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Livelihood Transitions as Responses to Social-Ecological Stressors: Insights From the Central Coast of Viet Nam

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Abstract

This study examines how coastal households in Viet Nam's Central Coast adjust their livelihoods in response to multiple social–ecological stressors. Drawing on surveys of 540 households and 63 semi-structured interviews with local officials and households, the analysis highlights clear differences in livelihood transitions across household groups. Wage labor and service-oriented households demonstrate greater flexibility in reconfiguring income sources, whereas fishers, aquaculturists, and farmers remain more constrained, often persisting with vulnerable practices. Livelihood transitions are found to strengthen household economic resilience more effectively than ecological resilience, revealing an imbalance between short-term income security and long-term ecological sustainability. The findings underscore the need for policies that broaden access to alternatives beyond resource dependence while embedding ecological safeguards, ensuring that livelihood resilience and ecosystem stewardship progress in tandem.

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Introduction

Coastal areas are transitional zones where terrestrial and marine processes intersect (MEA, 2005; Prakash et al., 2021). These regions provide critical ecosystem services and support the livelihoods of millions of people, particularly in developing countries (Bennett, 2019; MEA, 2005; United Nations, 2017). Coastal households depend on diverse and interdependent resources such as agricultural land, fisheries, freshwater, and marine ecosystems to secure food and income (Bennett, 2019; Cinner & Bodin, 2010; Ferrol-Schulte et al., 2013; Kramer et al., 2017; Mills et al., 2017). However, these livelihoods have become increasingly vulnerable to multiple, interacting stressors arising from the close interlinkages between environmental change and socio-economic development (Barbier, 2015; Berkes, 2011; Berkes et al., 2002; Folke, 2007; Kramer et al., 2017; Räsänen et al., 2016).

Climate change amplifies exposure to hazards such as sea-level rise, storms, flooding, and coastal erosion, disrupting production activities and damaging essential assets (Boonstra & Hanh, 2014; Hossain et al., 2025; IPCC, 2022; Tarolli et al., 2023). Simultaneously, resource degradation, environmental pollution, and volatile seafood markets increase uncertainty for resource-dependent livelihoods (Belton & Little, 2008; Béné et al., 2016; Cinner et al., 2009; Crona et al., 2016; Ha & van Dijk, 2013; Tuyen et al., 2022). These cumulative pressures compel households to continually adjust how they make a living.

In response, many coastal households are reconfiguring their livelihood strategies, often shifting away from natural resource-based activities toward wage employment, services, or handicrafts (Idrobo & Johnson, 2020; Rahman & Begum, 2011). Such transitions can reduce vulnerability and improve well-being while potentially easing exploitation pressure and allowing natural resources to recover.

While the literature on coastal livelihood transitions has expanded, much of it focuses on responses to individual stressors such as climate change (Salgueiro-Otero et al., 2022), resource depletion (Idrobo & Johnson, 2020), globalization (Kramer et al., 2017), or natural disasters (Islam et al., 2021; Uddin et al., 2021). Few studies have investigated livelihood transitions as responses to a "bundle" of economic, social, and environmental stressors (Fabinyi et al., 2022). Moreover, existing analyses often emphasize socio-economic outcomes such as income recovery and improved living standards (Coulthard, 2008; Finkbeiner, 2015; Idrobo & Johnson, 2020) while paying limited attention to ecological outcomes. This is a critical gap, as some livelihood transitions that improve income may inadvertently accelerate environmental degradation (Baker et al., 2004; Folke et al., 2003; Giri et al., 2022). Addressing this gap requires assessing livelihood transitions through both economic and ecological lenses.

The Central Coast of Vietnam provides a compelling context for exploring these issues. The region is highly exposed to storms, floods, and other extreme climate events (Ngo-Duc, 2014; World Bank, 2010), while simultaneously undergoing rapid socio-economic restructuring (Kinghan & Newman, 2017; Newman & Kinghan, 2015). The expansion of industrial manufacturing, export-oriented aquaculture and agriculture, and urbanization is creating new livelihood opportunities but also contributing to resource degradation and environmental crises that undermine resource-dependent households (Boonstra & Nhung, 2012; Tuyen et al., 2022). Unlike northern and southern Viet Nam, however, the Central Coast has experienced a slower pace of socio-economic transformation, leaving many households with limited alternatives beyond farming, capture fisheries, and aquaculture (Hanh & Boonstra, 2019). This heavy dependency on fragile resources heightens vulnerability, as even minor disturbances can trigger disproportionate impacts on household well-being. Following Flyvbjerg's (2006) notion of a "*critical case,"* the Central Coast represents an analytically powerful setting where multiple stressors converge with unusual intensity. Yet, it has received less scholarly attention than other coastal regions, such as the Mekong Delta. Insights from this case are therefore relevant not only to the local context but also to other coastal economies experiencing similar pressures.

This study examines how coastal households in Viet Nam's Central Coast navigate livelihood transitions in response to multiple, interacting stressors and evaluates the extent to which these transitions contribute to both economic security and ecological sustainability. By linking household-level responses to broader social and ecological outcomes, the study offers an empirically grounded contribution to understanding livelihood adaptation and resilience in coastal settings.

The remainder of the paper is structured as follows. Section 2 reviews the literature on social-ecological stressors, livelihood transitions, and livelihood resilience. Section 3 outlines the study area and methodology. Section 4 presents the findings, categorizing observed livelihood transitions and evaluating their outcomes. The paper concludes by discussing how livelihood transitions may strengthen or undermine livelihood resilience in coastal areas and by providing implications for policy and management.

Social-Ecological Stressors, Livelihood Transitions, and Livelihood Resilience

Stressors are disturbances that exert pressure on a system, altering its structure, functions, or dynamics (Adger, 2000; Folke, 2006; Räsänen et al., 2016). They may arise in ecological systems (e.g., climate change, natural hazards), in social contexts (e.g., economic crisis, pandemics), or at the interface between ecological and social systems, such as resource degradation, environmental pollution (Armitage & Marschke, 2013; Bennett et al., 2016; Fabinyi et al., 2022; Hoque et al., 2018). These multiple and interacting disturbances are conceptualized as social-ecological stressors.

Social-ecological stressors can be acute, such as hurricanes, floods, or environmental disasters, or chronic, including habitat degradation, resource depletion, and gradual

environmental change (Adger, 2000; Carpenter et al., 2001; Folke, 2006). Importantly, such stressors do not occur in a vacuum but are embedded within broader social-ecological systems, ranging from local to global scales, that shape both their impacts and feedback loops (Adger, 2000; Bennett et al., 2016; Levin et al., 2013; Räsänen et al., 2016). For example, resource degradation and climate change can destabilize resource-based livelihoods, promoting the intensification of activities such as fisheries and aquaculture. Yet, this intensification often accelerates ecological decline, trapping households in cycles of vulnerability and livelihood impoverishment (Hanh & Boonstra, 2018; Laborde et al., 2016; Nayak, 2017). The proximity of coastal to marine ecosystems intensifies exposure to acute hazards such as storms and floods, while dependence on increasingly fragile coastal resources for livelihoods heightens vulnerability to long-term social-ecological decline (Barbier, 2015; Coulthard, 2008; Fabinyi et al., 2022; Hoque et al., 2018; Kron, 2013).

In response to these social-ecological stressors, coastal households often shift their livelihood, undertaking livelihood transitions to sustain and improve their well-being (Allison et al., 2007; Béné et al., 2016; Cinner & Bodin, 2010; Ellis & Allison, 2004; Ferrol-Schulte et al., 2013; Torell et al., 2017). Livelihood transitions are defined as processes in which households partially or entirely abandon activities that no longer yield sufficient returns in favor of alternatives with greater potential (Betcherman & Marschke, 2016; Kramer et al., 2017). These transitions may involve a complete exit from one livelihood to another (Kramer et al., 2017), or a reorientation in which households shift their primary income activities—defined as the one contributing the largest share to total income - toward new pursuits (Betcherman & Marschke, 2016).

Livelihood transition differs from livelihood diversification. Livelihood diversification refers to households engaging in multiple income-generating activities to spread risks and stabilize income (Ellis, 2000). It rarely involves abandoning the primary occupation. Households may still retain their identity, for example, as "farmers" or "fishers" while supplementing their main activity with secondary sources of income. In contrast, livelihood transition reflects a structural and directional shift, whereby households gradually move away from traditional occupations toward new, dominant sources of income and identity. Rather than simply adding to existing strategies, transition entails a reconfiguration of the livelihood system itself.

Decisions to adjust livelihood strategies depend not only on exposure to social-ecological stressors but also on households' awareness of their impacts (Grothmann & Patt, 2005; Herrfahrdt-Pähle et al., 2020). Yet, awareness alone is insufficient. Variations in power and agency further shape the nature and outcomes of livelihood transitions (Armitage, 2006; Béné et al., 2014; Beymer-Farris et al., 2012; Brown, 2015; Widgren, 2012). To capture this heterogeneity, our analysis disaggregates households by their primary income activities. Moreover, recognizing that livelihood transitions are long-term processes, we examine livelihood transitions over a 10-year period (2014–2023).

Livelihood transitions constitute a central adaptive response to social-ecological stressors, enabling households to mitigate adverse impacts and secure more stable livelihoods (Béné et al., 2016; Ellis, 2000; Kramer et al.,

2017; Marschke & Berkes, 2006). In doing so, these transitions contribute to enhancing livelihood resilience among coastal households (Béné et al., 2016; Poelma et al., 2021). Livelihood resilience is defined as *"the capacity of all people across generations to sustain and improve their livelihood opportunities and well-being despite environmental, economic, social, and political disturbances"* (Tanner et al., 2015, p. 23).

Grounded in the resilience approach - which emphasizes the fundamental interdependence between human societies and the natural environment (Berkes et al., 2002; Cumming, 2017; Folke, 2002) - this study conceives livelihood resilience as a dual capacity: sustaining and improving human well-being while maintaining the ecological foundations upon which livelihoods depend. A resilient livelihood is therefore one that not only secures household income but also safeguards the natural resource base underpinning long-term sustainability. This perspective moves beyond narrow economic interpretations of resilience, advancing a broader social-ecological understanding that captures the dynamic interactions between people and ecosystems. Accordingly, this study examines whether livelihood transitions enhance livelihood resilience by assessing the extent to which such transitions enable coastal households to sustain and improve their well-being while simultaneously supporting the ecological integrity of coastal resources.

Methods

Study Site Selection

The study was conducted in Thua Thien Hue province, located along Viet Nam's Central Coast. The province covers an area of 4,947.11 km^2 and has a population of approximately 1.17 million people, with more than 47% residing in rural areas (Thua Thien Hue Statistics Office, 2024). Thua Thien Hue has a hot and humid tropical monsoon climate characterized by two distinct seasons: a hot season from May to September, with temperatures ranging from 35°C to 40°C, and a cold season from October to March, with average temperatures between 20°C and 22°C. The province's average annual rainfall exceeds 2,700 mm, concentrated mainly between September and February. November alone accounts for about 70% of the total annual precipitation, frequently leading to flooding and erosion (UBND Thừa Thiên Huế, 2023).

Economically, the province has transitioned from an agriculture-based to one oriented toward industry and services. The agricultural share declined from over 40% in the 1990s to about 10% in 2023 (Phúc, 2025). In 2023, the agriculture sector accounted for 10.7% of the provincial GRDP; industry and construction represented 31.9%; services contributed 48.8%; and product taxes minus subsidies accounted for 8.6% (Thua Thien Hue Statistics Office, 2024). However, the economic structure in coastal areas still depends heavily on agriculture (Hanh & Boonstra, 2019). The average monthly per capita income reached 4.7 million VND per month (approximately 180 USD, equivalent to only 87% of the national average (Thua Thien Hue Statistics Office, 2024).

With a 128-km coastal line, Thua Thien Hue is among Viet Nam's most climate-vulnerable regions, highly exposed to typhoons, floods, and sea-level rise (Ngo-Duc, 2014; UBND Thừa Thiên Huế, 2023). In addition, its coastal areas face resource degradation and environmental pollution while simultaneously undergoing rapid urbanization, economic restructuring, and tourism development (Béné et al., 2016; Boonstra & Hanh, 2014; Tuyen et al., 2022). These overlapping pressures create a dynamic context for examining how coastal households adapt and transition their livelihoods in response to multiple stressors.

Nine coastal communes were selected, including Hai Duong, Dien Hai, Quang Cong, Phu Dien, Thuan An, Vinh Thanh, Giang Hai, Vinh Hien, and Lang Co (see Figure 1). Selection criteria included (1) proximity to urban and tourism destinations, (2) proximity to the coast, and (3) diversity of coastal ecosystems, which captures heterogeneity in both social-ecological conditions and livelihood structures. Such heterogeneity is critical because it shapes households' exposure to stressors and creates varied opportunities for livelihood transitions (Boonstra & Hanh, 2014; Cao et al., 2024; Hanh & Boonstra, 2019; Nayak, 2017).

Data Collection

The research employed a mixed-methods approach combining secondary data analysis, qualitative interviews, and household surveys. We first collected extensive secondary data to develop an overview of key social-ecological stressors, household livelihoods, and livelihood transitions in the study areas. This involved compiling annual socio-

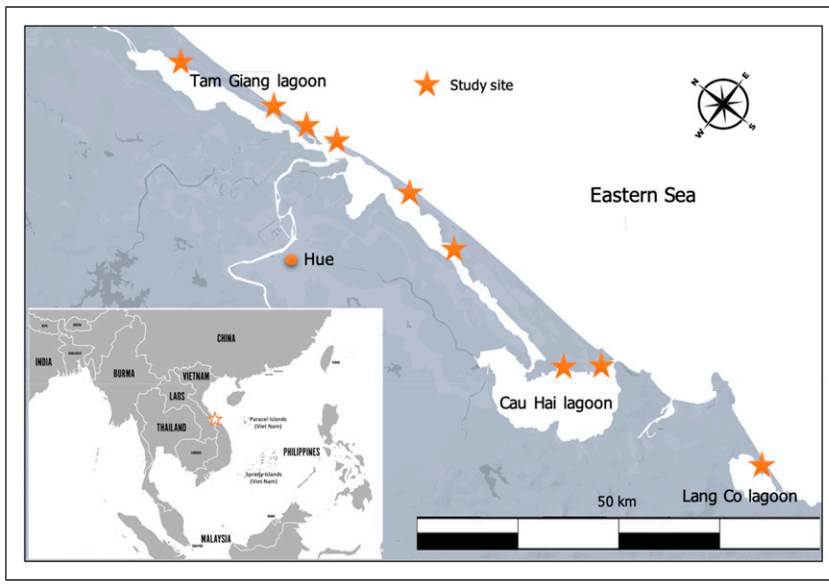

Figure 1. Map of the Study Sites

economic development reports from the selected communes, assessment reports on disaster and environmental impacts on local development, and statistical records of household occupations between 2014 and 2023. The period 2014–2023 was selected because it captures a decade marked by major social-ecological disturbances that substantially affected coastal livelihoods, including the Formosa environmental disaster in 2016 (Tuyen et al., 2022), ongoing resource degradation (Hanh & Boonstra, 2018), the COVID-19 pandemic (2021–2023), and intensified extreme climate events (Boonstra & Hanh, 2014).

Next, we conducted semi-structured interviews with 63 respondents, including commune- and village-level officials as well as coastal households (seven interviews per commune). Specifically, we interviewed commune officials with at least 15 years of experience in overseeing socio-economic development and village leaders who possessed in-depth knowledge of local contexts. These officials assisted in identifying household interviewees, prioritizing middle-aged members whose livelihoods were heavily affected by social-ecological stressors. While this support ensured access to well-informed interviewees, it may have introduced selection bias toward more affected households. The interviews focused on: (1) the impacts of social-ecological stressors on livelihoods; (2) the processes and forms of livelihood transitions at the community level; and (3) the outcomes of these transitions in strengthening livelihood resilience. Thematic coding of interview transcripts informed the design of the household survey, provided explanatory insights, and supported triangulation across data sources. Given the potential for selection bias, qualitative findings are interpreted with caution regarding their generalizability.

Finally, we administered household surveys to examine: (1) the livelihood characteristics and living conditions of coastal households; (2) the impacts of social-ecological stressors on household livelihoods; (3) the processes and forms of livelihood transitions in response to stressors; and (4) the contributions of these transitions to livelihood resilience.

To determine the sample size, Slovin's formula $n = N/(1+Ne^2)$ (Ariola, 2006) was applied, where n is the sample size, N is the population, and e is the margin of error (set at 5%). Statistical records and key informant estimates indicated that each commune had about 2,500–3,000 households, totaling roughly 25,000 households across the nine communes. Based on Slovin's formula, the minimum required sample size was 400 households (≈44 per commune). To enhance reliability and enable commune-level analyses, the sample was expanded to 60 households per commune, resulting in 540 surveyed households. Commune-level household lists were updated in consultation with local officials to ensure a complete sampling frame, and households were then selected using a random-number procedure.

Survey households were classified into livelihood groups according to their primary income source, defined as the source contributing the largest share to household income (see Section 2). The nine groups included wage employment, agriculture-based handicrafts and services, agriculture, aquaculture, non-agricultural services, day labor, inshore fishing, and offshore fishing. This categorization enabled comparison of livelihood transitions and their outcomes across groups. The distribution of households by livelihood group and commune is presented in Table 1, while the socio-demographic characteristics of each group are reported in Table 2. Quantitative data were analyzed

Table 1. Sample Distribution by Surveyed Communes and Household Groups

Household group	Dien Hai	Giang Hai	Hai Duong	Lang Co	Phu Dien	Quang Cong	Thuan An	Vinh Hien	Vinh Thanh	Total
Wage employment	4	1	4	6	9	9	4	4	6	47
Agriculture-based handicraft and services	11	10	8	4	2	10	8	10	8	71
Agriculture	3	5	5	4	7	5	4	4	8	45
Aquacultrue	7	13	8	12	8	7	8	10	10	83
Non-agricultural services	13	4	8	13	22	11	9	6	0	86
Day labor	12	11	11	6	2	9	0	7	8	66
In-shore fishing	10	12	11	15	9	9	10	11	10	97
Off-shore fishing	0	4	5	0	1	0	17	8	10	45
Total	60	60	60	60	60	60	60	60	60	540

(Source: Household survey 2024).

Table 2. Characteristics of Household Groups

Household group	Mean age (years)	Female-headed households (%)	Household size (persons)	Labor per household (persons)	Mean years of shooling	Tertiary education (%)	Vocational training (%)
Wage employment	43.5	6.7	3.8	2.6	11.5	43.3	35.0
Agriculture-based handicraft and services	46.6	11.7	3.6	2.5	7.9	7.5	40.0
Agriculture	55.8	3.3	3.7	3.0	7.4	0.0	10.0
Aquaculture	52.0	5.0	3.9	2.9	7.4	15.0	23.3
Non-agricultural services	46.5	10.0	4.2	2.7	8.8	23.3	63.3
Day labor	49.6	15.0	4.0	2.8	7.4	15.0	50.0
In-shore fishing	48.9	0.0	4.0	2.9	6.5	8.3	13.3
Off-shore fishing	46.7	0.0	4.5	2.5	6.5	1.7	28.3
All households	48.6	5.6	4.0	2.8	7.8	12.6	32.6

(Source: Household survey 2024).

using descriptive statistics and inferential tests (chi-square and Kruskal–Wallis) to assess differences in livelihood transitions and evaluate their contributions to household livelihood resilience (Table 4, 5 and 6).

Households' Livelihood Transitions as Responses to Social-Ecological Stressors in the Central Coast of Viet Nam

Patterns and Intensity of Social-Ecological Stressors Affecting Coastal Livelihoods

Semi-structured interviews with local officials and households reveal that coastal households are simultaneously exposed to multiple acute and chronic social-ecological stressors. Following established definitions (Adger, 2000; Folke, 2006; Räsänen et al., 2016), acute stressors are sudden, high-intensity events that cause immediate livelihood disruption, whereas chronic stressors exert gradual, long-term pressure. The impacts of these stressors on household livelihoods were evaluated on a five-point Likert scale (1 = lowest, 5 = highest) and assessed along two dimensions: the proportion of households affected and the severity of impacts (Table 3).

Two acute stressors received the highest severity ratings (5/5). The first was the Formosa environmental disaster (2016), when industrial wastewater discharged from the Taiwanese Formosa steel plant caused mass marine mortality. This stressor devastated fishing, aquaculture, seafood trade, seafood processing, and tourism, while also contributing to longer-term degradation of marine resources (see also Tuyen et al., 2022). The second was the COVID-19 pandemic, which disrupted almost all livelihood sectors. Between 2021 and 2023, many coastal residents lost their incomes due to factory, business, and market closures. Agriculture, aquaculture, and fishing were also disrupted as producers faced difficulties selling their products amid transportation and trade restrictions. Rising fuel/input prices were likewise classified as acute stressors because of their rapid and unpredictable increases driven by external shocks such as geopolitical tensions, global energy crises, or

Table 3. Social-Ecological Stressors in Coastal Areas and their Impact on Households' Livelihoods

Social-ecological stressors	Type of stressors	Livelihood impact level[a]
Covid-19	Acute	5
Environmental disaster (Formosa 2016)	Acute	5
Rising fuel/input prices	Acute	3
Extreme climate events, for example, storms, floods, etc.	Chronic	4
Decline in natural resources	Chronic	3
Market fluctuation	Chronic	3

[a]*Impact levels:* 1 = lowest, 5 = highest
(Source: Semi-structured interview, 2024)

supply disruptions. Households perceived these abrupt increases as sudden shocks that immediately constrained their operational capacity and income stability. However, their severity was rated at moderate (3). Our interviewees explained that the prevalence of this stressor was narrower than that of the Formosa environmental disaster (2016) and the Covid-19 pandemic, being concentrated mainly among fishing and agricultural households.

Among chronic stressors, extreme climate events such as storms and floods received a high rating (4), reflecting their destructive consequences. These events not only disrupted fishing, aquaculture, and service activities but also damaged key livelihood assets such as roads and houses and, in some cases, caused loss of life. Our interviewees emphasized that the impacts of such events are intensifying as they become more severe and unpredictable (see also Boonstra & Hanh, 2014). Yet, they noted that households are somewhat less affected compared to acute stressors such as the Formosa environmental disaster (2016) and the COVID-19 pandemic, as preparedness measures (e.g., strengthening houses, harvesting products before storms or floods coming) help reduce losses. Other chronic stressors, including the decline in natural resources and market fluctuations, were both assigned an average severity score of 3. These stressors primarily affected fishing, agricultural, and aquacultural households that depend heavily on fish stock and the volatile seafood market.

While semi-structured interviews with local officials and key households provide an overview of stressor categories and perceived impacts, the household survey allows for a more detailed disaggregation across household groups (Table 4). Regarding acute stressors, the COVID-19 pandemic registered high prevalence across nearly all livelihood groups. More than 80% of agriculture, agriculture-based handicraft and services, and day labor households reported being affected, with severity scores between 2.8 and 3.7. By contrast, the Formosa environmental disasters (2016) was concentrated in aquaculture and both inshore and offshore fishing households, where prevalence exceeded 90% and severity levels often surpassed 4. This underscores the disproportionate vulnerability of marine-dependent households. Rising fuel/input prices had a more limited overall impact but significantly disrupted fisheries-related livelihoods, with aquaculture households reporting severity levels as high as 4.0.

Impacts of chronic stressors also varied widely. Extreme climate events affected agriculture households (62.2%), aquaculture households (65.8%), and fishing households (61.7–64.2%), with moderate severity levels (3.0–3.2). The impacts of the decline in natural resources were reported primarily by fishing (28.4–31.9%) and aquaculture households (17.1 %). While aquaculture households rated this stressor extremely high (4.6), fishing households gave lower ratings (2.3–3.0). Declines in water quality led to aquatic disease outbreaks and reduced growth of farmed species, causing severe losses for aquaculture households, many of whom subsequently fell into debt (Hanh & Boonstra, 2018). Market fluctuations were more widespread across household groups than the decline in natural resources or rising fuel/input prices, but they were again concentrated among fishing households, where 12.8–15.8% reported being affected, with severity scores between 2.1 and 3.

Statistical tests confirm these differences. Chi-square tests on the percentage of affected households show significant variation across household groups (all $p < 0.05$). Kruskal–Wallis tests on severity also revealed significant differences for most stressors, including the

Table 4. Impacts of Social-Ecological Stressors on Households' Livelihoods in Coastal Areas

Household group	Covid-19		Environmental disaster (Formosa 2016)		Decline in natural resources		Rising fuel/input prices		Market fluctuation		Extreme climate events e.g. storms, floods	
	%	Level	%	Level	%	Level	%	Level	%	Level	%	Level
Wage employment	44.68	3.2	12.77	2.3	0.00		0.00		2.13	2.0	10.64	2.6
Agriculture-based handicraft and services	80.00	3.5	26.67	4.1	1.33	3.0	2.67	3.5	2.67	3.0	22.67	3.8
Agriculture	86.49	3.3	35.14	3.4	0.00		0.00		2.70	2.0	62.16	3.2
Aquaculture	68.42	3.3	94.74	3.8	17.11	4.6	2.63	4.0	3.95	3.7	65.79	3.3
Non-agricultural services	74.73	3.7	21.98	3.9	0.00		0.00		1.10	2.0	27.47	3.1
Day labor	81.94	3.5	43.06	4.1	1.39	2.0	0.00		0.00		36.11	3.0
In-shore fishing	77.89	3.4	93.68	4.1	28.42	2.3	20.00	1.8	15.79	2.1	64.21	3.2
Off-shore fishing	68.09	2.8	97.87	4.0	31.91	3.0	21.28	2.1	12.77	3.0	61.70	3.0
p-value (Chi-square test)	0.035	N/A	0.001	N/A	0.002	N/A	0.004	N/A	0.001	N/A	0.023	N/A
p-value (Kruskal-Wallis test)	N/A	0.055	N/A	0.033	N/A	0.030	N/A	0.048	N/A	0.041	N/A	0.061

Note. "%" = proportion of households affected; "Level" = average severity rating (1 = lowest, 5 = highest).
(Source: Household survey, 2024)

Formosa environmental disaster (2016) ($p = 0.033$), decline in natural resources ($p = 0.030$), rising fuel/input prices ($p = 0.048$), and market fluctuations ($p = 0.041$). By contrast, variation in severity ratings for the Covid-19 ($p = 0.055$) and extreme climate events ($p = 0.061$) provides limited statistical support for differences across livelihood groups.

We note, however, that subjective evaluations may be biased toward recent, salient shocks such as the Covid-19 pandemic and the Formosa environmental disaster (2016), while long-term stressors (e.g., resource decline) may be underestimated due to recall decay. To address this, we reported both prevalence (percentage of households affected) and severity scores, applied statistical tests across household groups, and triangulated household responses with semi-structured interviews and secondary sources, following Räsänen et al. (2016). Moreover, our interpretations emphasize relative differences across groups rather than absolute values.

In summary, while all social-ecological stressors affect coastal households, resource-dependent groups (fishing, aquaculture, agriculture) consistently report the most severe and widespread impacts, underscoring their structural vulnerability. By contrast, households engaged in wage employment and non-resource-based livelihoods are less affected by ecological stressors but remain exposed to social stressors such as the COVID-19 pandemic. The next section examines whether households are shifting their livelihood to mitigate the impacts of these social-ecological stressors.

Livelihood Transitions Under Multiple Social-Ecological Stressors

We examined how different household groups have transitioned their livelihoods in response to socio-ecological stressors over the past decade, from 2014 to 2023. Figure 2

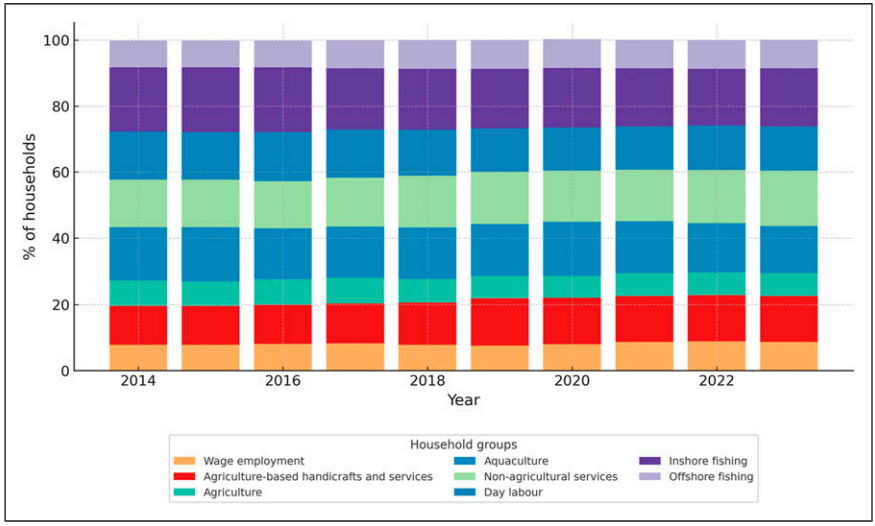

Figure 2. Distribution of Households by Primary Income Sources, 2014–2024 (Percent of Households)

presents a breakdown of primary income activities over this period, highlighting notable differences across household groups.

Households engaged in non-natural resource-based livelihoods displayed a clear upward trend. For example, the share of households relying on non-agricultural services increased steadily from 14.4% in 2014 to 16.9% in 2023. Those depending on agriculture-based handicrafts and services also grew, rising from 11.8% in 2014 to a peak of 14.3% in 2019 before stabilizing around 13.9%. Similarly, wage employment registered a modest but consistent increase, moving from 7.8% to approximately 8.7–8.9% in recent years. In contrast, day labor, an income activity typically associated with older household members with limited education and vocational training, declined from 14.6% to 13.3%. Interview evidence suggests that this decline stems primarily from health-related constraints that reduce the capacity of older individuals to sustain physically demanding work.

By comparison, natural resource-based livelihoods - including agriculture, aquaculture, and fishing - revealed a more mixed pattern. Agricultural households declined slightly from 7.6% to 6.9%, while aquaculture fluctuated, decreasing from 16.1% to 14.1%. In-shore fishing households contracted from 19.4% to 17.6%, whereas off-shore fishing households showed a modest rise from 8.1% in 2014 to 8.7% in 2023.

A gradual reorientation is evident: agricultural and aquacultural households are shifting their primary income away from natural resource-based activities towards non-natural resource-based ones. However, many in-shore fishing households have not followed this path. Instead, some shifted from inshore to offshore fishing, a transition largely supported by government initiatives promoting offshore fishing before 2019.

Table 5 illustrates how households adjusted their primary income sources when confronted with social-ecological stressors. Chi-square tests confirmed that the Covid-19 pandemic had a particularly strong effect on non-natural resource-based households ($\chi^2 = 8.52$, df = 1, $p = 0.003$). Conversely, the Formosa environmental disaster (2016) ($\chi^2 = 6.77$, df = 1, $p = 0.009$) and extreme climate events ($\chi^2 = 5.98$, df = 1, $p = 0.015$) were strongly associated with switching among natural resource-dependent households. Other stressors—such as decline in natural resources ($p = 0.497$), rising fuel/input prices ($p = 0.135$), and market fluctuations ($p = 0.345$)—did not significantly influence switching behavior.

Despite being disproportionately affected by these social-ecological stressors, natural resource-based households displayed low rates of switching. Extreme climate events were the most influential drivers, promoting 13.51% of agricultural households, 14.47% of aquacultural households, and 9.47% of inshore fishing households to alter their primary income source. Notably, even though more than 60% of offshore fishing households reported being impacted by extreme climate events, none changed their primary income source. Similarly, the Formosa environmental disaster (2016) triggered only modest shifts: 7.89% among aquacultural households and 2.13% among offshore fishing households, while inshore fishing households reported no changes. Importantly, no households cited a decline in natural resources as a reason for switching their main income.

These findings underscore a paradox: although natural resource-based households are among the most impacted by social-ecological stressors, they remain the least likely to alter their primary income sources.

Table 5. Percentage of Households Shifting their Primary Income Sources in Response to Social-Ecological Stressors

Household group	Covid-19	Environmental disaster (Formosa 2016)	Decline in natural resources	Rising fuel/input prices	Market fluctuations	Extreme climate events e.g. storms, floods
Wage employment	2.13	0.00	0.00	0.00	0.00	2.13
Agriculture-based handicraft and services	10.67	5.33	1.33	0.00	1.33	5.33
Agriculture	2.70	2.70	0.00	0.00	0.00	13.51
Aquaculture	5.26	7.89	0.00	0.00	0.00	14.47
Non-agricultural services	8.79	1.10	0.00	0.00	0.00	6.59
Day labor	6.94	4.17	0.00	0.00	0.00	5.56
In-shore fishing	5.26	0.00	0.00	1.05	1.05	9.47
Off-shore fishing	2.13	2.13	0.00	2.13	0.00	0.00
p-value (Chi-square test)	0.003	0.009	0.497	0.135	0.345	0.015

(Source: Household survey 2024)

Table 6 reveals that the contribution of primary income sources to total household income declined between 2014 and 2023. Kruskal–Wallis tests indicate that the declines of aquaculture (p = 0.810), non-agricultural services ($p = 0.573$), and offshore fishing ($p = 0.747$) were not statistically significant. In contrast, significant declines

Table 6. Changes in the share of households' primary income sources (%)

Primary income source	2014	2019	2023	Change 2019 vs 2014	Change 2023 vs 2019	Change 2023 vs 2014	*p*-value (2023 vs. 2014)
Wage employment	76.8	74	72.5	−2.8	−1.5	−4.3	0.024
Agriculture-based handicraft and services	85.3	78	78.95	−7.3	0.9	−6.35	0.017
Agriculture	74.1	78	65.2	3.9	−12.8	−8.9	0.009
Aquaculture	79.8	79.7	78.8	−0.1	−0.9	−1	0.810
Non-agricultural services	80.4	79.7	81.1	−0.7	1.4	0.7	0.573
Day labor	74.1	64.4	71.1	−9.7	6.7	−3	0.038
In-shore fishing	79.5	74.1	74	−5.4	−0.1	−5.5	0.092
Off-shore fishing	87.1	85.6	85.1	−1.5	−0.5	−2	0.747

(Source: Household survey 2024).

were found for wage employment ($p = 0.024$), agriculture-based handicraft and services ($p = 0.017$), agriculture ($p = 0.009$), and day labor ($p = 0.038$).

This suggests that natural resource-dependent incomes declined more slowly than non-natural-resource-based ones, reflecting households' difficulties in reducing reliance on traditional livelihoods. For example, aquacultural income remains relatively stable, dropping only slightly from 79.8% in 2014 to 78.8% in 2023. Inshore fishing declined steadily by 5.5% (79.5% to 74%), and offshore by just 2% (87.1% to 85.1%). Agricultural income followed a mixed trajectory - rising from 74.1% in 2014 to 78% in 2019 before falling to 65.2% in 2023, a net decline of 8.9%.

By contrast, non-resource-based incomes demonstrated more dynamic changes. Wage employment decreased by 4.3% (from 76.8 to 72.5), and agriculture-based handicraft and services fell by 6.35% (from 85.3% to 78.95%). Day labor contracted by nearly 10% between 2014 and 2019, followed by a partial recovery, though still 3% below its 2014 level. Only non-agricultural services, including small-scale trade, retail, transportation, and tourism-related services, showed modest growth, rising by 0.7% (from 80.4% to 81.1).

Taken together, these findings yield two insights. Firstly, many natural resource-dependent households persist with existing activities or make only minimal adjustments despite facing disproportionate exposure to social-ecological stressors (see also Béné et al., 2016). Limited access to viable livelihood alternatives constrains their ability to switch (Hanh & Boonstra, 2019), leaving them more vulnerable to future social-ecological stressors. Second, households in non-natural-resource-based sectors appear more proactive, either diversifying or shifting their income sources in ways that reduce reliance on vulnerable activities.

Contributions of Livelihood Transitions to Economic and Ecological Resilience

As highlighted in Section 2, the literature indicates that livelihood transitions can strengthen livelihood resilience by improving income security and supporting the sustainability of the ecological systems on which livelihoods depend. In this study, we assess the extent to which such transitions contribute to resilience outcomes by using a five-point Likert scale (1 = lowest, 5 = highest) to evaluate whether transitions enable coastal households to (i) recover and maintain income; (ii) increase income; (iii) improve living standards; (iv) protect the environment and natural resources; (v) reduce natural resource exploitation; and (vi) lessen the impacts of extreme climate events (Figure 3).

Overall, coastal households rated the outcomes of their livelihood transitions between 3.1 and 3.9, indicating a moderate level of perceived contribution to livelihood resilience. Income-related outcomes consistently scored higher: recovery and maintenance of household income averaged 3.6–3.7, while improvements in living standards and income increases ranged between 3.7 and 3.9. By contrast, environment-related outcomes were rated lower, with protecting the environment and natural resources and minimizing natural resources exploitation typically scoring 3.3–3.5. These results suggest that households view livelihood transitions as more effective in sustaining economic resilience than in enhancing ecological resilience.

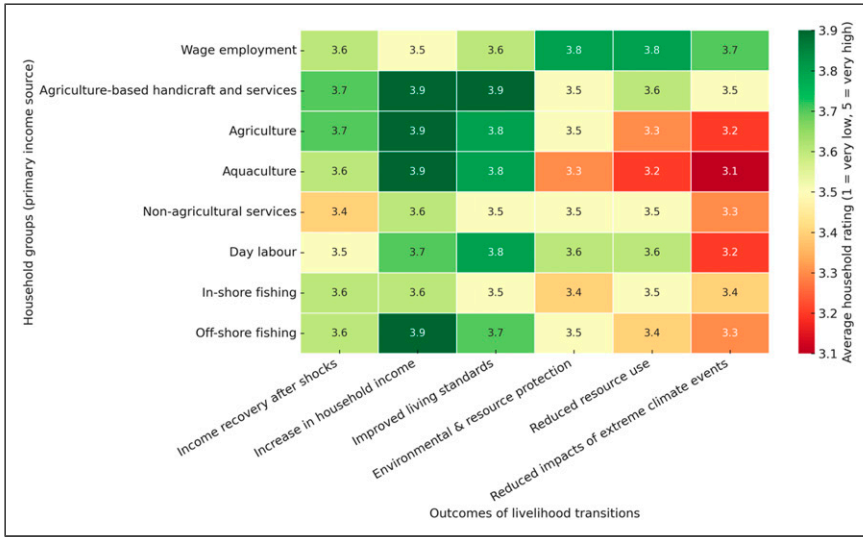

Figure 3. Household Perceptions of Livelihood Transition Outcomes (1 = Lowest, 5 = Highest)

Notably, divergent patterns emerged across household groups. Wage employment households scored environmental outcome relatively high (around 3.8) – in some cases even exceeding their ratings for income recovery (3.6) and income increase (3.5). Interviews suggest that this perception reflects their reduced dependence on resource extraction, which they associate with lower pressure on coastal ecosystems. Because their livelihoods do not rely directly on harvesting natural resources, these households view their transitions as indirectly supporting environmental protection. By contrast, households engaged in agriculture, aquaculture, and fishing reported the opposite pattern: economic outcomes averaged 3.8–3.9, while environmental outcomes ranged from 3.1 to 3.4, resulting in discrepancies of 0.5–0.7 points. These contrasts highlight the difficulty natural resource-dependent households face in reconciling economic gains with environmental stewardship.

This perception reflects broader patterns of livelihood transitions under social-ecological stressors. The relatively low proportion of natural resource-based households shifting away from their primary income sources indicates a persistent reliance on already degraded natural resources. Such dependency compels households to continue, or even intensify, the exploitation of natural resources. As a result, opportunities for ecological recovery remain limited, further entrenching the vulnerability of natural resource-dependent livelihoods (Hanh & Boonstra, 2018).

Taken together, these findings demonstrate that current livelihood transitions primarily enhance economic resilience by supporting income recovery and increase, while offering only limited improvements in ecological resilience. This imbalance is most pronounced among households directly dependent on natural resources, where the pursuit of short-term economic security continues to outweigh long-term environmental sustainability.

Discussion

The findings highlight that coastal households are exposed to a wide spectrum of social-ecological stressors. These range from acute stressors such as the Formosa environmental disasters and the Covid-19 pandemic to chronic stressors like extreme climate events and declines in natural resources. Similar patterns of overlapping social-ecological stressors have been documented in Bangladesh (Hoque et al., 2018), India (Nayak, 2017), and Ghana (Freduah et al., 2017). This reinforces the argument that it is the combination of stressors, rather than single ones, that cause vulnerability of coastal households (Bennett et al., 2016; Fabinyi et al., 2022). Recognizing this cumulative effect is therefore essential for assessing households' vulnerability and designing strategies to reduce it.

Although social-ecological stressors affect all coastal households to some extent, their intensity and consequences vary across groups. Natural resource-dependent groups - fishers, aquaculturists, and farmers - reported more pronounced impacts, reflecting the higher sensitivity of these occupations to social-ecological stressors. By contrast, households engaged in wage labor or non-natural-resource-based activities appeared less exposed to ecological stressors, though they remained vulnerable to broader social stressors such as pandemics. This differentiation echoes findings from other parts of Viet Nam, where integration into wage or service sectors has offered some protection, while fishers and small-scale aquaculturists remained structurally fragile (Betcherman & Marschke, 2016).

Despite facing significant pressures, many natural resource-dependent households in the Central Coast continue with their existing activities or make only incremental adjustments. This observation aligns with previous studies (Béné et al., 2016; Hanh & Boonstra, 2018; Laborde et al., 2016) that show how structural barriers, cultural attachments, and limited access to alternative opportunities constrain livelihood transitions. Persistent reliance on traditional practices not only heightens their vulnerability to ongoing stressors but also raises concerns about the long-term sustainability of coastal ecosystems. By contrast, households engaged in wage labor and service-oriented activities were somewhat more likely to reconfigure their income sources - consistent with evidence that non-natural-resource-based households tend to provide greater flexibility (Betcherman & Marschke, 2016). Understanding the factors that shape livelihood transitions is therefore crucial for developing strategies to better support coastal households.

It is also important to note that transitions do not always involve a complete exit from a sector. In some cases, households shifted within their existing domain - for example, moving from inshore to offshore fishing. These patterns resemble experiences in the Mekong Delta, where households shifted from rice monoculture to rice–shrimp farming (Poelma et al., 2021). However, such shifts should be viewed with caution: while they may reduce immediate risks, they often sustain or even deepen reliance on already degraded natural resources.

Another key finding concerns the disparity between economic and environmental outcomes of livelihood transitions. Economic benefits, such as income recovery,

income growth, and improvement in living standards were rated relatively high (3.6–3.9). In contrast, environmental outcomes, such as protecting natural resources and reducing exploitation, were rated lower (3.2–3.5). This suggests that while livelihood transition can bolster household economic resilience, they are less effective in advancing ecological resilience. The imbalance highlights a common challenge: households understandably prioritize income stability, but in doing so, may compromise broader ecological sustainability (Hanh & Boonstra, 2018; Stoop et al., 2016).

These results point to several policy implications. Efforts to reduce vulnerability to social-ecological stressors should expand access to alternative livelihoods beyond natural resource dependence while embedding safeguards to prevent further ecological decline. Because different household groups follow distinct trajectories, livelihood policies should be tailored to reflect this diversity rather than adopting one-size-fits-all approaches. Equally important is inclusive governance that ensures transitions are not only economically viable but also socially equitable and environmentally responsible. Linking household-level transitions to broader sustainability goals could help reconcile immediate livelihood security with the long-term stewardship of coastal ecosystems.

Conclusion

This study examined how households along Viet Nam's Central Coast navigate livelihood transitions in response to multiple social–ecological stressors. The findings reveal that although all households are affected, fishers, aquaculturists, and farmers experience the most severe vulnerabilities. By contrast, those engaged in wage employment or non-natural-resource sectors are less exposed to ecological pressures but remain susceptible to broader social disruptions, particularly pandemics. Many natural-resource-dependent households continue to rely on traditional practices or shift only within their sector, limiting their ability to reduce exposure. Overall, livelihood transitions tend to strengthen economic resilience more than ecological resilience. These results highlight the need for policies that expand livelihood alternatives beyond natural resource dependence while embedding ecological safeguards. By linking household-level responses to broader social–ecological outcomes, the study demonstrates that fostering livelihood transitions requires not only economic adjustment but also the deliberate integration of ecological sustainability. Future research should adopt longer-term and comparative perspectives to better understand how such transitions shape both household well-being and ecosystem resilience.

Several limitations should be acknowledged. First, while the household survey and interviews provide valuable insights, reliance on self-reported data may introduce recall bias, particularly regarding long-term or less visible stressors such as gradual resource decline. Second, the analysis covers a 10-year period (2014–2023), which may not fully capture longer historical trajectories of livelihood change or new shifts emerging beyond this timeframe. Third, although the study focused on nine communes in Thua Thien Hue, the findings may not be directly generalizable to other coastal regions, where ecological conditions, policy environments, and livelihood opportunities differ.

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The data and information used in this article are not publicly available to preserve interviewees' privacy but are available upon reasonable request.

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