings, electricity systems, roads, and household assets. Field observations indicated that approximately 50 residential buildings experienced partial or complete damage. Many households suffered roof damage, collapsed walls, weakened structures, and complete building destruction, leading to temporary displacement of affected residents. Some displaced households sought shelter in the community secondary school due to limited emergency accommodation options.

The loss of housing resulted in temporary displacement of some households.

✓ *One Participant Explained:*

"Many people from four villages have been rendered homeless. The community's secondary school was converted into a temporary shelter for displaced victims."*(Affected youth, Umueke).*

✓ *Another Participant Reported:*

"Many displaced victims who could not find neighbours to squat with temporarily converted the community's secondary school to their abode for the first two nights after the incident."*(Affected adult, Umuogide).*

These experiences highlight the limited emergency accommodation capacity available within rural communities during sudden environmental disasters.

➢ *Field Observations*

Field observations supported these reports, showing visible damage to Infrastructure Damage, Displacement, and Livelihood Disruption across the affected villages.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul969

Fig 6 Structural Damage to Residential Buildings Following the Rainstorm

Participants also reported significant damage to electricity and transportation infrastructure, including fallen electricity poles, prolonged power outages, and difficulties accessing affected areas. Field observations confirmed damaged electricity infrastructure along major routes, including the Umuogide–Federal College of Land Resources Technology (FECOLART) road. These disruptions affected household activities, communication, local businesses, and community recovery efforts, while damaged roads further limited movement and access to affected households.

Fig 7 Damaged Electricity Infrastructure Along Major Routes, Including the Umuogide–Federal College of Land Resources Technology (FECOLART) Road.

The findings illustrate that rural communities experience climate-related disasters through multiple interconnected pathways involving environmental damage, infrastructure vulnerability, and socioeconomic consequences.

V. DISCUSSIONS

This study explored the environmental impacts of the April 2021 rainstorm in Oforola Ancient Kingdom, Imo State, Nigeria. The findings demonstrate that the rainstorm produced substantial environmental and infrastructural consequences, including flooding, destruction of vegetation, loss of household resources, damage to residential structures, disruption of electricity infrastructure, and livelihood disturbances. These findings highlight how localized climate-related hazards can generate complex environmental and socioeconomic consequences, particularly in rural communities where livelihoods are closely connected to natural resources and where disaster preparedness capacity may be limited.

The findings support broader evidence that climate change is increasing the risks associated with extreme rainfall events worldwide. The IPCC (2023) reports that global warming is contributing to changes in precipitation patterns, including increases in the intensity of heavy rainfall events in many regions. These climatic changes increase the likelihood

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of flooding, erosion, infrastructure damage, and ecosystem disruption. The environmental consequences observed in Oforola Ancient Kingdom reflect the interaction between climate hazards and existing vulnerabilities, consistent with the Sendai Framework for Disaster Risk Reduction, which emphasizes that disasters occur through the interaction of hazards, exposure, vulnerability, and coping capacity rather than hazards alone (UNDRR, 2015).

- *Flooding and Environmental Degradation Following Extreme Rainfall*

Flooding was one of the most prominent environmental impacts identified in this study. Participants reported that floodwater entered residential compounds, damaged household materials, destroyed important documents, affected movement, and raised concerns regarding environmental contamination. Field observations supported these accounts by identifying water accumulation, household damage, and environmental disruption within affected locations.

These findings are consistent with international evidence demonstrating that extreme rainfall events produce environmental consequences beyond temporary water accumulation. Flooding can alter landscapes, accelerate soil erosion, damage agricultural systems, contaminate water sources, and increase exposure to environmental health risks (Ahern et al., 2005; WHO, 2022). In rural communities where households often depend on local environmental resources, flooding can create both immediate and long-term challenges.

The environmental concerns expressed by residents regarding waste movement and possible contamination are particularly important from an environmental health perspective. Floodwaters can transport biological and chemical contaminants from waste disposal areas, sanitation facilities, and polluted environments into residential spaces. This may increase risks of waterborne diseases and other environmental health problems, especially where access to safe water and sanitation infrastructure is limited (WHO, 2022).

Similar challenges have been documented in Nigeria. Flood disasters frequently result in displacement, contamination concerns, agricultural losses, and infrastructure disruption (NEMA, 2023). The experiences of Oforola residents therefore reflect broader national patterns of increasing vulnerability to climate-related environmental hazards.

- *Destruction of Vegetation and Ecological Resources*

A significant finding of this study was the destruction of vegetation and economic trees following the rainstorm. Participants described the loss of trees that served as sources of food, income, and ecological protection.

The destruction of vegetation represents an important environmental consequence because trees provide multiple ecosystem services, including erosion control, soil protection, biodiversity support, and household economic benefits. In rural communities, economic trees and agricultural resources often function as essential livelihood assets; therefore, their destruction can increase household vulnerability after disasters.

Similar findings have been reported in climate-sensitive agricultural communities globally. The Food and Agriculture Organization (FAO, 2021) emphasizes that climate-related disasters increasingly threaten agricultural systems through crop destruction, land degradation, and loss of productive assets. These impacts are particularly severe among smallholder farming households that depend heavily on environmental resources.

The loss of vegetation in Oforola Ancient Kingdom may also have longer-term ecological implications. Reduced vegetation cover can increase soil exposure, accelerate erosion, and reduce environmental resilience against future climate hazards. Therefore, post-disaster recovery efforts should incorporate ecological restoration alongside reconstruction of physical infrastructure.

- *Infrastructure Damage and Rural Community Vulnerability*

Infrastructure destruction was among the most severe consequences identified in this study. More than 50 residential buildings were reported to have experienced partial or complete damage, while electricity infrastructure and roads were also affected.

Housing damage following extreme weather events represents a major indicator of community vulnerability. Homes provide physical protection, social stability, and economic security; therefore, their destruction can result in displacement, increased financial burden, and prolonged recovery periods.

The findings align with global evidence showing that climate change increasingly threatens infrastructure systems, particularly in areas where construction standards, maintenance systems, and adaptation investments are inadequate (IPCC, 2023; Hallegatte et al., 2019). Rural communities often experience greater impacts because infrastructure may not be designed to withstand increasing climate pressures.

The temporary use of community facilities as emergency shelters in Oforola demonstrates limited disaster response capacity at the local level. Similar challenges have been observed in other disaster-affected communities where inadequate emergency accommodation increases vulnerability among displaced populations.

- *Comparison with Other African Climate Disaster Experiences*

The environmental impacts observed in Oforola Ancient Kingdom are consistent with experiences from other African countries facing increasing climate-related hazards.

In Ghana, flood-prone communities have experienced repeated environmental challenges associated with poor drainage systems, inadequate urban planning, and limited

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flood management capacity. Amoako and Inkoom (2021) reported that flood vulnerability is produced through interactions between environmental conditions, socioeconomic factors, and infrastructure limitations.

The environmental impacts observed in Oforola Ancient Kingdom are consistent with experiences from other regions facing increasing climate-related hazards. In South Africa, studies conducted following the 2022 KwaZulu-Natal floods documented widespread destruction of homes, transport infrastructure, and community livelihoods while emphasizing that social vulnerability, exposure, and adaptive capacity strongly influence disaster outcomes. These findings reinforce the need for climate-resilient infrastructure, community-based preparedness, and locally informed adaptation strategies to reduce future disaster risks (Udo and Naidu 2023).

These similarities demonstrate that the environmental challenges experienced in Oforola are part of a wider regional pattern in which increasing climate hazards interact with existing vulnerabilities to produce severe impacts.

- *Livelihood Disruption and Socioeconomic Consequences*

The destruction of household resources, vegetation, and agricultural assets significantly affected community livelihoods. Many residents depended on agriculture, economic trees, and environmental resources for household income and food security.

Climate-related disasters frequently produce indirect socioeconomic consequences by reducing household productivity, increasing financial stress, and limiting recovery capacity. These impacts are particularly severe among households without insurance, savings, or alternative income sources.

Similar findings have been reported in other climate-vulnerable settings. In the Philippines, for example, extreme weather events such as typhoons have been associated with agricultural losses, livelihood disruption, and prolonged recovery challenges among affected households, (Udo and Naidu 2023)

The experiences of Oforola residents demonstrate that environmental disasters should not be assessed solely by physical destruction. Effective disaster assessment must also consider livelihood impacts, household resilience, and long-term recovery needs.

- *Implications for Environmental Health and Disaster Risk Reduction*

The findings highlight important implications for environmental health, climate adaptation, and disaster management. The destruction of homes, electricity systems, and community infrastructure underscores the need for climate-resilient infrastructure, including improved building standards, resilient housing programs, and community infrastructure upgrades.

The observed flooding and environmental damage emphasize the importance of effective environmental planning and flood management through improved drainage systems, flood risk mapping, land-use planning, and protection of natural drainage pathways.

Recent reviews have emphasized that disaster risk reduction, climate change adaptation, and sustainable development should be implemented as integrated rather than separate policy approaches. Such integration strengthens community resilience, enhances adaptive capacity, and supports sustainable recovery in climate-vulnerable settings

Given the dependence of households on agricultural resources and economic trees, disaster recovery programs should incorporate livelihood restoration, including agricultural rehabilitation, replacement of damaged economic trees, and support for affected households.

Finally, strengthening post-disaster environmental health surveillance is essential to monitor risks related to water contamination, sanitation challenges, waste accumulation, vector breeding, and potential disease outbreaks. Integrating environmental health measures into disaster response can improve community resilience and reduce future health risks.

Environmental health professionals should collaborate with emergency agencies to integrate health protection into disaster response activities.

- *Study Limitations*

This study provides important insights into the environmental impacts of the April 2021 rainstorm; however, some limitations should be acknowledged.

First, the study focused on selected affected communities within Oforola Ancient Kingdom; therefore, findings may not represent experiences of all communities affected by similar events.

Second, environmental assessments were based primarily on qualitative observations rather than quantitative measurements of rainfall intensity, wind speed, flood depth, or economic losses.

Third, satellite imagery, remote sensing analysis, and geographic information system (GIS)-based environmental modelling were not available to quantify the spatial extent of damage.

Despite these limitations, the study provides valuable qualitative evidence regarding how rural communities experience and respond to climate-related environmental disasters.

VI. CONCLUSION

The April 2021 rainstorm in Oforola Ancient Kingdom, Imo State, Nigeria, resulted in substantial environmental and infrastructural impacts that affected household wellbeing,

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community functioning, and local livelihoods. The disaster caused flooding, destruction of vegetation and economic trees, loss of household resources, damage to residential buildings, disruption of electricity infrastructure, and temporary displacement of affected residents.

The findings demonstrate that rural communities are particularly vulnerable to climate-related hazards because of their dependence on natural resources, limited infrastructure resilience, inadequate disaster preparedness systems, and constrained capacity for recovery. The environmental consequences observed in Oforola were not solely determined by the intensity of the rainstorm but were shaped by the interaction between climate hazards, community exposure, existing vulnerabilities, and available coping mechanisms.

This study contributes valuable qualitative evidence on the localized environmental impacts of extreme rainfall events in rural Nigeria. While large-scale disasters often receive greater scientific and policy attention, community-level climate events can produce significant environmental damage and socioeconomic consequences that require targeted interventions.

Reducing future disaster impacts requires an integrated approach that combines climate adaptation, environmental management, disaster risk reduction, and community resilience-building. Priority actions should include investment in climate-resilient infrastructure, improved flood management systems, strengthened early warning mechanisms, environmental health surveillance, and community-based preparedness strategies.

The findings are consistent with growing international evidence that disaster resilience depends not only on reducing exposure to hazards but also on strengthening livelihoods, governance systems, community participation, and adaptive capacity. Integrating these components into disaster preparedness and recovery programs will improve resilience to increasingly frequent climate-related extreme weather events.

As climate variability continues to increase the likelihood of extreme weather events, documenting local experiences remains essential for developing context-specific adaptation strategies capable of protecting vulnerable rural populations.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed for key stakeholders involved in climate adaptation, environmental management, and disaster risk reduction.

- *Government Authorities*

Government agencies should integrate climate risk assessment into environmental planning, infrastructure development, and disaster management policies. Priority should be given to climate-resilient infrastructure through improved building standards, stronger housing designs, and upgrades to electricity and transport systems.

Flood management should be strengthened through improved drainage systems, flood risk mapping, sustainable land-use planning, protection of natural drainage pathways, and regular environmental monitoring. Recovery programs should also support affected households through agricultural restoration, replacement of damaged economic trees, livelihood assistance, and financial support for vulnerable groups.

- *Emergency Management Agencies*

Disaster management agencies should improve local preparedness and response capacity by establishing systematic disaster assessment systems to document environmental damage, infrastructure losses, household impacts, and livelihood disruptions.

Communities should have pre-planned emergency shelters and clear displacement management procedures. Agencies should strengthen early warning systems through improved weather monitoring, community communication mechanisms, and regular disaster preparedness training. Response efforts should integrate humanitarian support with environmental recovery activities, including waste management, water safety monitoring, and ecosystem restoration.

- *Community Leaders*

Community leaders should promote environmental awareness through education on proper waste disposal, drainage protection, and sustainable environmental practices. They should encourage safer construction methods, establish local disaster committees, develop community response plans, and support vulnerable groups such as older adults and households with limited resources during disasters.

- *Environmental Health Practitioners*

Environmental health professionals should play a stronger role in climate-related disaster management by conducting post-disaster environmental assessments. These should focus on water quality risks, sanitation conditions, waste accumulation, vector breeding sites, and other environmental health threats to support effective disaster response and disease prevention.

SECTION 9: DECLARATIONS

➢ *Declaration of Interest Statement*

The authors declare that there is no conflict of interest regarding the publication of this article.

➢ *Funding Statement*

This research received no specific grant or financial support from any funding agency in the public, commercial, or non-profit sectors.

➢ *Data Availability Statement*

The datasets generated and analyzed during this study are available from the corresponding author upon reasonable

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request. Access to the data may be granted for academic and research purposes while maintaining participant confidentiality and ethical protections.

➢ *Author Contributions*

Author contributions were based on the CRediT (Contributor Roles Taxonomy) framework.

- *Ugwuegbulam Joe Chibuike*

Conceptualization; Methodology; Investigation; Data collection; Formal analysis; Data curation; Visualization; Writing – original draft preparation; Writing – review and editing; Project administration; Corresponding author.

- *Chidiebere Ugwuegbulam*

Field investigation; Environmental observations; Data verification; Writing – review and editing.

- *Mandlenkosi Khumalo*

Literature review; Conceptual support; Writing – review and editing.

- *Egbukichi Ugonna Johnbull*

Literature review; Environmental health interpretation; Writing – review and editing.

- *Nnoshiri Ike Godswill*

Literature review; Environmental engineering perspectives; Writing – review and editing.

- *Murungi Priscilla*

Psychological and social impact interpretation; Literature review; Writing – review and editing.

All authors reviewed and approved the final manuscript.

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