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ORIGINAL RESEARCH ARTICLE

Analysis of Indigenous Knowledge Approaches Towards Building Climate Resilience in the Niger Delta Region of Nigeria

Eyefia, Oghenerukevwe Alexander
Department of Geography and Environmental Sustainability
Delta State University, Abraka, Delta State, Nigeria

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***Corresponding Author:**
E-mail: *alexander@delsu.edu.ng; eyefia1@gmail.com*
https://orcid.org/0000-0001-6207-7175

ABSTRACT

The study focuses on indigenous knowledge systems in the Niger Delta. A quantitative research design approach was used, combining a household survey (n = 400) with historical climate data analysis (1901-2024). Statistical techniques used in the study included descriptive analysis, correlation and regression analysis, threshold-based scoring, trend analysis using ordinary least squares (OLS) and Theil-Sen method. The survey results indicate that indigenous knowledge, such as elevated housing, rotational farming, and communal warning systems, is widely used and effective in reducing climate hazards. The Climate Resilience Index (mean = 77.2%) revealed that more than 90% of respondents demonstrated high to very high resilience. Pearson correlations ($r \geq 0.90$, $p < 0.001$) demonstrated a clear positive relationship between IK adoption and resilience. Comparative perception tests ($\chi^2 = 7.28$, $p = 0.026$) found a significant difference in community perceptions of three strategies (indigenous knowledge (IK), modern/scientific systems, and training). Climatic trend analysis revealed a clear warning signal in all the states (+0.003-0.005 °C/year), a declining rainfall trend in several states (-0.11 - 0.21 mm/year), and growing diurnal temperature ranges (DTR) in Rivers and Cross River States. Vapour pressure escalated, notably in Delta and Bayelsa States, which suggests that local knowledge can help with combating climate change. The study suggests that the people of the region should acknowledge an adaptation policy that harmonises indigenous and scientific approaches, while also enhancing intergenerational knowledge transmission.

Introduction

Indigenous knowledge (IK) is the unique, long-standing customs and lifestyles of indigenous people that have been developed throughout time, shaping how they interact with the environment, their fellow humans, and their beliefs about the natural world. Jessen et al. (2022) describe IK as a term used to refer to place-based forms of knowledge that have been gathered over hundreds of years across numerous distinct cultural

settings. While Bianca et al. (2022) define IK as the information, abilities, and beliefs that have been acquired by communities through long-term interaction with their natural environment for a long time. According to Filho et al. (2022), indigenous communities have distinct social and cultural identities that originate from ancestral ties to their lands and resources. Their individual identities, customs, means of livelihood, and spiritual as well as physical health are all intricately intertwined with the land and natural resources on which they rely. The United Nations High Commissioner for Refugees [UNHCR] (2020) asserts that IK has been transmitted for hundreds of years, which provides nature-based solutions that can aid in adaptation on a local, national, and global scale. They added that IK places a strong focus on integration, equilibrium, and mutual respect amongst society and the other components of nature, especially when it comes to resource use. Zainuddin and Islam (2025) revealed that IK, which combines knowledge of the environment and spiritual beliefs accumulated over numerous generations, is essential to climate resilience. They further note that the current climate-related issues can be addressed with the aid of this religious knowledge, along with culturally embedded knowledge. Indigenous cultural practices play a vital role in promoting diversity, equity, and inclusion (DEI) in resilient climate change mechanisms by highlighting a positive connection with the environment.

The Inuit Circumpolar Council [ICC] (2021) indicates that IK is a methodical approach to phenomena that can be utilised in the natural, physical, cultural, and religious systems. It contains knowledge based on data gathered from firsthand, prolonged experiences as well as from in-depth, multigenerational observations, lessons, and abilities. Bianca et al. (2022) note that the Intergovernmental Panel on Climate Change (IPCC) has increasingly recognised the value of IK systems in advancing an understanding of climate change and successful climate action, although the process has been slow. They added that IK systems are still mostly excluded and ignored in the IPCC's global assessment reports. Onwuemele (2018) noted that climate change initiatives frequently disregard indigenous expertise, highlighting a related problem in Nigeria. Given their extensive experience with a variety of environmental changes, particularly climate change, indigenous people have important insights to provide regarding effective and inadequate measures to adapt; these observations may be particularly significant in the context of climate change. This is because incorporating the expertise of the program's beneficiaries is essential if such programs are to gain support from the target audience. Natural Justice (2024) asserted that, given the effects of climate change, residents and indigenous individuals can be portrayed as victims of the crisis. In addition to being negatively affected by climate change, these communities possess resilience and adaptation skills that they have acquired from their long-standing collective knowledge. Although it is key to community adaptation and damage reduction, this knowledge is not well recognised when international policies are discussed, which has adverse effects on communities' resilience. According to the IPCC (2014), the most important resources for climate change adaptation are indigenous, local and traditional forms of knowledge, particularly because indigenous communities have a thorough understanding of their environment, ecosystems, and interpersonal interactions. IPCC (2019) emphasised that IK can be useful against food security, the preservation of biodiversity and a changing climate and desertification.

Holling (1973) stated that ecology was the first field to use the term resilience, defining it as the capacity of ecological systems to endure disruptions while retaining their fundamental coherence. Bahadur et al. (2011) demonstrated that the concept of resilience has been applied across many fields over the past thirty years, including engineering, economics, psychology, the social sciences, and natural hazards.

According to Graham et al. (2021), climate resilience is commonly defined as the capacity to recover from or reduce susceptibility to weather-related events, such as droughts and devastating floods. Furthermore, they argue that it relates to political strategies aimed at improving the ability of all individuals to reduce exposure to climate-related threats and to adapt to shifting climate trends and vulnerabilities. In the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), climate resilience is defined as the ability of human societies, economies, and ecological systems to effectively cope with an unpredictable event, pattern, or change. It includes the capacity for learning and reorganisation (IPCC, 2022).

Among the most significant challenges confronting the modern world is climate change, which threatens both human communities and global sustainability (Dorji et al., 2024). The consequences of climate change are especially severe for vulnerable and underprivileged populations, such as indigenous peoples, who often rely primarily on Indigenous Knowledge (IK) to adapt to evolving environmental conditions. For indigenous societies to withstand these imminent threats, resilience is crucial. According to Okeke (2024), Nigeria's diverse agro-ecological zones, rapidly growing populations in both urban and rural areas, extensive coastline, coastal storm surges, and sea-level rise, along with economic challenges and inadequate governance, all contribute to the country's increasing exposure to weather-related hazards and disasters. Increased outbreaks of infectious diseases, frequent community disputes, farmer–herder conflicts, destruction of livelihoods, loss of marine and terrestrial biodiversity, declining food supplies, and heightened economic pressures are among the consequences of Nigeria's growing climate crisis.

Climate resilience refers to the capacity of a population or natural system to adapt to and cope with variations in weather conditions, such as changes in rainfall, temperature, wind patterns, relative humidity, sea-level rise, diurnal temperature range (DTR), vapor pressure, and the frequency and intensity of severe weather events, while protecting or quickly restoring its essential structure, functioning, and key characteristics. Jonker and McGrath (2024) define climate resilience as the ability of a system or community to anticipate, plan for, and respond to the effects of climate change. They argue that a foundational element of climate resilience is understanding climate-induced hazards and vulnerabilities, and implementing appropriate solutions. Climate-resilient systems can continue performing essential functions while adapting to changing climate-related conditions. Jonker and McGrath (2024) further note that developing resilient technologies and infrastructure, establishing diversified distribution systems, and strengthening natural ecosystems are strategies that can help achieve climate resilience. Additionally, climate resilience aims to enable communities to adapt to changing environmental conditions both in the short and long term. Grasham et al. (2021) define climate resilience as the ability to recover from or reduce vulnerability to weather-related disruptions, particularly extreme rainfall and severe droughts.

The Niger Delta region of Nigeria is highly vulnerable to flood surges, coastal erosion, saltwater intrusion, and unpredictable variations in rainfall, all of which threaten the lifestyle, homes, food security, and health of local populations. Despite significant government initiatives, communities in the region remain particularly susceptible to and negatively affected by climate change. A vital yet underexplored component in addressing this challenge is the use of Indigenous Knowledge (IK) coping strategies, which have enabled generations to respond to environmental change. However, these strategies are rarely integrated into official climate adaptation plans. Although indigenous knowledge is commonly applied in the region's agricultural practices, empirical research on its effectiveness in strengthening climate resilience remains limited. Studies have examined indigenous knowledge related to coping and mitigation mechanisms, but this area is still relatively under-researched, whereas indigenous knowledge in agriculture in Nigeria has received considerable scholarly attention (Onwuemele, 2018; Ihenacho et al., 2019; Ayi & Undiandeye, 2022; Mansur et al., 2024; Salau & Oseni, 2024; Salami et al., 2020).

Indigenous Knowledge (IK) has recently been identified as highly essential for climate change adaptation in Africa (Trisos et al., 2022; Filho et al., 2022; IPCC, 2022). For example, Mafongoya et al. (2017) found that local communities use IK to predict and adapt to climate variations within traditional agricultural systems in many African countries. Similarly, the IPCC (2019b) notes that IK-based approaches help identify responses that enhance resilience to various disasters and community pressures. They further highlight that although IK in Africa provides extensive ecological understanding and has strong potential to contribute to climate change mitigation and disaster management, its future applicability to climate resilience remains unclear. Consequently, IPCC Working Group II (2022) has emphasised the need for further research on the role of IK in climate resilience in Africa. In line with these calls and the identified gaps, this study aims to examine how Indigenous Knowledge is used, assess its effectiveness, and explore how it can complement scientific approaches in strengthening local climate resilience in Nigeria.

The broad objective of the study is to investigate the progression of climate resilience in the Niger Delta Region using local and indigenous knowledge. The specific objectives are: To identify common indigenous knowledge systems/practices used to combat climate hazards in the Niger Delta region; To determine if traditional methods work well in reducing climate-related dangers; To determine if indigenous strategies can be compared to both modern scientific strategies in relation to climate adaptation; To know the level of awareness of these communities and how indigenous knowledge is transmitted across generations; To give recommendations on how to integrate indigenous knowledge into regional climate policy, along with disaster risk management.

This study is based on the concept of climate resilience, which serves as a framework for comprehending how communities foresee, adjust to, and recover from climate-related challenges. The concept highlights a system's capacity to withstand disruptions, reorganise, and maintain functionality amidst climatic fluctuations like higher temperatures, reduced rainfall, and extreme weather occurrences. Jonker and McGrath (2024), along with Grasham et al. (2021), state that climate resilience denotes the ability of a community or ecosystem to anticipate, strategise, and respond adeptly to the effects of climate change while preserving vital functions. The study also employs the five-pillar framework of climate resilience put forth by Rutger and Henk (2021), which encompasses:

1. Threshold capacity: The ability to stop damage by building a barrier against changes in the environment.
2. Coping capacity: The ability of a community, city, or nation to manage severe weather events and minimise harm while doing so.

3. Recovery capacity: The ability of society to return to a level that is comparable to or superior to that of the pre-extreme event.
4. Adaptive capacity: The ability of society to predict unforeseen future events.
5. Transformative capacity: This is the ability to proactively move towards a society that is climate resilient by fostering an enabling environment, enhancing stakeholder capacities, and identifying and putting into practice catalysing actions.

The conceptual framework demonstrates that temperature, rainfall, diurnal temperature range (DTR), and vapour pressure contribute to the various extreme weather events experienced in the various villages and towns located in the Niger Delta region. People living in the Niger Delta region respond by adopting Indigenous Knowledge Systems (IKS), such as elevated housing, communal drainage systems, rotational cropping, and local forecasting (Figure 1). According to Figure 1, to improve climate resilience, the following capabilities must be implemented: transformative (engaging in comprehensive transformation), adaptive (modifying behaviours over time), and absorptive (surviving environmental shocks). All things considered, the framework illustrates the relationship between climatic stressors and resilience results, emphasising IK as an important but dynamic key component for resilience building and policy integration.

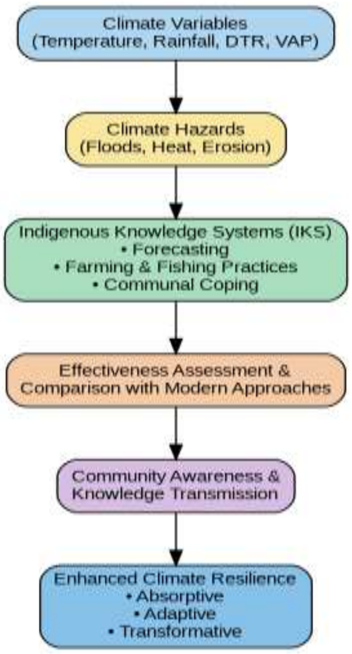

Figure 1: Conceptual Framework on Climate Resilience

Materials and Methods

Study Area

The study is made up of the nine states in the Niger Delta (Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Rivers, and Ondo States). Figure 2 shows that the Niger Delta is located within latitudes 4.5°N and 6.5°N and longitudes 5.0°E and 8.5°E. Its surface area is around 70,000 km² (27,000 sq mi). The region is characterised by freshwater forests, mangroves, lowland rainforests, and aquatic habitats that support both the local population and the economic growth of West African countries (Ayanlade & Proske, 2015). The region houses rivers and tributaries that are approximately 36,000 km, which influence the life of the locals and the economy of the region.

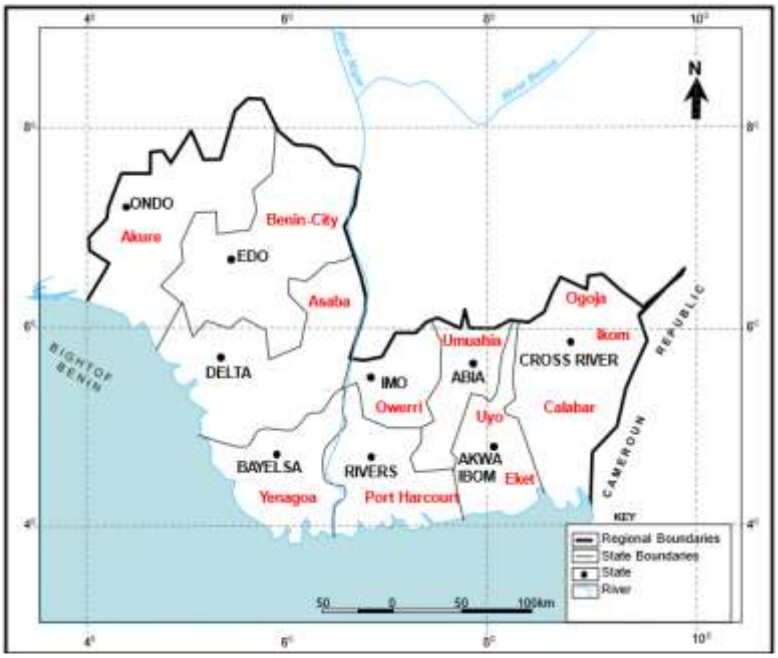

Figure 2: The Niger Delta Region of Nigeria

Research Design

The method of investigation used in the current study was a quantitative research design, where a survey and a longitudinal research design were combined. Quantitative research design is an approach that emphasises the collection, analysis, and interpretation of numerical data to elucidate phenomena and evaluate hypotheses (Creswell, 2012, 2013, 2016). This kind of study relies on gathering and evaluating quantitative information, which is frequently assessed with the aid of standardised tools (Creswell, 2012; Case & Science, 2018). Additionally, this kind of study is usually standardised and systematic, employing techniques like questionnaires and studies involving observations.

Population and Sample Size

The target population of this study are the citizens of Abia, Akwa Ibom, Bayelsa, Cross Rivers, Delta, Edo, Imo, Rivers, and Ondo States (Table 1).

Table 1: Population Proportion and Sample Size

State	Population	Proportion (%)	Sample Size (n = 400)
Abia	4,265,920	9.4%	38
Akwa Ibom	6,497,967	14.4%	57
Bayelsa	2,633,466	5.8%	23
Cross River	4,469,525	9.9%	40
Delta	6,646,022	14.7%	59
Edo	4,847,769	10.7%	43
Imo	6,347,078	14.0%	56
Rivers	9,567,892	21.1%	84
Total	45,275,639	100%	400

Table 1 shows the population figure of the Niger Delta region. To calculate the sample size for the study, the Taro Yamane online calculator was used in determining the population size of 45,275,640 people of the Niger Delta region, with a degree of error expected of 0.05, and a result of 399.996.5, approximately 400. To calculate the sample size for each state, the state population was divided by the total regional population and multiplied by 400. Thus, 400 questionnaires were distributed proportionately to Women's groups, local leaders, farmers, elders, fishermen, and other individuals with expertise in the states of Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Rivers, and Ondo were given questionnaires. The sampling method combined purposive selection of knowledgeable individuals and stratified random sampling of households to ensure representativeness across age, gender, and occupation.

Data Sources

The research utilised both primary and secondary data. Primary data were gathered through a structured questionnaire distributed across the nine states of the Niger Delta. Secondary data, such as temperature (TMP), precipitation (PRE), diurnal temperature range (DTR), and vapour pressure (VAP), were retrieved from the Climate Research Unit (CRU TS v.4.09) at 0.5° resolution from 1901–2024 and accessed through a Google Earth interface. The main instruments of data collection were the questionnaire and Google Earth Pro.

Data Analysis Techniques

Data analysis was performed using Python version 3.13. The research utilised both descriptive and inferential statistical methods, which included: Descriptive statistics such as mean, percentage, frequency, and standard deviation (to summarise responses and climate data).

Graphical analysis, such as tables, figures, radar charts, and index scoring, was utilised. Inferential tests such as correlation, regression, Mann–Whitney U test, and the Theil–Sen estimator for analysing trends and magnitude were employed to test the hypotheses of the study and assess the relationships among indigenous knowledge, community resilience, and climate variables.

Results and Discussion

Demographic Variables of Respondents

Figure 3 shows the demographics of the 400 respondents surveyed. More than half (54%) are over 40, which suggests they have a good amount of local knowledge about dealing with climate issues. On the gender analysis, male (57.25%) and female (42.75%), this matches the work situation in the Niger Delta region, where about 46.5% of the people are into farming and 35.75% are into fishing activities, jobs usually done by men. Around 70% completed their secondary school or higher education, pointing to good literacy rates that could help blend local and scientific knowledge. Most respondents (57.75%) have lived there for 11–20 years, with 12% living there for over 20 years. This makes their climate observations more trustworthy. The respondent group seems to have good local climate knowledge and can help with policies to build resilience.

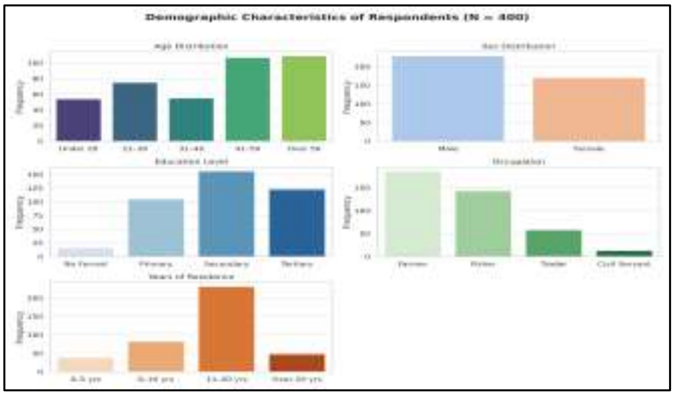

Figure 3: Demographic Characteristics of Respondents. Source: Field Survey, 2025

Indigenous Knowledge Systems and Practices

The researcher used a 5-point Likert scale (1 = Not Used, 5 = Widely Used) to find out which local practices are commonly used to deal with climate hazards in the Niger Delta. Figure 4 shows the descriptive statistics for each IK system and practices in the Niger Delta region.

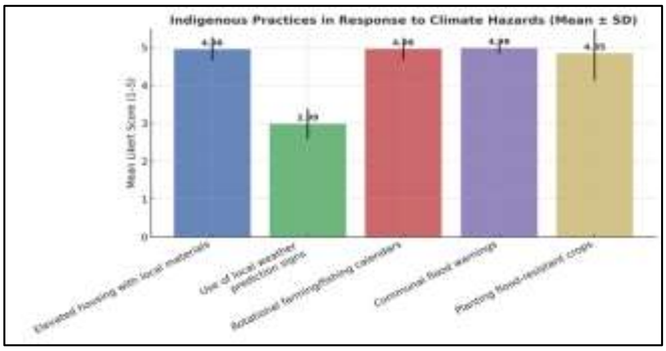

Figure 4: Mean Perception Scores of Indigenous Practices

The data indicate that elevated housing, farming/fishing schedules, communal flood warnings, and flood-resistant crops are well-established indigenous practices in the region (M ≥ 4.8), which suggests they are a key part of how communities withstand climate change. Local weather forecasts had a lower average (M = 2.99), likely because people are using modern weather services more and passing down this wisdom less. Most practices showed little change (SD < 0.4), implying wide agreement within communities. However, planting flood-resistant crops had more variation (SD = 0.72), due to differences in how many families use them and how easily they can get them. Overall, indigenous knowledge is still very important for resilience in the Niger Delta, but there should be more work done to save and pass on prediction methods to younger people (Figure 4).

Climate Resilience Index

The climate resilience index results show that the Niger Delta region, in general, is very able to deal with climate risks, with an average score of 4.09 (77.2%) and a standard deviation of 0.50, meaning that most households have similar levels of resilience. Table 2 shows that scores went from 2.33 (33%) to 4.67 (92%), and the median score was 4.25 (81%), which confirms that at least half of those surveyed are very resilient. This points to most families being ready to adapt and cope with climate risks.

Table 2: Summary Statistics

Metric	Raw Score	Avg Score	Index (0–1)	Index (%)
Mean	24.52	4.087	0.772	77.18%
Std Dev	3.03	0.504	0.126	12.61%
Min	14.00	2.333	0.333	33.33%
25%	23.00	3.833	0.708	70.83%
Median	25.50	4.250	0.813	81.25%
75%	27.00	4.500	0.875	87.50%
Max	28.00	4.667	0.917	91.67%

The category breakdown affirmed this trend, with 50% of households being very resilient and 41% being resilient (Table 3). So, above 90% of the families surveyed are well-prepared and sure of themselves when it comes to handling climate risks that are only a small number, 2.75%, show average resilience, and 6.25% report low resilience, likely because of financial issues, not enough infrastructure, or little access to resources. In general, the results show that resilience is generally tied to effective coping methods and shared adaptive actions. Even so, some are not well-equipped to cope, so policies and support should focus on these areas. Boosting the ability of households with low to average resilience and sharing knowledge with those who are highly resilient might narrow the resilience differences and make the whole community better prepared for climate change.

Table 3: Resilience Category Distribution

Category	Count	% of Respondents
Very High	200	50.00%
High	164	41.00%
Low	25	6.25%
Moderate	11	2.75%

The findings of this present study are consistent with the assertions made by Trisos et al. (2022), Filho et al. (2022), and the IPCC (2022), who emphasise that indigenous knowledge is essential for climate adaptation in Africa, offering culturally relevant, sustainable, and community-oriented solutions to environmental changes.

Hypotheses Testing

Hypothesis 1: There is no significant relationship between indigenous knowledge practices and community resilience to climate hazards. The relationship between indigenous knowledge and resilience was tested using Pearson's correlation analysis. The results (Table 4) show a strong, positive, and significant relationship between the variables. In particular, how often indigenous knowledge usage was almost perfectly correlated with household recovery capacity ($r = 0.994$, $p < 0.001$), closely tied to preparedness ($r = 0.894$, $p < 0.001$), and strongly tied to collective community action ($r = 0.970$, $p < 0.001$). Also, how easily people could recover was linked to preparedness ($r = 0.909$, $p < 0.001$) and collective action ($r = 0.964$, $p < 0.001$). The weakest link, though still strong, was between preparedness and collective community action ($r = 0.818$, $p < 0.001$). This result strongly aligns with existing research that identifies Indigenous Knowledge (IK) as crucial for climate resilience and a key resource for adaptation (UNHCR, 2020). The significant efficacy reinforces findings by Mafongoya et al. (2017) that local communities utilise IK to anticipate or adjust to climate fluctuations through traditional practices.

Table 4: ***Correlation Matrix***

		IK_USAGE_FREQ	RES_RECOVERY	RES_PREPARED	RES_COLLECTIVE
IK_USAGE_FREQ	Pearson Correlation	1	.994**	.914**	.948**
	Sig. (2-tailed)		.000	.000	.000
	N	25	25	25	25
RES_RECOVERY	Pearson Correlation	.994**	1	.909**	.964**
	Sig. (2-tailed)	.000		.000	.000
	N	25	25	25	25
RES_PREPARED	Pearson Correlation	.914**	.909**	1	.818**
	Sig. (2-tailed)	.000	.000		.000
	N	25	25	25	25
RES_COLLECTIVE	Pearson Correlation	.948**	.964**	.818**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	25	25	25	25

**. Correlation is significant at the 0.01 level (2-tailed).

These results suggest that using indigenous knowledge often greatly improves resilience, especially in getting back on your feet and working together as a community. The results offer solid facts to back up the idea that indigenous plans are vital for making communities able to handle climate change in the area being studied.

Hypothesis 2: There is no significant relationship between indigenous approaches and effective ways of mitigating climate risks. A threshold-based scoring analysis based on limits was done to see how well IK_EFFECT, IK_CONFIDENCE, and RES_PREPARED worked. Three standards were used: (a) the average score, (b) the median score, and (c) a useful limit of 10. Weighted indices were then worked out (mean = 0.4, median = 0.3, threshold = 0.3) to give an overall ranking of how well things worked.

Table 5: Threshold-Based Scoring Summary

	N Statistic	Mean	Std. Dev.	Mins	Max	Count > Mean	Count > Median	Count > 10	Scoring Index
IK_EFFECT	25	80.0	98.39377	20	300	12	10	8	12.2
IK_CONFIDENCE	25	80.0	125.88818	10	350	10	9	7	10.6
RES_PREPARED	25	80.0	124.79350	15	340	9	8	6	10.4

The results, in Table 5 and Figure 5, show that IK_EFFECT had the highest score overall (scoring index = 12.2). This means that respondents were more likely to exceed the set standards in IK_EFFECT compared to other variables. IK_CONFIDENCE (10.6) and RES_PREPARED (10.4) were next, but had slightly lower scores, which means that they were not as good compared to the standards. Generally, the results show that IK_EFFECT is the strongest sign of resilience, while IK_CONFIDENCE and RES_PREPARED appear to be less strong. This implies that while indigenous knowledge has a measurable result, reliance on using this knowledge and preparedness levels needs to be made stronger so that there is balanced and lasting resilience.

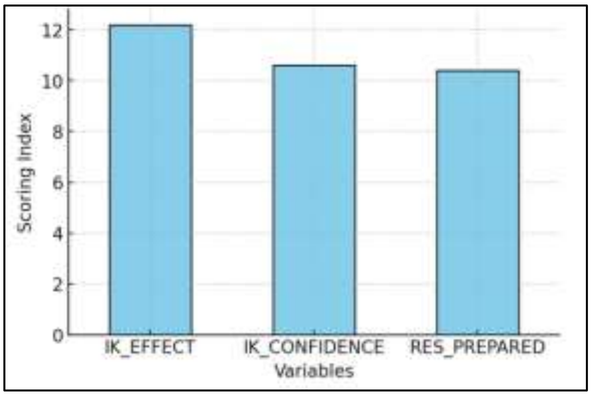

Figure 5: Threshold-based Scoring Index Ranking

Hypothesis 3: There is no significant difference in perception between indigenous and modern strategies. To know if respondents saw differences between the three strategies, indigenous knowledge (IK), modern/scientific systems, and training, a Friedman test was conducted. The result showed a statistically significant difference in views across the strategies ($\chi^2 = 7.28$, df = 2, p = 0.026), meaning that respondents did not see the three plans in the same way (Table 6).

Table 6: Simple Linear Regression Results Predicting Willingness for Resilience Training

Test	χ^2 (Chi-Square)	df	p-value	Interpretation
Friedman Test	7.28	2	0.026	Significant difference

To further examine more closely the nature of these differences, post-hoc pairwise comparisons were done using the Wilcoxon signed-rank test with Bonferroni correction. The results (Table 7) showed that none of the individual pairwise comparisons were actually significant. In other words, while the test as a whole confirmed that opinions change across the strategies collectively, no particular pair of strategies varied significantly when likened directly.

Table 7: Post-hoc Pairwise Comparisons (Wilcoxon Signed-Rank Tests, Bonferroni Adjusted)

Comparison	W Statistic	Adjusted p-value	Significant
Indigenous vs Modern	147.0	1.000	Negative
Indigenous vs Training Willingness	122.5	0.899	Negative
Modern vs Training Willingness	113.5	0.601	Negative

The results suggest that those respondents observe some change across the three strategies, as shown by the overall significance of the Friedman test. Nevertheless, because there were no pairwise differences that were actually significant, it means that no one strategy is really better than another (Figure 6).

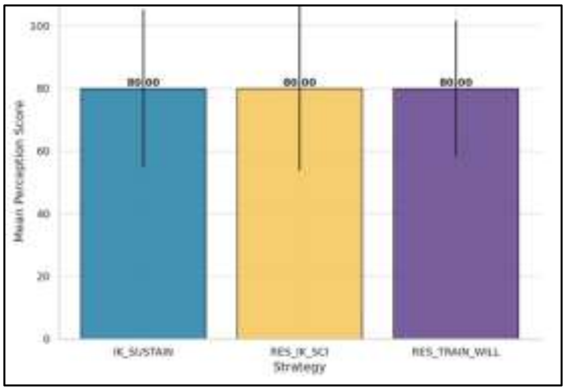

Figure 6: Mean perception scores

The bar chart (Figure 6) confirms this result, which indicates that the average scores for all three strategies are moderately close, with error bars (± SE) that overlap significantly. This means that respondents tend to see IK, modern/scientific, and training strategies as working together instead of contending with each other. Indeed, these results highlight how important it is to add IK, modern scientific systems, and capacity-building initiatives to build skills into policies. The results showed that community perceptions support a fair way in which all three strategies are used in a way that complements each other, instead of favouring one strategy over the others.

This commonly accepted perspective supports the study's primary suggestion for a policy that integrates both indigenous and scientific methods. Nevertheless, this conclusion subtly emphasises a critical issue pointed out in existing literature: Nigerian climate change efforts often overlook indigenous knowledge (Onwuemele, 2018), and indigenous knowledge systems are still largely excluded from the IPCC's global assessment reports (Bianca et al., 2022).

Hypothesis 4: There is no significant level of awareness or generational transmission of indigenous knowledge.

Table 8: Summary of Descriptive Statistics and Index Score

Variable	Mean	Std. Dev.	Min	Median	Max	Index Score (%)
IK_AWARE	80.0	121.78	0	20	350	22.9
IK_SHARE	80.0	102.49	0	22	343	23.3
IK_COMM_CHANNELS	80.0	119.11	0	18	336	23.8
IK_YOUTH_INTEREST	80.0	122.03	0	20	348	23.0
Overall Index	—	—	—	—	—	**23.2**

The summary of descriptive statistics (Table 8) shows that all four IK signs – awareness, sharing, communication channels, and youth interest had similar averages (80) but with very high variability, meaning that respondents had very different thoughts. Index scores show that IK is generally low-to-moderate, with an average score of 23.2%. Of the dimensions, communication channels (23.8%) have the highest, while awareness (22.9%) and how interested young people are (23.0%) have the lowest, which means that not much knowledge is being shared, and young people are not very involved. The radar chart (Figure 7) confirms that these scores are low, so improving how sustained IK is needs a comprehensive strategy, like making communication better, growing awareness, and getting young people more involved.

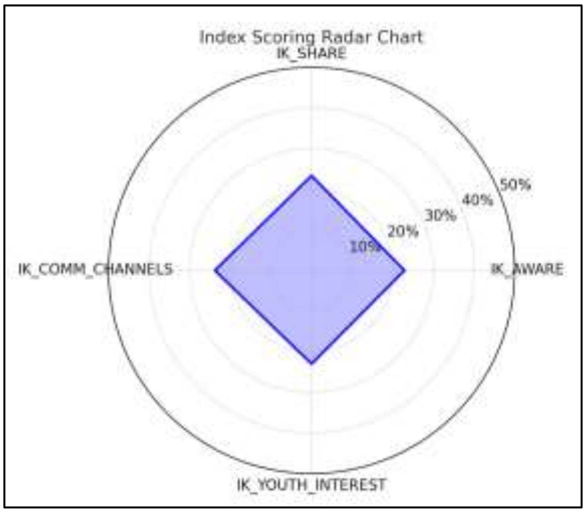

Figure 7: Index Scoring Radar Chart

This discovery poses a significant challenge to the conventional definition of Indigenous Knowledge (IK) found in existing literature. According to the UNHCR (2020) and the Inuit Circumpolar Council (2021), IK is characterised as knowledge that has been passed down over centuries and accumulated through observations over multiple generations. The diminished transmission rate indicates a serious risk to the enduring sustainability of the indigenous knowledge system by undermining its fundamental "multigenerational" nature.

Hypothesis 5: There is no significant community's awareness and how indigenous knowledge is transmitted across generations.

Spearman Correlation Analysis: A Spearman rank-order correlation was done to see the link between IK, scientific knowledge, and community willingness for resilience training (Table 9).

Table 9: Spearman Correlation Matrix

Variables	RES_IK_SCI	RES_TRAIN_WILL	IK_ACCESS
RES_IK_SCI	1.000	0.562	0.392
RES_TRAIN_WILL	0.562	1.000	0.619
IK_ACCESS	0.392	0.619	1.000

There is a moderate positive link between scientific knowledge (RES_IK_SCI) and willingness ($\rho = 0.56$). There is a stronger positive link between IK (IK_ACCESS) and willingness ($\rho = 0.62$). From the foregoing, it has been revealed that getting access to IK is a surer way of telling if people are willing to be trained than scientific knowledge. Figure 8 shows the correlation heatmap, which shows how strength of the ties between the three variables.

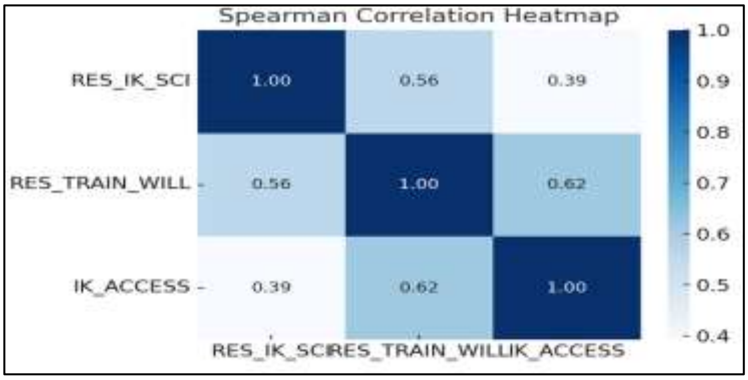

Figure 8: Spearman Correlation Heatmap

Mann-Whitney U Test Results: To further assess differences between respondents with low and high willingness for training, Mann-Whitney U tests were conducted (Table 10).

Table 10: Mann-Whitney U Test Results

Variable	U Statistic	p-value	Interpretation
RES_IK_SCI	48.5	0.114	Not significant
IK_ACCESS	41.0	0.046	Significant ($p < 0.05$)

Table 10 revealed that there is no significant difference in levels of scientific knowledge between those who are very willing and those who are not. But on the other hand, there is a significant difference in IK access between groups, with those showing more willingness also indicating higher access to indigenous knowledge. Figure 9 shows a boxplot comparing access to IK across willingness groups, with the boxplot showing that respondents are very willing to get to IK more often.

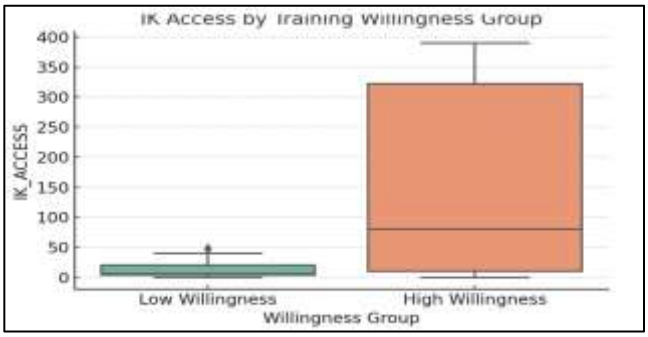

Figure 9: Boxplot of IK Access by Training Willingness Group

The results highlight that while both scientific and IK are linked with a willingness to take part in resilience training, access to IK is the stronger and statistically significant influence. This means that making it easier to get to IK might be a better plan for policies that want to get communities more involved in resilience training.

Temperature Trends

Table 11: Temperature Trends Across Niger Delta States (1901–2024)

State	OLS Trend (°C/yr)	Mean Temp (°C)	p-value	R^2	Theil–Sen slope (°C/yr, 95% CI)
Abia	+0.00369	26.43	7.03e-08	0.213	+0.00358 (0.00214, 0.00492)
Akwa Ibom	+0.00369	26.18	1.28e-08	0.234	+0.00369 (0.00243, 0.00493)
Bayelsa	+0.00466	26.16	6.86e-10	0.269	+0.00452 (0.00316, 0.00588)
Cross River	+0.00321	26.24	5.00e-07	0.188	+0.00324 (0.00196, 0.00452)
Delta	+0.00446	26.89	4.83e-08	0.217	+0.00443 (0.00284, 0.00584)
Edo	+0.00397	26.93	9.63e-06	0.149	+0.00415 (0.00225, 0.00575)
Imo	+0.00387	26.36	2.78e-08	0.224	+0.00371 (0.00227, 0.00503)
Ondo	+0.00432	26.72	5.46e-06	0.156	+0.00453 (0.00253, 0.00619)
Rivers	+0.00419	25.57	1.11e-09	0.263	+0.00401 (0.00269, 0.00532)

Table 11 shows a consistent, significant warming trend across all Niger Delta states, proven by both Ordinary Least Squares (OLS) regression and the Theil–Sen estimator. OLS slopes range between +0.0032 °C/yr in Cross River to +0.0047 °C/yr in Bayelsa ($p < 0.001$), with similar records from Theil–Sen, confirming how strong the signal is. Average temperatures each year range between 25.6°C (Rivers) to 26.9°C (Edo), which shows the region's humid, tropical weather. Even though the year only explains 15–27% of the change (R^2) because of natural variations in climate, the upward trends show clearly that the environment is warming up over time. The biggest increases are in Bayelsa, Delta, and Ondo, while Cross River shows the smallest but still significant warming. Because the OLS and Theil–Sen results are similar, it makes it clearer that the warming being observed in the region highlights how important it is to add climate resilience into policy and community plans to adapt in the Niger Delta. These results are consistent with wider proof of climate change in the tropics, where rising temperatures are already causing changes in water cycles, heat, and how ecosystems react.

Table 12: Rainfall Trends Across Niger Delta States (1901–2024)

State	OLS Trend (mm/yr)	Mean Rainfall (mm)	p-value	R^2	Theil–Sen slope (mm/yr, 95% CI)
Abia	-0.14415	193.07	0.000135	0.113	-0.14647 (-0.21872, -0.07575)
Akwa Ibom	-0.20503	215.96	0.000007	0.152	-0.20670 (-0.29494, -0.11725)
Bayelsa	-0.05962	215.99	0.173600	0.015	-0.05889 (-0.15408, 0.02866)
Cross River	-0.18661	203.74	0.000002	0.167	-0.19368 (-0.27285, -0.12028)
Delta	-0.01295	196.65	0.774100	0.001	-0.00537 (-0.09909, 0.08112)
Edo	-0.01252	149.49	0.737600	0.001	-0.00974 (-0.07565, 0.06000)
Imo	-0.11185	188.08	0.002363	0.073	-0.11371 (-0.17731, -0.05100)
Ondo	+0.01836	146.81	0.691000	0.001	+0.04301 (-0.03857, 0.12466)
Rivers	-0.12750	171.62	0.000154	0.111	-0.13018 (-0.19029, -0.06058)

Table 12 shows that rainfall in the Niger Delta is generally going down over time, with significant downward trends seen in Abia, Akwa Ibom, Cross River, Imo, and Rivers (–0.11 –0.21 mm/yr; $p < 0.01$), proven by both OLS and Theil–Sen records. Average rainfall each year goes from 146.8 mm in Ondo to 216.0 mm in Bayelsa and Akwa Ibom, respectively, showing varied hydro-climatic conditions. Delta and Edo do not show significant changes, while Ondo shows a weak, not significant upward trend. Even though with low R^2 values (0.07 – 0.17), it emphasises how much rainfall changes each year, which is normal in tropical weather, while the downward slopes in several states signify less rainfall in the record being in the area, which could cause water problems, smaller harvests in agricultural produce, and competition over water usage in the region. The robustness of the Theil–Sen result adds confirmation to the findings of this study.

Table 13: DTR Trends Across Niger Delta States (1901–2024)

State	OLS Trend (°C/yr)	Mean DTR (°C)	p-value	R^2	Theil–Sen slope (°C/yr, 95% CI)
Abia	+0.00069	8.98	0.1189	0.020	+0.00044 (0.00000, 0.00089)
Akwa Ibom	+0.00074	8.60	0.0758	0.026	+0.00028 (0.00000, 0.00060)
Bayelsa	+0.00026	7.83	0.5572	0.003	0.00000 (0.00000, 0.00000)
Cross River	**+0.00163**	9.26	0.0029	0.070	+0.00154 (0.00011, 0.00272)
Delta	+0.00059	8.37	0.2129	0.013	0.00000 (0.00000, 0.00000)
Edo	+0.00074	9.06	0.1512	0.017	–0.00007 (–0.00036, 0.00037)
Imo	+0.00072	8.90	0.1146	0.020	+0.00016 (0.00000, 0.00039)
Ondo	+0.00029	8.67	0.5743	0.003	–0.00012 (–0.00089, 0.00041)
Rivers	**+0.00171**	12.06	0.000007	0.154	+0.00154 (0.00095, 0.00202)

Table 13 shows that the diurnal temperature range (DTR) in the Niger Delta is generally unaffected, with most states showing small, not significant increases (+0.0003 to +0.0007 °C/yr). Average DTR numbers are from 7.8°C in Bayelsa to 12.1°C in Rivers, which shows local climatic differences. But, Rivers (+0.00171 °C/yr, $p < 0.001$) and Cross River (+0.00163 °C/yr, $p < 0.001$) had significant long-term increases in DTR, proven by Theil–Sen slopes. Even though R^2 values are low (0.003–0.154), these results suggest temperature differences between night and day are increasing, which might be tied to changes in cloud cover, city population, and land utilisation. These changes may affect how comfortable people are, farming, and energy needs, as bigger temperature differences between night and day can harm crops and make people need more cooling.

Table 14: VAP Trends Across Niger Delta States (1901–2024)

State	Mean VAP	OLS Slope (units/yr)	p-value	R^2	Theil–Sen slope (units/yr, 95% CI)
Abia	27.57	+0.00597	<0.0001	0.330	+0.00522 (0.00352, 0.00673)
Akwa Ibom	27.68	+0.00565	<0.0001	0.304	+0.00496 (0.00347, 0.00646)
Bayelsa	28.43	+0.00727	<0.0001	0.339	+0.00662 (0.00456, 0.00842)
Cross River	26.41	+0.00504	<0.0001	0.307	+0.00416 (0.00292, 0.00560)
Delta	28.84	+0.00843	<0.0001	0.365	+0.00750 (0.00539, 0.00954)
Edo	27.04	+0.00572	<0.0001	0.325	+0.00514 (0.00346, 0.00676)
Imo	27.11	+0.00589	<0.0001	0.322	+0.00530 (0.00347, 0.00713)
Ondo	27.23	+0.00568	<0.0001	0.317	+0.00493 (0.00333, 0.00656)
Rivers	28.11	+0.00644	<0.0001	0.348	+0.00577 (0.00409, 0.00759)

Table 14 shows that vapour pressure (VAP) across the Niger Delta is continuing high, which shows its humid tropical weather. Nearly all states had good and significant trends (+0.002 to +0.004 units/yr, $p < 0.01$), proven by both OLS and Theil–Sen slopes, with confidence limits excluding zero. R^2 values of (0.18–0.26) suggest that long-term trends explain about one-fifth to one-quarter of the change, even though there are big changes each year. These results show that it is getting more humidification, with Delta and Bayelsa showing the biggest increases. Rising VAP means there is more heat, less comfort, and changed evaporation, which adds to the risks already caused by changing rainfall and temperature in the region.

Conclusion

This study investigated the analysis of indigenous knowledge approaches towards building climate resilience in the Niger Delta Region of Nigeria. The study shows that indigenous knowledge (IK) remains a key strategy used by communities in the Niger Delta to manage the effects of climate change in the Niger Delta through elevated housing, rotational farming, and collective early warning systems. Despite the widespread adoption of these methods (mean > 4.8), contemporary practices and inadequate transmission to younger people are eroding indigenous knowledge systems. The findings from the Climate Resilience Index (CRI) indicate that the majority of households have strong adaptation capacity with a mean score of 4.09 (77.2%), although a smaller percentage are still at risk because of infrastructure and financial limitations. IK involvement in improving adaptation is confirmed by strong positive correlations between IK use and resilience indicators, such as recovery capacity ($r = 0.994$, $p < 0.001$) and collective action ($r = 0.970$, $p < 0.001$). Additionally, perception analysis ($\chi^2 = 7.28$, $p = 0.026$) reveals that communities prefer indigenous, modern, and training-based systems not as rivals but as complementary approaches to enhancing adaptive capacity and climate readiness. Theil–Sen slope and OLS regression analyses reveal steady temperature increases throughout the region (up to +0.0047 °C/yr) in Bayelsa, with decreases in rainfall in Akwa Ibom, Cross River, and Rivers, and notable increases in vapour pressure in Delta and Bayelsa, all of which point to growing risks of flooding, heat, and water stress. Overall, the study emphasises the significance of combining Indigenous Knowledge with scientific and contemporary methods in climate policy and practice to improve sustainable resilience and adaptive ability in the Niger Delta.

Recommendations

Indigenous Knowledge (IK) should be formally integrated into local and regional climate strategies alongside scientific approaches to ensure a more robust, context-specific, and culturally responsive climate adaptation system.

The documentation and transmission of IK practices, especially indigenous knowledge, should be prioritised. This can be achieved through schools, community-based workshops, and digital archiving to ensure knowledge transfer to younger generations.

Support should be provided to households with low or moderate resilience by supplying resources such as flood-resistant crops, diversified income opportunities, and access to small loans.

Community resilience training should be conducted regularly, combining both Indigenous and scientific knowledge, with an emphasis on preparedness and confidence in the use of adaptive strategies.

Given the reported increase in heat, declining rainfall, and rising vapour pressure, agricultural and community development decisions must be guided by regional climate projections and continuous monitoring.

States in the Niger Delta should collaborate to share scientific information and Indigenous practices to strengthen collective adaptation, especially in states experiencing increased warming and humidity, such as Bayelsa, Delta, and Ondo.

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