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Livelihood Diversification and Transition among Lagoon Fishing Households and White leg Shrimp *(Litopenaeus vannamei)* Farming Expansion in Phu Dien Commune, Hue City, Vietnam

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Abstract. This study examines the expansion of white leg shrimp farming as a livelihood stressor shaping diversification and constraining transitions among small-scale lagoon fishing households in Phu Dien Commune, Hue City, Vietnam. Data were collected through a survey of 100 fishing households, complemented by focus group discussions and key informant interviews. The findings show that households are affected by multiple and overlapping pressures, including declining aquatic resources, lagoon pollution, market fluctuations, rising input costs, natural disasters, COVID-19, and the expansion of white-leg shrimp farming. Despite these pressures, most households continue to depend on fishing because of constraints related to capital, skills, and employment opportunities; only 7% of households exited fishing, while 11% adjusted their fishing gear, effort, or fishing grounds. The study suggests that livelihood diversification mainly takes the form of incremental and constrained adaptation rather than full livelihood transformation. Based on these findings, the study recommends strengthening environmental management in aquaculture, supporting livelihood transitions, and promoting co-management of lagoon resources to enhance community resilience.

Keywords: livelihood diversification, livelihood transition, Tam Giang Lagoon, white leg shrimp farming.

1 Introduction

The Tam Giang-Cau Hai Lagoon, covering more than 22,000 ha, is of particular importance to coastal communities in central Vietnam [1]. Small-scale fishing households in this area depend directly on lagoon resources through activities such as nearshore fishing, gillnetting, stake-trap fishing, fish trapping, and seasonal harvesting.

Since the early 2000s, the boom in white leg shrimp (*Litopenaeus vannamei*) farming in Vietnam, particularly in central Vietnam, has marked a major economic turning point. With its short production cycle, high productivity, and strong export value, white leg shrimp rapidly became a leading species in Vietnam's shrimp industry. In Thua Thien Hue (now Hue City), the transition from black tiger shrimp to white leg shrimp occurred rapidly but with limited regulation [2]. Although the province issued a 2007 directive prohibiting white leg shrimp culture in the Tam Giang-Cau Hai Lagoon, the activity has in practice continued to expand in pond systems along the lagoon margin [2, 3]. In Phu Dien Commune alone, nearly 90% of the aquaculture area has shifted to white leg shrimp, even though most ponds do not meet technical standards and lack wastewater treatment systems. This has caused localized pollution and seriously affected lagoon resources. Previous domestic and international studies likewise highlight the rapid growth of white leg shrimp farming in central Vietnam, while also

pointing to major sustainability concerns, including unstable seed quality, widespread chemical use, water pollution, and heavy dependence on traders [2, 4, 5]. In this context, fishing households have been compelled to seek livelihood responses to cope with the environmental impacts associated with the expansion of white leg shrimp farming. Related studies suggest that fishing households tend to: (1) diversify their livelihoods, (2) reduce dependence on fishing, or (3) exit the sector when resources decline [6, 7].

In addition to the expansion of white leg shrimp farming, this study also situates livelihood change within the broader literature on shocks, stresses and livelihood diversification. The livelihoods of small-scale fishing households are closely to natural resources and are therefore highly vulnerable to both shocks and long-term stresses. In livelihood studies, shocks are generally understood as sudden events that severely disrupt household income and well-being, such as natural disasters, disease outbreaks, marine pollution incidents, mass fish mortality, or disease outbreaks in aquaculture. By contrast, stresses refer to slower but persistent pressures, such as resource decline, water pollution, rising input costs, shrinking fishing grounds, and changes in resource governance. According to DFID (1999) [11], a sustainable livelihood is one that can cope with and recover from shocks while maintaining or enhancing livelihood assets over time. For fishing communities, fisheries-related shocks—such as environmental incidents, shrimp disease outbreaks, abnormal fish mortality, or market collapse—can rapidly affect income, productive assets, and household confidence in existing livelihood strategies. Livelihood diversification is widely regarded as an important strategy for spreading risk and reducing dependence on a single income source [6, 13]. However, among small-scale fishers, diversification does not necessarily result in full livelihood transition, as many households add supplementary activities while continuing to depend on fishing because of limited capital, skills, and alternative employment opportunities [6, 13]. In this study, the expansion of white leg shrimp farming is therefore treated as a persistent livelihood stressor that also increases the risk of localized fisheries-related shocks, including pollution, disease outbreaks, and resource decline, thereby shaping how fishing households in Phu Dien Commune diversify, adjust, or become constrained in their livelihood transition.

However, very little research has examined the interaction between aquaculture expansion and capture fisheries, particularly in distinctive lagoon systems such as Tam Giang-Cau Hai. Although many studies have addressed aquaculture and livelihoods in the Tam Giang-Cau Hai Lagoon, community-level research on the livelihood transitions of fishers affected by the expansion of white leg shrimp farming remains limited. In particular, there is still a gap in understanding the extent of livelihood change among households under conditions shaped by multiple pressures, such as environmental degradation, declining aquatic resources, and the barriers that keep households trapped in existing livelihoods.

This study was conducted to: (i) identify key coastal shocks and stresses affecting fishing households in Phu Dien Commune; (ii) assess the impacts of aquaculture expansion on lagoon resources and livelihoods; and (iii) analyse livelihood diversification of fishing households as a response to these pressures.

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2 Methodology

2.1 Study area

The study was conducted in the Thanh My fishing community, Phu Dien Commune, Phu Vang District, Thua Thien Hue Province (now part of Hue City). This is one of the coastal lagoon areas of Hue City, bordered by the East Sea on one side and the lagoon on the other, creating a brackish-water ecosystem that is environmentally sensitive and hydrologically complex. Phu Dien Commune has approximately 54.48 ha of aquaculture area along the lagoon [8]. The site was selected as a representative case not only because of the rapid expansion of whiteleg shrimp farming, but also because it typifies coastal livelihood conflicts. Specifically, the locality embodies three central features of the research context: (i) strong environmental pressure resulting from the spontaneous development of shrimp ponds along the lagoon; (ii) a fishing community with a high degree of dependence on natural resources; and (iii) barriers that slow and constrain occupational restructuring. The choice of this study site therefore makes it possible to test clearly the effects of environmental change on household livelihood decisions.

2.2 Research design

The study adopted a mixed-methods design based on a case study of Thanh My village, Phu Dien Commune, Phu Vang District, Thua Thien Hue Province (now Hue City). This approach combines the breadth of quantitative data with the depth of qualitative evidence, thereby providing a comprehensive and nuanced understanding of livelihood structure, levels of transition, and socio-environmental impacts. The study also applied triangulation to cross-check information from different stakeholder groups and treated fishers' indigenous ecological knowledge as a reliable indicator for assessing environmental change over time. The study uses perception-based data from a single case study site; therefore, the findings are context-specific and not intended for generalization.

2.3 Household survey

Sample selection and sample size

The study surveyed 100 households in Thanh My village (Phu Dien Commune) based on Cochran's formula [9], while accounting for practical resource constraints and community scale. Using purposive stratified sampling based on records from the commune People's Committee and the fishery association, the sample was divided into two groups for comparison: (i) households primarily engaged in capture fisheries; and (ii) households engaged in aquaculture or that had shifted their livelihoods from fishing to white leg shrimp farming. This design facilitates a comprehensive analysis of livelihood transitions and socio-environmental impacts within the lagoon community.

Data collection instrument

A semi-structured questionnaire was used to collect information on the following: Sociodemographic characteristics and income structure; current fishing and aquaculture activities; livelihood transition over the past 10 years; perceptions of the environmental impacts and livelihood risks associated with white leg shrimp farming.

2.4 Data collection

Focus group discussions: The study conducted two focus group discussions (FGDs), each involving 10-12 participants, to explore systemic issues and shared understandings: Capture fisheries group: focused on spatial conflicts over water use between white leg shrimp farming and declining aquatic resources; Aquaculture/livelihood-transition group: focused on economic drivers, technical and disease risks, and ongoing livelihood trends.

Key informant interviews (KIIs): Seven in-depth key informant interviews were conducted with knowledgeable respondents, including commune-level agriculture and fisheries officers, the chair of the fishers' association, village officials, and representatives of white leg shrimp-farming households

2.5 Data processing and analysis

Data were processed using SPSS and analyzed descriptively to examine income structure and the contribution of different livelihood groups.

Data were analyzed using thematic analysis following Braun and Clarke's six-step process: (1) familiarization with the data; (2) initial coding; (3) searching for themes; (4) reviewing themes; (5) defining and naming themes; and (6) synthesizing and interpreting the results [10]. Coding was conducted openly and then synthesized and grouped according to the Sustainable Livelihoods Framework [11]. Given the limited availability of long-term environmental monitoring data in the lagoon area, observations from fishing communities—who interact daily with the coastal lagoon ecosystem—were treated as reliable indicators for assessing environmental change over time [12].

3 Results

3.1 Socio-economic background of Phu Dien Commune

Phu Dien is a coastal commune located in Phu Vang District, Thua Thien Hue Province, total natural area is approximately 1,311 hectares, of which a significant portion is dedicated to aquaculture and agricultural production. As of 2023, the local economy recorded a total production value of 541 billion VND, with the agriculture, forestry, and fishery sector contributing 36.4%, followed by the services and industry-construction sectors. In 2023, the total aquatic production reached 2,342 tons. Of this total, aquaculture occupies 228.6 hectares, including 54.48 hectares of ponds located directly along the lagoon margin. A major technical shift has occurred with the rapid expansion of white leg shrimp (*Litopenaeus vannamei*) farming, which now utilizes intensive and semi-intensive models. In 2023 alone, white leg shrimp output reached 1,234 tons, accounting for over 52% of the total aquatic volume produced by the commune. Meanwhile, the capture fishery fleet consists of both inshore and offshore vessels, with the inshore group primarily operating small boats (below 20 CV) using traditional gear such as nets, traps, and stake traps within the lagoon waters [8].

3.2 Livelihood and household characteristics in Phu Dien Commune

The survey of 100 households in Thanh My village, Phu Dien Commune, shows that the livelihood structure of the local fishing community is diverse but fragmented. Households tend to combine multiple livelihood activities—including agriculture, fishing, and non-farm work—to sustain income in the context of declining natural resources. Fishing households in the lagoon area of Phu Dien mainly operate small boats (below 20 CV), and their main fishing methods include traps, nets, and stake traps.

The survey results show that more than half of households (53.6%) still maintain agricultural livelihoods (small household gardens) or combined agro-fishery activities, reflecting the traditional livelihood base of the lagoon-side fishing community. However, the discussions also revealed that the proportion of households engaged in aquaculture (40.9%), especially white leg shrimp farming along the lagoon, has increased rapidly over the past decade (Table 1)

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Table 1. Sociodemographic and livelihood characteristics of surveyed households in Phu Dien

Indicator	Value
Average age of household heads	49.41 (SD = 9.697)
Household size	4.22 (SD = 1.160)
Percentage of female household heads	69.4%
Households engaged in agricultural activities	53.6%
Households engaged in aquaculture (white leg shrimp and mixed brackish-water fish culture)	40.9%
Households engaged in non-farm activities (e.g., petty trade)	68.8%
Households engaged in inshore fishing	38.3%
Households engaged in offshore fishing	29.7%

Source: Household survey, 2024

Alongside aquaculture, a notable trend is the sharp increase in non-farm livelihoods, with 68.8% of households reporting income from at least one non-farm activity such as wage labour, petty trade, small-scale services, or seasonal employment. This reflects the increasing diversification of livelihoods—a common phenomenon in coastal communities facing the combined pressures of climate change and resource decline [6, 13]. This high proportion indicates that households are attempting to diversify their income sources; however, most non-farm activities remain seasonal, unstable, and low-paying.

Nevertheless, fishing remains a crucial livelihood for many households. A total of 38.3% of households continue to fish in the lagoon using traditional methods such as nets, traps, and stake traps, while 29.7% participate in offshore fishing fleets that involve higher risks and costs. Households engaged in lagoon-edge fishing are particularly vulnerable to environmental degradation because they depend directly on lagoon waters, which are most affected by aquaculture effluent and hydrological fluctuations. This close relationship between dependence on degraded resources and livelihood vulnerability is consistent with studies showing that resource-dependent livelihood systems are often highly vulnerable and have limited adaptive capacity in the face of environmental shocks [14, 15]

3.3 Coastal stresses and shocks in Phu Dien Commune

Survey results and focus group discussions reveal that the livelihoods of fishing households in Phu Dien Commune are simultaneously affected by multiple shocks and prolonged pressures. Among these, the decline in fishery resources is the most frequent ecological pressure, recorded 15 times in 10 years and impacting an average of 217 days per year. According to focus group discussions with fishing households, this trend is closely related to the development of intensive aquaculture along the lagoon, from the boom in tiger shrimp farming to the rapid shift to white leg shrimp farming. The expansion of high-density ponds, the lack of settling ponds and wastewater

treatment, increases local pollution, causing foul odors, sedimentation, water discoloration, and scattered fish deaths after pond discharges. In addition, the community has also experienced major shocks such as the Formosa environmental incident in 2016, Covid-19, natural disasters like storms and floods, fluctuations in the seafood market, and rising fuel prices (Table 2).

Table 2. Major livelihood shocks and stresses in Phu Dien Commune

Shock & Stress	Most recent year	Frequency (per 10 years)	Average duration (days)	Impact	Recovery
Formosa-2016 incident	2016	1	158	3.8	3
Covid-19	2022	1	112	3.2	2.9
Decline in aquatic resources	2023	15	217	2.8	2.4
Fisheries market fluctuations	2020	3	215	2.9	2.8
Rising fuel/input costs	2022	61	195	2.3	2
Natural disasters (storms, floods)	2023	14	70	2.7	2.9

Source: Focus group discussion and Household survey, 2024

3.4 Aquaculture (white leg shrimp) farming expansion

The expansion of white leg shrimp farming in Hue City has continued in recent years, placing considerable pressure on the lagoon environment. According to the provincial Fisheries Sub-department, the total shrimp-farming area, including both black tiger shrimp and white leg shrimp, is approximately 3,450 ha, of which 2,675 ha (77.5%) are located in lagoon areas. Data for 2018-2024 (Figure 1) show that the area under white leg shrimp farming in Hue City increased from 506 ha in 2018 to 622 ha in 2024. This represents an average annual increase of 19-35 ha over the seven-year period, with particularly rapid expansion around 2020 because of the perceived economic advantages of switching from black tiger shrimp to white leg shrimp.

In Phu Dien Commune, the total aquaculture area along the lagoon was approximately 54.48 ha in 2023. This area has remained relatively stable in recent years and is considered to be close to the local planning limit, indicating that aquaculture land in terms of total area has largely reached its maximum. Although the commune's statistics only mention the shrimp farming area and do not specify the species of shrimp because in reality, white leg shrimp farming is not allowed in lagoon pond areas that do not have adequate treatment systems, so interviews with officials from the Fisheries Sub-department and local agricultural authorities indicate that white leg shrimp now accounts for more than 90% of the lagoon shrimp-farming area. This indicates that the dominance of white leg shrimp is driven not by an increase in total

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aquaculture area, but by a rapid internal shift in species composition within a relatively fixed aquaculture area. This suggests that the actual spread of white leg shrimp farming is much larger than what is captured in official commune-level statistics.

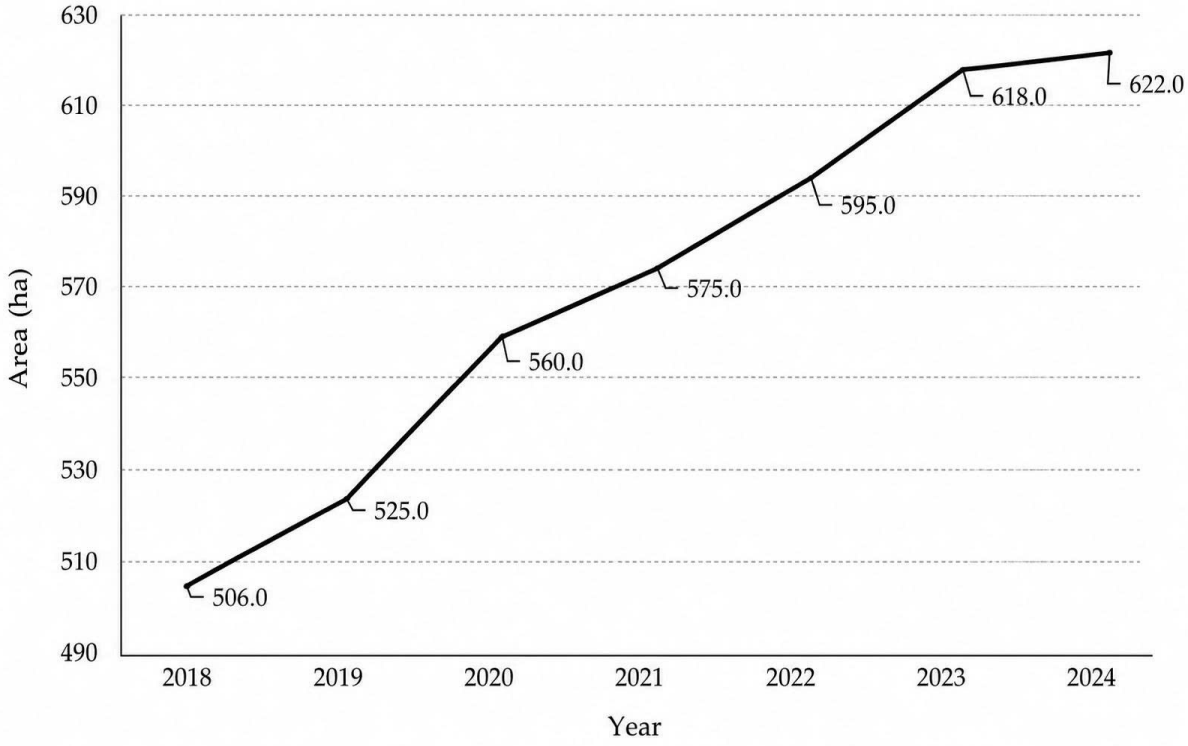

Figure 1. Area under white leg shrimp farming in Hue City

Source: Fisheries Sub-department, 2024

3.5 Community assessment of impacts of shocks and white leg shrimp farming expansion

Table 3 shows that aquaculture households in Phu Dien clearly noted the link between intensive shrimp farming and the decline in lagoon environmental quality. 68% of households reported that wastewater from the ponds had a foul odor and caused turbidity in the surrounding water; this issue was also assessed as very serious in both group discussions and interviews with knowledgeable individuals. Unusual fish deaths, floating garbage, and sedimentation around the ponds were also recorded, albeit to a lesser extent, at 49% and 35% respectively of the surveyed households. The survey results also showed that 71% of households reported a decline in catch yields, 64% noticed a decrease in the size of aquatic products, and 58% believed that some traditional species had declined or disappeared seasonally. In particular, the decline in resources and shrinking of fishing grounds around the ponds were noted by 63% of households and assessed as very serious by both the FGD (Farmer Group Development) and interviews with knowledgeable individuals. This shows that the impact of shrimp farming extends beyond local pollution to encompass the livelihoods of farming households. This result reinforces the argument that the expansion of white leg shrimp farming along the lagoon is a significant socio-ecological pressure in Phu Dien.

Table 3. Community assessment of environmental impacts and aquatic resource decline associated with white leg shrimp farming

Indicator	Household survey (n = 100) (%)	FGD assessment	Key informant assessment
Foul-smelling wastewater and increased turbidity	68%	Very serious	Very serious
Unusual fish mortality and floating waste	49%	Serious	Serious
Sludge accumulation around pond areas	35%	Moderate	Moderate
Decline in aquatic resources and shrinking fishing grounds associated with white leg shrimp farming expansion	63%	Very serious	Very serious
Decline in catch volume	71%	Very serious	Very serious
Smaller size of aquatic organisms	64%	Serious	Serious
Loss of traditional species	58%	Serious	Serious

Source: Household survey, focus group discussions and key informant interviews, 2024

3.6 Livelihood diversification and transition among fishing households after White leg Shrimp Farming Expansion in Phu Dien Commune

Despite being strongly affected by resource depletion, lagoon pollution, and shrinking fishing grounds, fishing households in Phu Dien have undergone only limited livelihood transition over the past decade. The survey of 100 households in the Thanh My fishing community shows that 82% made no strategic change to their main income source; instead, they maintained traditional diversified livelihood patterns or continued fishing despite declining returns. Only 11% made minor adjustments within the sector, and 7% shifted to entirely different sectors (Table 4).

Table 4. Livelihood transition among fishing households after White leg Shrimp Farming Expansion in Phu Dien Commune (n = 100)

Type of livelihood response	Household survey (%)	Assessment from FGD and KIIs	Description
No major livelihood transition	82	Very common	Continued fishing or combined fishing with small-scale activities, but did not change their main livelihood due to limited capital, skills, land, and job opportunities.

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Type of livelihood response	Household survey (%)	Assessment from FGD and KIIs	Description
Intra-sectoral adjustment	11	Limited	Remained in the fisheries sector but adjusted practices, such as changing gear, shifting fishing grounds, reducing effort, or working as hired worker in a shrimp farm
Inter-sectoral transition	7	Very limited	Shifted to non-fishing jobs such as wage labour, petty trade, services, or factory work, but several still returned to fishing seasonally.

Source: Household survey, focus group discussions and key informant interviews, 2024

The fact that 82% of households fall into the "no-transition" group does not mean that they have not been affected. On the contrary, it indicates that they have been affected but are unable to leave the occupation, a condition widely recognized as a "livelihood trap." Qualitative evidence from the focus group discussions likewise shows that many fishing households reported wanting to transition but being unable to do so. The main reason lies in the mismatch between environmental pressure and adaptive capacity. The social profile of this group—dominated by older workers, limited access to productive land, and lack of non-farm skills—creates substantial inertia against livelihood transition.

Among the 11% of households that made intra-sectoral adjustments, the most common response was changing fishing gear, followed by combining fishing with wage labour in shrimp ponds, shifting fishing grounds, and reducing fishing effort. These adjustments should be understood as adaptation within the existing livelihood system rather than full livelihood transition (Table 5)

Table 5. Forms of intra-sectoral adjustment among fishing households in Phu Dien Commune (n = 11)

Type of adjustment	Household survey (%)	Assessment from FGD and KIIs	Description
Change fishing gear	54.5	Common	Fish and shrimp have become smaller, lead to the use of nets and traps with smaller mesh sizes
Combine fishing with shrimp-farm labour	45.5	Common	Guarding ponds and harvesting shrimp
Shift fishing grounds	36.4	Limited	Fishing takes place further out, closer to the estuary, or in neighboring villages.
Reduce fishing effort	27.3	Limited	Because of declining health and rising costs

Source: Household survey, focus group discussions and key informant interviews, 2024

Table 6 shows that 7% of the sample shifted from fishing to other occupations. Most of these households had younger and better-educated workers or benefited from support from relatives. However, many of them only shifted seasonally and still returned to fishing during the main season, while their new jobs remained precarious and unstable.

Table 6. Characteristics of households undergoing inter-sectoral transition in Phu Dien Commune (n = 7)

Characteristic	Household survey (%)	Qualitative assessment from FGD and KIIs	Description
Household head younger than 45	71.4	Common	Younger than the remaining households
Education at upper secondary level or above	57.1	Moderate	Better positioned to find non-farm jobs in newly established industrial zone near home
Return to fishing seasonally	57.1	Common	Transition in complete
Support from relatives	42.9	Limited	Strong social connections, family members living or working aboard
Stable non-farm employment	28.6	Rare	Most new jobs remain part time

Source: Household survey, focus group discussions and key informant interviews, 2024

These findings show that livelihood diversification and transition in Phu Dien remain limited, incremental, and largely constrained. While some households have adjusted their livelihood strategies, most changes do not constitute full structural transformation but rather reflect adaptive responses to environmental stress and declining resource conditions.

3.7 Household assessment of livelihood diversification outcomes under environmental stress

This section presents household perceptions of livelihood diversification outcomes under the combined influence of resource decline, market changes, environmental pressures and livelihood shocks. The analysis does not isolate the effects of white leg shrimp farming alone, but reflects household assessments of livelihood diversification in the broader context of environmental stress.

Table 7 shows that households assessed livelihood diversification relatively positively in terms of economic and livelihood outcomes. The highest score on a 5-level Likert scale was found for improved production/business efficiency and household livelihoods (Mean = 3.93), followed by increased income and employment (Mean = 3.84), maintained and restored household livelihoods (Mean = 3.75), and reduced negative impacts of disasters (Mean = 3.80). These results suggest that livelihood diversification, although limited, still plays a role in helping households maintain income, improve livelihood efficiency, and strengthen short-term coping capacity under conditions of environmental and economic stress.

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Table 7. Household assessment of livelihood diversification outcomes in Phu Dien Commune (n = 100)

Indicator	Mean of Likert scale	FGD assessment	KIIs assessment
Improved production/business efficiency and household livelihoods	3.93	Positive	Positive
Increased income and employment	3.84	Positive	Positive
Maintained and restored household livelihoods	3.75	Positive	Positive
Reduced negative impacts of disasters	3.80	Moderate	Positive
Reduced exploitation of natural resources	3.73	Moderate	Moderate
Environmental and resource protection	3.67	Moderate	Moderate

Source: Household survey, focus group discussions and key informant interviews, 2024

Note: Household survey scores were measured on a 1–5 Likert scale (1 = Very strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Very strongly agree).

However, indicators related to environmental and resource outcomes were rated lower. Reduced exploitation of natural resources reached Mean = 3.73, while environmental and resource protection had the lowest score among the selected indicators (Mean = 3.67). These two indicators were also assessed only at a moderate level in both FGD and KIA (evaluated at 3 sacle: positive, moderate and limited). This suggests that livelihood diversification in Phu Dien has not yet created a clear reduction in dependence on Coastal resources, and its contribution to environmental sustainability remains weaker than its contribution to income and livelihood maintenance.

4 Conclusion and policy implications

4.1 Main findings

This study provides a comprehensive analysis of the impacts of expanding white leg shrimp farming on the lagoon environment and on the livelihoods of small-scale fishing households in Phu Dien Commune, Thua Thien Hue. The results show that the shift from black tiger shrimp to white leg shrimp occurred rapidly but with limited control, leading to a series of serious environmental consequences, including increased organic pollution, sludge accumulation, scattered fish mortality, and shrinking fishing grounds in the lagoon. These changes have contributed to an alarming decline in natural aquatic resources and have directly reduced fishing catches—a trend confirmed by survey data, focus group discussions, and key informant interviews in Thanh My village, Phu Dien Commune.

Taken together, these findings suggest that the fishing community in Phu Dien Commune is undergoing livelihood change in several uneven and incomplete forms:

(i) Traditional capture-fisheries livelihoods still persist but are clearly declining (71% of households reported reduced catches, and 58% reported the loss of traditional species).

(ii) Intensive white leg shrimp farming is expanding rapidly but generates environmental risks (68% of households reported foul-smelling water and 49% observed fish deaths), and it does not include the entire community (only 40.9% of households are engaged in aquaculture).

(iii) Non-farm livelihoods are expanding, but they remain largely low-end, seasonal, and precarious.

(iv) Livelihood inequality between groups is increasing, as reflected in unequal access to key means of production such as land and water space between aquaculture households and capture-fisheries households.

4.2 Unsustainable and non-inclusive development

The livelihood structure in Thanh My village, Phu Dien Commune, reveals a growing disparity between households that have the means to engage in aquaculture and those that remain dependent on traditional capture fisheries. Households with pond land or investment capital can more easily enter white leg shrimp farming and increase their income quickly when production conditions are favorable. By contrast, fishing households without productive land—accounting for more than 60% of the sample and representing the majority of poor and near-poor households according to the survey and in-depth interviews—face declining resources, rising gear costs, and shrinking fishing grounds, yet have little opportunity to access more profitable livelihood options. This situation creates a "livelihood trap," in which households are heavily affected but unable to transition because they lack capacity, capital, and opportunity.

At the same time, the expansion of white leg shrimp farming should not be viewed as entirely negative. From a macroeconomic perspective, it has contributed significantly to local economic growth. However, the findings reveal a clear trade-off between the short-term economic gains captured by a relatively small group of shrimp-farming households and the long-term sustainability of the lagoon ecosystem and the wider community, including lagoon fishing households. This is a typical example of non-inclusive development, in which profits are privately appropriated while environmental risks are effectively socialized and borne by more vulnerable fishing households.

4.3 The "livelihood trap" mechanism and the low flexibility of community livelihoods

Against this backdrop of environmental degradation, the level of livelihood transition among fishing households remains particularly low: 82% of households made no transition, only 11% made minor within-sector adjustments, and just 7% actually moved into other occupations. This limited mobility does not indicate stability; rather, it reflects a locked-in livelihood system in which households are constrained by limited capital, limited skills, older age, scarce employment opportunities, and socio-cultural barriers.

This is an important finding, as it sheds light on the adaptive limits of fishing communities exposed to environmental shocks and contributes to broader debates on coastal livelihood transition.

First, the findings reinforce the theoretical argument that resource-dependent livelihood systems often exhibit low mobility. As Allison and Ellis an Hanh [13, 19] noted, small-scale fishing communities are frequently "locked into" traditional livelihood trajectories because of limited capital, limited skills, and enduring socio-cultural constraints, making transition difficult even when resources decline.

Moreover, the difficulty of livelihood change in Phu Dien can also be explained through the concept of path dependency. Over generations, fishing households have accumulated specialized skills and social capital that are closely tied to the lagoon. Shifting to a new livelihood requires not only financial investment, but also a reconfiguration of human capital and a willingness to accept risk. When the costs of transition exceed

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household capacity—and when labour markets remain unstable—households tend to adopt a strategy of "minimal adaptation" in order to preserve short-term security, thereby unintentionally reinforcing their long-term entrapment.

4.4 Adaptive limits under environmental change

Second, the findings highlight the mechanism of the "livelihood trap"—a seemingly stable livelihood state in which the interaction between social and ecological systems continually pushes communities towards unfavorable outcomes such as poverty and vulnerability, from which escape becomes extremely difficult. In Phu Dien Commune, environmental impacts linked to white leg shrimp farming—including organic pollution, fish mortality, sludge accumulation, aquaculture waste, and shrinking fishing grounds—reduce income from fishing, but do not generate sufficient momentum for households to leave the sector because alternatives are limited and institutional support is weak.

This condition of being "affected but unable to leave the livelihood" closely reflects the notion of double exposure, whereby households simultaneously face environmental and socio-economic risks, resulting in increasing vulnerability. This interpretation is consistent with studies describing Southeast Asian coastal communities as facing multiple layers of risk without clear livelihood exit options.

Third, the findings provide additional empirical evidence for arguments about the unequal effects of aquaculture development. While white leg shrimp farming generates economic benefits for households with investment capital, fishing households bear most of the environmental costs. Although they are not directly involved in aquaculture, they are strongly affected by declining water quality and the contraction of fishing space. This is a form of livelihood-environment inequality that has been noted in many Asian contexts.

Fourth, the study contributes to a broader discussion of adaptation under conditions of environmental change. Although many studies view livelihood transition as a form of positive adaptation, the findings from Phu Dien Commune suggest that adaptation has largely remained at the level of tactical adjustment—changing gear or shifting fishing grounds—rather than strategic restructuring. This aligns with the concept of passive adaptation, in which households make partial adjustments to maintain their livelihoods but lack the capacity to fundamentally reorganize their livelihood systems.

Finally, the study shows the importance of analysing livelihood transition as a non-linear process shaped simultaneously by economic, cultural, environmental, and institutional factors. Transition does not occur because of a single cause; rather, it emerges from the interaction of multiple constraints.

4.5 Policy implication

Based on these analyses, the study proposes three major policy implications:

First, environmental management of white leg shrimp farming needs to be strengthened. This includes controlling stocking density, requiring settling ponds and wastewater treatment systems, and closely monitoring wastewater discharge. Such measures are necessary to reduce pressure on the lagoon and to protect natural resources, which remain the foundation of lagoon fishing livelihoods.

Second, targeted livelihood-transition support programmes should be developed for small-scale coastal fishing communities. These programmes should include small-scale financial support, non-farm vocational training,

employment linkage, and support for alternative production activities. Such interventions would help break the capital-skill-opportunity barriers that currently lock households into traditional livelihoods.

Third, a more equitable distribution of benefits is needed in aquaculture development. While households with capital derive benefits from aquaculture, fishing households—which bear substantial environmental risks—should also benefit through mechanisms such as benefit sharing, environmental compensation fees, or community livelihood funds. Such measures would help reduce livelihood inequality and strengthen community resilience.

In sum, the rapid expansion of white leg shrimp farming in the lagoon area of Phu Dien Commune has not promoted broad-based occupational restructuring. Instead, it has undermined the conditions that support traditional livelihoods while simultaneously generating environmental and social-equity challenges.

Achieving sustainable development therefore requires simultaneous control of shrimp-farming activities, protection of the lagoon ecosystem, and the creation of real opportunities for fishing households to pursue livelihood transition. However, environmental management alone is not sufficient. Following the perspective advanced by Cinner [14] and Béné [6], policy interventions should move beyond technical support and place greater emphasis on building flexible adaptive capacity through education, non-farm skills training, and social protection networks. Only when these resources are in place will traditional fishing communities be able to escape the current livelihood trap and adapt effectively to future economic and ecological change.

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