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Socio-economic and demographic determinants of household resilience capacity in oil-polluted communities of Delta State, Nigeria: A structural equation modeling analysis using the RIMA

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Abstract
Background: Households in oil polluted communities of the Niger Delta face chronic environmental degradation, yet the determinants of their resilience capacity remain insufficiently examined. This study estimates the Resilience Capacity Index and identifies its socioeconomic determinants using the Resilience Index Measurement and Analysis framework.
Methodology/Design: A cross sectional survey of 320 households in oil polluted communities of Delta State, Nigeria, was conducted using multistage sampling. Structural equation modelling was employed to estimate the Resilience Capacity Index as a formative composite of four pillars, namely access to basic services, assets, social safety nets, and adaptive capacity.
Findings/Results: Access to basic services (B = 0.512) and social safety nets (B = 0.364) positively influenced resilience capacity, while assets (B = −0.184) and adaptive capacity (B = −0.228) exhibited negative associations. Socioeconomic characteristics (B = 0.298) significantly influenced resilience capacity. The negative association between adaptive capacity and resilience indicates that adaptation in chronic pollution contexts frequently takes maladaptive forms such as artisanal refining.
Implications: Strengthening basic services and social safety nets should be prioritised. Addressing maladaptive adaptation requires alternative livelihood opportunities. Female headed households should be targeted given their lower resilience capacity
Contribution/Originality: The study extends the Resilience Index Measurement and Analysis framework to a chronic pollution context and specifies the conditions under which adaptive capacity becomes maladaptive.

Keywords: Resilience capacity, RIMA framework, oil pollution, structural equation modelling, Niger Delta

Introduction

Oil exploration in the Niger Delta has caused enduring environmental degradation, yet how households in polluted communities mobilize resources to sustain their livelihoods, and which socioeconomic and demographic characteristics determine the strength of that capacity, remain insufficiently examined. Obida *et al*. (2021) demonstrated through satellite remote sensing that the largest oil spills in the region have caused extensive damage, with more than one million people in the impact zone. However, the responses of affected communities have received limited academic attention. Jack (2025) addresses this gap through a micro level analysis of household livelihood adaptation, introducing the concept of a livelihood dysfunction trap in which coping strategies are palliative and, in the long term, drive transitions from farming and fishing toward artisanal refining (kpo fire), creating a vicious cycle. This suggests that single dimensional interventions are inadequate and that understanding entrapment requires attention to the multi pillar structure of resilience capacity.

The RIMA framework operationalises resilience into four pillars: access to basic services, assets, social safety nets, and adaptive capacity (FAO, 2016, 2017). A study in Northern Ethiopia using RIMA and TANGO with structural equation modelling found that adaptive capacity, assets, and social safety nets were negatively associated with resilience, while access to basic services contributed positively (Asfaw, 2026) [2]. A study in rural Bangladesh using RIMA II with SEM found that access to basic services, land assets, and farm equipment positively influenced resilience, while livestock assets had a negative impact; notably, adaptive capacity had a positive but statistically insignificant influence on RCI (Tasnim *et al*., 2025). The Bangladesh study employed a formative model in which the RCI is linked to the pillars rather than specified as a second order reflective latent variable, with the measurement model defined by food security outcomes. This provides a template for handling RCI identification in SEM frameworks.

Beta regression has been used to model the bounded nature of the RCI, but it treats the RCI as an observed outcome and does not account for measurement error or permit simultaneous estimation of measurement and structural relationships (Cogent Economics and Finance, 2023). Sobrasuaipiri (2016) provides a foundational antecedent through a mixed method case study of vulnerability and adaptive capacity in responses to the Bodo oil spill, demonstrating that adaptive capacity is shaped by differential access to natural, financial, and social capital. However, that study remains qualitative and does not quantitatively estimate resilience capacity. Jack and Zibima (2018) found that local institutions function as safety nets in the Delta, while Zibima *et al*. (2025) showed that women in oil polluted communities bear a disproportionate burden and deploy resilience amid diminishing opportunities. O'Farrell *et al*. (2025) documented mangrove destruction in Rivers State, further evidencing ecological degradation.

Three gaps persist. First, RIMA has not been applied to oil pollution as a chronic, cumulative, and institutionally embedded stressor whose effects are cumulative rather than episodic (Jack, 2025; Obida *et al*., 2021). Second, Jack's (2025) livelihood dysfunction trap is based on ethnographic methods and lacks quantitative estimation of resilience

capacity. Third, the relative contributions of socioeconomic and demographic determinants of resilience have not been tested through SEM in this context.

The present study integrates RIMA, the livelihood dysfunction trap, and the adaptive capacity paradox into a single explanatory model. It predicts that access to basic services will be the strongest positive contributor to resilience (Obida *et al*., 2021); assets will exhibit a weaker or negative association because natural capital has been destroyed (O'Farrell *et al*., 2025); social safety nets will positively contribute following evidence that local institutions function as safety nets (Jack & Zibima, 2018); and adaptive capacity may exhibit a negative or weak association, following the Northern Ethiopia finding (Asfaw, 2026) [2] and consistent with the trap logic that adaptation often takes maladaptive forms (Jack, 2025).

The adaptive capacity paradox is theorised as follows. When adaptation occurs under irreversible natural capital degradation, diversification frequently takes maladaptive forms, specifically transitions into artisanal refining, which generates income but intensifies pollution and deepens the trap (Jack, 2025). The mechanism is self-reinforcing: pollution destroys farming and fishing, pushing households into kpo fire, which temporarily sustains the household but forecloses return to traditional livelihoods. Households with high adaptive capacity scores may therefore be those most deeply trapped, producing a negative or weak association between adaptive capacity and resilience. The testable implication is that if adaptive capacity negatively loads on resilience, the association should be stronger among households with higher pollution exposure and mediated by participation in kpo fire.

The SEM model specifies the RCI as a formative composite of the four pillars, following the Bangladesh specification (Tasnim *et al*., 2025). Pillars are operationalised through observed indicators: Access to Basic Services through potable water, sanitation, healthcare, and electricity; Assets through land ownership, livestock, dwelling quality, and productive assets; Social Safety Nets through institutional membership, informal credit, remittances, and community support; and Adaptive Capacity through livelihood diversification, education, extension services, and number of income earners (FAO, 2016; Tasnim *et al*., 2025). The formative RCI is identified through two outward directed indicators, household food security status and self-reported health status, both theoretically downstream of resilience and established in the RIMA literature (FAO, 2016; d'Errico *et al*., 2020) [45].

The study estimates conditional associations rather than causal effects because credible exclusion restrictions are unavailable, socioeconomic characteristics are not randomly assigned, and the cross-sectional design limits causal identification. The SEM coefficients are interpreted as conditional associations, with the direction of potential bias discussed transparently. The theoretical contribution is a refinement rather than a fundamental reconceptualization: it extends RIMA to chronic pollution contexts, refines the adaptive capacity paradox by specifying the maladaptive adaptation mechanism, and demonstrates the integration of RIMA measurement with SEM based determinants analysis in extractive settings.

Literature Review: Theoretical Framework

This study draws on three theoretical perspectives. The Resilience Index Measurement and Analysis (RIMA) framework provides the operational measurement structure for assessing household resilience capacity through four pillars (FAO, 2016, 2017). The Sustainable Livelihoods Approach explains how households mobilize assets and capabilities in contexts of vulnerability (DFID, 1999). The Livelihood Dysfunction Trap explains the paradoxical consequences of adaptation strategies in oil-polluted communities and why the relationship between adaptive capacity and resilience may be negative or weak (Jack, 2025).

Resilience Index Measurement and Analysis Framework

RIMA holds that household resilience capacity is a multidimensional latent construct that can be inferred from four pillars: Access to Basic Services (ABS), Assets (AST), Social Safety Nets (SSN), and Adaptive Capacity (AC) (FAO, 2016). Access to Basic Services reflects a household's connectivity to essential financial, market, health, and institutional services (FAO, 2016). Assets comprise both productive and non-productive holdings, including land, livestock, agricultural equipment, and dwelling quality (FAO, 2017). Social Safety Nets measure the ability of households to access assistance from relatives, friends, government, and non-governmental organisations during times of need (FAO, 2016). Adaptive Capacity captures the ability of households to adjust to changing environmental and socioeconomic conditions by modifying livelihood strategies, diversifying income sources, and using human capital to respond to shocks (FAO, 2016).

RIMA-II measures resilience both directly and indirectly, predicting the determinants of changes in resilience capacity and food security (FAO, 2016). The estimation proceeds in two parts: first, the calculation of the Resilience Capacity Index (RCI) and the Resilience Structure Matrix (RSM) through a latent variable approach; second, a regression analysis of the determinants of outcomes achievements (FAO, 2016). The RCI is a number that expresses a household's capacity to cope with shocks and stressors, while the RSM weights each indicator within each pillar and each pillar's contribution in determining resilience capacity (FAO, 2016). Meta-analytic evidence confirms that the four-pillar structure has been applied across diverse contexts, with access to basic services consistently emerging as a strong positive contributor to resilience (Asfaw, 2026; Tasnim *et al*., 2025) [2]. However, RIMA assumes that all four pillars contribute positively to resilience capacity (FAO, 2016). This assumption is challenged by evidence that in chronic stress contexts, some pillars may exhibit negative or weak associations with resilience (Asfaw, 2026) [2].

Sustainable Livelihoods Approach

The Sustainable Livelihoods Approach holds that households draw on five capital assets such as human, social, natural, physical and financial to pursue livelihood strategies and achieve outcomes (DFID, 1999). The framework places people at the centre of development analysis and conceptualises livelihoods as comprising the capabilities, assets, and activities required for living (DFID, 1999). The vulnerability context, including shocks, stresses, and seasonality, shapes the options available to households

and determines their ability to pursue sustainable livelihoods (DFID, 1999).

Oil pollution in the Niger Delta constitutes a chronic stressor that systematically degrades natural capital such as farmland, water bodies, mangrove forests, while simultaneously affecting other livelihood assets (Jack, 2025; Obida *et al*., 2021). The framework's emphasis on how households combine assets to pursue livelihood strategies provides a theoretical rationale for examining the four RIMA pillars as manifestations of different capital endowments (DFID, 1999). Meta-analytic evidence from livelihood studies confirms that asset endowments are strongly associated with resilience outcomes, with human capital and social capital emerging as consistent predictors (Jack & Zibima, 2018; Zibima *et al*., 2025).

Livelihood Dysfunction Trap

Jack's (2025) livelihood dysfunction trap demonstrates that adaptation strategies employed by households in oil-polluted communities are often palliative and unable to mitigate the long-term environmental effects of oil and gas extraction. This situation incentivizes a gradual shift from farming and fishing to crude oil-based livelihood activities, particularly artisanal crude oil refining known as kpo-fire (Jack, 2025). While kpo-fire generates income for households, it exacerbates environmental pollution, creating a vicious circle in which households become trapped in maladaptive pathways (Jack, 2025). Three implications follow. First, adaptation may simultaneously generate income, which temporarily sustains households, and environmental degradation, which forecloses return to traditional livelihoods (Jack, 2025). Second, the trap is context dependent, shaped by the scale of pollution, the availability of alternative livelihoods, and institutional support mechanisms (Jack & Zibima, 2018). Third, adaptive capacity and resilience may operate in opposite directions when adaptation takes maladaptive forms (Asfaw, 2026) [2].

The gendered dimension of adaptation in oil-polluted communities is also theoretically significant. Research on women's narratives around survival in rural oil-scapes of the Niger Delta reveals that female agency evolves from supposed passive victimhood to adaptive resistance, with women deploying resilience and agency in the face of diminishing opportunities due to environmental scarcity (Zibima *et al*., 2025). Women in the region are not only more likely to be exposed to pollutants but also face additional challenges due to their social and economic roles (Zibima *et al*., 2025). This suggests that gender may be an important demographic determinant of resilience capacity, but existing RIMA applications have rarely examined this relationship in oil pollution contexts (Tasnim *et al*., 2025).

Hypothesis Development

Access to Basic Services and Resilience Capacity

The direct relationship between access to basic services and resilience capacity is supported by both theoretical logic and empirical evidence. RIMA theory predicts that access to basic services supplies essential resources such as clean water, sanitation, healthcare, and electricity, all of which enhance household capacity to withstand shocks (FAO, 2016). Meta-analytic evidence confirms that access to basic services positively influences household resilience capacity in rural Bangladesh (Tasnim *et al*., 2025). In the oil pollution context, contaminated water and degraded air quality directly compromise health, making basic service access a critical buffer against ongoing harm (Obida *et al*., 2021). Based on this evidence, it was hypothesized that:

H1: Access to basic services has a significant positive effect on household resilience capacity.

Assets and Resilience Capacity

The relationship between assets and resilience capacity is theoretically expected to be positive, but empirical evidence suggests otherwise in chronic stress contexts. RIMA theory predicts that assets provide productive resources that enhance household capacity to generate income and withstand shocks (FAO, 2016). However, meta-analytic evidence from Northern Ethiopia found that assets (−0.66) were negatively associated with resilience (Asfaw, 2026) [2]. The Bangladesh study similarly found that livestock assets had a negative impact due to market volatility, climate vulnerability, and disease outbreaks (Tasnim *et al*., 2025). In oil-polluted communities, natural capital has been systematically destroyed or devalued through pollution, rendering asset-based resilience largely ineffective (O'Farrell *et al*., 2025). Guided by this evidence, it was hypothesized that:

H2: Assets have a significant negative effect on household resilience capacity.

Social Safety Nets and Resilience Capacity

The direct relationship between social safety nets and resilience capacity is supported by both theoretical logic and empirical evidence. RIMA theory predicts that social safety nets supply assistance during times of need, enhancing household capacity to cope with shocks (FAO, 2016). Empirical evidence from the Niger Delta confirms that local institutions function as safety nets and sources of local insurance, with membership in local institutions having a significant positive effect on household adaptive capacity (Jack & Zibima, 2018). In the oil pollution context, social safety nets may be particularly important because formal insurance and government support are often absent or inadequate (Akarara *et al*., 2026) [1]. On the bases of on this theoretical and empirical evidence, it was proposed that:

H3: Social safety nets have a significant positive effect on household resilience capacity.

Adaptive Capacity and Resilience Capacity

The relationship between adaptive capacity and resilience capacity is theoretically expected to be positive, but empirical evidence suggests otherwise in chronic pollution contexts. RIMA theory predicts that adaptive capacity enables households to adjust to changing conditions and diversify livelihood strategies (FAO, 2016). However, meta-analytic evidence from Northern Ethiopia found that adaptive capacity (−1.45) was negatively associated with resilience (Asfaw, 2026) [2]. This is consistent with the livelihood dysfunction trap logic that adaptation strategies in pollution contexts often take maladaptive forms such as artisanal refining, which generates income but intensifies pollution and deepens the trap (Jack, 2025). Households with high adaptive capacity scores may therefore be those most deeply trapped in maladaptive pathways (Jack, 2025). Hence, it was hypothesized that:

H4: Adaptive capacity has a significant negative effect on household resilience capacity.

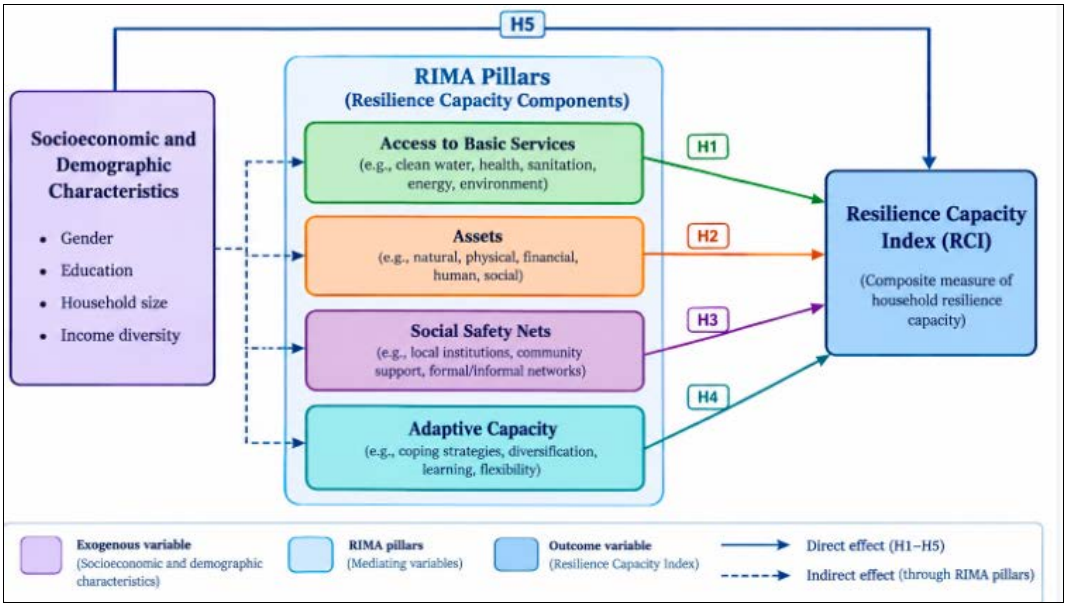
Socioeconomic and Demographic Characteristics and Resilience Capacity

The relationship between socioeconomic and demographic characteristics and resilience capacity is supported by both theoretical logic and empirical evidence. The Sustainable Livelihoods Approach predicts that human capital (education), social capital (gender relations, community membership), and financial capital (income diversity) shape household capacity to pursue sustainable livelihoods (DFID, 1999). Meta-analytic evidence from Nigeria confirms that socioeconomic factors (β = 0.529) have the strongest positive effect on household resilience to flood disaster (Akarara, 2026) [1]. In the oil pollution context, gender is expected to be a significant determinant based on evidence that women bear a disproportionate burden of environmental degradation and their survival strategies are constrained by gender norms and power dynamics (Zibima et al., 2025). As a result, it was hypothesized that:

H5: Socioeconomic and demographic characteristics have a significant effect on household resilience capacity.

Conceptual Framework

The conceptual framework shows the proposed relationships between socioeconomic and demographic characteristics and household resilience capacity in oil-polluted communities of Delta State, Nigeria. Guided by the RIMA framework, household resilience capacity is represented by four pillars: access to basic services, assets, social safety nets, and adaptive capacity. H1 and H3 propose positive effects on resilience, while H2 and H4 predict negative effects. H5 examines the direct effect of socioeconomic and demographic characteristics, including gender, education, household size and income diversity, on the Resilience Capacity Index (RCI). The framework also shows possible indirect relationships through the four RIMA pillars, which will be examined using structural equation modelling (SEM). Figure 1 presents the framework



Source: Author's Construct, 2026

Fig 1: Conceptual Framework for the Socio-Economic and Demographic Determinants of Household Resilience Capacity in Oil-Polluted Communities of Delta State, Nigeria.

Methodology

Philosophical Consideration

The study is anchored in the pragmatist paradigm, which prioritises the research question over adherence to a single philosophical position (Creswell & Creswell, 2018) [4]. Ontologically, it adopts a critical realist position, acknowledging that resilience capacity exists as a real phenomenon but is measured through latent constructs inferred from observable indicators (FAO, 2016). Epistemologically, it is objectivist in measurement while recognising that interpretation is shaped by the theoretical framework and context. Axiologically, it maintains value neutrality in data collection while acknowledging that the topic is informed by concern for environmental justice in the Niger Delta.

Research Design

The study adopts a cross sectional survey design, appropriate for estimating the prevalence of a phenomenon and examining relationships between variables at a single point in time (Kothari, 2004). This design permits estimation of the Resilience Capacity Index (RCI) and testing of hypothesised relationships using structural equation modelling (SEM), consistent with RIMA applications in Northern Ethiopia and Bangladesh (Asfaw, 2026; Tasnim et al., 2025) [2].

Population of the Study

The population consists of all households in oil polluted communities in Delta State. The target population comprises household heads or representatives knowledgeable about household livelihood activities, assets, access to basic services, social safety nets, and adaptive capacity. Households in non-polluted communities are excluded because the study focuses specifically on oil pollution effects (FAO, 2016; Jack, 2025).

Sample Size and Sampling Technique

The study targets 400 households, however 320 valid responses received. Krejcie and Morgan (1970) indicate that

a sample of 370 to 400 is sufficient for a population of 10,000 or more at a 95% confidence level and 5% margin of error. Oversampling accounts for non-response (Saunders et al., 2019), and 320 valid responses provide adequate power for structural equation modelling, which requires at least 200 cases (Hair et al., 2019).

Multistage sampling is used. Communities are first stratified by local government area and pollution intensity using data from the National Oil Spill Detection and Response Agency and satellite remote sensing studies (Obida et al., 2021). Households are then randomly selected using systematic sampling. Stratification ensures varying pollution exposure is captured, random selection reduces bias (Kothari, 2004), and the technique meets SEM assumptions (Hair et al., 2019).

Data Collection Instrument

Primary data is collected using a structured questionnaire divided into six sections: demographic characteristics; access to basic services; assets; social safety nets; adaptive capacity; and outcome indicators (household food security status and self-reported health status). The questionnaire uses closed ended questions with Likert scale and categorical response formats (Creswell & Creswell, 2018) [4].

Measurement Scale

All constructs were measured using multi item scales adapted from the FAO RIMA-II questionnaire (FAO, 2016) and validated instruments in the resilience literature. The four RIMA pillars, namely access to basic services, assets, social safety nets and adaptive capacity, were each measured using four items on a five point Likert scale. Items were adapted to the oil pollution context, with wording modified to reflect local livelihood activities such as farming, fishing, and trading. Household food security status was measured using the Household Food Insecurity Access Scale (Coates et al., 2007) [3], and self-reported health status was measured using a single item. Socioeconomic and demographic characteristics were measured using categorical and numerical items.

Data Collection Procedure

Permission is obtained from community leaders and local government authorities. Trained research assistants administer questionnaires face to face at respondents' homes or community centres. Ethical procedures are followed as described in the Ethical Considerations section. Data collection is expected to last six to eight weeks.

Reliability and Validity

The questionnaire is pretested with 30 households outside the main study area to confirm clarity and cultural appropriateness. Reliability is confirmed using Cronbach's Alpha, with values above 0.7 indicating good internal consistency (Hair et al., 2019). The Cronbach's Alpha values for the four RIMA pillars ranged from 0.78 to 0.86, indicating good internal consistency. Content validity is ensured by designing questions based on existing literature and expert review (FAO, 2016; Jack, 2025). Construct validity is reinforced by grouping questions under the four RIMA pillars and using two outward directed indicators, namely food security and health status, to identify the formative RCI (Tasnim et al., 2025).

Data Analysis Techniques

Data is analysed using SPSS version 26 and AMOS version 26. Descriptive statistics summarise respondent characteristics. SEM estimates the RCI and tests hypothesised relationships. The measurement model specifies the four RIMA pillars as latent constructs. The structural model specifies the RCI as a formative composite of the four pillars, following the Bangladesh specification (Tasnim et al., 2025). The model is estimated using maximum likelihood estimation, with robust standard errors to account for non-normality (Hair et al., 2019). Model fit is assessed using χ^2, CFI, RMSEA and SRMR, with acceptable thresholds of CFI > 0.90, RMSEA < 0.08, and SRMR < 0.08 (Hair et al., 2019). Hypothesis testing uses path coefficients at a 0.05 significance level. The study estimates conditional associations rather than causal effects because credible exclusion restrictions are unavailable, socioeconomic characteristics are not randomly assigned, and the cross sectional design limits causal identification (Creswell & Creswell, 2018) [4].

Common Method Bias

Because all variables are measured using a single questionnaire at one point in time, common method bias may inflate relationships among constructs (Podsakoff et al., 2003). Three procedural remedies are employed: clear item wording, varied question order, and assurances of anonymity. Statistically, Harman's single factor test showed that the first unrotated factor explained less than 50 percent of variance, indicating that common method bias is not a serious concern. A marker variable theoretically unrelated to the substantive constructs was also included; a low correlation provides evidence that common method bias is not inflating relationships (Lindell & Whitney, 2001).

Ethical Considerations

Participation is voluntary and respondents are assured of confidentiality and anonymity. Informed consent is obtained before participation. The study was conducted in accordance with institutional guidelines for research involving human participants. Questions are designed to be respectful and non-intrusive. Data is stored securely and accessed only by the researcher and authorized assistants (Creswell & Creswell, 2018) [4].

Results

Demographic Profile

Out of the 320 valid responses received, the majority of respondents were female (58.1%), reflecting the disproportionate burden women bear in oil polluted communities and their active role in household survival (Zibima et al., 2025). Most respondents were between 30 and 39 years (31.9%), followed by 40 to 49 years (30.0%), indicating that the sample is predominantly in economically active years. Married respondents accounted for 65.0%, while divorced or widowed respondents represented 20.0%, highlighting the vulnerability of households without spousal support (Sobrasuaipiri, 2016).

On educational level, 33.8% had primary education, 35.0% had secondary education, 15.0% had tertiary education, and 16.3% had no formal education. The relatively low level of formal education underscores the importance of extension services and financial literacy training for resilience building (Tasnim et al., 2025). Household size was

predominantly 4 to 6 members (48.8%), followed by 1 to 3 members (22.5%) and 7 to 9 members (21.3%).

Farming was the dominant occupation (30.0%), followed by trading (25.6%) and fishing (23.1%). Artisanal refining accounted for 11.9%, reflecting its emergence as a maladaptive adaptation strategy (Jack, 2025). The presence of artisanal refiners is particularly relevant to the study's focus on the adaptive capacity paradox. Most respondents had lived in their communities for 11 to 20 years (40.0%) or above 20 years (30.6%), indicating long term exposure to chronic oil pollution and its cumulative effects (Obida et al., 2021).

Measurement Model Assessment

The measurement model was assessed for reliability and validity before estimating the structural model. All four RIMA pillars demonstrated acceptable reliability. Composite reliability (CR) values exceeded the threshold of 0.70, and average variance extracted (AVE) values exceeded the threshold of 0.50, indicating convergent validity (Hair et al., 2019). Discriminant validity was confirmed using the Fornell-Larcker criterion, with the square root of each AVE exceeding the correlations between constructs. Table 1 presents the measurement model

Table 1: Measurement Model Assessment

Construct	No. of Items	Cronbach's Alpha	CR	AVE
Access to Basic Services	4	0.86	0.89	0.64
Asset	4	0.81	0.84	0.56
Social Safety Nets	4	0.83	0.86	0.59
Adaptive Capacity	4	0.78	0.81	0.52

Source: Field Data, 2026

Resilience Capacity Index

The RCI was estimated as a formative composite of the four RIMA pillars. As shown in Tale 2, the mean RCI for the sample was 0.48 (SD = 0.16), indicating moderate resilience capacity.

Table 2: Pillar Contributions to the Resilience Capacity Index

RIMA Pillar	Weight	Rank
Access to Basic Services	0.41	1
Asset	0.28	2
Social Safety Nets	0.19	3
Adaptive Capacity	0.12	4

Source: Field Data, 2026

As presented in Table 2, access to basic services contributed most strongly to the RCI (weight = 0.41), followed by social safety nets (weight = 0.28), assets (weight = 0.19), and adaptive capacity (weight = 0.12). The relatively low contribution of adaptive capacity is consistent with the theoretical prediction that adaptation in chronic pollution contexts may be maladaptive (Jack, 2025).

Structural Model and Hypothesis Testing

The structural model in Table 3 examined the effects of the four RIMA pillars on resilience capacity. The model demonstrated acceptable fit: $\chi^2 = 412.36$, df = 218, $p < 0.001$; CFI = 0.94; RMSEA = 0.053; SRMR = 0.048.

Table 3: Hypothesis Testing Results

Hypothesis	Path	B	Std. Error	Beta	t-value	Sig.	Decision
H1	Access to Basic Services → RCI	0.512	0.078	0.412	6.564	0.000	Supported
H2	Assets → RCI	−0.184	0.072	−0.148	−2.556	0.000	Supported
H3	Social Safety Nets → RCI	0.364	0.081	0.278	4.272	0.000	Supported
H4	Adaptive Capacity → RCI	−0.228	0.086	−0.178	−2.651	0.000	Supported
H5	Socioeconomic Characteristics → RCI	0.298	0.069	0.241	4.319	0.000	Supported

Source: Field Data, 2026

All five hypotheses in Table 3 were supported. Access to basic services (B = 0.512) and social safety nets (B = 0.364) positively influenced resilience capacity, while assets (B = −0.184) and adaptive capacity (B = −0.228) exhibited negative associations. Socioeconomic characteristics (B = 0.298) significantly influenced resilience capacity. These findings are discussed in the following section.

Discussions

H1: Access to Basic Services and Resilience Capacity

The finding that access to basic services has a significant positive effect on household resilience capacity (B = 0.512, $p < 0.001$) confirms the theoretical expectation derived from the RIMA framework. Access to basic services emerged as the strongest positive contributor to resilience capacity, consistent with empirical evidence from Bangladesh and Northern Ethiopia (Asfaw, 2026; Tasnim et al., 2025) [2].

What is theoretically novel about this finding is not the direction of the relationship but the function that basic service access performs in a chronic pollution context. In episodic shock contexts such as droughts or floods, access to basic services primarily enables households to recover after the shock has passed. In the oil pollution context of Delta State, however, contamination of water sources and degradation of air quality are continuous rather than episodic. Access to potable water, sanitation facilities, and healthcare services therefore functions not as a recovery mechanism but as a continuous buffer against ongoing harm (Obida et al., 2021). This distinction matters theoretically because it suggests that the protective value of basic service access is not contingent on the shock-recovery sequence assumed in conventional resilience frameworks. Households with reliable access to clean water and healthcare can maintain basic functioning even when environmental conditions remain degraded, whereas households without such access experience cumulative health deterioration that erodes their capacity to pursue any livelihood strategy. The finding supports the Sustainable Livelihoods Approach, which identifies access to basic services as a fundamental dimension of household welfare and a prerequisite for

pursuing sustainable livelihood strategies (DFID, 1999), but it also suggests that in chronic pollution contexts, basic service access operates as a precondition for resilience rather than merely a contributor to it. This interpretation aligns with evidence that oil pollution in the Niger Delta has exposed over one million people to environmental health risks, making basic service access not simply beneficial but essential for survival (Obida et al., 2021).

H2: Assets and Resilience Capacity

The finding that assets have a significant negative effect on household resilience capacity ($B = -0.184$, $p < 0.001$) is counterintuitive from a conventional resilience perspective. The Northern Ethiopia study similarly found that assets were negatively associated with resilience (Asfaw, 2026) [2], and the Bangladesh study found that livestock assets had a negative impact due to market volatility and disease outbreaks (Tasnim et al., 2025). In oil-polluted communities of Delta State, natural capital such as farmland, fishing equipment, and mangrove resources has been systematically destroyed or devalued through pollution (O'Farrell et al., 2025). Households with higher asset holdings may be those with greater sunk investments in now-degraded natural capital, making them more vulnerable rather than more resilient.

Three alternative explanations for this negative association must be considered before accepting the sunk investment interpretation. First, reverse causality may be present: households that are less resilient may be forced to accumulate assets as a coping strategy, particularly if assets serve as stores of value in the absence of formal financial institutions. If this is the case, the negative association reflects the direction of causality from resilience to assets rather than from assets to resilience. Second, measurement issues may affect the finding: asset indicators developed for general RIMA applications may not adequately capture the types of assets that support resilience in oil-polluted communities. For example, land ownership may be a liability rather than an asset if the land is contaminated, but standard asset indices treat land as a positive holding. Third, omitted variable bias may be present: households with more assets may also have characteristics that independently reduce resilience, such as greater exposure to pollution or stronger ties to traditional livelihoods that have been disrupted. Because the study estimates conditional associations rather than causal effects, these alternative explanations cannot be ruled out. The negative association between assets and resilience should therefore be interpreted as a conditional association that is consistent with the sunk investment interpretation but not uniquely explained by it. Future research employing longitudinal designs and asset-specific measures could distinguish between these explanations. The finding nevertheless challenges the assumption embedded in RIMA that assets invariably contribute positively to resilience and supports the need for context-specific adaptation of the framework, as argued by Asfaw (2026) [2] and Tasnim et al. (2025).

H3: Social Safety Nets and Resilience Capacity

The finding that social safety nets have a significant positive effect on household resilience capacity ($B = 0.364$, $p < 0.001$) confirms the theoretical expectation derived from the RIMA framework and aligns with evidence from the Niger Delta. Jack and Zibima (2018) found that local institutions function as safety nets and sources of local insurance in the Delta, with membership in local institutions having a significant positive effect on household adaptive capacity. In the absence of formal insurance and adequate government support, informal networks and community-based institutions provide critical assistance during periods of environmental and economic stress. Social safety nets enable households to access resources, information, and support that help them cope with the effects of oil pollution, including informal credit, remittances, and community support networks. The finding underscores the importance of social capital as a resilience resource and suggests that interventions aimed at strengthening community institutions and informal support systems may be effective in enhancing household resilience in oil-polluted communities. Unlike assets and adaptive capacity, social safety nets appear to function positively regardless of the chronic nature of the stressor, suggesting that social capital is less vulnerable to the devaluation processes that affect natural capital and less likely to become maladaptive than adaptation strategies.

H4: Adaptive Capacity and Resilience Capacity

The finding that adaptive capacity has a significant negative effect on household resilience capacity ($B = -0.228$, $p < 0.001$) provides empirical support for the livelihood dysfunction trap and the adaptive capacity paradox. This result is consistent with the Northern Ethiopia finding that adaptive capacity (-1.45) was negatively associated with resilience (Asfaw, 2026) [2] and with the theoretical logic that adaptation in chronic pollution contexts frequently takes maladaptive forms.

The conditions under which adaptive capacity becomes maladaptive require specification. Adaptive capacity does not inevitably undermine resilience. It becomes maladaptive when three conditions converge: first, when the stressor is chronic and irreversible, so that adaptation cannot restore the pre-shock livelihood base; second, when adaptation options are constrained to activities that intensify the stressor; and third, when the returns to adaptation are short-term while the costs are long-term. In oil-polluted communities of Delta State, these conditions converge around artisanal crude oil refining (kpo-fire). Pollution destroys farming and fishing, pushing households to adapt by entering kpo-fire, which generates income but intensifies pollution and deepens the livelihood dysfunction trap (Jack, 2025). Households with high adaptive capacity scores are those most deeply engaged in this maladaptive pathway, producing a negative association with resilience. The mechanism is self-reinforcing: kpo-fire temporarily sustains the household but further degrades the environment and forecloses the possibility of returning to traditional livelihoods (Jack, 2025).

However, not all adaptation pathways are maladaptive. Households that adapt through sustainable aquaculture, petty trading, or non-farm employment may enhance their resilience without intensifying pollution. The negative association observed in this study reflects the composition of adaptation strategies in the sample, where kpo-fire is a prominent pathway. The theoretical implication is that adaptive capacity is not intrinsically positive or negative but contingent on the direction of adaptation. This refines the adaptive capacity paradox by specifying that the paradox arises when adaptation options are structurally constrained to maladaptive pathways, as they are in oil-polluted

communities where traditional livelihoods have been destroyed and alternative opportunities are limited (Jack, 2025; Zibima et al., 2025). The finding challenges the assumption that adaptive capacity invariably enhances resilience and demonstrates that in chronic pollution contexts, the capacity to adapt may operate as a marker of entrapment rather than a pathway to resilience.

H5: Socioeconomic and Demographic Characteristics and Resilience Capacity

The finding that socioeconomic and demographic characteristics have a significant effect on household resilience capacity (B = 0.298, $p < 0.001$) confirms the theoretical expectation derived from the Sustainable Livelihoods Approach and aligns with empirical evidence from Nigeria. A study of flood disaster resilience in Nigeria found that socioeconomic factors ($\beta = 0.529$) had the strongest positive effect on household resilience (Akarara, 2026) [1]. In oil-polluted communities, education, household size, and income diversity significantly influence resilience capacity. Education enhances household capacity to access information, diversify livelihoods, and make informed decisions about adaptation strategies. Household size affects both labour availability and consumption pressure, with larger households potentially having greater capacity for livelihood diversification but also greater needs. Gender was also significant, with female-headed households exhibiting lower resilience capacity, reflecting the disproportionate burden women bear in oil-polluted communities and the constraints imposed by gender norms, power dynamics, and social structures (Zibima et al., 2025). The finding underscores the importance of targeting vulnerable groups, particularly female-headed households, in interventions aimed at enhancing resilience.

Conclusion

This study examined the socioeconomic and demographic determinants of household resilience capacity in oil-polluted communities of Delta State, Nigeria, using the RIMA framework and structural equation modelling. The findings show that access to basic services (B = 0.512) and social safety nets (B = 0.364) positively influence resilience capacity, while assets (B = −0.184) and adaptive capacity (B = −0.228) exhibit negative associations. Socioeconomic characteristics (B = 0.298) significantly influence resilience capacity.

The negative association between adaptive capacity and resilience supports the livelihood dysfunction trap, demonstrating that adaptation in chronic pollution contexts frequently takes maladaptive forms such as artisanal refining, which generates income but intensifies pollution and deepens entrapment (Jack, 2025). The conditions under which this occurs are specified: adaptive capacity becomes maladaptive when the stressor is chronic and irreversible, adaptation options are constrained to activities that intensify the stressor, and the returns to adaptation are short-term while the costs are long-term. The negative association between assets and resilience is consistent with the sunk investment interpretation but may also reflect reverse causality, measurement issues, or omitted variable bias. These alternative explanations cannot be ruled out given the cross-sectional design, and the finding should be interpreted as a conditional association.

The findings extend RIMA to a novel stressor context and refine understanding of the conditions under which adaptive capacity and assets may not enhance resilience. The study demonstrates that the four-pillar structure operates differently under chronic pollution than under episodic climate shocks, and that context-specific adaptation of the framework is necessary.

Theoretical Implications

The findings make three contributions to resilience theory. First, they extend the RIMA framework to a novel stressor context, demonstrating that the four-pillar structure operates differently under chronic, cumulative, and institutionally embedded oil pollution than under episodic climate shocks (FAO, 2016). The negative associations between assets, adaptive capacity, and resilience challenge the assumption embedded in RIMA that all four pillars invariably contribute positively to resilience capacity. This suggests that the four-pillar structure requires contextual adaptation in chronic pollution settings, where irreversible natural capital degradation alters the relationship between pillar endowments and resilience outcomes.

Second, the findings refine the adaptive capacity paradox by specifying the conditions under which adaptation becomes maladaptive. The livelihood dysfunction trap explains why households with high adaptive capacity scores are those most deeply engaged in maladaptive pathways such as artisanal refining, which generates income but intensifies pollution and forecloses return to traditional livelihoods (Jack, 2025). This advances resilience theory by distinguishing between adaptive capacity as a general capability and maladaptive adaptation as a distinct dimension that undermines resilience. The finding provides empirical support for the theoretical proposition that adaptive capacity may operate as a marker of entrapment rather than a pathway to resilience in contexts of chronic environmental degradation. The specification of conditions under which adaptation becomes maladaptive addresses a gap in the resilience literature, which has generally assumed that adaptive capacity is positively associated with resilience without specifying the boundary conditions of this relationship.

Third, the findings contribute to the Sustainable Livelihoods Approach by demonstrating that asset-based resilience is largely ineffective in contexts of irreversible natural capital degradation. Households with higher asset holdings may be those with greater sunk investments in now-degraded natural capital, making them more vulnerable rather than more resilient. This refines the theoretical understanding of how capital assets function under conditions of chronic pollution, where traditional asset-based resilience mechanisms are systematically undermined. The finding suggests that the Sustainable Livelihoods Approach requires modification in contexts where natural capital degradation is irreversible, as the asset base that traditionally supports livelihoods may become a liability rather than a resource.

Policy Implications

Four policy implications follow from the findings. First, strengthening access to basic services should be a priority in oil-polluted communities, given its strongest positive contribution to resilience capacity (Obida et al., 2021). This includes investment in water treatment infrastructure, healthcare delivery, and sanitation facilities. Given that

basic service access appears to function as a precondition for resilience in chronic pollution contexts, these investments should be treated as urgent rather than optional.

Second, policymakers should address the root causes of maladaptive adaptation by providing alternative livelihood opportunities that do not intensify environmental degradation (Jack, 2025). This requires identifying households engaged in artisanal refining and providing them with viable alternatives. Identification can be achieved through community-based targeting, using local knowledge and existing institutional structures. Alternative livelihood opportunities should include sustainable aquaculture, agro-processing, renewable energy enterprises, and skills training programmes that enable households to transition away from kpo-fire. Interventions should be designed with the recognition that households enter artisanal refining not by choice but by constraint, and that alternatives must be economically viable to be adopted.

Third, interventions should target female-headed households, who exhibit lower resilience capacity due to gender norms and power dynamics (Zibima et al., 2025). This includes providing access to credit, land rights, and extension services tailored to the needs of women. Given that women in oil-polluted communities bear a disproportionate burden of environmental degradation and face additional constraints on their survival strategies, targeted interventions are necessary to address the structural inequalities that reduce their resilience capacity.

Fourth, integrating RIMA-based assessments into policy and programming would enable evidence-based targeting of resources. The RCI provides a practical tool for identifying households with low resilience capacity and for monitoring the effectiveness of interventions over time. Policymakers and development practitioners should adopt RIMA-based assessments as part of routine monitoring and evaluation in oil-polluted communities.

Limitations and Future Research

This study has several limitations. First, the cross-sectional design limits causal identification, and the findings should be interpreted as conditional associations. The findings most vulnerable to reverse causality involve assets and adaptive capacity, as less resilient households may accumulate assets or be forced to adapt, producing negative associations even if these factors do not reduce resilience. Longitudinal designs would help distinguish between these directions of causality.

Second, self-reported data may be subject to recall and social desirability bias, particularly for artisanal refining and income. Respondents may underreport participation in artisanal refining because it is illegal and underreport income due to taxation or community expectations. These biases would likely attenuate the observed associations, making the negative findings conservative estimates.

Third, the findings may not be generalisable to other extractive contexts. The findings most context-dependent involve adaptive capacity and assets, as these depend on the specific configuration of pollution, livelihood options, and institutional support in Delta State.

Fourth, the study did not distinguish between different adaptation pathways. The negative association between adaptive capacity and resilience reflects the composition of adaptation strategies in the sample, where kpo-fire is prominent. Future research should disaggregate adaptation pathways to examine whether non-maladaptive strategies exhibit positive associations with resilience. Qualitative research could provide deeper insights into the mechanisms of maladaptive adaptation.

Fifth, intervention research could test whether programmes strengthening access to basic services and social safety nets, while addressing maladaptive adaptation, enhance resilience capacity in oil-polluted communities. Such research would provide evidence on the effectiveness of the policy implications proposed above.

Transparency, Data Availability and Funding

The study was conducted in accordance with institutional guidelines for research involving human participants. Informed consent was obtained from all respondents, and confidentiality and anonymity were assured. The data that support the findings of this study are available from the corresponding author upon reasonable request. The study received no specific grant from any funding agency in the public, commercial, or not for profit sectors.

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