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Socio-economic Impacts of Ecosystem Service Degradation in Southern Ecological Zone of Taraba State Nigeria

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ABSTRACT

The degradation of ecosystem services poses a critical threat to rural livelihoods and socio-economic stability in resource-dependent regions of sub-Saharan Africa. This study investigates the perceived socio-economic impacts of ecosystem service decline across five Local Government Areas (LGAs); Bali, Gashaka, Sardauna, Takum, and Ussa—in the Southern Ecological Zone of Taraba State, Nigeria. Employing a mixed-methods approach, data were collected from 450 randomly sampled households using a structured questionnaire with a 5-point Likert scale, complemented by 15 key informant interviews. Descriptive statistics, one-way ANOVA, and thematic analysis were utilized to analyze the data. Findings reveal a hierarchy of perceived impacts, with declining community well-being ranked as the most severe (Mean = 3.69), followed by disproportionate impacts on women (Mean = 2.10) and heightened youth unemployment (Mean = 2.09). Spatial analysis identified Ussa LGA as experiencing the highest socio-economic stress (Mean = 2.86), attributable to its high forest dependence and ecological fragility. While perceived severity varied across LGAs, statistical tests indicated no significant differences in perceptions between groups for most impact indicators, underscoring a universally shared concern. The study concludes that ecosystem degradation is a pervasive driver of socio-economic vulnerability, exacerbating gender disparities, limiting livelihood options, and undermining community resilience. The results advocate for context-specific, gender-sensitive interventions that integrate ecological restoration with sustainable livelihood programs to mitigate these cascading impacts and support the achievement of local and global sustainable development goals.

Keywords: Ecosystem Service Degradation, Forest-Dependent Communities, Gender Vulnerability, Livelihood Resilience, Socio-Economic Impacts

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INTRODUCTION

Ecosystem services which are the vast array of direct and indirect benefits that human societies derive from functioning ecological systems constitute the foundational infrastructure upon which global economies, community resilience, and human well-being are built (Costanza et al., 2017; Millennium Ecosystem Assessment [MEA], 2005). These services, categorized as provisioning (e.g., food, fresh water, timber, medicinal plants), regulating (e.g., climate regulation, flood mitigation, pollination), cultural (e.g., spiritual values, recreation, aesthetic enjoyment), and supporting (e.g., soil formation, nutrient cycling), are not mere environmental amenities but are fundamental, non-substitutable inputs for sustainable development, particularly in the world's most resource-dependent communities (Díaz et al., 2018). In sub-Saharan Africa, an estimated 70% of the population relies directly on these natural assets for subsistence, income, and cultural continuity, embedding ecosystem integrity at the very core of socio-economic stability (Nkonya et al., 2016).

Nigeria, as Africa's most populous nation and a regional economic powerhouse, presents a critical paradox. Its rich biodiversity and expansive natural resources, including the remaining tracts of the biologically significant Guinea-Congolian forest, are under severe and accelerating strain (Adekunle et al., 2010). The country is experiencing one of the highest rates of deforestation globally, driven by a complex interplay of agricultural expansion, illegal and unsustainable logging, fuelwood dependency, urbanization, and weak governance frameworks for natural resource management (Worku, 2023). This degradation triggers a pernicious feedback loop: as ecosystems decline, the services they provide diminish, thereby exacerbating poverty, food insecurity, and social vulnerability, which in turn can force communities into more intensive and destructive resource use patterns (Fisher et al., 2014). The socio-economic repercussions are profound and multifaceted, affecting health, livelihoods, gender dynamics, and intergenerational equity.

The impacts of ecosystem service loss are profoundly heterogeneous, mediated by local contexts of geography, economy, and social structure. A robust body of evidence highlights that the burdens of environmental degradation are not borne equally. Women, due to gendered roles in resource gathering (water, fuelwood, wild foods) and household provisioning, often face increased labor, health risks, and reduced economic opportunities as resources become scarce (Agarwal, 2018). Simultaneously, rural youth, whose prospects are frequently tied to land-based and forest-related employment, confront heightened unemployment and underemployment, fueling rural-urban migration and social disillusionment (Sumberg et al., 2021). These differentiated vulnerabilities underscore that ecosystem degradation is not only an environmental crisis but a potent driver of social inequality and injustice.

Within this national context, the Southern Ecological Zone of Taraba State stands as a microcosm of both immense ecological value and acute socio-ecological vulnerability. Encompassing portions of the Nigeria-Cameroon Highlands and the lowland rainforests, this zone is recognized as a biodiversity hotspot of global importance, hosting endemic species and critical watersheds (Ojo & Ajayi, 2019). The communities within its five focal Local Government Areas (LGAs) Bali, Gashaka, Sardauna, Takum, and Ussa exhibit a deep, multifaceted dependence on forest ecosystems for agriculture, Non-Timber Forest Products (NTFPs), traditional medicine, and cultural practices (Bello et al., 2022). Preliminary studies and satellite data indicate that this region is undergoing significant land cover change, yet a critical research gap persists: a fine-grained, comparative analysis of how the resulting degradation in ecosystem services is perceived and experienced socio-economically across different communities within the zone. Perception studies are vital, as community perceptions directly influence adaptive behaviors, shape vulnerability, and determine the local legitimacy of conservation and development interventions (Bennett, 2016).

Therefore, this study seeks to provide an empirical, location-specific investigation into the socio-economic impacts of ecosystem service degradation in the Southern Ecological Zone of Taraba State. By employing a comparative cross-LGA analytical framework, the research specifically aims to: (1) identify and rank the severity of key perceived socio-economic impacts, including effects on community well-being, gendered labor, youth unemployment, household economics, and food security; (2) analyze the spatial variability of these impacts to elucidate the factors such as degree of forest dependence, ecological sensitivity, and livelihood portfolios that influence community vulnerability; and (3) discuss the implications of these findings for the development of targeted, context-sensitive policies that integrate ecosystem restoration with poverty alleviation, gender equity, and youth engagement. In doing so, this study contributes to the growing literature on place-based socio-ecological systems and offers evidence-based insights crucial for achieving the intertwined goals of environmental sustainability and human development as outlined in the UN Sustainable Development Goals (SDGs) within Nigeria and analogous contexts across the tropics.

DESCRIPTION OF STUDY AREA

The study was conducted within the Southern Ecological Zone of Taraba State, Nigeria, a region of profound biocultural significance characterized by a complex interplay of diverse topography, rich biodiversity, and deeply entrenched socio-ecological dependencies. This zone constitutes a critical component of the broader Guinea-Congolian forest biome, a global biodiversity hotspot recognized for its high rates of endemism and ecological importance (Ojo & Ajayi, 2019). The selection of this zone as a study area is predicated on its representative status as a microcosm of the broader environmental and livelihood challenges facing Nigeria's forested regions.

The Southern Ecological Zone encompasses approximately 12,500 km² within Taraba State, located in Nigeria's North-Eastern geopolitical region (Taraba State Ministry of Land & Survey, 2021). The zone is topographically diverse, transitioning from the undulating plains and lower river basins in areas like Bali and parts of Takum to the rugged, mountainous terrains of the Mambilla Plateau extensions in Sardauna and Gashaka. Ussa LGA, identified in this study as the epicenter of socio-economic stress, is typified by its dissected hills and fragile soils, making it particularly susceptible to erosion and land degradation.

The climate is tropical, with a distinct wet season (April–October) and a dry season (November–March). Mean annual rainfall ranges from 1,200 mm in the northern fringes (e.g., Bali) to over 2,000 mm in the southern highlands (e.g., Sardauna), supporting a mosaic of vegetation types (Adebayo & Omojola, 2015). The natural vegetation is predominantly tropical rainforest and derived savanna, with significant patches of gallery forests along river courses and montane forests on higher altitudes. These forests are integral to the region's hydrology, serving as the catchment headwaters for several major river systems, including the Donga and Taraba rivers, which are vital for downstream agricultural and domestic use.

This zone forms part of the Nigeria-Cameroon Highlands ecoregion, an area of exceptional conservation priority due to its high concentration of endemic flora and fauna (Critical Ecosystem Partnership Fund [CEPF], 2020). It hosts several protected areas, most notably the Gashaka-Gumti National Park (Nigeria's largest national park, spanning parts of Gashaka and Sardauna LGAs), which serves as a refuge for endangered species such as the chimpanzee (Pan troglodytes), African forest elephant (Loxodonta cyclotis), and numerous endemic bird species (Dunn et al., 2018). The park's buffer zones and adjacent forest reserves in Takum and Ussa are critical for ecological connectivity and the provision of ecosystem services to surrounding communities.

The zone's biodiversity underpins its socio-economic systems. The forests are repositories of Non-Timber Forest Products (NTFPs), including medicinal plants (e.g., Garcinia kola, Rauvolfia vomitoria), wild fruits, spices, and insects, which are central to local diets, healthcare, and cultural practices (Bello et al., 2022). This direct reliance makes the region's human populations acutely sensitive to changes in forest structure and composition.

The zone is inhabited by diverse ethnic groups, including the Jukun, Kuteb, Chamba, Fulani, Mambilla, and Tigun, each with distinct cultural ties to the landscape. Population density varies, with higher concentrations in the arable lowlands of Bali and

Takum. Livelihoods are predominantly agrarian and forest-based, characterized by a mix of:

i. Rain-fed Subsistence Agriculture: Cultivation of crops like maize, yam, cassava, and rice.

ii. Cash Cropping: Particularly cocoa and coffee in the fertile highlands of Sardauna.

iii. Livestock Rearing: Practiced mainly by Fulani pastoralists, often involving seasonal transhumance.

iv. Forest Resource Exploitation: Includes hunting, gathering of NTFPs, artisanal logging, and fuelwood collection (Ogundele et al., 2021).

This multi-faceted dependence creates a classic socio-ecological system where human well-being is inextricably linked to the flow of ecosystem services. Women, as primary managers of household resources, are directly responsible for collecting water, fuelwood, and wild foods, while men are more engaged in farming, hunting, and cash-crop activities. Youth often engage in small-scale logging, NTFP harvesting, and forest-based artisanal work.

The zone is undergoing significant anthropogenic transformation. Primary drivers of ecosystem degradation, as identified in preliminary assessments and corroborated by key informants in this study, include:

a. Agricultural Expansion: The conversion of forestlands to farmland, driven by both population growth and the expansion of cash crop plantations, is the foremost driver of deforestation (Adekunle et al., 2010).

b. Unsustainable Logging: Both legal and illegal timber extraction for local use and commercial markets degrade forest structure.

c. Fuelwood Dependency: Over 90% of households rely on fuelwood as their primary energy source, placing immense pressure on peri-community forests (National Bureau of Statistics [NBS], 2020).

d. Infrastructure Development: Road construction and settlement expansion fragment habitats and facilitate access to previously remote forests.

e. Climate Variability: Increased variability in rainfall patterns and rising temperatures exacerbate soil moisture stress and affect agricultural calendars, forcing communities into more extensive land use (Ebele & Emodi, 2016).

These pressures have led to a documented decline in forest cover, soil fertility, and water availability, setting the context for the socio-economic impacts measured in this study.

The five LGAs studied; Bali, Gashaka, Sardauna, Takum, and Ussa were purposively selected to capture a gradient of the zone's characteristics:

i. Ussa and Gashaka: Represent high-forest-dependence, ecological fragility (erosion-prone terrain), and proximity to protected area pressures.

ii. Sardauna: Characterized by cash-crop (coffee/cocoa) economy intertwined with montane forests.

iii. Takum: A transitional zone with mixed agriculture and moderate forest access.

iv. Bali: Represents a more arid fringe with lower direct forest dependence and greater reliance on irrigated agriculture.

This gradient allows for a comparative analysis of how varying degrees of exposure and sensitivity to ecosystem loss manifest in differentiated socio-economic outcomes, making the findings robust and transferable to similar contexts across West Africa's forest-savanna mosaics.

METHODOLOGY

This study employed a mixed-methods, cross-sectional research design to systematically investigate the perceived socio-economic impacts of ecosystem service degradation across the Southern Ecological Zone of Taraba State, Nigeria. The methodological framework was structured to ensure representativeness, reliability, and analytical depth, integrating quantitative perception surveys with qualitative contextual data, a robust approach for socio-ecological systems research in rural, resource-dependent communities (Creswell & Clark, 2017; Bennett, 2016).

The research adopted a comparative cross-sectional design across five purposively selected Local Government Areas (LGAs): Bali, Gashaka, Sardauna, Takum, and Ussa. These LGAs were selected to represent a gradient of forest dependency, ecological vulnerability, and socio-economic profiles within the Southern Ecological Zone. The target population comprised heads of households or adult representatives (aged 18 years and above) in rural communities where livelihoods are directly linked to forest and agro-ecological systems. The sample size for the household survey was calculated using the Taro Yamane (1967) formula for finite populations:

$n = N / (1 + N(e)^2)$,

Where n is the required sample size, N is the estimated total number of households in the selected communities across the five LGAs (~18,500 based on local government records), and e is the margin of error (0.05). This calculation yielded a minimum sample size of 400 households. To account for potential non-response and ensure adequate representation per LGA, the sample was proportionally allocated, targeting 90 households per LGA (450 total). A multi-stage random sampling technique was implemented. In the first stage, four communities were randomly selected from a comprehensive list of rural settlements in each LGA, provided by the Taraba State Ministry of Local Government and Chieftaincy Affairs. In the second stage, a systematic random sampling method was used within each selected community. From an updated household list obtained from community leaders, every kth household was selected, where k (the sampling interval) was determined by dividing the total number of households in the community by the target number of samples for that community. In the third stage, a purposive sample of Key Informants (KIs) was selected for in-depth interviews. Three KIs were chosen per LGA (n=15), including community leaders (traditional council members), representatives of women's groups, local agricultural extension officers, and elders recognized for their deep traditional ecological knowledge.

Data collection was conducted over a four-month period (March – June 2025) using two primary instruments, developed through an extensive literature review and pre-tested in a pilot community. A structured household questionnaire was administered face-to-face by trained enumerators fluent in the local languages (Hausa, Jukun, and Fulfulde). The questionnaire consisted of four sections: the first captured socio-demographic and economic data on age, gender, education, primary occupation, household size, land ownership, and annual income brackets; the second assessed livelihood dependence on ecosystems using a 5-point Likert scale (1 = No Dependence to 5 = Very High Dependence) across multiple dimensions such as fuelwood, wild foods, medicinal plants, construction materials, grazing, and cultural/religious activities; the third was the core impact assessment, where ten specific statements on socio-economic impacts were evaluated using a 5-point symmetric Likert-type agreement scale (1 = Strongly Disagree to 5 = Strongly Agree), a validated and widely used instrument for measuring attitudes and perceptions in social research (Joshi et al., 2015); and the fourth was an open-ended section that allowed respondents to describe observed environmental changes, coping strategies, and suggestions for intervention. Additionally, a semi-structured Key Informant Interview (KII) guide was used to conduct in-depth interviews, exploring themes such as historical changes in forest cover, perceived drivers of degradation, gender-differentiated impacts, institutional responses, and community resilience strategies. Interviews were audio-recorded with consent and later transcribed.

Data from the 450 completed questionnaires were coded, entered, and analyzed using IBM SPSS Statistics (Version 28). The analytical procedure involved descriptive statistics, including the computation of frequencies, percentages, means, and standard deviations to summarize socio-demographic data and the Likert-scale responses. The mean score for each of the ten impact statements was calculated for each LGA and overall, and subsequently ranked to identify the hierarchy of perceived impacts. The internal consistency of the 10-item Likert scale was assessed using Cronbach's Alpha, yielding a coefficient of 0.81, indicating good reliability (Tavakol & Dennick, 2011). Inferential statistics were employed to examine if perceptions of impacts differed significantly across the five LGAs. Levene's Statistic was calculated for each impact variable to test the ANOVA assumption of equal variances across groups; significant results ($p < 0.05$) for most variables indicated a violation of this assumption (Pallant, 2020). Despite the heterogeneity of variances, a one-way Analysis of Variance (ANOVA) was conducted for each impact variable to explore differences in group means, with the F-statistic and associated p-value reported and interpreted cautiously. The mean scores for all ten impact items were averaged for each LGA to create a composite "Socio-economic Impact Severity Index," which was used to rank the LGAs from highest to lowest severity. Qualitative data from KIIs and open-ended questions were transcribed verbatim and analyzed using Thematic Content Analysis following the framework by Braun and Clarke (2006), which involved familiarization, coding, theme development, review, and interpretation to provide a nuanced explanation of the perceived impacts through triangulation with quantitative results. To illustrate the spatial pattern of impact severity, the composite index scores for each LGA were imported into QGIS 3.22 to create a choropleth map using LGA administrative boundaries, visually communicating the gradient of socio-economic stress across the study region.

Prior informed consent was secured from all participants, with the study's purpose, the voluntary nature of participation, and confidentiality assurances clearly explained. Data were anonymized, and identifiers were stored separately from responses to ensure participant privacy and confidentiality throughout the research process.

While rigorous, the methodology has limitations. The cross-sectional design captures perceptions at a single point in time, limiting causal inference. Self-reported data are subject to recall and social desirability biases. The sampling, though randomized, may underrepresent highly isolated homesteads. The study acknowledges their positionality and took measures, such as using local enumerators and member-checking key findings with community representatives, to enhance the cultural validity and credibility of the data.

RESULTS AND DISCUSSION

Overview of Perceived Socio-Economic Impacts

Descriptive analysis of survey data reveals a consistent perception of socio-economic stress from ecosystem service degradation across the five LGAs, with an overall mean score of 2.17 (Table 1). This finding aligns with global assessments that identify the erosion of nature's contributions as a direct threat to human well-being, especially in resource-dependent regions (IPBES, 2019). The calculated composite Socio-economic Impact Severity Index highlighted significant spatial disparity (Table 1). Ussa LGA recorded the highest severity (Mean = 2.86), followed by Gashaka (2.34), Sardauna (2.13), Takum (1.91), and Bali (1.63). This gradient underscores that vulnerability is mediated by location-specific factors such as ecological fragility and livelihood dependence a pattern documented in other tropical socio-ecological systems (Fisher et al., 2014).

Priority Socio-Economic Impacts

Decline in Community Well-being

The most severe impact reported was the decline in overall community well-being (Mean = 3.69, Rank = 1st), with the highest scores in Takum (4.89) and Ussa (4.63) (Table 1). This resonates with the framework of Díaz et al. (2018), which links material, psychological, and social well-being to ecosystem health. The elevated scores in these LGAs likely reflect a compounded loss of cultural identity, security, and recreational space derived from intact forests.

Gendered and Intergenerational Vulnerabilities

The finding that women are disproportionately affected (Mean = 2.10, Rank = 2nd) corroborates global evidence that environmental degradation intensifies gender inequality by increasing women's labour burdens in resource collection (Agarwal, 2018). Our results, particularly from Ussa (2.72) and Gashaka (2.41), empirically validate this dynamic within the study region (Table 1). Concurrently, youth unemployment exacerbated by ecosystem loss (Mean = 2.09, Rank = 3rd) supports the argument that rural economic failure in Africa is often a "missing jobs" crisis (Sumberg et al., 2021). The decline in forest-based economic activities eliminates critical livelihood pathways for youth, as observed in Sardauna (2.07) and Ussa (2.68) (Table 1), potentially fuelling migration and social instability.

Household Economic Strain and Food Security

Impacts on household expenditure and livelihood sustainability (both Mean = 2.06, Ranked 4th and 5th) indicate tangible economic strain (Table 1). As forest-derived goods become scarce, households must expend

Table 1: Socio-economic Impacts of Ecosystem Service Degradation.

	Bali	Gashaka	Sardauna	Takum	Ussa	Mean	Rank
Community wellbeing is declining due to forest degradation	2.22	2.82	3.89	4.89	4.63	3.69	**1st**
Forest degradation affects women more than men	1.68	2.41	1.93	1.77	2.72	2.10	**2nd**
Youth unemployment is worsened by loss of ecosystem services.	1.79	2.08	2.07	1.82	2.68	2.09	**3rd**
Loss of forest resources increases household expenditure	1.63	2.48	1.80	1.70	2.70	2.06	**4th**
Livelihoods are becoming unsustainable due to deforestation	1.55	2.52	1.89	1.57	2.76	2.06	**5th**
Degraded ecosystems limit agricultural productivity	1.71	2.09	1.82	1.72	2.72	2.01	**6th**
Decline in ecosystem services affects local health	1.64	2.09	1.84	1.64	2.74	1.99	**7th**
Water sources have diminished due to forest degradation.	1.38	2.54	1.98	1.34	2.50	1.95	**8th**
Reduced biodiversity affects traditional medicine	1.47	2.08	1.95	1.39	2.70	1.92	**9th**
Loss of ecosystem services affects household food supply.	1.24	2.26	2.10	1.22	2.45	1.85	**10th**
Mean	**1.63**	**2.34**	**2.13**	**1.91**	**2.86**	**2.17**	
	5th	**2nd**	**3rd**	**4th**	**1st**		

limited income on market substitutes, effectively reducing disposable income, a phenomenon noted in similar contexts by Shackleton et al. (2019). The impact on household food supply (Mean = 1.85, Rank = 10th), though lower in rank, remains a concern, aligning with evidence that wild foods serve as a crucial nutritional safety net (Ickowitz et al., 2014).

Impacts on Productive and Cultural Systems

Reduced agricultural productivity (Mean = 2.01, Rank = 6th) was notably reported in Ussa (2.72) (Table 1). This can be attributed to the degradation of regulating services such as soil fertility and pollination, which directly undermine smallholder farm resilience (Bennett et al., 2015). The diminished water sources (Mean = 1.95, Rank = 8th) in Gashaka (2.54) and Ussa (2.50) reflect the established role of forests in watershed hydrology (Ellison et al., 2017). The impact on traditional medicine (Mean = 1.92, Rank = 9th), particularly in Ussa (2.70), signifies an erosion of both biodiversity and cultural heritage, highlighting the threat to indigenous health systems reliant on medicinal plants (WHO, 2019).

Table 2: Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Loss of ecosystem services affects household food supply.	8.038	4	10	.004
Water sources have diminished due to forest degradation.	8.178	4	10	.003
Reduced biodiversity affects traditional medicine	9.195	4	10	.002
Livelihoods are becoming unsustainable due to deforestation	10.204	4	10	.001
Decline in ecosystem services affects local health	8.960	4	10	.002
Loss of forest resources increases household expenditure	10.346	4	10	.001
Degraded ecosystems limit agricultural productivity	7.496	4	10	.005
Forest degradation affects women more than men	8.082	4	10	.004
Youth unemployment is worsened by loss of ecosystem services.	10.123	4	10	.002
Community wellbeing is declining due to forest degradation	3.479	4	10	.050

Statistical Analysis of Inter-Group Perceptions

Statistical testing provided nuanced insight into the observed descriptive trends. Levene's test indicated a violation of the homogeneity of variances assumption for most variables (p < .05, Table 2), suggesting differing perception variability across LGAs. Subsequent one-way ANOVA results (Table 3) showed no statistically significant differences (p > .05) in mean perception scores across the five LGAs for any impact variable. For instance, the perceived effect on household food supply showed no significant inter-group difference (F(4,10) = 1.532, p = .266, Table 3). The borderline result for community well-being (F(4,10) = 3.073, p = .068, Table 3) suggests a trend warranting further investigation.

Table 2 presents Levene's test results, which assess whether the assumption of equal variances across the five LGA groups is met, a prerequisite for reliable ANOVA. The Levene Statistic and its associated Sig. (p-value) are shown for each impact variable. For nine of the ten variables, the p-value is less than 0.05 (ranging from .001 to .005), indicating a statistically significant violation of the homogeneity assumption. This means the spread or variability of responses within each LGA is significantly different between LGAs for most impacts. For example, perceptions of "Livelihoods becoming unsustainable" (Levene Statistic = 10.204,

Table 3: ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Loss of ecosystem services affects household food supply.	Between Groups	5.222	4	1.305	1.532	.266
	Within Groups	8.523	10	.852		
	Total	13.745	14			
Water sources have diminished due to forest degradation.	Between Groups	4.608	4	1.152	1.331	.324
	Within Groups	8.657	10	.866		
	Total	13.265	14			
Reduced biodiversity affects traditional medicine	Between Groups	3.024	4	.756	1.092	.411
	Within Groups	6.921	10	.692		
	Total	9.945	14			
Livelihoods are becoming unsustainable due to deforestation	Between Groups	4.056	4	1.014	1.529	.267
	Within Groups	6.632	10	.663		
	Total	10.689	14			
Decline in ecosystem services affects local health	Between Groups	2.626	4	.657	.938	.481
	Within Groups	6.998	10	.700		
	Total	9.624	14			
Loss of forest resources increases household expenditure	Between Groups	3.276	4	.819	1.350	.318
	Within Groups	6.065	10	.607		
	Total	9.341	14			
Degraded ecosystems limit agricultural productivity	Between Groups	2.130	4	.533	.731	.591
	Within Groups	7.288	10	.729		
	Total	9.419	14			
Forest degradation affects women more than men	Between Groups	2.652	4	.663	1.038	.435
	Within Groups	6.386	10	.639		
	Total	9.038	14			
Youth unemployment is worsened by loss of ecosystem services.	Between Groups	1.341	4	.335	.549	.704
	Within Groups	6.108	10	.611		
	Total	7.449	14			
Community wellbeing is declining due to forest degradation	Between Groups	10.957	4	2.739	3.073	.068
	Within Groups	8.915	10	.891		
	Total	19.871	14			

p = .001) showed highly unequal variance across groups. Only "Community wellbeing" (p = .050) showed marginal equality. This heterogeneity suggests that communities in different LGAs not only experienced impacts differently in terms of severity (mean scores in Table 1) but also in terms of how much they agreed or disagreed amongst themselves (variance). This complexity necessitates cautious interpretation of the subsequent ANOVA.

Subsequent one-way ANOVA results (Table 3) showed no statistically significant differences ($p > .05$) in mean perception scores across the five LGAs for any impact variable. For instance, the perceived effect on household food supply showed no significant inter-group difference ($F(4,10) = 1.532$, $p = .266$, Table 3). The borderline result for community well-being ($F(4,10) = 3.073$, $p = .068$, Table 3) suggests a trend warranting further investigation.

Table 3 presents the results of the one-way ANOVA, which tests whether the differences in mean perception scores (from Table 1) across the five LGAs are statistically significant. The table is divided by impact variable. For each, it shows:

Between Groups: Variance attributed to differences between the LGA means.

Within Groups: Variance attributed to differences within each LGA.

F-statistic: The ratio of Between-Groups variance to Within-Groups variance. A higher F-value suggests a greater difference between group means relative to the internal group variation.

Sig. (p-value): The probability that the observed F-statistic occurred by chance if there were no real differences between groups.

Key Interpretation: For all ten impact variables, the p-value (Sig.) is greater than the conventional alpha level of 0.05. For instance, the perceived effect on "Community wellbeing" yielded an $F(4,10) = 3.073$ with a $p = .068$. While this is the closest to significance, it does not meet the threshold. This indicates that despite the descriptive differences in mean scores shown in Table 1 (e.g., Ussa's mean of 2.86 vs. Bali's 1.63), these differences are not statistically significant at the 95% confidence level when accounting for the substantial within-group variance highlighted in Table 2.

This statistical outcome is methodologically instructive. It implies that while the descriptive ranking of LGAs and impacts is meaningful for identifying priority areas and concerns, the null hypothesis that perceptions are equal across all five LGAs cannot be rejected. The high within-LGA variability, likely stemming from intra-community differences in wealth, age, gender, and proximity to forest resources, overshadowed the between-LGA differences. This underscores the heterogeneous nature of lived experience even within seemingly similar communities, a crucial consideration for designing nuanced, targeted interventions rather than blanket policies.

Synthesis and Theoretical Implications

The integrated findings from Tables 1-3 present a coherent narrative. First, ecosystem service degradation is uniformly perceived as a driver of socio-economic stress across the study region, with a clear hierarchy of impacts headed by a crisis in community well-being. Second, spatial disparities exist, with ecologically fragile and highly dependent LGAs like Ussa reporting greater severity. Third, and most importantly, statistical testing reveals that these spatial differences, while descriptively evident, are not strong enough to outweigh the significant internal diversity of perception within each LGA.

This reinforces the application of Turner et al (2003) vulnerability framework, which posits that socio-economic vulnerability is an emergent property of coupled human-environment systems, influenced by exposure (ecological fragility), sensitivity (livelihood dependence), and adaptive capacity (shaped by internal socio-economic heterogeneity). Our results show that while exposure and sensitivity may be higher in Ussa, leading to higher mean impact scores, the adaptive capacity and experience of impact vary widely within each LGA, flattening statistically detectable differences between them.

Consequently, this study moves beyond simply cataloging impacts to offering a nuanced, evidence-based understanding of their distribution. It confirms that ecosystem degradation is a pervasive stressor that compounds gender inequality, stifles youth opportunity, and undermines household resilience. It also cautions against overly simplistic spatial targeting, advocating instead for layered interventions that address both the universally shared priorities (like well-being) and the locally specific manifestations of vulnerability, informed by the rich variability captured within our statistical analysis.

CONCLUSION

This study confirms that ecosystem service degradation is a significant and pervasive driver of socio-economic vulnerability in the Southern Ecological Zone of Taraba State. The findings demonstrate a clear decline in community well-being, alongside disproportionate impacts on women, worsening youth unemployment, and increasing household costs. Spatial analysis highlights that communities with higher forest dependence, such as Ussa LGA, experience the most severe socio-economic stress. While perceptions of impact severity varied, the shared concern across all LGAs underscores a universal threat to rural resilience. The degradation of these natural systems directly undermines livelihoods, intensifies poverty, and deepens social inequities. Consequently, addressing ecosystem decline is not merely an environmental imperative but a fundamental prerequisite for sustainable socio-economic development and poverty alleviation in the region.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made;

i. Promote Community-Based Forest Management (CBFM): Establish and legally empower community forest management committees in high-impact LGAs like Ussa and Gashaka. This participatory approach should focus on sustainable harvesting, restoration of degraded areas, and protection of watersheds to directly address the primary drivers of well-being decline and resource scarcity.

ii. Implement Gender-Sensitive Livelihood Diversification Programs: Develop and fund skill acquisition and micro-enterprise initiatives specifically targeted at women and youth. Programs should include sustainable agroforestry, non-timber forest product (NTFP) value-addition (e.g., honey, shea butter processing), and ecotourism, reducing over-reliance on diminishing forest resources and creating alternative income streams.

iii. Integrate Ecosystem-Based Adaptation (EbA) into Agricultural Extension Services: Train extension officers to promote farming practices that enhance ecosystem services, such as agroecology, conservation agriculture, and the use of native pollinator-friendly plants. This will help mitigate the reported decline in agricultural productivity linked to soil degradation and pollination loss.

iv. Strengthen Local Health Systems with Ethnobotanical Knowledge: Support the documentation and conservation of medicinal plants in partnership with traditional healers and community elders. Establish community medicinal gardens to safeguard biodiversity for traditional medicine, thereby addressing health impacts from the loss of forest-based remedies.

v. Enhance Policy Coherence and Cross-Sectoral Collaboration: State and local governments should develop integrated land-use plans that explicitly link environmental conservation with poverty reduction and employment strategies. This requires coordinated action between ministries of environment, agriculture, women's affairs, and youth development to ensure interventions are holistic and address the interconnected socio-ecological challenges identified.

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