

Oil Spill Preparedness, Institutional Capacity and Socioeconomic Stability as Predictors of Community Resilience in High-Risk Oil-Producing Communities of Delta State, Nigeria

Esemuede Taye Gideon^{1*} and Christopher Onosemuode¹

¹Department of Environmental Management and Toxicology,
Federal University of Petroleum Resources,
Effurun, Delta State, Nigeria

Correspondent Email: tayeesemuode@gmail.com

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Abstract

Although environmental quality and livelihoods are continually harmed and community recovery is hampered by recurrent oil spills in Delta State, there is a lack of evidence on the cumulative effects of preparedness, institutional capacity, and socioeconomic stability on resilience. This study investigated these as predictors of community resilience in high-risk oil-producing communities in Delta State, Nigeria. A cross-sectional, analytical, and community-based design was adopted. Using a multi-stage sampling technique, 9 communities were sampled, and a structured questionnaire was developed from a validated instrument and subsequently administered to 423 eligible adults in the communities. Five-point Likert-scale items and composite scales were used to assess oil-spill preparedness, institutional preparedness, socioeconomic stability, and community resilience. Descriptive statistics, one-way ANOVA (Tukey HSD), Pearson correlation, and multiple linear regression were conducted at a 0.05 level of significance. Scores for community resilience (3.22 ± 0.81), institutional readiness (3.06 ± 0.79), and oil-spill readiness (3.05 ± 0.87) were in the moderate category, whereas the score for socioeconomic stability was low (2.11 ± 0.73). Results showed a strong correlation between resilience and preparedness ($r=0.746$, $p<0.01$), institutional preparedness ($r=0.718$, $p<0.01$), and socioeconomic stability ($r=0.701$, $p<0.01$). Resilience to sink the regression model was significant, $F(3,419) = 301.84$, $p<0.001$, accounting for 67.9% of the variance in resilience. Oil-spill preparedness emerged as the most powerful predictor ($\beta=0.438$), followed by institutional preparedness ($\beta=0.319$) and socioeconomic stability ($\beta=0.285$). The study distills the following set of policy recommendations: institutionalized preparedness in response to the threat of sustainable resilience; responsive governance; a transparent compensation mechanism; environmental remediation and livelihood protection; solidarity among the people; and concrete support for those who are highly exposed.

Keywords: *Oil-spill preparedness; institutional capacity; socioeconomic stability; community resilience; petroleum-producing communities; Delta State.*

Introduction

The Niger Delta region in Africa remains one of the most stressed regions in the country, with frequent occurrences of oil spills, leakages, and pipeline failures, and poorly remediated operations, continuing to threaten the integrity of ecosystems and the security of livelihoods and the well-being of communities. Petroleum contamination is associated with soil, surface water, surface soils/groundwater, sediment, and vegetables, and with aquatic organisms, causing associated ecological, socioeconomic, and human-health risks. Accidental spills and pipeline leakages are among the causes of adverse effects on marine livelihoods and Blue economy development, as reported by Timidi and Ugbomah (2026), while pipeline leakages negatively impact aquatic organisms and Fish productivity, as reported by Igbani *et al.* (2024). Crude oil contamination in Delta State affects certain physicochemical properties of the soil, while Okudo *et al.* (2024) found heavy metals associated with petroleum in water, sediment, and soil. The impacts are environmental, but also include destroyed livelihoods, food insecurity, water conflicts, social marginalisation, and decreased household welfare. Anthony *et al.* (2026) blamed the decline in food security on petroleum-related operations; Udensi *et al.* (2026) pointed out the socio-economic and One Health impacts of land dispossession arising from oil pollution; and Babatunde (2020) illustrated how oil pollution led to conflict over safe access to water amongst the riverine communities. While coping and rebuilding processes have been in place during the exposure, long-term exposure may be depleting coping and rebuilding resources, especially in areas such as weak early-warning systems, emergency plans, response equipment, institutional coordination, communication, environmental, compensation, and remediation capacities. Ekeipre *et al.* (2025) and preparedness and coordinated emergency management (Isangadighi and Udeh, 2023) argue that the frequency of exposure to oil spills and the community's response capacity shape the community's perceptions and adaptive responses. In the realm of spill detection and environmental-risk management, remote sensing and geostatistical analysis, risk mapping and risk predictive modelling can improve detection and management of environmental risks as demonstrated by the work of the researchers Obida *et al.* (2018), Adebangbe *et al.* (2025), Orhuebor *et al.* (2026) and Onavwie *et al.* (2026). The adoption of technologies, however, will not make communities resilient when institutions are unresponsive, household incomes are unstable, livelihood diversification is limited, and access to basic services is poor. Research has focused on contamination, ecological impacts, health impacts, and/or aspects of adaptation, and there is limited empirical evidence linking preparedness for oil spills, institutional capacity, and socioeconomic stability to community resilience, especially when viewed as a combination. Therefore, this study examined the three factors (Demographic, socio-economic, and cultural) to assess their predictive power for community resilience in high-risk oil-producing communities in Delta State, Nigeria. In particular, it offers an up-to-date prevalence snapshot, compares prevalence across selected communities, builds links, and quantifies the impact at the individual and combined levels of prevalence and incidence on community resilience. The study adopts a composite indices methodology, community-based comparative analysis, correlation analysis, and multivariate regression to build a new evidence base for community-based contingency planning, institutional reform, livelihood restoration, and sustainable environmental governance.

Methodology

Study Area

The study was carried out in selected high-risk oil-producing communities, namely Otujeremi, Ajoki, Uzere, Odidi, Uwakeno, Elume, Ododomgwa, and Uzere and Odidi-Modi of Delta State, southern Nigeria. These communities are located near oil wells, pipelines, flow stations, and other petroleum equipment and have been affected by varying levels and frequencies of oil spills. The region has a humid tropical climate with abundant freshwater and brackish water bodies, wetlands, and farmland suitable for fishing, farming, trade, and the harvesting of natural resources. Households are highly dependent on soil, surface water, and aquatic resources, which exacerbates their vulnerability to petroleum contamination. Repeated spills have been reported to degrade farmland, fisheries, and domestic water resources. The lack of containment, remediation, and compensation has worsened income insecurity, disrupted livelihoods, and increased public distrust. Selected communities also vary in their levels of petroleum infrastructure, institutional experience, and spill response, as well as in socioeconomic stability and community resilience, making them appropriate for examining spatial differences in preparedness for oil spills, institutional capacity, socioeconomic stability, and community resilience.

Research Design, Study Population and Sampling Procedure

A cross-sectional analytical design based in the community was used to quantify oil spill preparedness, institutional capacity, socioeconomic stability and community resilience, and investigate their relationships at a specific time. The target population consisted of adults living in the selected communities who had been directly or indirectly affected by the environmental and socioeconomic impacts of petroleum operations. The respondents were permanent residents aged 18 years and above who had long resided in their communities and could provide informed accounts of oil spills, institutional interventions, livelihood disruptions, and the conditions of livelihood recovery. Those who were temporarily residing in the country, were younger than 18 years or refused informed consent were excluded. Based on Cochran's formula, which yielded a minimum sample size of 384 respondents. Multistage sampling was used. The two communities (Delta State and the study communities) were purposively selected due to their exposure to oil spills, proximity to petroleum infrastructure, dependence on the environment for livelihoods, and accessibility. The sample was proportionately allocated to the communities based on the estimated household population in each community, and systematic sampling was used to select households from the identified streets and settlement clusters. A single eligible and knowledgeable adult was selected from each home, and simple random sampling was used when more than one eligible respondent was present.

Research Instrument, Validity and Reliability

A structured questionnaire was used to gather data, developed from the study goal, the literature, and the operational dimensions of the principal constructs. The instrument included information on respondents' sociodemographic characteristics, experiences with oil spills, preparedness, institutional capacity, socioeconomic stability, and community resilience. Oil-spill preparedness was evaluated based on risk awareness, early-warning systems, emergency communication, contingency plans, evacuation, community training, drills, and response materials. Institutional capacity comprises institutional accessibility, timeliness, interagency coordination, environmental monitoring, regulatory enforcement, community involvement, compensation and transparency.

Socio-economic stability was measured by income security, employment continuity, livelihood diversification, food security, access to essential services, household savings, and the ability to weather the storm of a spill. Community resilience integrated coping capacity, social cohesion, collective action, adaptive capacity, access to support networks and livelihood recovery and restoration of normal community functions. The items of the construct were rated on a five-point scale, from 1 (strongly disagree) to 5 (strongly agree). The instrument was assessed by environmental management, disaster-risk reduction, community development, and quantitative research experts for its clarity, relevance, and coverage. An exploratory study was conducted in a similar oil-producing community that was not included in the main survey, and the results were used to improve the wording, sequence, and administration of the survey. The internal consistency of the items was assessed using Cronbach's alpha, which was 0.70 or higher. Ambiguous, overlapping or statistically inconsistent items were also reviewed for each item and item-item corrected item-total correlations were examined.

Data Collection, Quality Assurance and Ethical Considerations

To ensure that the questionnaires were completed in full and that there were no literacy difficulties, trained research assistants administered them through face-to-face interviews. They were trained in the following: respondent eligibility, informed consent, neutral interviewing, consistent questioning of respondents, questionnaire review and confidentiality. Prior to the fieldwork, community leaders and relevant local representatives were contacted to explain the study and ensure it was available without influencing participant selection or responses. The questionnaires were filled in at people's homes or at the most convenient places, and the completed questionnaires were checked daily for any missing items, contradictory responses, or coding errors. Each questionnaire was assigned a specific identification number, and the data were entered using a previously developed coding guide. To reduce entry and classification errors, range and frequency checks, as well as random comparisons between entered records and the original questionnaires, were performed. Community entry and approval were granted by relevant authorities, and ethical clearance was obtained from the appropriate institutional research ethics committee. Written and/or documented informed consent was obtained from participants after providing information about the purpose, procedures, potential benefits, minimal risks, and the voluntary nature of participation in the research. They were able to refuse any question and go back without losing any points. No names or direct identifiers were included in the analytical data; the data were protected, and results were presented only in summary form.

Construction of Composite Indices and Statistical Analysis

Any items in the questionnaire that were negatively worded were reverse-coded so that higher scores always indicated more favourable conditions. Each construct was collapsed into a composite item to measure it to create the Oil-Spill Preparedness Index, Institutional Capacity Index, Socioeconomic Stability Index, and Community Resilience Index. Due to the different number of items on each scale, the scores for the scales were standardized to a common 0–100 metric with:

$$\text{Index Score} = \frac{\text{Observed Score} - \text{Minimum Possible Score}}{\text{Maximum Possible Score} - \text{Minimum Possible Score}} \times 100$$

The continuous scores were used for inferential analyses and then transformed into low (scores < 40), moderate (scores 40–59.9), and high (scores ≥ 60). The summary of the socio-demographic

characteristics and spill experiences was presented as frequencies and percentages, while the composite indices were summarised as means, standard deviations, ranges, and 95% confidence intervals. Individual communities were compared for Mean Index scores using One-way analysis of variance, and Tukey's honest significant difference test was used when significant overall differences were found. The strength and direction of relationships between the indices were calculated using Pearson's correlation analysis. Multiple linear regression was used to model the effects of oil-spill preparedness, institutional capacity, and socioeconomic stability on community-resilience, individually and combinedly using:

$$CRI = \beta_0 + \beta_1 OSPI + \beta_2 ICI + \beta_3 SESI + \varepsilon$$

where CRI is the Community Resilience Index, OSPI is the Oil-Spill Preparedness Index, ICI is the Institutional Capacity Index, SESISESISESI is the Socioeconomic Stability Index, β_0 is the intercept, $\beta_1 - \beta_3$ are regression coefficients and ε is the error term. Normality, linearity, homoscedasticity, independence of residuals, and multicollinearity were examined using residual plots, the Durbin–Watson statistic, tolerance values, and variance inflation factors. Results were interpreted using unstandardized and standardized coefficients, 95% confidence intervals, R^2 , adjusted R^2 , and the model F-statistic, with statistical significance set at $p < 0.05$.

Results

Table 1: Questionnaire Administration and Response Rate by Study Community

Senatorial District	LGA	Community	Questionnaires Distributed	Questionnaires Retrieved	Valid Responses	Invalid Responses	Response Rate (%)
Delta North	Ndokwa East	Okpai	50	48	47	1	96.0
		Aboh	50	49	48	1	98.0
	Ndokwa West	Kwale	50	47	46	1	94.0
Delta Central	Udu	Udu	50	48	47	1	96.0
	Sapele	Sapele	50	49	49	0	98.0
	Udu	Ovwian-Aladja	50	47	46	1	94.0
	Warri South	Warri	50	49	48	1	98.0
Delta South	Burutu	Forcados	50	48	47	1	96.0
	Warri South West	Escravos	50	46	45	1	92.0
Total			450	431	423	8	95.8

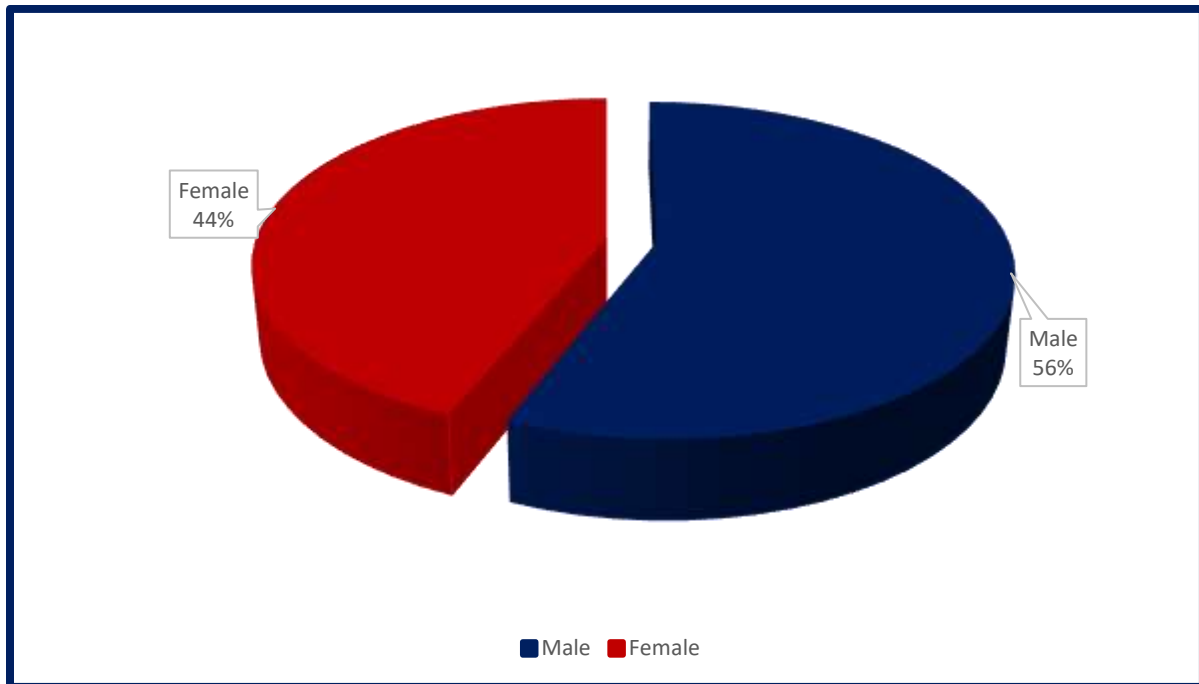


Figure 1: Gender Characteristics of Respondents

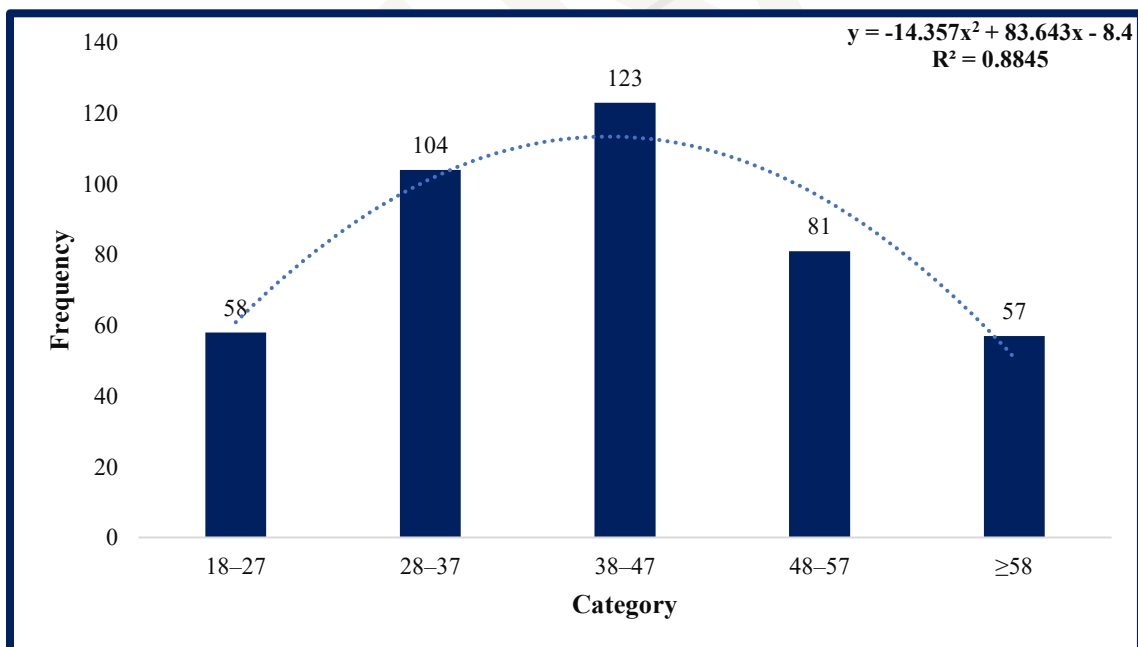


Figure 2: Age Groups of Respondents

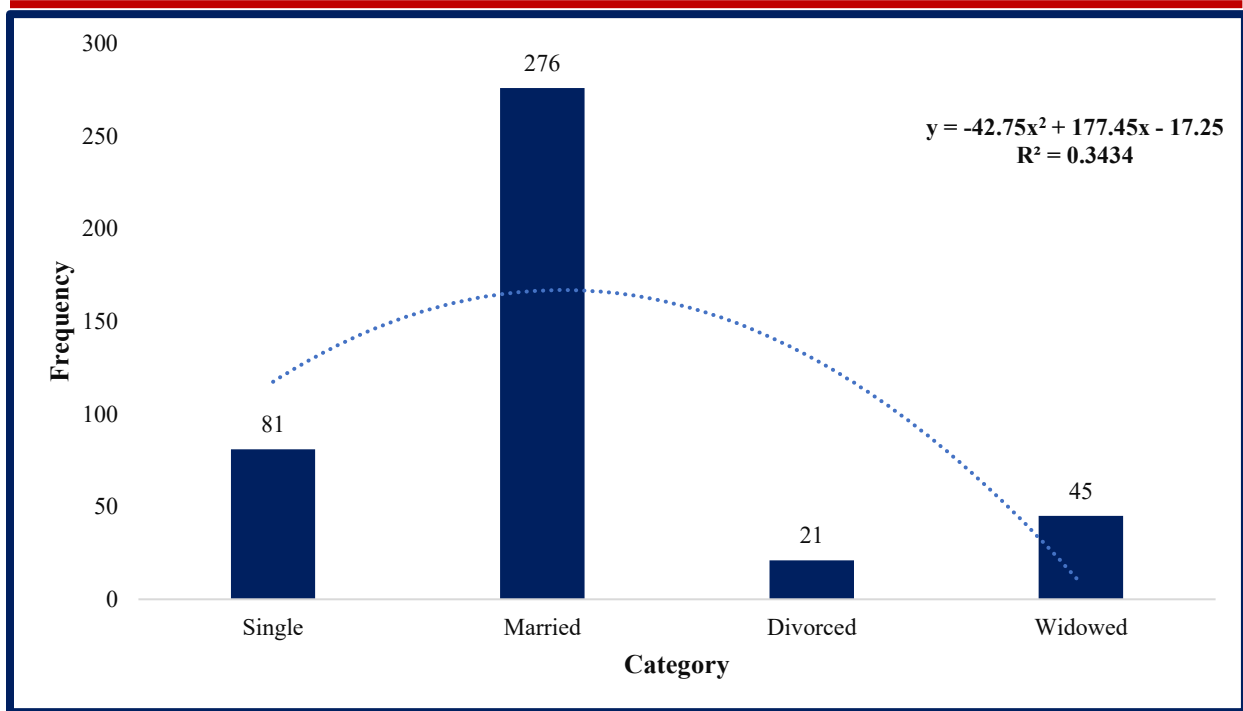


Figure 3: Marital Status of the Respondents

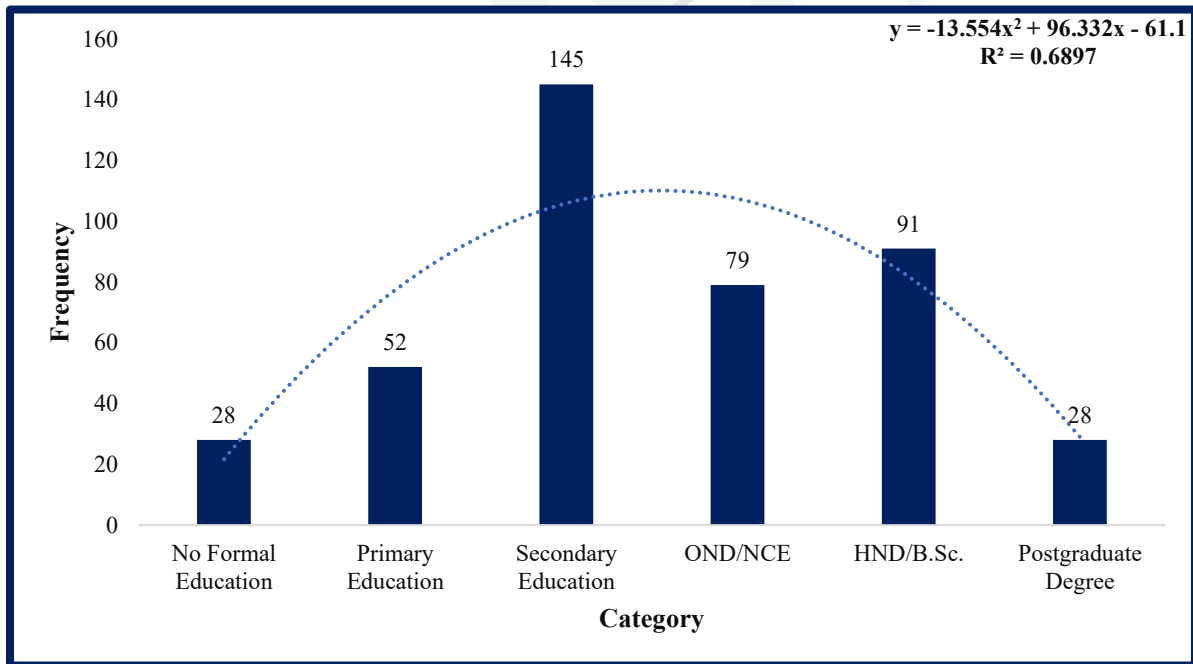


Figure 4: Educational Qualification of the Respondents

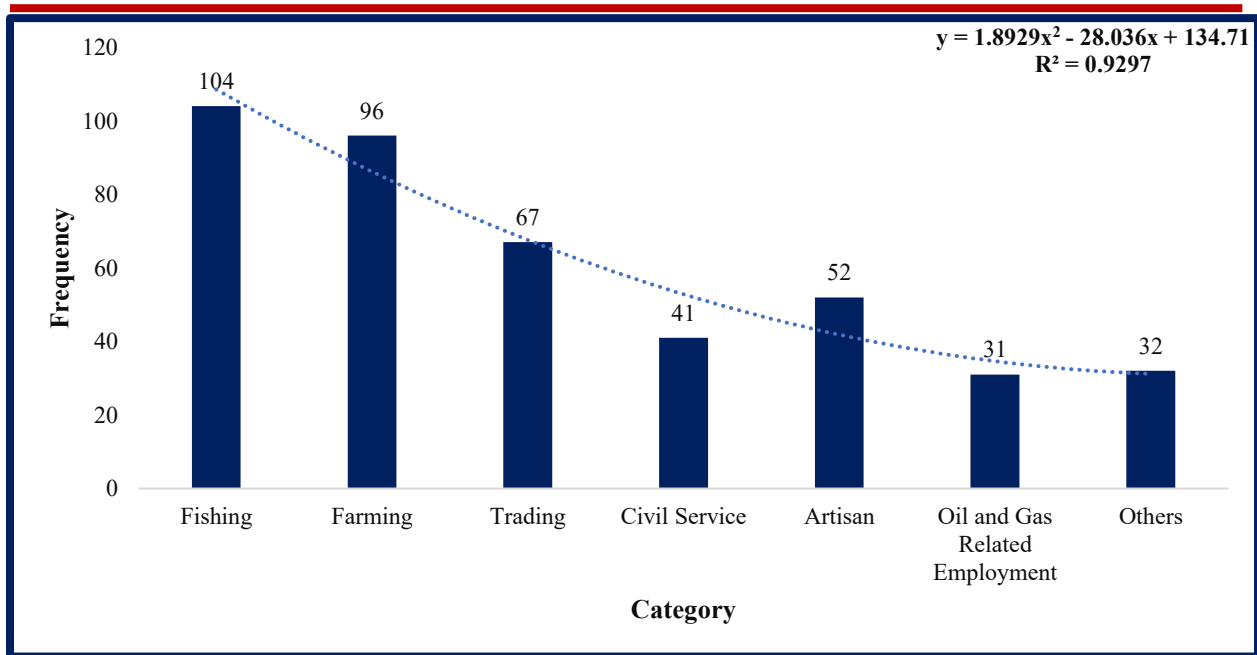


Figure 5: Primary Occupation of the Respondents

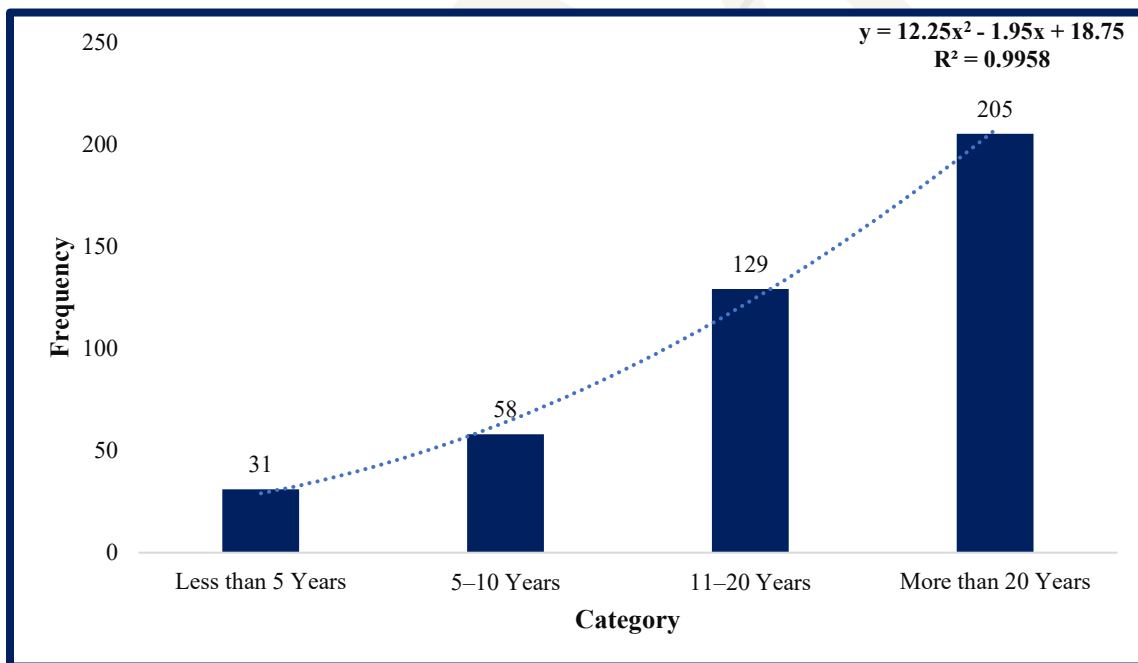


Figure 6: Respondents' Years of Residence

Household Socioeconomic Characteristics of Respondents

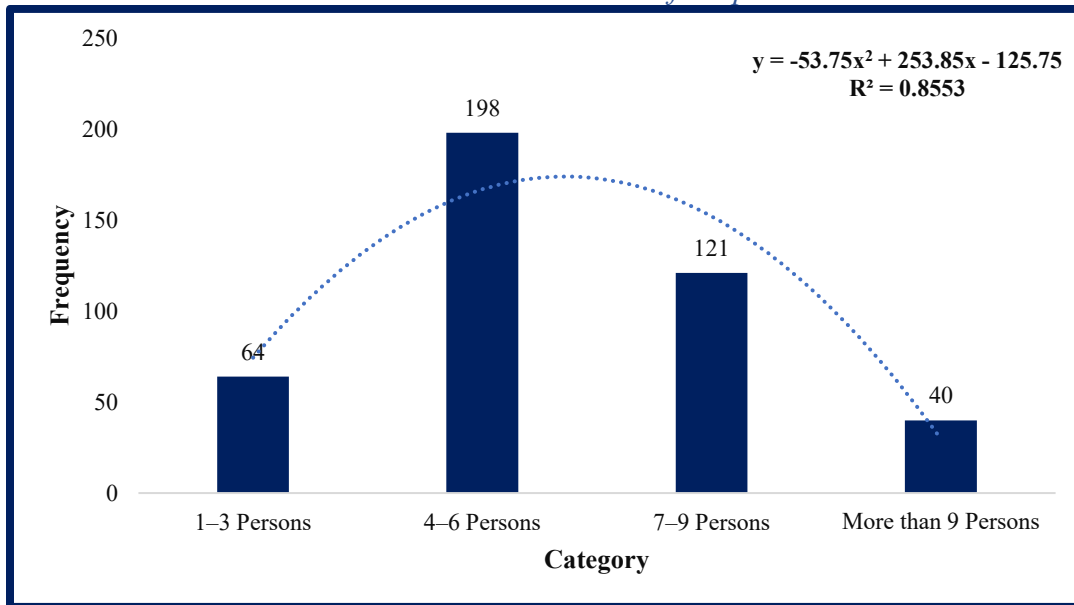


Figure 7: Household Size of Respondents

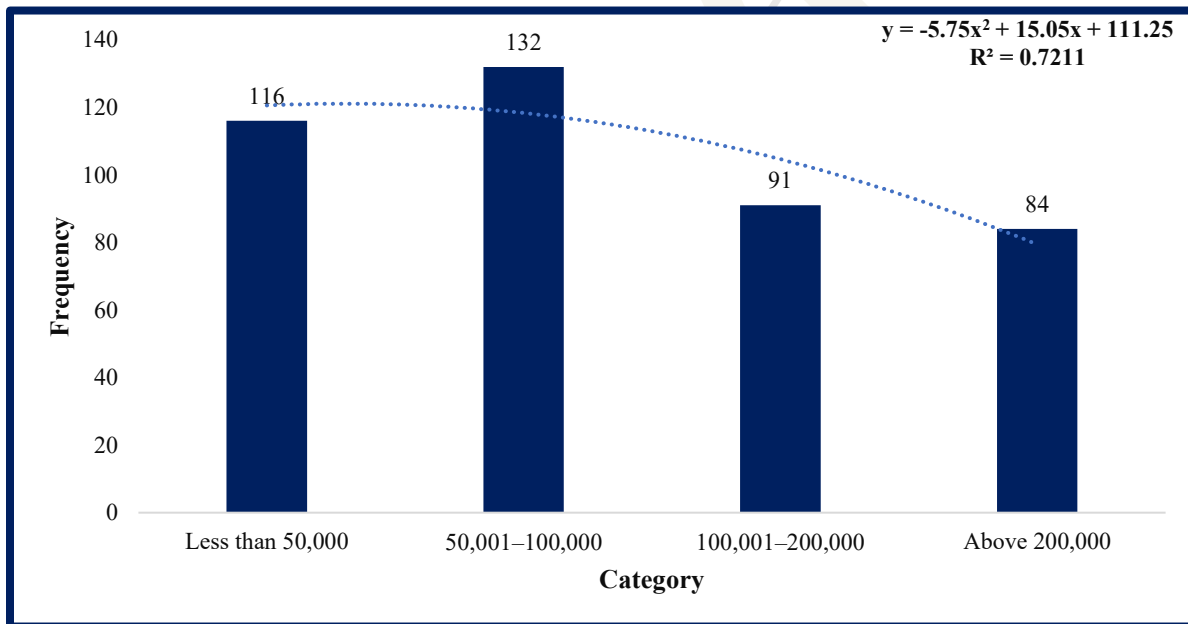


Figure 8: Monthly Household Income (₦) of the respondents

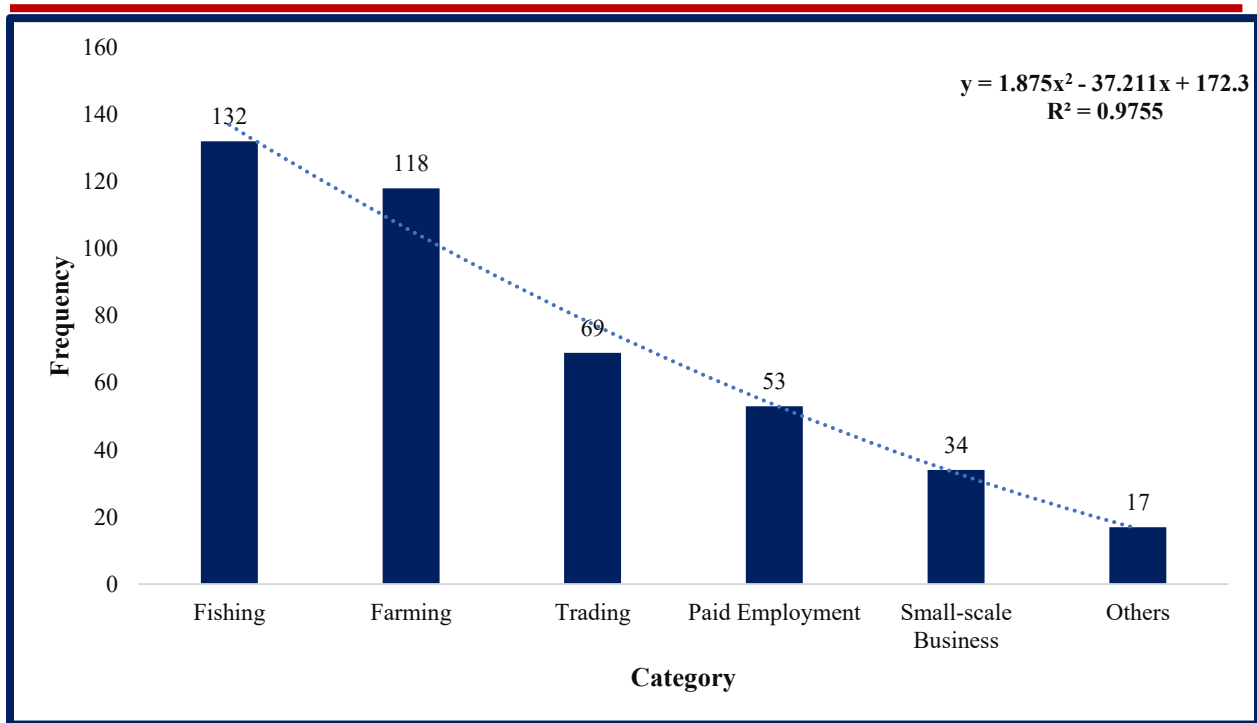


Figure 9: Major Source of Livelihood of the respondents

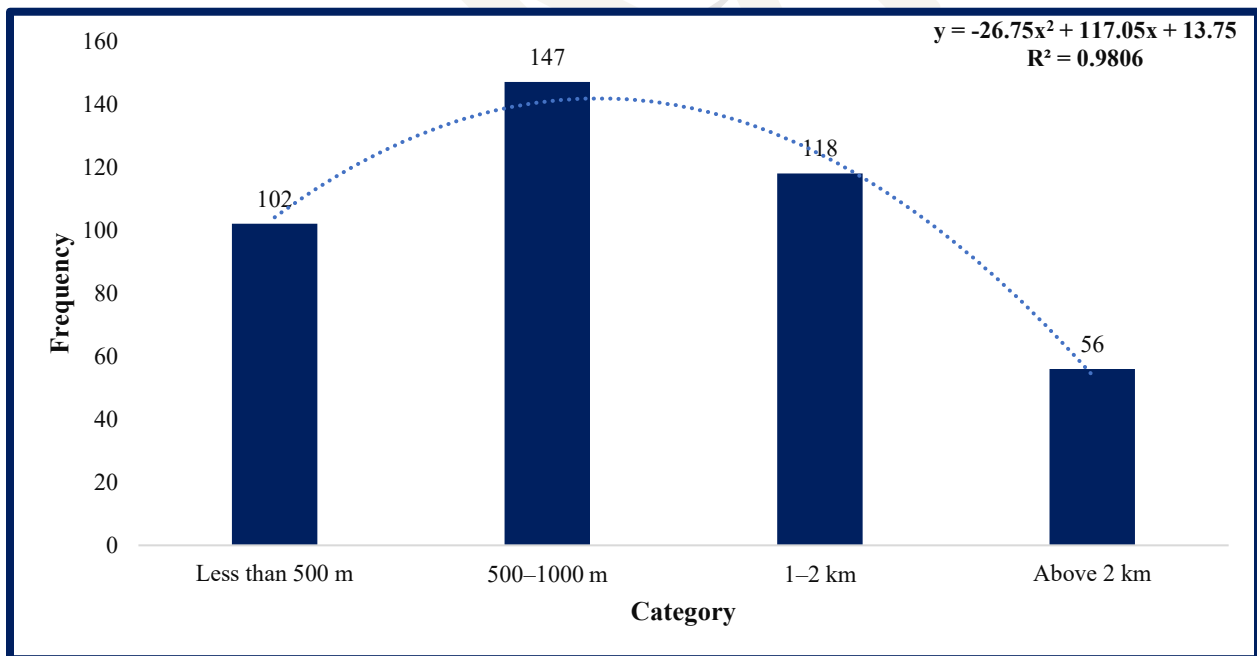


Figure 10: Respondents' Distance from Oil Installations

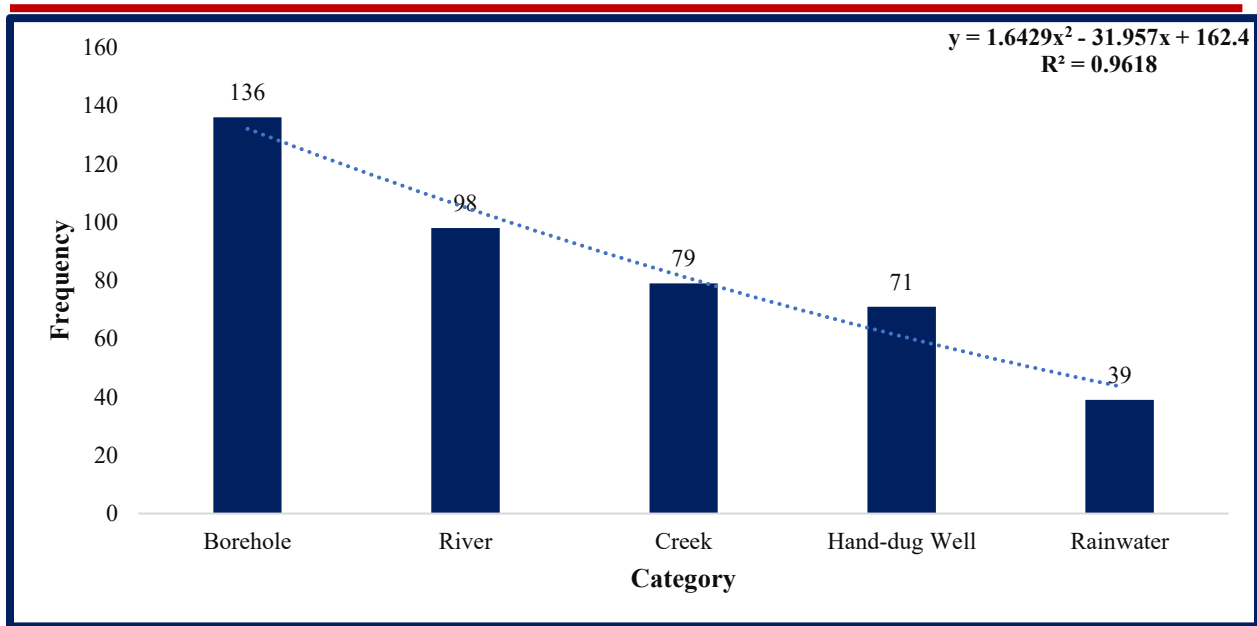


Figure 11: Primary Domestic Water Source of the Respondents

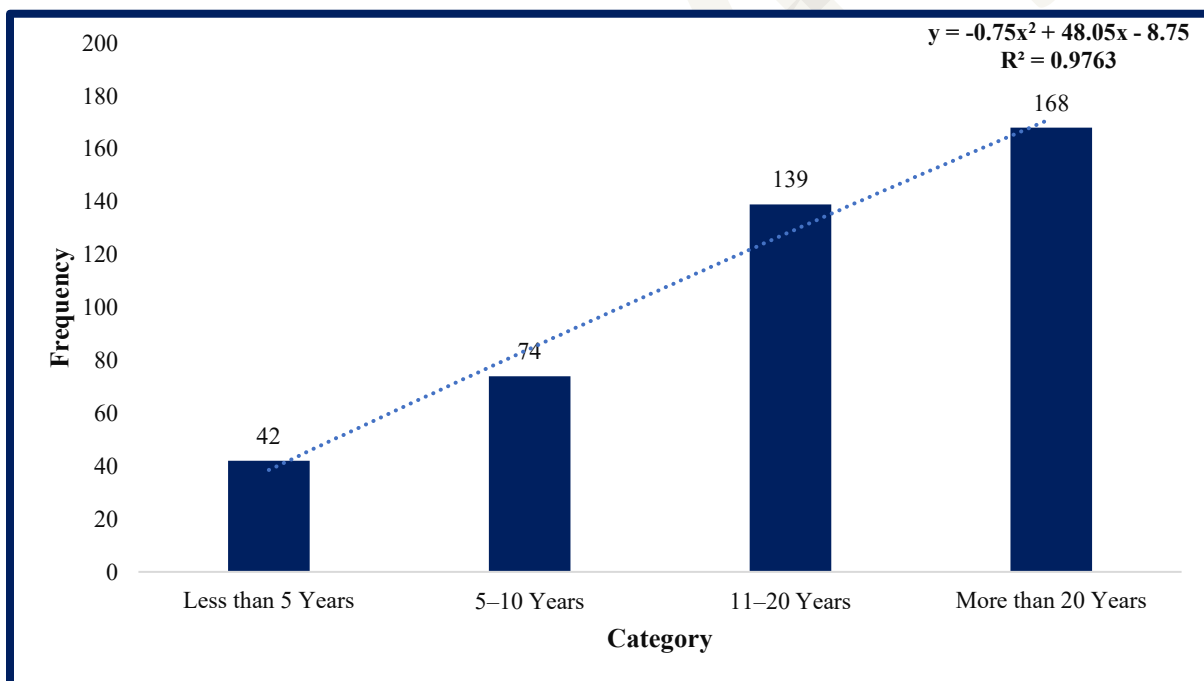


Figure 12: Respondents' Length of Exposure to Oil Spill Events

Table 2: Oil Spill Preparedness among Residents of High-Risk Communities

Preparedness Indicator	SA	A	U	D	SD	Mean	SD
Residents are aware of the risks associated with oil spills.	172 (40.7)	143 (33.8)	38 (9.0)	46 (10.9)	24 (5.7)	3.93	1.12
The community has a functional oil spill emergency response plan.	48 (11.3)	79 (18.7)	52 (12.3)	156 (36.9)	88 (20.8)	2.63	1.24
Regular oil spill preparedness training and sensitization programs are conducted.	39 (9.2)	68 (16.1)	41 (9.7)	167 (39.5)	108 (25.5)	2.44	1.21
Community members know the emergency agencies to contact during an oil spill.	126 (29.8)	154 (36.4)	43 (10.2)	65 (15.4)	35 (8.3)	3.64	1.18
Emergency response equipment is readily available within the community.	54 (12.8)	88 (20.8)	49 (11.6)	149 (35.2)	83 (19.6)	2.72	1.25
Oil companies provide adequate preparedness support to host communities.	47 (11.1)	76 (18.0)	39 (9.2)	169 (40.0)	92 (21.7)	2.58	1.23
Government agencies respond promptly to oil spill emergencies.	61 (14.4)	97 (22.9)	56 (13.2)	136 (32.2)	73 (17.3)	2.91	1.27
Community leaders actively coordinate preparedness activities.	113 (26.7)	169 (40.0)	41 (9.7)	63 (14.9)	37 (8.7)	3.61	1.15
Communication systems for reporting oil spills are effective.	101 (23.9)	162 (38.3)	47 (11.1)	71 (16.8)	42 (9.9)	3.50	1.19
Overall, the community is adequately prepared to respond to major oil spill incidents.	44 (10.4)	73 (17.3)	46 (10.9)	171 (40.4)	89 (21.0)	2.56	

Table 3: Community Resilience Indicators among Residents

Community Resilience Indicator	SA	A	U	D	SD	Mean	SD
Residents support one another during oil spill emergencies.	161 (38.1)	158 (37.4)	39 (9.2)	45 (10.6)	20 (4.7)	3.94	1.03
The community recovers quickly after major oil spill incidents.	69 (16.3)	102 (24.1)	44 (10.4)	133 (31.4)	75 (17.7)	2.90	1.28
Alternative livelihood opportunities exist following oil spill events.	57 (13.5)	88 (20.8)	51 (12.1)	142 (33.6)	85 (20.1)	2.74	1.27
Community members actively participate in environmental restoration programmes.	116 (27.4)	173 (40.9)	38 (9.0)	63 (14.9)	33 (7.8)	3.65	1.14
Traditional leadership effectively coordinates community recovery efforts.	128 (30.3)	162 (38.3)	35 (8.3)	66 (15.6)	32 (7.6)	3.68	1.16
Government assistance enhances community recovery after oil spills.	64 (15.1)	101 (23.9)	46 (10.9)	139 (32.9)	73 (17.3)	2.87	1.29
Oil companies adequately support livelihood restoration programmes.	53 (12.5)	84 (19.9)	47 (11.1)	154 (36.4)	85 (20.1)	2.68	1.24
Residents possess adequate skills to cope with oil spill impacts.	105 (24.8)	154 (36.4)	49 (11.6)	75 (17.7)	40 (9.5)	3.49	1.20
Community organizations effectively mobilize residents during emergencies.	121 (28.6)	166 (39.2)	42 (9.9)	60 (14.2)	34 (8.0)	3.66	1.15
The community has become more resilient because of previous oil spill experiences.	118 (27.9)	164 (38.8)	41 (9.7)	63 (14.9)	37 (8.7)	3.62	1.18

Table 6 Socioeconomic Stability Indicators

Socioeconomic Indicator	SA	A	U	D	SD	Mean	SD
Oil spills have significantly reduced household income.	208 (49.2)	141 (33.3)	29 (6.9)	31 (7.3)	14 (3.3)	4.18	0.98
Fishing activities have declined because of oil pollution.	226 (53.4)	128 (30.3)	25 (5.9)	28 (6.6)	16 (3.8)	4.23	0.95
Agricultural productivity has reduced due to environmental contamination.	191 (45.2)	149 (35.2)	31 (7.3)	34 (8.0)	18 (4.3)	4.09	1.01
Oil spills have increased household healthcare expenditures.	176 (41.6)	158 (37.4)	34 (8.0)	39 (9.2)	16 (3.8)	4.01	1.03
Access to potable water has deteriorated over time.	169 (40.0)	162 (38.3)	32 (7.6)	40 (9.5)	20 (4.7)	3.99	1.05
Youth unemployment has increased following repeated oil spills.	158 (37.4)	169 (40.0)	29 (6.9)	46 (10.9)	21 (5.0)	3.94	1.08
Food security has declined in the community.	151 (35.7)	164 (38.8)	36 (8.5)	49 (11.6)	23 (5.4)	3.88	1.10

Many households have diversified their livelihood sources.	92 (21.7)	147 (34.8)	51 (12.1)	94 (22.2)	39 (9.2)	3.38	1.22
Migration from the community has increased due to oil spill impacts.	116 (27.4)	149 (35.2)	46 (10.9)	74 (17.5)	38 (9.0)	3.55	1.19
Overall socioeconomic stability has been negatively affected by recurrent oil spills.	204 (48.2)	148 (35.0)	24 (5.7)	29 (6.9)	18 (4.3)	4.16	0.97

Table 5: Institutional Preparedness and Stakeholder Participation

Institutional Indicator	SA	A	U	D	SD	Mean	SD
Government agencies respond promptly to oil spill incidents.	61 (14.4)	97 (22.9)	56 (13.2)	136 (32.2)	73 (17.3)	2.91	1.27
Oil companies adequately compensate affected communities.	42 (9.9)	74 (17.5)	48 (11.3)	162 (38.3)	97 (22.9)	2.53	1.21
Environmental regulations are effectively enforced.	58 (13.7)	88 (20.8)	46 (10.9)	150 (35.5)	81 (19.1)	2.75	1.24
NOSDRA effectively coordinates oil spill response activities.	74 (17.5)	129 (30.5)	52 (12.3)	112 (26.5)	56 (13.2)	3.13	1.25
NUPRC effectively monitors oil industry compliance.	79 (18.7)	137 (32.4)	47 (11.1)	107 (25.3)	53 (12.5)	3.19	1.22
Community leaders actively participate in emergency decision-making.	142 (33.6)	171 (40.4)	31 (7.3)	50 (11.8)	29 (6.9)	3.82	1.08
Community members are consulted before major environmental decisions.	108 (25.5)	151 (35.7)	46 (10.9)	78 (18.4)	40 (9.5)	3.49	1.19
Collaboration among stakeholders is effective.	84 (19.9)	126 (29.8)	52 (12.3)	107 (25.3)	54 (12.8)	3.19	1.24
Environmental monitoring programmes are conducted regularly.	67 (15.8)	116 (27.4)	48 (11.3)	128 (30.3)	64 (15.1)	2.99	1.26
Institutional preparedness is adequate to manage future oil spill incidents.	49 (11.6)	83 (19.6)	44 (10.4)	158 (37.4)	89 (21.0)	2.64	1.23

Table 6 Composite Indices of Oil Spill Preparedness, Community Resilience and Socioeconomic Stability

Index	No. of Indicators	Mean Score	SD
Community Resilience Index (CRI)	10	3.22	0.81
Oil Spill Preparedness Index (OSPI)	10	3.05	0.87
Institutional Preparedness Index (IPI)	10	3.06	0.79
Socioeconomic Stability Index (SSI)*	10	2.11	0.73

4.50–5.00 (*Very High*), 3.50–4.49 (*High*), 2.50–3.49 (*Moderate*), 1.50–2.49 (*Low*), 1.00–1.49 (*Very Low*)

Table 7 Pearson Correlation Matrix among Major Study Variables

Variables	OSPI	CRI	IPI	SSI
Oil Spill Preparedness Index (OSPI)	1.000			
Community Resilience Index (CRI)	0.746**	1.000		
Institutional Preparedness Index (IPI)	0.691**	0.718**	1.000	
Socioeconomic Stability Index (SSI)	0.632**	0.701**	0.655**	1.000

**** Correlation is significant at $p < 0.01$ (2-tailed).**

Table 8: Multiple Regression Analysis Predicting Community Resilience

A. Model Summary

R	R ²	Adjusted R ²	Std. Error	Durbin-Watson
0.824	0.679	0.676	0.431	1.91

B. ANOVA

Source	SS	df	MS	F	p-value
Regression	167.84	3	55.95	301.84	<0.001
Residual	77.67	419	0.185		
Total	245.51	422			

C. Regression Coefficients

Predictor	B	Std. Error	Beta	t	p-value
Constant	0.694	0.144		4.82	<0.001
Oil Spill Preparedness	0.412	0.039	0.438	10.56	<0.001
Institutional Preparedness	0.301	0.042	0.319	7.18	<0.001
Socioeconomic Stability	0.276	0.037	0.285	7.46	<0.001

Table 9: One-Way ANOVA for Oil Spill Preparedness by Senatorial District

Source of Variation	Sum of Squares	df	Mean Square	F	p-value
Between Groups	18.27	2	9.14	8.63	<0.001
Within Groups	444.39	420	1.06		
Total	462.66	422			

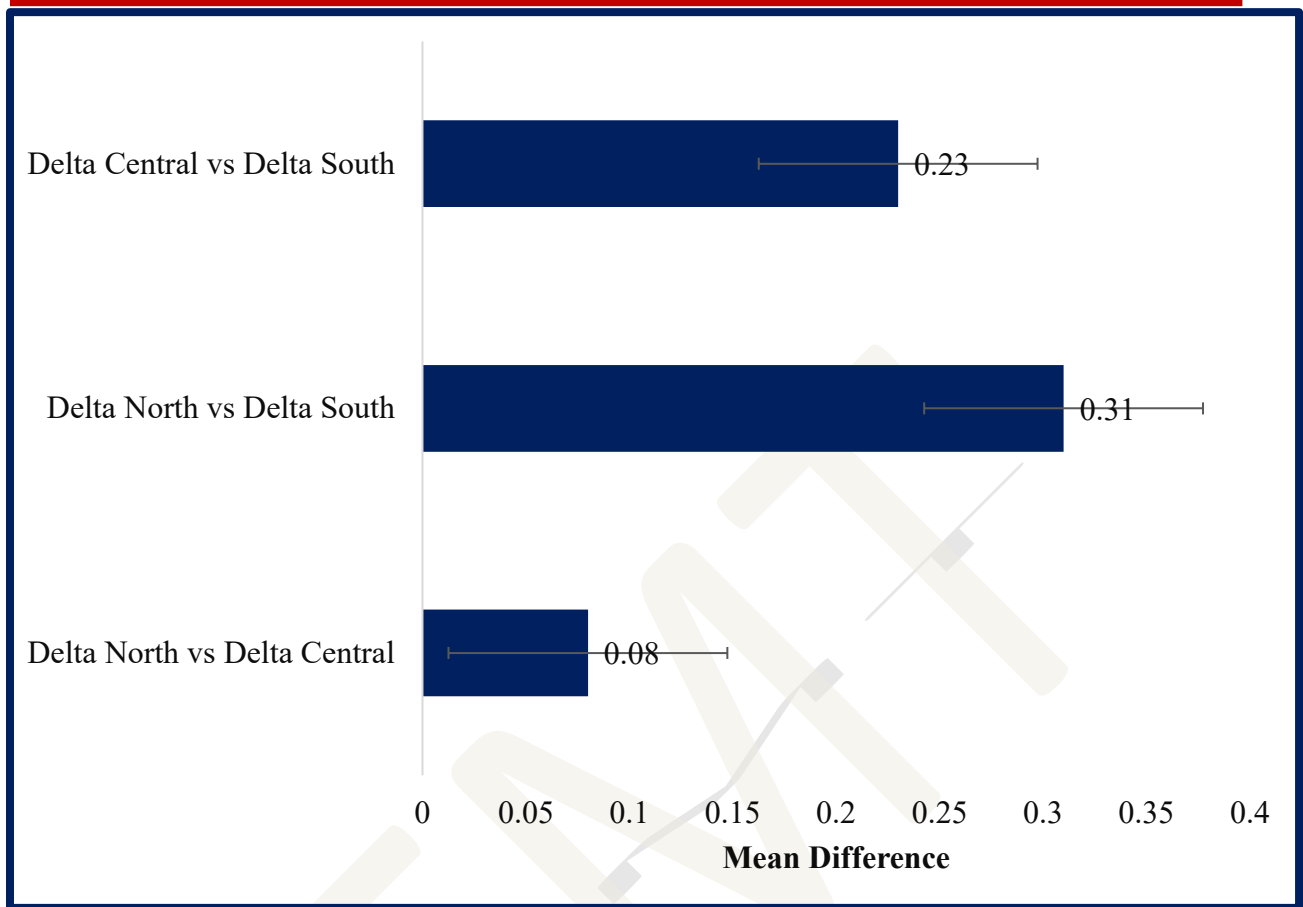


Figure 13: Tukey HSD Multiple Comparison Test

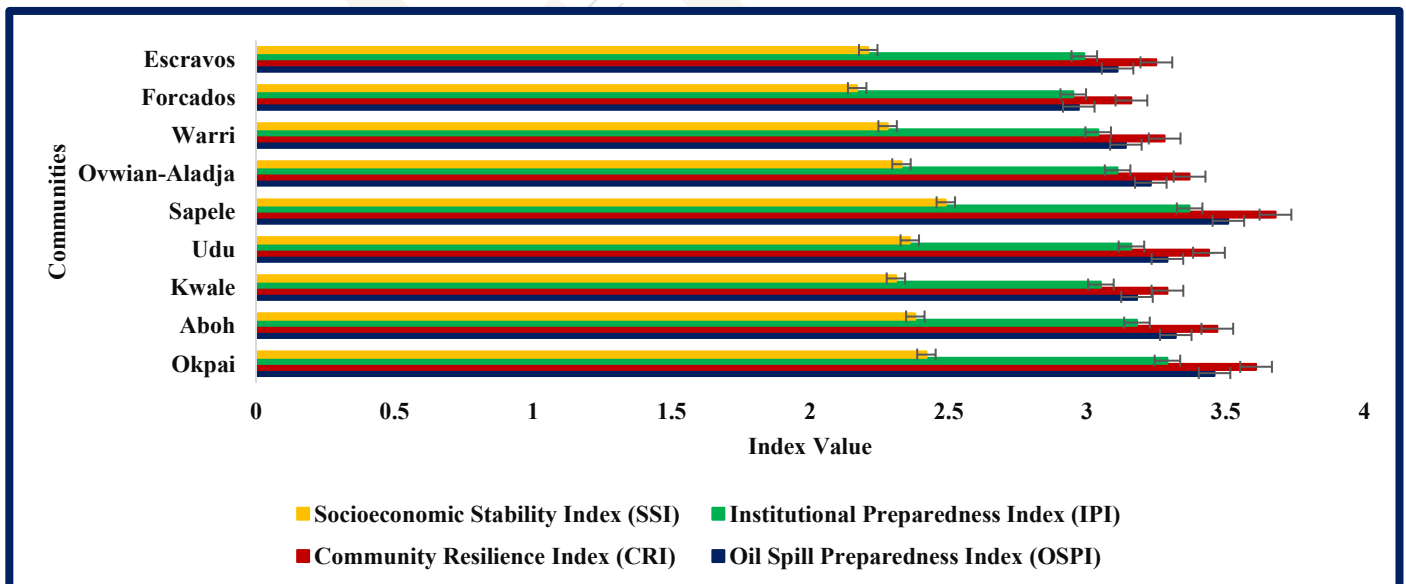


Figure 14: Comparative Assessment of Oil Spill Preparedness, Community Resilience, Institutional Preparedness and Socioeconomic Stability across the Study Communities

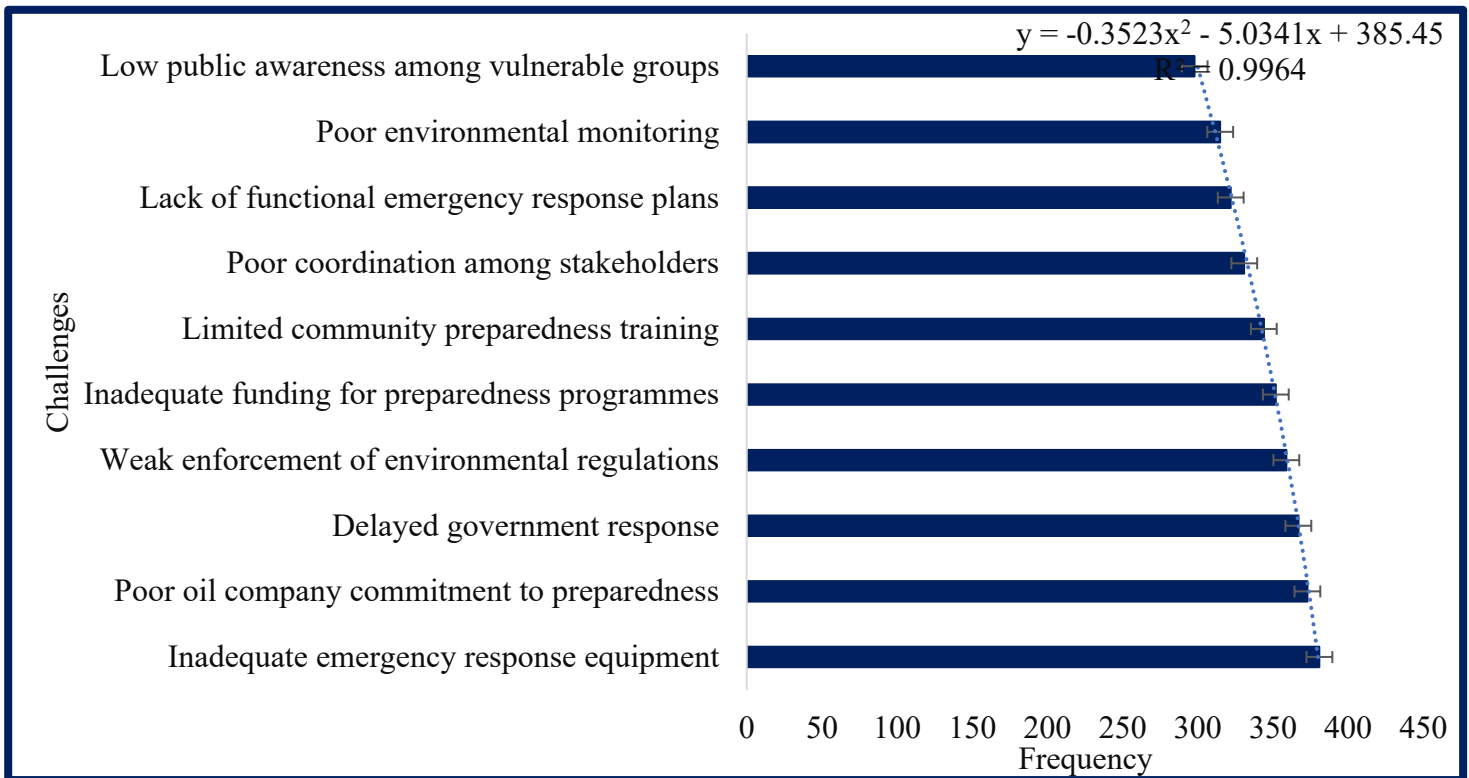


Figure 15: Major Challenges Limiting Oil Spill Preparedness

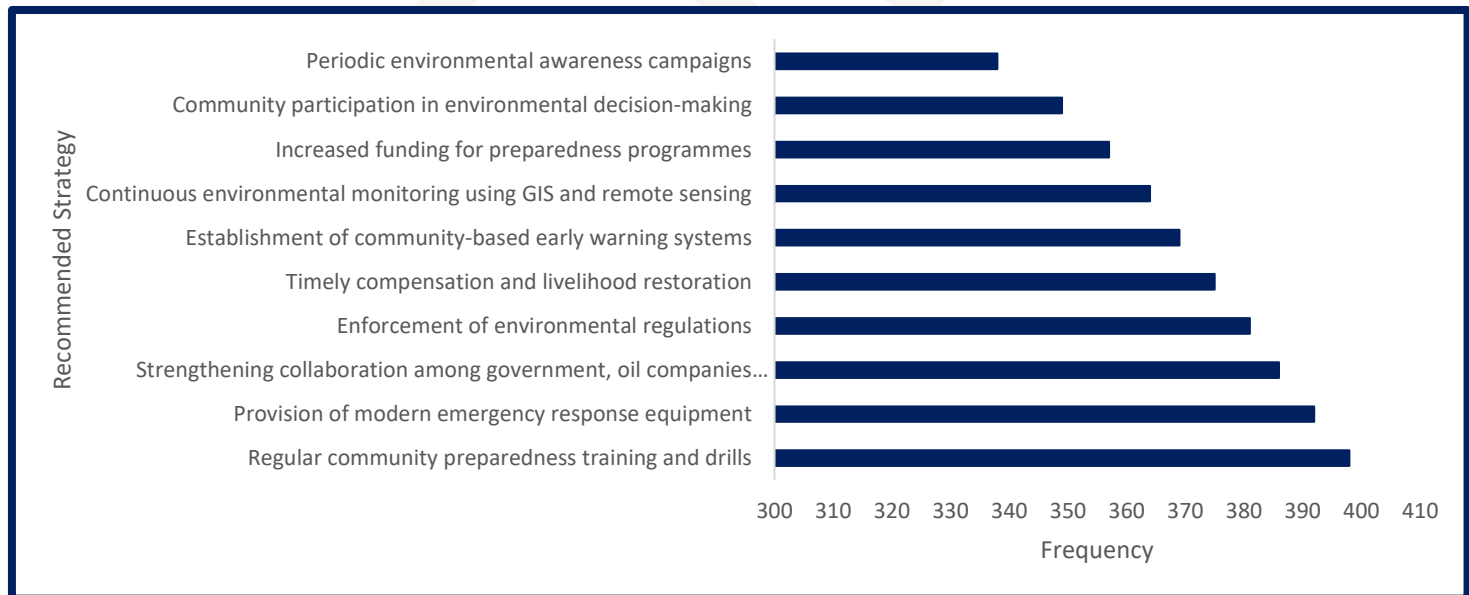


Figure 16: Suggested Strategies for Improving Oil Spill Preparedness and Community Resilience

Discussion

The total number of valid responses from the nine study communities was 423 (a very high questionnaire response rate of 95.8%), indicating a relatively evenly distributed number of responses across communities, which minimises the risk of skewing by any one community. Figures 1-6 demonstrate that the majority of the respondents were male (56%), in the age group economically working age (28-57 years), with a higher value in (38-47 years) ($n = 123$) married ($n = 276$) and generally had a formal education, with secondary education having the highest count ($n = 145$). In addition to the 205 respondents living in their community for more than 20 years (Figure 6), there was a strong correlation between all types of jobs with the environmental species and informal economic activity (Figure 5), denoting a high level of experience in watching petroleum operations and very frequent involvement in the cleanup of spills, which supported their assessment. The parameters indicated as vulnerability of the households were low-income age 20-24 years ($n=248$, Fig.7); low income of not exceeds ₦100,000 monthly ($n=248$, Fig. 8); household in fishing/agriculture for ≥ 11 years ($n=250$, Fig. 9); dwelling place within 1km of the oil installation ($n=249$, Fig. 10) and household depending directly on rivers/creeks for water ($n=177$, Fig.11). Such conditions, which interact with each other: high responsibility of member households, low income, high dependency on affected natural resources; being close to installations and having chronic exposure to installations, clearly mean that in the event of an oil spill it would be an environmental emergency, a health risk to the population and an economic shock to the member households. This projection is low and corroborates the projection of Timidi and Ugbomah (2026), which revealed that the leaks would be associated with the loss of marine livelihoods and the possible vulnerabilities of fish and aquatic resources to petroleum pollution, as per the projection by Igbani *et al.* (2024). This falls in line with Ejairu and Okiotor (2022), Okudo *et al.* (2024) and Aa *et al.* (2022) who demonstrated how alteration of soil properties could be attributed to the oil spill and how many of the Petroleum Associated Metals (PAM) get released to water, sediments and soil, and how this could create an ecological disturbance for several years till good clean up practices are adopted. Compared to past studies, residents had not yet developed high levels of risk awareness (mean 3.93), knowledge of the emergency agency (3.64), leadership coordination (3.61), or reporting communication (3.50), as Table 2 indicates, resulting in an average lack of preparedness for emergency exposures. Basically, he was pointing out that the hopefully moderate Oil-Spill Preparedness Index might not necessarily indicate a level of preparedness that is institutionalized, but rather the product of several oil-spill experiences and some leadership in the community. Also, Ekeipre *et al.* (2025) indicated that repeated exposure to spills and the timing of their occurrence over time can influence community perceptions and adaptations to risk; however, if perception is not accompanied by the necessary equipment, drills, or a formal contingency plan, a lack of sensitivity could exacerbate community vulnerability. The results have supported the assertion of the necessity to use the traditional approach, which is the best approach as compared to the conventional approach, whose benefits have been doubted by Ekunke *et al.* (2025) and the need to incorporate information derived from remote sensing of substances contaminated by HHCs with the ground-based warning and response tools as proposed by Adebangbe *et al.* (2025). Moreover, Arausi *et al.* (2024) and Ejim (2026) find that during a petroleum spill, this pollution, along with its positive interaction with social and environmental vulnerabilities, can exacerbate the vulnerability of already vulnerable households, in addition to other environmental and social stressors.

This is because community resilience was more supported by horizontal relationships within the community than by external institutions, as shown by the results in Table 3. The highest mean was in the areas of mutual support in emergency situations (3.68), community organisation mobilisation (3.66), participation in restoration (3.65) and resilience built on past spill experiences (3.62). However, other factors such as speedy recovery after the oil spill (2.90), Government assistance (2.87), alternative livelihoods (2.74), and oil company livelihood restoration (2.68) were comparatively low. This coping-resilience type of resilience is therefore different from this type of transformative resilience, as communities would not be able to mobilise and share resources, or coordinate an immediate response without coping resilience, but would be able to acquire/recover income, environmental resources, and welfare (long term). This is also evident in the adjusted Table 5, which presents the socio-economic outcome. Very strong agreement was obtained in the items responding the decrease in the household incomes affected by the spills (4.18), the fishing activity (4.23) and the decrease in agricultural production (4.09) and there was also an increased investment in health care (4.01), loss of potable water sources (3.99) and the increase of the youth unemployed (3.94), loss of food security (3.88) and decreased socioeconomic stability in general (4.16). Sometimes migration was a distress-driven alternative to livelihood, and a livelihood score of 3.38, not being able to reduce overall economic risk, turns into a livelihood score (indicator of voluntary/involuntary). This was similar to the results of Okafor *et al* (2025), who demonstrated the influence of petroleum-related OBM on Soil Systems, water and Onosemuode and Uruemuesiri (2025), who also carried out an integrated survey to illustrate the linkages between pollution in rivers and Damage to ecology and livelihood. Whatever it is, they uphold Onosemuode (2025), claiming that the poor management of pollution is related to both man-made and natural pollution and ecotoxicological hazards. Limited socioeconomic recovery is associated with the indication of institutional recovery in Table 5. The monitoring by NOSDRA factor showed a value of 2.91, regular monitoring factor value showed 2.99, the overall institutional preparedness factor value of 2.64, regulatory enforcement factor value of 2.53 and the compensation factor recorded 2.88, which was found to be weak, whereas the community leadership factor recorded relatively high value; being 3.82, 3.49, 3.19; 3.13, respectively. Thus, not all cases of visibility necessarily led to immediate action or reaction by the institution, or to compensation or restoration of livelihoods. This agrees with Isangadighi and Udeh (2023), who said that coordination and preparedness are essential components in handling flood emergencies, and with Miepeikumo and Onosemuode (2025), who claim in their study on flood risk that communities inundated by floods must be prepared and mitigate rather than cope. These patterns were also in the moderate and high ranges of the composite scores for community resilience (3.22 ± 0.81) and for institutional preparedness and oil-spill preparedness, which were at the moderate level (3.06 ± 0.79 , 3.05 ± 0.87 , respectively), while the socioeconomic stability variable score was low (2.11 ± 0.73), as presented in Table 6. As illustrated in Figure 14, Sapele scores highest in all 4 indicators – preparedness: 3.51, resilience: 3.68, institutional preparedness: 3.37, socioeconomic stability: 2.49 – while Forcados has the lowest scores in all the indicators – 2.97, 3.16, 2.95 and 2.17, respectively. Put to the test: If more is better, then more can lead to decreased finances/adaptive capacity; even more can lead to depletion of finances/adaptive capacity. This is manifested in Figure 15, where the main constraints, such as poor coordination and monitoring of the environment by stakeholders, lack of equipment, slow government response and lack of funding are presented. Training, response equipment, and regulatory enforcement (DE) show the most promise for addressing the gaps identified in the main approaches shown in Figure 16, as do compensation, early-warning systems,

GIS-based monitoring, collaboration, and funding and community participation. Isangadighi *et al.* (2025) and Adeyemi and Isangadighi (2025), respectively, also reported the expedient of environmental awareness and environmental-exposure monitoring as a positive step towards ameliorating the identification of occupational risk, and Orhuebor *et al.* (2026) indicated the usefulness of machine-learning risk mapping and the exposure indices in improving occupational risk identification. The wider dissemination and sharing of information derived from further predictive hydrocarbon modelling, as proposed by Orhuebor *et al.* (2026), and wider sharing of information derived from airborne-pollutant simulation, as was done by Chinedu *et al.* (2026), along with its use in operational-response decision-making, would significantly aid preparedness. The inferential results validate that relations and preparedness, institutions, and socioeconomic stability can also have a significant impact on the community's resilience. Results (Table 7) show that there was a positive relationship between community resilience and oil-spill preparedness ($r=0.746$, $p<0.01$), institutional preparedness ($r=0.718$, $p<0.01$), and socioeconomic stability ($r=0.701$, $p<0.01$). In addition, a positive correlation was found between preparedness and institutional preparedness ($r = 0.691$), and between preparedness and socioeconomic stability ($r = 0.632$), while a positive correlation was also observed between institutional preparedness and socioeconomic stability ($r = 0.655$). All are interdependent – good institutions foster good warning, good preparedness minimises the loss of life or property, and stable livelihoods create opportunities for family recovery. However, correlation would only show the joint significance of the factors; hence, the regression results presented in Table 8 are significant. The model was highly significant, $F(3,419) = 301.84$, $p < 0.001$, $R = 0.824$, $R^2 = 0.679$ and adjusted $R^2 = 0.676$, thus accounting for 67.9% of the variance in community resilience. Additionally, the Durbin-Watson statistic is 1.91, which is acceptable. Oil-spill preparedness was the strongest predictor ($B = 0.412$; $\beta = 0.438$; $t = 10.56$; $p < 0.001$), followed by institutional preparedness ($B = 0.301$; $\beta = 0.319$; $t = 7.18$; $p < 0.001$) and socioeconomic stability ($B = 0.276$; $\beta = 0.285$; $t = 7.46$; $p < 0.001$). Other factors, such as the most pervasive direct effects on resilience and effectiveness, were preparedness, coming through a change of one unit, and household stability; institutional performance was also very influential. The above interrelationship has been corroborated in part by the combined sediment–water–biota pollution assessment carried out by Chinedu *et al.* (2026) that confirmed all the pollutants from the petrochemical industry flow one way or the other; and plant and soil circulation of heavy metals carried out by Raluchukwu *et al.* (2026) in one of the oil-producing areas. This is a multi-dimensional exposure, and that's one reason why it's so hard to create an exposure intervention via emergency interventions. While the present results confirmed the literature findings that geostatistics (Obida *et al.*, 2018), groundwater-vulnerability mapping (Onavwie *et al.*, 2026) and remote sensing (Adebangbe *et al.*, 2025) have proven to be useful tools in the identification of exposure hotspots, it is stated here that institutional action and livelihood protection must be given consideration besides the technical risk identification. In the table (9), the third row showing the F value of “8.63” between the Delta location and sea turtle occurrence, indicates that there is a significant difference between the occurrence of the sighted sea turtle and between the different locations in Delta. The results of Tukey at HSD 0.95 (Figure 13) confirmed that there is a significant difference between the Delta North and Delta South, which is 0.31, Delta Central and Delta South, which is 0.23 and not a significant difference between Delta North and Delta Central, which is 0.08. The communities that had the lowest values were those that had the greatest exposure, e.g., in the south. The above is congruent with history data collected by Raji and Abejide (2013); Water-conflict analysis data collected by Babatunde (2020); Food-

security analysis data and data of pollution-induced land dispossession by Anthony, *et al.* (2026), as well as data of One Health analysis conducted by Udensi, *et al.* (2026). In addition, it is aligned with the strong focus on environmental communication in Ughelli, which included in its messages and appendices 'warning information, transparent risk reporting, and community involvement' as it was deemed as a crucial connection between scientific information and protective behaviours (Guanah *et al.*, 2026). The overall conclusions are in keeping with the social-ecological approach to resilience, which focuses on a system of contributing elements: knowledgeable communities, responsive institutions, working preparedness systems and rehabilitated environment (including secure livelihoods) that help to facilitate the adaptation of a system. Hence, the policy should emphasise risk-differentiated interventions in the most exposed communities, contingency plans in the community, modern equipment for the response, regular training for drills, GIS monitoring, unambiguous targets for response, remediation of the ecosystem and livelihood diversification. If there aren't any buildings that the communities can demonstrate and support their social cohesion with, then they will be more vulnerable to petrol shocks.

Conclusion

The study highlights that oil-spill preparedness, community institutional capacity, and socioeconomic stability are foundational factors influencing community resilience in the high-risk oil-producing communities of Delta State. Residents showed a high level of awareness of, and ability to cope with, risks; mutual assistance; collective mobilisation; and leadership coordinating institutional preparedness – mostly experience-based coping. There was still insufficient attention to emergency plans, training, response equipment, governmental intervention, and compensation and restoration of livelihoods. Repeated oil spills had a significant impact on household incomes, farm and fishing productivity, food security, access to potable water, healthcare spending, unemployment, and migration. Overall, however, socioeconomic stability proved to be the weakest dimension, despite moderate resilience reported by respondents. The correlation among preparedness, institutional capacity, socio-economic stability, and resilience revealed a strong relationship among these, indicating interdependence, and regression explained a high proportion of the variance in community resilience from a combination of the three predictors. The major predictive influence was on the oil-spill preparedness factor, followed by institutional capacity and socioeconomic stability. There were also major spatial variations, revealing that different pollution conditions, institutional reprimand, livelihood reliance, and access to response resources were all associated with different resilience conditions. Thus, social solidarity is not enough to assure sustainable recovery. True resilience involves the melding of community knowledge and functioning preparedness systems, responsive institutions, environmental remediation strategies, and economic security and inclusive governance in a way that minimises vulnerability to oil-spill incidents before, during and after.

Recommendations

The study proposes that community-based oil spill contingency plans, involving an early-warning system readily available to the community, well-defined evacuation procedures, emergency communication, and frequent simulation activities, should be established. Government authorities and petroleum businesses must be able to mobilise response teams with the necessary skills, along with PPE and containment materials strategically placed, and ensure appropriate funds are available to intervene immediately. NOSDRA, NUPRC and relevant state institutions should

increase environmental monitoring through routine field monitoring, satellite imagery, geographic information systems, groundwater vulnerability mapping and predictive risk modelling. Operators must not delay responses and must adhere to mandatory response timeframes; operators who do not meet response deadlines may incur proportionate sanctions. Documented losses to the environment, health and livelihoods should be used, and there should be transparent compensation and remediation processes, which are independently verified. Increase economic resilience through livelihood diversification, concessional credit, agricultural restoration, fishing support programmes, and vocational and targeted support for vulnerable households. All community members, women, youth, fishers, and farmers should be actively involved in assessing spills, in the decision-making process, in monitoring remediation, and in programme evaluation. Local languages are an effective way to communicate environmental and health information, fostering stronger protective behaviour and trust in institutions. Also, interagency coordination platforms should be developed to define responsibilities and help in data sharing. Last but not least, interventions should be risk-differentiated – give preference to communities at high risk that lack institutional coverage and are in poor socioeconomic and dependent situations with respect to polluted land and water resources.

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