Impact of Mangrove Ecosystem Service Value on Farmers' Livelihood Choices – An Empirical Study in the Southern Region of Vietnam

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ABSTRACT

This study aims to evaluate the impact of mangrove ecosystem service value on farmers' livelihood choices in the southern region of Vietnam. Based on 197 survey samples for farmers in the Southern region and quantitative analyses such as reliability testing, exploratory factor analysis and Binary Logistics regression analysis. The results show that the value of mangrove ecosystem services has a positive impact on farmers' livelihood choices, in which provisioning services are the ecosystem services with the greatest impact, followed by regulating services and finally cultural services. Based on the above findings, the study offers a number of governance implications to help state management agencies, local authorities and development organizations in formulating mangrove conservation policies associated with sustainable livelihood development, raising public awareness of the importance of mangrove ecosystems, thereby promoting the active participation of people in forest protection and rational exploitation of natural resources.

KEYWORDS

mangrove ecosystem service value, livelihoods, farmers, Southern Vietnam.

1. INTRODUCTION

Mangrove forests are one of the coastal ecosystems rich in resources and have particularly important ecological, economic, and social values (Tran et al., 2022). In the world, mangrove forests are likened to the "green lungs of the coast" thanks to their ability to store carbon, stabilize shorelines, limit erosion, and mitigate damage from natural disasters such as storms and high tides. At the same time, this is also a rich source of natural aquatic products, a place to breed, breed and inhabit many aquatic species with high economic value. In addition, mangrove forests also have potential in developing ecotourism, environmental education and biodiversity conservation. In Vietnam, the mangrove ecosystem is mainly distributed in coastal provinces, in which the southern region, especially provinces such as Ca Mau, Bac Lieu, Soc Trang, Tra Vinh and Ben Tre, owns the largest mangrove forest area in the country. Not only playing a protective role, the mangrove forest here is also closely associated with the livelihood of millions of coastal farmers. Activities such as fishing, aquaculture under the forest canopy, exploitation of forest products in addition to timber, harvesting of natural products and even agricultural farming on land transformed from forests have become important means of subsistence for many generations (Pham et al., 2012).

However, in recent decades, the mangrove ecosystem in the southern region is under great pressure from many sides: the process of converting forest land to industrial shrimp farming, uncontrolled resource exploitation, the impact of climate change such as sea level rise, etc saltwater intrusion, abnormal storms and floods, along with the process of coastal urbanization and industrialization. As a result, the area and quality of mangrove forests are significantly reduced, reducing the ability to provide ecosystem services and seriously threatening the livelihood security of forest dweller communities (Besset et al., 2019). According to Do et al. (2005), the loss of mangrove forests leads to a decline in biodiversity, loss of habitats and spawning grounds for many species of fish and fisheries, destruction of nutrient cycles in mangrove areas, and especially deterioration of ecosystem services. Therefore, when people are fully aware of the value that the ecosystem brings, they tend to choose sustainable, environmentally friendly livelihood models and tend to actively participate in conservation activities. In addition, people's livelihood strategies are not only governed by economic,

social, or personal resources, but are also significantly affected by natural environmental factors, in which ecosystem services are a fundamental factor but are rarely quantified in traditional livelihood analysis models. Stemming from these practices, studying the impact of mangrove ecosystem service value on farmers' livelihood choices – Empirical research in the southern region of Vietnam is extremely necessary to explore and deeply analyze the relationship between the types of mangrove values (value provided, regulation, support and culture) with the behavior of choosing the livelihood model of coastal households, thereby serving as a basis to help state management agencies, local authorities and development organizations in formulating policies on mangrove conservation associated with sustainable livelihood development, raising public awareness of the importance of mangrove ecosystems, thereby promoting the active participation of people in forest protection and rational exploitation of natural resources.

2. OVERVIEW OF THE MANGROVE ECOSYSTEM SERVICE VALUE

Research by Phan (1999) said that mangrove forests are considered one of the coastal ecosystems with the highest level of biomass production in nature. According to the Millennium Ecosystem Assessment (2005), ecosystem services are the benefits that humans achieve from ecosystems, including services such as food and water, regulating services such as flood and drought control; support services such as soil formation and nutrient cycles; and cultural services such as entertainment, spirituality, beliefs as well as other material benefits. Mangrove ecosystems include plants and animals with many distinct biological and ecological characteristics (Pham et al., 2021). In particular, rich plants include plants such as tigers, mangroves, parrots, and fish sauce,... capable of living in mangrove environments, with the majority of plants having a cluster root system such as buds, growing intertwined to help firmly adhere and spread around, reducing the velocity of flows, creating conditions for sediment to accumulate faster in coastal estuaries. Abundant animal resources with a variety of seafood and aquatic animals. Similar to this view, the studies of Phan (1999), Ash et al. (2010), Nguyen and Do (2014), Nguyen et al. (2017) show that mangrove ecosystems are particularly important for economic development, as they are the place where many alluvial beds have been formed to create an abundance of mangrove tree composition protecting the habitat, providing food for animals, breakwater, fighting flying sand, air conditioning and also an effective response to climate change. With the great values that mangrove ecosystems bring to human life, mangrove ecosystems are often divided into ecosystem service groups. The Millennium Ecosystem Assessment (2005) developed the concept of ecosystem services as an important framework tool for analyzing the value that humans derive from nature. According to this classification framework, ecosystem services are divided into four main groups: (1) Provisioning services such as food, wood, fuel, medicinal materials; (2) Support services such as nutrient cycles, soil formation, biodiversity maintenance; (3) Regulating services such as climate conditioning, erosion prevention, flood and storm mitigation; and (4) Cultural services such as entertainment, tourism and spiritual values (Barbier, 2007; DasGupta and Shaw, 2017; Schwenke et al., 2021). Many studies have applied this theoretical framework to evaluate and model the value of mangrove ecosystems globally (Giri et al., 2015). These studies highlight the superior benefits of mangroves in conservation and climate change adaptation compared to alternative land use options. In particular, a number of recent studies have also expanded the analysis of the linkages between mangroves and the Sustainable Development Goals (SDGs) to quantify the role of these ecosystems in the global development program (Son et al., 2017; Abdullah-Al-Mamun et al., 2017). In Vietnam, research by Nguyen et al. (2017) shows that mangrove ecosystems are divided into 4 groups of ecosystem services: regulating services, support services, provisioning services and cultural services. In particular, regulating services have the role of watershed protection, flood control, climate regulation, water regulation, water purification, and disease prevention. Support services contribute to soil composition, nutrient regulation, photosynthesis and support of material circulation cycles. The service provides people with food, clean water, raw materials, fuel. Cultural services create aesthetic values, social relations, entertainment, ecotourism, history, science, education and spiritual issues. In terms of mangrove ecosystem resource groups, according to Pham Thi Thuy Nga et al. (2021), mangrove ecosystems are divided into 3 types: Provisioning services; Regulating Services and Cultural Services.

Through actual observation and review of documents on mangrove ecosystem services, in this study, mangrove ecosystem services are divided into 3 types: Provisioning services; Regulating services and cultural services are shown in the following table:

Table 1. Synthesis of mangrove ecosystem services

Mangrove ecosystem resources	Provisioning Services	Regulating Services	Cultural Services
Mangrove plants(fish sauce,mangrove, tiger, parrot,...)	- Forestry products (wood, firewood, charcoal,...), used as building materials. - Medicinal herbs. - Tree sap for paint processing, printing ink,... - Genetic source. - Residences and residences of animals and microorganisms.	- Climate regulation (absorption of polluting gases), reducing the greenhouse effect. - Water filtration. - Protection: Preventing wind, storms, tornadoes... - Heat and humidity conditioning. - Limit the intrusion of saltwater into the interior. - Ecological balance. - Carbon sequestration. - Erosion resistance. - Nutrient cycle. - Keeping silt, expanding the area of the landfill.	- Scientific research. - Ecotourism, resort, landscape. - Cultural sensitivity. - Historical value. - Creating jobs for people.
Aquatic resources (fish, shrimp, crab, oysters, snails,...)	- Food for humans. - Animal feed, other species. - Medicinal herbs. - Source of seeds and genes for aquaculture.	- Water purification, partial removal of water pollution. - Ecological balance. - Decompose organic matter that contributes to soil structure. - Nutrient cycle.	- Scientific research. - Learning and experiencing. - Cultural sensitivity. - Create jobs.
Wildlife (monkeys, cranes, storks, turtles, snakes, bees,...)	- Food for humans. - Medicinal herbs.	- Ecological balance. - Soil structure. - Helps flowers pollinate. - Seed dispersal. - Conservation and reserve of genetic resources.	- Scientific research. - Cultural sensitivity. - Creating jobs for people.
Soil and water in mangrove forests	- Place of residence. - Cultivated land. - Provisioning of fresh water from rain, groundwater.	- Climate control. - Conservation of land and water resources. - Ecological balance. - Land reclamation. - Forest fire protection.	- Historical value. - Cultural sensitivity. - Creating jobs for people.

Source: The authors

The mangrove ecosystem possesses rich resources with a variety of plant and animal species, creating favorable conditions for livelihood activities such as fishing for seafood, farming under the forest canopy, food processing, provisioning of production materials and conservation of seed sources. The provisioning services that mangroves provide, such as food (fish, shrimp, crab, oysters), forestry products (wood, firewood, charcoal, sap), medicinal herbs, building materials, they serve as a direct, practical and recognizable source of benefits for coastal farmers (Bimrah et al., 2022). These benefits contribute significantly to ensuring income, stabilizing life and promoting people's attachment to natural resources. Farmers tend to choose livelihood models that are directly exploited from the resources available in mangroves, because this is a familiar source of livelihood, low risk and associated with local experience. Thereby, the proposed research hypothesis is:

H1: Provisioning services have a positive impact on farmers' livelihood choices

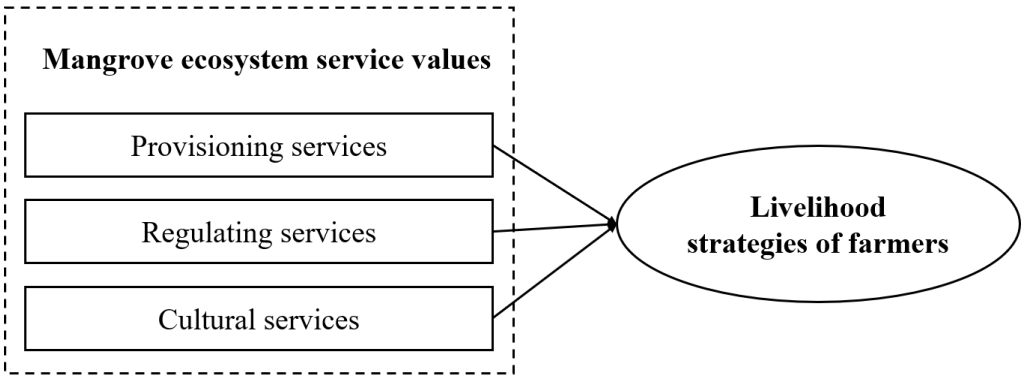
Mangrove ecosystems provide important regulating services that help maintain the stability of the natural environment and mitigate risks caused by climate change. According to Pham Thi Thuy Nga et al. (2021), mangrove forests act as a "green lung" of coastal areas, contributing to climate regulation, absorbing CO_2, reducing the greenhouse effect, stabilizing soil salinity, preventing saltwater intrusion, protecting water resources and cleaning the marine environment through microbiome in the root system. In addition, mangroves are also considered a natural line of defense to help mitigate the impact of storms, high tides and extreme weather phenomena – factors that are taking place increasingly fiercely due to the impact of climate change. In addition, ecological functions such as storing and regenerating genetic resources, supporting the reproductive life cycle of many aquatic species are also considered important factors in maintaining long-term resources for local residents. These regulating services are not only indirect but also contribute to improving the sustainability and resilience of coastal livelihood models. When people are well aware of the regulating role of mangroves, they tend to choose livelihood models associated with resource conservation, sustainable exploitation and adaptation to environmental risks. Thereby, the proposed research hypothesis is:

H2: Regulating services have a positive impact on farmers' livelihood choices

Cultural services from mangrove ecosystems are expressed through spiritual, aesthetic, educational and recreational values that humans can access through activities such as ecotourism, scientific research, environmental education, traditional festivals and indigenous cultural experiences. In the context of the trend of sustainable tourism development, green tourism and experiential education are increasingly concerned, mangrove forests are considered an ideal ecological space to develop livelihood models associated with community tourism, experiential services, and environmental education. Activities related to cultural services such as research, learning, conservation of indigenous knowledge or organizing festivals have not been exploited commensurate with the potential of mangroves. However, in some coastal localities, mangrove ecotourism activities have initially brought obvious benefits to people through creating more jobs, increasing income and promoting community cohesion with natural resources. When people are more aware of the cultural value and potential for livelihood development associated with tourism – education – entertainment from mangroves, they will tend to expand or transform their livelihood models from direct exploitation of resources to the provision of experiential services. accommodation, guides, handicraft products associated with the natives... This not only creates an additional source of income but also reduces the pressure to exploit natural resources. Thereby, the proposed research hypothesis is:

H3: Cultural services have a positive impact on farmers' livelihood choices

Summarizing the above hypotheses, the proposed research model is as follows:



The study uses the Binary Logistics regression analysis method to evaluate the impact of mangrove ecosystem service value on farmers' livelihood choices. With this method, the dependent factor is binary to estimate the probability of an event occurring or not occurring from the data collected from independent factors with two values: 1 when the value of mangrove ecosystem services has an impact on the livelihood choices of farmers and 0 when the value of the epidemic The mangrove

ecosystem has no impact on farmers' livelihood choices. From there, the Binary Logistics regression model is written in the form of an equation as follows:

$$\mathbf{LOG\ (P^*(Y=1)/\ P^*(Y=0)) = a + b^*X1 + c^*X2 + d^*X3}$$

In which:

Y: The dependent factor shows impact of mangrove ecosystem service values on the choice of livelihood strategies of farmers

X_i: mangrove ecosystem service values includes Provisioning services, Regulating services, Cultural services

a: Regression Constant

b, c, d: Regression coefficient

3. RESEARCH METHODS

- Secondary data: collected and synthesized from domestic and foreign studies on the value of mangrove ecosystem services, statistical reports and yearbooks from the General Statistics Office of Vietnam and the Statistics Departments of provinces in the Southern region. Thematic reports, development strategies and regional planning from the Ministry of Agriculture and Environment, as well as interdisciplinary programs on climate change adaptation and mangrove conservation.

- Primary data: research is conducted to collect and survey farmers living in provinces with large mangrove forest areas in the southern region in order to assess the level of awareness of people about the impact of the value of ecosystem services on corresponding livelihood choices. The questionnaire is designed on a Likert scale of 5 levels from level 1 – Strongly disagree to level 5 – Strongly agree. The research scale is built by inheriting from relevant domestic and foreign studies. The study sample size was calculated based on the proposal of Hair et al. (2010) to ensure reliability and significance in the analysis of discovery factors at a minimum ratio of 5:1. With a convenient non-probability sample selection method, the survey period will take place from 01/2025 to 03/2025. At the end of the survey process, 197 valid survey votes were collected, eligible for quantitative analysis on SPSS26 software.

4. RESEARCH RESULTS

Table 2. Statistical results

Factor	Sign	Number of Observed Variables	Mean	SD
Provisioning services	PS	5	3.87	0.71
Regulating services	RS	4	3.65	0.68
Cultural services	CS	5	3.22	0.85
Choice of livelihood strategies of farmers	LSF	5	3.78	0.74

Source: Author's analysis results

The statistical results of all factors show that the level of farmers' evaluation of mangrove ecosystem service value groups is generally relatively high, reflecting the practical role of these services in the livelihood of people in coastal areas. For provisioning services (Mean = 3.87; SD = 0.71) is the most appreciated group by the people. This shows that products such as seafood, timber, firewood, medicinal herbs, and resources directly from mangroves provide clear and visible benefits. This is the basis for farmers to choose livelihood models based on exploitation and aquaculture under the forest canopy. This is followed by regulating services (Mean = 3.65; SD = 0.68) shows that people have a good level of awareness of the role of mangroves in natural disaster prevention, climate regulation, environmental protection and climate change response. This average reflects the actual recognition through storms, strong tides, or saltwater intrusion that people have directly experienced. Meanwhile, cultural services were rated at a lower average (Mean = 3.22; SD = 0.85). This means that intangible values such as ecotourism, education, research and festivals, although they have potential, have not yet been exploited and are closely associated with people's daily livelihoods. The level of awareness and access of people to this service is still limited, which needs to be promoted in the future through community tourism and environmental education programs. For the choice of livelihoods of farmers,

the average level is quite high (Mean = 3.78; SD = 0.74), indicating that people are tending to choose and maintain livelihood models associated with mangrove ecosystem resources, reflecting the possible relationship between ecosystem service values that affect the livelihood choices of farmers in the southern region.

Table 3. Reliability test results and scale discovery factor analysis

Observation variables	Factor			Cronbach's Alpha	Corrected Item-Total Correlation	Cronbach's Alpha if Items deleted
	1	2	3			
PS	0.816			0.816	0.560	0.805
PS	0.800				0.542	0.780
PS	0.795				0.529	0.765
PS	0.771				0.501	0.757
PS	0.762				0.493	0.731
RS			0.832	0.795	0.515	0.784
RS			0.825		0.502	0.772
RS			0.816		0.522	0.758
RS			0.801		0.489	0.743
CS		0.798		0.807	0.493	0.791
CS		0.774			0.486	0.786
CS		0.756			0.413	0.765
CS		0.742			0.472	0.749
CS		0.737			0.450	0.732
Eigenvalue	3.546	2.083	1.309			
Total Variance (%)			76.215			
KMO = 0.829						
Bartlett's Test	Approximate Chi Squared				6894,712	
	df				231	
	Sig.				0.000	
LSF	0.829			0.838	0.523	0.848
LSF	0.811				0.574	0.832
LSF	0.803				0.492	0.819
LSF	0.789				0.518	0.800
LSF	0.776				0.561	0.796
Eigenvalue			1.958			
Total Variance (%)			77.482			
KMO = 0.803						
Bartlett's Test	Approximate Chi Squared				834.701	
	df				5	
	Sig.				0.000	

Source: Author's analysis results

The results of the analysis show that independent factors have a total Cronbach's Alpha coefficient greater than the Cronbach's Alpha coefficient when the variable type is greater than 0.7; the total variable correlation coefficient is greater than 0.3 so the reliability of the scale is good and no variables need to be eliminated. The results of EFA by the component extraction method (PCA) and the Varimax rotation showed that the KMO coefficient reached 0.829 satisfactory (greater than 0.5 and less than 1); the Chi-square statistic of the Bartlett Test reached a value of 6894.712 with a significance of 0.000 (less than 0.05). At the Eigenvalue value greater than 1. there are 3 factors extracted with a total variance of 76.215% (greater than 50%), which means that these 3 factors explain 76.215% of the variability of the data. In addition, the factor load coefficient is greater than 0.5, indicating that the

quality of the observed variables is good and the observed variables are allocated as originally expected. Thus, the results achieved ensure the level of significance in the EFA (Hair et al., 2010).

For the dependent factor of the reliability test results showing that Croanbach's Alpha coefficients, the total variable correlation coefficient all satisfied the requirements set by Hair et al. (2010). The exploratory factor analysis showed that the KMO coefficient was 0.803 with the Sig. coefficient of Bartlett's test of 0.000. which was less than the significance of 0.05. At the Eigenvalue of 1.958, only 1 factor was extracted with a total variance of 77.482% (greater than 50%) and the load coefficient of the observed variables was greater than 0.5, so the data obtained was in line with the requirements (Hair et al., 2010).

With the available data on dependent factors and independent factors after reliability testing and analysis of discovery factors, EFA has satisfied the conditions, the study conducted a binary logistics regression analysis to assess the impact of mangrove ecosystem service value on farmers' livelihood choices. The results of the Logistics binary regression analysis show that:

Table 4. Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	36,595	0.714	0.768

Source: Author's analysis results

The analysis results show that the Sig. value of the Chi-square test is 0.000 (satisfying the condition less than 0.05). In addition, the -2LL value of the Block 1 model reached 36.595, which is smaller than the -2LL value in the Block 0 model by 113.982. so the model is statistically significant (Field, 2009). In addition, the Cox & Snell R Square coefficient of 0.714 and the Nagelkerke R Square coefficient of 0.768 are both satisfied greater than 0 and less than 1 (Cox & Snell, 1989; Nagelkerke, 1991). Therefore, the regression model is perfectly fitting.

Table 5. Results of Binary Logistic Weighing Regression Analysis

		B	S.E.	Wald	df	Sig.	Exp (B)
Step 1[a]	PS	0.329	0.026	2.381	1	0.002	1.389
	RS	0.285	0.019	1.496	1	0.000	1.330
	CS	0.257	0.023	1.519	1	0.001	1.293
	Constant	4,281	0.041	1.076	1	0.000	0.004

Source: Author's analysis results

The analysis results show that the forecast accuracy is quite high, with the correct prediction % of the whole model being 95.9%, which confirms that the independent factors included in the Logistic binary regression model all have an effect on the dependent factor. The Wald test shows that all independent factors have a Sig. coefficient of less than 0.05, which confirms once again the correlation between independent and dependent factors. In addition, the evaluation of the multi-collinear phenomenon of the regression model through the VIF variance magnification coefficient shows that the factors are satisfactory (less than 2 and greater than 1) and the tolerance is greater than 0.5, so the multi-collinear phenomenon does not occur.

In addition, the degree of influence of independent factors on the dependent factor is expressed by the Exp (B), which means that the likelihood of the dependent factor receiving a value of 1. When the independent factors PS, RS, CS increase to 1 unit, the dependent factor also increases to 1.389; 1.330; 1.293 units. Therefore, the hypotheses given are accepted and have a positive effect on the dependency factor, based on the regression coefficient in the table of results of the Binary Logistics regression equation written as follows:

$$\mathbf{LOG\ (P^*(Y=1)/\ P^*(Y=0)) = 4.281 + 0.329^*PS + 0.285^*RS + 0.257^*CS}$$

Thus, through the analysis of mangrove ecosystem service values, there is a positive impact on the choice of livelihood strategies of farmers, in which, Provisioning services are the ecosystem services with the most impact, followed by Regulating services and Cultural services are the ecosystem services

with the weakest impact. The research results are the basis for helping farmers choose the right livelihood to optimize the benefits that the value of ecosystem services brings.

5. CONCLUSIONS AND IMPLICATIONS OF GOVERNANCE

Based on the findings, some important governance implications to support the development of sustainable livelihood strategies for farming communities in mangrove areas are as follows:

Focus on integrating ecosystem conservation into local livelihood development strategies. Coastal provincial governments need to integrate mangrove ecosystem service values into socio-economic development planning, especially livelihood support programs for farmers. Prioritize and deploy more environmentally friendly livelihood models such as aquaculture under the forest canopy, sustainable exploitation, and ecotourism, which should be prioritized for support through credit policies, training and output markets.

Actively propagate to raise public awareness of ecosystem values, promote communication and community education activities and integrate the content of mangrove ecosystem services into general education and vocational training programs. Raising awareness is a premise to help people voluntarily choose sustainable forms of livelihood, and at the same time improve the sense of responsibility in protecting natural resources.

To develop cultural and eco-tourism services associated with conservation. Localities should consider exploiting cultural services from mangroves as a new livelihood development strategy. It is necessary to build eco-tourism routes, experience areas, outdoor learning models, etc. combine conservation and livelihood creation. The State can support infrastructure, train skills and promote community tourism.

To consolidate the mechanism of multi-sectoral coordination in conservation and development. Mangrove conservation and livelihood development cannot be effectively implemented without coordination between the following sectors: agriculture, environmental resources, tourism, education and localities. To develop inter-sectoral and inter-level coordination mechanisms and promote the participation of the population community as the main actors in resource management.

Investment and technical support and investment in infrastructure for livelihoods associated with the ecosystem. Governments and international organizations need to continue to invest in livelihood models suitable to the characteristics of mangrove ecosystems such as organic aquaculture, combined farming, traditional product processing or bioenergy development, etc. This is a way to both conserve mangrove forests and improve sustainable income for people.

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