Article

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Abstract: This research is to identify factors affecting sustainable households' livelihoods in coastal forest areas of Quang Tri province – Central Vietnam, then implying for an appropriate sustainable livelihood strategy. The data from semi-structure interviews on 317 households indicated that factors affecting sustainable livelihoods with positive significant are human resources; physical resources; financial resources; social and community resources; seasonal fluctuations; and livelihood strategies. In addition, the group with factors having a negative coefficient (<0) include (i) social and environmental trends; (ii) shock and crisis; and (iii) natural resources. Results of research also analyse the influence levels of different factors on the sustainable livelihoods of households. In there, social resources and community factors are highest levels positive influence and social and environmental trends factors is highest level negative influence on sustainable livelihood of households. Therefore, in the future, transferring technologies to increase labour productivity, reduce product costs, and make products more competitive need to consider transformative social learning aspect and the State should have appropriate and reasonable policies for households who have seriously affect by climate change as well as social-economic transitions.

Keywords: livelihood; sustainability; forest; coastal areas; Quang Tri; Vietnam

1. Introduction

The livelihoods of coastal forest people in Vietnam have significantly changed in recent years under the impact of policies, market mechanisms, local economic development programs, and support from non-governmental organizations [1–3]. One of these changes is the shift from self-sufficiency to commodity production and aligning output with market demand [4,5]. This change has created opportunities for local people to develop production to escape poverty, but also created risks and challenges for people in the transition process and required development towards sustainable livelihoods [1].

The coastal forest area of Quang Tri includes 27 communes. These communes belong to four districts including Vinh Linh, Gio Linh, Trieu Phong, and Hai Lang with a total area of 53,121.42 ha (accounting for 11.3% of the total area of the province, 50.4% of the coastal area) with a population of 126,908 people (accounting for 19.87% of the total population of the province and 45.54% of the coastal population). The coastal forest area of Quang Tri features sandy terrain, along with two other types: soil-filled mountains in Vinh Linh district and mangrove areas in Trieu Phong and Hai Lang districts. Therefore, the livelihood activities related to agricultural production and services have become the main income sources for households. The main occupations of the households in the coastal forest

areas of Quang Tri are farming, livestock raising, fishing, and forestry. However, agricultural and forest sectors have considered sensitive to climate change and shortage water use while the coastal areas have been predicted to be one of the area most severely affected by natural hazards [6–8]. In fact, natural hazards, such as high temperatures, floods, unusual rainfall, freshwater shortages, and saltwater intrusion, occur frequently depending on the ecological zone, causing significant damage to agricultural and forestry production and household livelihoods [9,10]. In addition, changes in natural and socio-economic conditions, such as dyke development in floodplains, freshwater projects in coastal areas, natural resource depletion, agricultural and rural development policies, and fluctuations in agricultural prices also cause both positive and negative impacts on households in developing and implementing livelihood strategies to achieve expected livelihood outcomes [11–13].

To adapt to the impacts of climate change and socio-economic changes, households use their livelihood assets to develop or adjust sustainable livelihood strategies [1,14,15]. Households carry out this process in a context where they are both affected by the vulnerability context and influenced by formal regulations and informal social constraints [16]. The sustainability of household livelihoods in developing countries amid extreme weather events and socio-economic fluctuations relies on various factors and resources[4,17–19]. Sustainable livelihoods of households in each coastal forest ecological are affected by the households' ability to access livelihood capital and by factors related to soil, access to water, markets, and production experience [7,13,20]. In the process of ensuring sustainable livelihoods, households will face different influencing factors, leading to certain differences in the livelihood outcomes of each household [20,21]. Therefore, identifying the factors influencing the sustainable livelihoods of coastal forest households is crucial, as they serve as key points for technical, market, and policy interventions. This understanding helps enhance appropriate livelihood strategies while reducing risks and failures in household livelihood development.

2. Theorical Framework

Livelihood research has received significant attention from social researchers seeking to understand its role in the dynamics of rural development, particularly in risk contexts. According to DFID (2000), a livelihood comprises the resources and capabilities that people have combined with the decisions and actions they implement to sustain themselves and achieve their goals. According to the livelihood concept of DFID (2000), livelihood includes all human activities to achieve goals based on available human resources such as natural resources, capital, labor, and the level of development of science and technology. Depending on the research and application context, the definition of livelihood is often adapted to fit specific circumstances [22,23].

The concept of sustainable livelihoods is fundamentally rooted in broader framework of sustainable development [24]. Sustainable development is understood as meeting present needs without compromising the ability of future generations to meet their own [25]. This concept emphasizes that sustainable development must ensure effective economic development, social equity, and environmental protection. According to Chambers and Conways (1992), a sustainable livelihood as one that can cope with or recover from stresses and shocks, maintain or enhance its capabilities and assets; create sustainable livelihood opportunities for future generations and provide net benefits for other livelihoods at both local and global levels in the short and long term. Similarly, Scoones [26] describes a sustainable livelihood as one that can withstand with or recover from external pressures while preserving and enhancing its resource base. According to WCED (1987), sustainable livelihood is an integrated concept aimed at achieving equity and sustainability. For this research, the concept of sustainable livelihood is simply understood as a livelihood that adapts to or avoids negative impacts from a vulnerable environment and market, while ensuring the maintenance and development of resources in both the present and the future. A livelihood is considered sustainable when it can withstand short-term shocks and adapt to long-term changes, and enhance its capabilities   without degrading natural resources [22].

A sustainable livelihood requires four key aspects: (i) resilience to short-term and long-term external impacts; (ii) independence from external support; (iii) maintenance of the long-term

productive capacity of natural resources; and (iv) avoidance of livelihoods or threatening the livelihood opportunities of others [17,27]. Therefore, this study applies a theoretical model to assess the factors influencing sustainable livelihoods of people in coastal forests of Quang Tri province. The model   is based on the sustainable livelihood framework model of DIFID (2000) and adopts the set of indicators of factors affecting sustainable livelihoods of coastal communities in the Central Coast provinces The framework considers multiple dimensions: (i) people's living context, including the impacts of external trends on them (economic trends, technological trends, population growth trends, etc.), (ii) shocks (natural or human-induced) and time, (iii) people's access to livelihood assets (physical, human, financial, natural, social) and their ability to use them for production, (iv) the institutions, policies and organizations that shape people's livelihood types and (v) the livelihood strategies that people apply to pursue their goals are considered as aspects to build a theoretical model for identifying factors affecting sustainable livelihoods of farming households at the research sites [27].

Recent researches indicates that sustainable livelihoods of households are influenced by many factors at different levels. These include the gender of the household head [13,28], the number of dependents in the household [29,30], the age and production experience of the household head [13,31], the total area of land for production and awareness of climate change [28,29]. Other significant factors include income [18,28,32], and the level of education [29,33]. Additionally, studies highlight that cooperation and collaboration with enterprises, policies supporting agroforestry conversion, and access to capital sources can also affect the sustainable livelihoods of farming households [19,28,34]. Sustainable livelihood strategies are shaped by location, assets, income, opportunities, and social networks. As a result, their motivations and outcomes vary across different contexts, manifesting in diverse ways depending on local circumstances [35].

3. Methodology

3.1. The Study Sites

The research was conducted across 27 communes in four districts within the coastal forest area of Quang Tri province, excluding Con Co island district due to its distinct characteristics. These communes represent various types of coastal forests, including mangrove forests, sand forests, and soil-mountain forests. Within each commune or town, villages located in coastal forest areas were selected for the survey

Table 1. Distribution of survey locations.

District	Commune/Town
Gio Linh	• 7 communes: Gio Hai, Gio Mai, Gio My, Gio Quang; Gio Viet; Trung Giang; Trung Hai • 1 town: Cua Viet
Hai Lang	• 4 communes: Hai Ba, Hai Dinh, Hai Duong, Hai Que • 1 town: Dien Sanh
Trieu Phong	• 7 communes: Trieu An, Trieu Do, Trieu Lang, Trieu Phuoc, Trieu Son, Trieu Trach, Trieu Van
Vinh Linh	• 7 communes: Kim Thach, Trung Nam, Vinh Chap, Vinh Giang, Vinh Long, Vinh Thai, Vinh Tu

3.2. Affecting Factors on Sustainable Livelihoods of Coastal Forest Households in Quang Tri

In terms of model, the dependent variable (function - Y) is often affected by 2 groups of independent variables (variables - X): the group of uncontrollable variables (X_1) and the group of controllable variables (X_2): Y = f (X_1, X_2) [3.1]

Uncontrolled variables, also known as objective variables or external variables and indirectly influence Y at the macro level. The effect of X_1 on Y remains independent of controllable variables, as these variables are difficult modify. Therefore, in achieving desired Y, the research often considers variable X_1 to have a random impact and focuses less emphasis on managing this type of variable.

The controllable variable is called the subjective variable or internal variable, directly influences Y and is strongly shaped by human activities. The impact of X_2 on Y is direct and depends heavily on direct human intervention. Therefore, this study prioritizes on analyzing variables that has a direct impact on human livelihood. As a result, the sustainable livelihood of the coastal forest households in Quang Tri has been affected by two main groups of factors, encompassing 58 observed independent variables affecting livelihoods and four dependent variables representing livelihood outcomes in the coastal forest communities of Quang Tri.

Independent variables (influencing factors) include (i) natural resources with 5 factors; (ii) human resources with 9 factors; (iii) physical resources (public and private) with 6 factors; (iv) financial resources with 6 factors; (v) social and community resources with 13 factors; (vi) social and environmental trends with 6 factors; (vii) seasonal fluctuations with 3 factors; (viii) shocks with 7 factors; and (ix) livelihood strategies with 3 factors. Dependent variables include (i) income level; (ii) income stability; (iii) quality of life; and (iv) adaptability to change and risk. Table 2 provides a detail description of the 58 observed variables considered for selection and analysis in assessing the factors influencing the sustainable livelihoods of households.

Table 2. The details of independent and dependent variables.

#	Influencing factors	Items
A	**Independent variables**	
A1	**Natural resources**	**N**
1	Water resources	N1
2	Aquaculture water surface area	N2
3	Forests and forest land	N3
4	Cultivation land	N4
5	Crop varieties and aquatic breeding	N5
A2	**Human resources**	**H**
6	Number of members in family	H1
7	Number of labors	H2
8	Age	H3
9	Percentage of men and women	H4
10	Health	H5
11	Production experiences	H6
12	Education	H7
13	Skills	H8
14	Labor division	H9
A3	**Physical resources (public and private)**	**P**

15	Infrastructure: Roads, electricity, healthcare, schools	P1
16	Housing	P2
17	Public transport	P3
18	Barns and processing plants	P4
19	Technology/engineering (Aquaculture, livestock, etc.)	P5
20	Tools, means of production (Boats, means of transport, processing equipment)	P6
A4	**Financial Resources**	**F**
21	Capacity to access finance	F1
22	Household assets	F2
23	Regular income	F3
24	Credit	F4
25	Supports from State	F5
26	Savings	F6
A5	**Social resources**	**S**
27	Customary law	S1
28	Social evils	S2
29	Kinship relations	S3
30	Power structures	S4
31	Community/professional organizations	S5
32	Religion/beliefs	S6
33	Training facilities	S7
34	Information systems	S8
35	Transportation systems	S9
36	Connecting communities, businesses, and the state	S10
37	Administrative procedures	S11
38	Laws	S12
39	Policies	S13
A6	**Social and environmental trends**	**X**
40	Coastal tourism development	X1
41	Migration due to industrial zones	X2
42	New rural construction	X3
43	Agricultural restructuring (job conversion, crop structure change, etc.)	X4
44	Production practices (cultivation/fishing/aquaculture/livestock)	X5
45	Vocational training for farmers	X6
A7	**Seasonal fluctuations**	**D**
46	Production seasons	D1
47	Seasonal changes in weather/climate	D2

48	Market fluctuations	D3
A8	**Shocks**	**K**
49	Depleted aquatic resources	K1
50	Increased marine pollution	K2
51	Land loss for urbanization projects	K3
52	Climate change	K4
53	Disputes in the East Sea	K5
54	Land use planning changes	K6
55	Market requirements for changes	K7
A9	**Livelihood strategies**	**C**
56	Choosing crops/products	C1
57	Participating in new activities/Changing activities	C2
58	Adjusting the scale of activities	C3
B	**Dependent variables (Livelihood outcomes**	**SK**
1	Income level	SK1
2	Income stability	SK2
3	Quality of life	SK3
4	Adaptability Responding to Change/Risk	SK4

In order to consider and select affecting factors on the sustainable livelihoods of households in the coastal forest areas of Quang Tri, the study conducted a reliability assessment of the scales and an exploratory factor analysis as follows:

(i) Assess the reliability of the scales: test the scales by using the Cronbach's Alpha reliability coefficient and assess whether the independent variables (observed variables) reflect the nature of the dependent variable. The Cronbach's Alpha reliability coefficient indicates whether the measurements are linked to each other or not, however, it does not indicate which observed variables should be removed and which observed variables should be retained. The criteria for testing the reliability of the Cronbach's Alpha scale include a variable meeting the requirements when it has a total item correlation coefficient (Corrected Item - Total Correction) ≥ 0.3 and a Cronbach's Alpha coefficient ≥ 0.6; if an observed variable has a Cronbach's Alpha value greater than the Cronbach's Alpha coefficient and the total item correlation coefficient is < 0.3, that variable will also be eliminated.

(ii) The exploratory factor analysis (EFA): EFA is used to determine the observed variables (influencing factors) that truly affect the dependent variable. The objectives of EFA are: (1) to eliminate inappropriate variables by checking the factor loading coefficients and extracted variance; and (2) to evaluate the suitability of the research model through the KMO coefficient and to test the suitability of the model using the R^2 index.

The criteria for applying and selecting variables for EFA analysis include: (i) Bartlett's criteria and KMO coefficient used to evaluate the appropriateness of EFA. Accordingly, the hypothesis H_0 (variables are not correlated with each other in the population) is rejected and therefore EFA is considered appropriate when: $0.5 \leq KMO \leq 1$ and sig. < 0.05. In case KMO < 0.5, factor analysis is likely not appropriate for the data. (ii) The criteria for extracting factors include the Eigenvalue index (representing the amount of variation explained by the factors) and the Cumulative index (the total extracted variance shows how much % the factor analysis explains and how much % is lost). According to Gerbing and Anderson (1988), factors with Eigenvalue <1 will not have a better effect

of summarizing information than the original variable (latent variable in the scales before EFA). Therefore, factors are only extracted at Eigenvalue >1 and accepted when the total extracted variance ≥ 50%.

Factor loadings criteria represent simple correlations between variables and factors, used to evaluate the significance level of EFA: (i) Factor loading > 0.3 is considered to reach the minimum level; (ii) Factor loading > 0.4 is considered important; (iii) Factor loading > 0.5 is considered to have practical significance.

3.3. Sample Size and Sample Selection

Using the stratified random sampling method (Stratified Sampling), combined with consultation with officials of the Commune People's Committee to select a list of households in the study areas. According to Bui Hong Ha et al., 2022 (survey results of the coastal forest area in Quảng Trị), the coastal forest areas of Quang Tri includes 4 districts with 27 communes, with a population structure of 49.45% male, 50.55% female, and the occupational structure as follows: Agriculture: 40.63%; Livestock farming: 39.93%; Fishing and Aquaculture: 20.14%; Forestry: 6.25%; Services and Tourism: 6.60%; Trading: 4.17%; Housework: 12.5%; Workers: 0.35%; Public employees: 1.74%. Therefore, when selecting the surveyed households, it is necessary to adhere to these proportions. On the other hand, sample size depends on the research objectives, sampling method and selection of sample elements. According to the theory of large sample distribution, the EFA method requires a very large sample size [36]. However, the sample size depends on the statistical method used. According to Bollen [37], the minimum sample size is 5-10/1, meaning 5-10 observations for one parameter and not less than 100.

To ensure a large enough sample size for the study, it is necessary to calculate the sample size sufficient for the maximum groups of factors affecting the sustainable livelihoods of coastal forest households in Quang Tri. According to the theoretical model, there are 58 factors affecting the sustainable livelihoods of coastal forest households, therefore the minimum sample size required is 290 observations (58 observed factors x 5 observations = 290 observations). Thus, the minimum sample size is 290 households.

Based on the arguments above, each commune selected 10 - 20 households participated in the interview. Therefore, the total number of surveyed households in this study were 317 households, distributed in 4 districts: Gio Linh (n=89); Hai Lang (n=67); Trieu Phong (n=100) and Vinh Linh (n=61).

3.4. Data Collection Method

Secondary Data Collection

Secondary data and information were collected from various government levels (Province, District, Commune) as well as from reports, books and specialized magazines on coastal households and coastal forests. Additionally published documents, policies and decisions were also compiled from relevant sources. Data on research area's characteristics including geographical location, terrain, climate and weather, hydrological regime, land use, population, labor, infrastructure and socio-economic development were collected.

Primary Data Collection

Primary data were obtained from interviews with 317 households across 27 communes in four districts in Quang Tri province. The interview questionnaire was designed using a 5-point Likert scale for each item, supplemented by open-ended questions to further explore households' assessments. The main interview topics focused on livelihood resources, institutions/policies, livelihood strategies and livelihood outcomes.

3.5. Data Analysis Method

The data was processed with descriptive statistics through SPSS software. For each survey content, it is necessary to determine: Average value $\overline{x}$

$$\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n} \, , \qquad [3.2]$$

Standard error S

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} \left(x_i - \overline{x} \right)^2} \qquad [3.3]$$

In which:

x_i : i-the survey value; n : the number of survey values

4. Findings and Discussion

4.1. Theoretical Model of Factors Affecting Sustainable Livelihoods of Households in Coastal Forests Areas in Quang Tri Province

The theoretical model for analyzing factors influencing the sustainable livelihoods of household in coastal forests of Quang Tri province is based on the sustainable livelihood framework model of DIFID (2000) and adopts the set of indicators of factors affecting sustainable livelihoods of coastal communities in the Central Coast provinces [38]. On that basis, the theoretical model of factors affecting sustainable livelihoods of households in coastal forests of Quang Tri includes: 58 independent variables representing factors that influence livelihoods and 4 dependent variables reflecting household livelihood outcomes in the coastal forests of Quang Tri.   Figure 1 illustrates the theoretical model, highlighting the relationships between these influencing factors and livelihood outcomes.
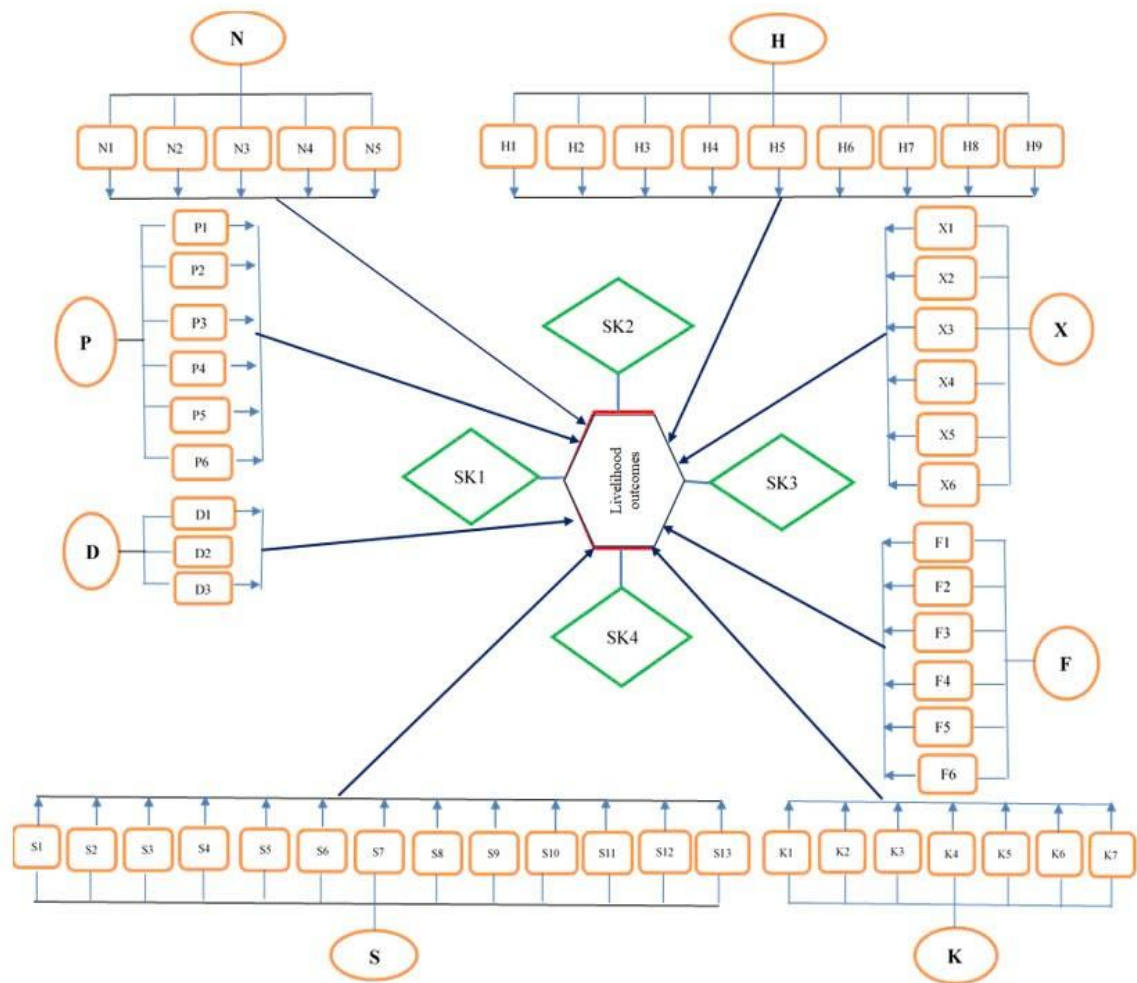
Figure 1. Theoretical model of factors affecting sustainable livelihoods of households in coastal forest areas of Quang Tri.

4.2. Practical Model of Factors Affecting Sustainable Livelihoods of Households in the Coastal Forest Areas in Quang Tri

The results of surveys of 317 households in 27 communes of 4 districts in the coastal forest areas were coded and compiled into summary tables and processed using the EFA method. The reliability of the scale was assessed through Cronbach's Alpha (Table 3) and analysis of the quality of the scale using the total variable correlation coefficient (Table 4). The results indicated that all variables (factors) had: (i) Cronbach's Alpha coefficient > 0.7; (ii) Total variable correlation coefficient > 0.3. These findings confirm that the five-level scale is appropriate, consisting of 58 independent variables representing influencing factors and 4 dependent variables reflecting livelihood outcomes.

Table 3. The results of scale quality analysis using Cronbach's Alpha coefficient.

TT	Factor groups	Items	Number of variables	Number of variables remaining	Cronbach's Alpha coefficient
A	**Independent variables**		**58**	**58**	
A1	Natural resources	N	5	5	.737
A2	Human resources	H	9	9	.887

A3	Physical resources (public and private)	P	6	6	.786
A4	Financial Resources	F	6	6	.825
A5	Social resources and community	S	13	13	.892
A6	Social and environmental trends	X	6	6	.775
A7	Seasonal fluctuations	D	3	3	.779
A8	Shocks	K	7	7	.726
A9	Livelihood strategies	C	3	3	.749
B	**Dependent variables (Livelihood outcomes) (SK)**	**SK**	**4**	**4**	**.853**

Table 4. Results of the analysis of the total variable correlation coefficient.

	Factors	Items	Number of variables	Total variable correlation coefficient	Number of remaining variables
A	**Independent variables**		58		58
A1	**Natural resources**	**N**	5		5
1	Water resources	N1		.392	
2	Aquaculture water surface area	N2		.422	
3	Forests and forest land	N3		.547	
4	Cultivation land	N4		.594	
5	Crop varieties and aquatic breeding	N5		.556	
A2	**Human resources**	**H**	9		9
6	Number of members in family	H1		.528	
7	Number of labors	H2		.684	
8	Age	H3		.680	
9	Percentage of men and women	H4		.563	
10	Health	H5		.728	
11	Production experiences	H6		.673	
12	Education	H7		.623	
13	Skills	H8		.677	
14	Labor division	H9		.609	
A3	**Physical resources (public and private)**	**P**	6		6
15	Infrastructure: Roads, electricity, healthcare, schools	P1		.469	

16	Housing	P2			.489	
17	Public transport	P3			.586	
18	Barns and processing plants	P4			.540	
19	Technology/engineering (Aquaculture, livestock, etc.)	P5			.596	
20	Tools, means of production (Boats, means of transport, processing equipment)	P6			.549	
A4	**Financial Resources**	**F**	6			6
21	Capacity to access finance	F1			.511	
22	Household assets	F2			.612	
23	Regular income	F3			.655	
24	Credit	F4			.632	
25	Supports from State	F5			.602	
26	Savings	F6			.557	
A5	**Social resources and community**	**S**	13			13
27	Customary law	S1			.640	
28	Social evils	S2			.521	
29	Kinship relations	S3			.595	
30	Power structures	S4			.596	
31	Community/professional organizations	S5			.601	
32	Religion/beliefs	S6			.381	
33	Training facilities	S7			.614	
34	Information systems	S8			.635	
35	Transportation systems	S9			.637	
36	Connecting communities, businesses, and the state	S10			.632	
37	Administrative procedures	S11			.630	
38	Laws	S12			.658	
39	Policies	S13			.492	
A6	**Social and environmental trends**	**X**	6			6
40	Coastal tourism development	X1			.441	
41	Migration due to industrial zones	X2			.511	
42	New rural construction	X3			.531	

43	Agricultural restructuring (job conversion, crop structure change, etc.)	X4		.564	
44	Production practices (cultivation/ fishing/aquaculture/ livestock)	X5		.612	
45	Vocational training for farmers	X6		.473	
A7	**Seasonal fluctuations**	**D**	**3**		**3**
46	Production seasons	D1		.548	
47	Seasonal changes in weather/climate	D2		.728	
48	Market fluctuations	D3		.584	
A8	**Shocks**	**K**	**7**		**7**
49	Depleted aquatic resources	K1		.345	
50	Increased marine pollution	K2		.503	
51	Land loss for urbanization projects	K3		.355	
52	Climate change	K4		.592	
53	Disputes in the East Sea	K5		.435	
54	Land use planning changes	K6		.483	
55	Market requirements for changes	K7		.382	
A9	**Livelihood strategies**	**C**	**3**		**3**
56	Choosing crops/products	C1		.523	
57	Participating in new activities/Changing activities	C2		.608	
58	Adjusting the scale of activities	C3		.601	
B	**Dependent variables (Livelihood outcomes)**	**SK**	**4**		**4**
1	Income level	SK1		.731	
2	Income stability	SK2		.751	
3	Quality of life	SK3		.743	
4	Adaptability Responding to Change/Risk	SK4		.568	

4.3. The Factors Affect the Sustainable Livelihood of Households in Coastal Forest Areas in Quang Tri

Based on the practical model of factors affecting the sustainable livelihood of households in Quang Tri province's coastal forest areas, the study conducted an EFA to identify the key factors that significantly impact household sustainability. The EFA suitability test was performed three times, ultimately identifying 42 variables that directly affect the sustainable livelihoods of households in these areas.

The first analysis eliminated 12 variables including N1; X4, X5; S2, S5, S7, S9, S13; H9; P3; K3 and F1 because they did not meet the EFA criteria (criteria in the rotation matrix). The second analysis

eliminated 4 variables including S8; H7, H8 and P2 were rejected because they did not meet the EFA criteria (criteria in the rotation matrix). The third analysis using KMO and Bartlett's tests gave the results in Table 5.

Table 5. The test of KMO and Bartlett's.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.871
Bartlett's Test of Sphericity	Approx. Chi-Square	5528.845
	df	861
	Sig.	.000

The results of Table 5 show that KMO = 0.871 is suitable for the condition 0.5 <KMO <1, therefore, EFA is suitable for the current data. It means that the observed variables are related to each other. Bartlett's test has a significant level of Sig. <0.05. Thus, the observed variables are linearly correlated with the representative variable. Results show that there are 42 variables that really affect the sustainable livelihoods of the coastal forest households of Quang Tri (satisfying the conditions for EFA). Therefore, the practical model (adjusted model) of factors affecting the sustainable livelihoods of the coastal forest households of Quang Tri is as shown in Figure 2:
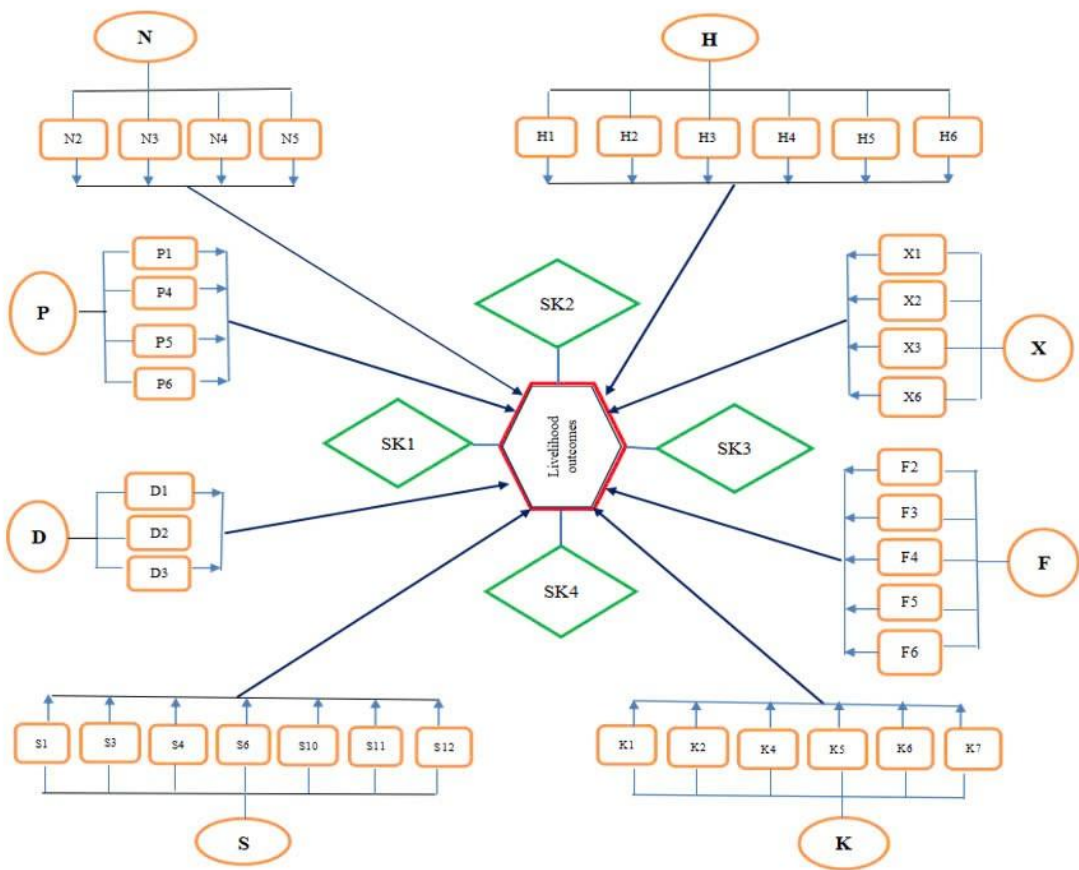
Figure 2. Practical model of factors affecting sustainable livelihoods of households in coastal forest areas of Quang Tri.

4.4. Analysis of Factors Affecting Sustainable Livelihoods of Coastal Forest Households in Quang Tri

The general equation of factors affecting sustainable livelihoods of coastal forest households in Quang Tri is as follows: SK = f (N, H, P, F, S, X, D, K, C) [3.4], in which:

(i) SK: Sustainable livelihoods of coastal forest residents in Quang Tri;

(ii) N, H, P, F, S, X, D, K, C: Factors affecting sustainable livelihoods of coastal forest households in Quang Tri (see Table 3 for details)

Assume that the relationship SK = f (N, H, P, F, S, X, D, K, C) is a linear correlation according to the equation: SK = $\beta_0 + \beta_1 N + \beta_2 H + \beta_3 P + \beta_4 F + \beta_5 S + \beta_6 X + \beta_7 D + \beta_8 K + \beta_9 C$ [3.5]

And the expectation of the signs of the coefficients: (i) $\beta_0 \leq 0$: When the input factors are 0, the livelihood results of household cannot be ≤ 0, so the intercept coefficient must take values ≥ 0; (ii) $\beta_2, \beta_3, \beta_4 > 0$: When this resource increases, the livelihood results increase and vice versa with conditions of factors unchanged (positive relationship); (iii) $\beta_8 > 0$: When shocks and crises occur, the livelihood results will decrease and vice versa with conditions of other factors unchanged (negative relationship); and (iv) $\beta_1, \beta_5, \beta_6, \beta_7, \beta_9$: Undetermined because it depends on the values of the variables N, S, X, D, and C

Table 6. The Coefficience value.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	.611	.275		2.217	.027
	N	-.057	.047	-.060	-1.200	`.231
	H	.196	.054	.209	3.668	.000
	P	.089	.055	.097	1.615	.107
1	F	.206	.053	.210	3.891	.000
	S	.255	.063	.241	4.080	.000
	X	-.089	.060	-.089	-1.480	.140
	D	.244	.046	.280	5.352	.000
	K	-.027	.055	-.021	-.486	.627
	C	.030	.043	.029	.694	.488

a. Dependent Variable: SK

The results of the analysis of variance show that (i) the correlation coefficient $R^2 = 0.484$, which means that 48.4% of the change in the livelihoods of the coastal forest households of Quang Tri is explained by the independent variables of the equation; (ii) VIF < 10, so the equation does not have multicollinearity; (iii) the Durbin Watson coefficient (1< d = 1.596 < 3), so the equation does not have multicollinearity. Thus, the correlation equation between the influencing factors and sustainable livelihoods of the coastal forest households of Quang Tri has the following form:

SK= 0.611-0.057N+0.196H+0.089P+0.206F+0.255S-0.089X+0.244D-0.027K+0.030C [3.6]

From equation [3.6], the estimated coefficients of the model show that:

$\widehat{\beta_1} = -0.057$: When natural resources (N) increase by 1, the average livelihood of households in forest coastal areas in Quang Tri decreases by -0.057 units and vice versa with assuming other factors remain constant.

$\widehat{\beta_2} = 0.196$: When human resources (H) increase by 1, the average livelihood of households in forest coastal areas in Quang Tri increases by 0.196 units and vice versa with assuming other factors remain constant.

$\widehat{\beta_3} = 0.089$: When physical resources (public and private) (P) increase by 1, the average livelihood of households in forest coastal areas in Quang Tri increases by 0.089 units and vice versa with assuming other factors remain constant.

$\widehat{\beta_4} = 0.206$: When financial resources (F) increase by 1, the average livelihood of households in forest coastal areas in Quang Tri increases by 0.206 units and vice versa with assuming other factors remain constant.

$\widehat{\beta_5} = 0.255$: When social and community resources (S) increase by 1, , the average livelihood of households in forest coastal areas in Quang Tri increases by 0.255 units and vice versa with assuming other factors remain constant.

$\widehat{\beta_6} = -0.089$: When social and environmental trends (X) increase by 1, the average livelihood of households in forest coastal areas in Quang Tri decreases by 0.089 units and vice versa with assuming other factors remain constant.

$\widehat{\beta_7} = 0.244$: When seasonal fluctuations (D) increase by 1 the average livelihood of households in forest coastal areas in Quang Tri increases by 0.244 units and vice versa with assuming other factors remain constant.

$\widehat{\beta_8} = 0.027$: When shocks (K) increase by 1, the average livelihood of households in coastal forest areas in Quang Tri decreases by 0.027 units and vice versa with assuming other factors remain constant.

$\widehat{\beta_9} = 0.030$: When livelihood strategy (C) increases by 1, the average livelihood of households in coastal forest areas in Quang Tri increases by 0.030 units and vice versa with assuming other factors remain constant.

Key factors influencing the sustainable livelihoods of households in coastal forest areas in Quang Tri

The study findings indicate that the factors affecting the sustainable livelihoods of households in coastal forest areas can be categorized into two groups The first group consists of factors with a positive coefficient (>0) meaning they contribute positively to the development of sustainable livelihoods. When the value of these factors increases, the livelihood becomes more and more sustainable. They include six group factors. Firstly factors related to human resources include family population; number of workers; age; male-female ratio; health and production experience. Secondly, factors related to physical resources (public and private ownership) include infrastructure, roads, electricity, healthcare, schools; barns, processing plants, techniques/technology, and means of production. Thirdly, Factors related to financial resources include family assets; regular income; credit; state support; and savings. Fourthly, factors related to social and community resources include village regulations or customary laws; kinship relations; power structure; religion/beliefs; connections between community, enterprises, state and technology transfer; and administrative procedures and laws. Fifthly, factors related to seasonal fluctuations include production seasons; seasonal changes in weather/climate; fluctuations in product consumption markets. Finally, factors related to livelihood strategies include choosing crops/products; participating in new activities/changing activities and adjusting the scale of production. These factors play a crucial role in enhancing the resilience and sustainability of livelihoods in Quang Tri's coastal forest areas.

Factors Negatively Affecting the Sustainable Livelihoods of Households in Coastal Forest Areas in Quang Tri

The second group consists of factors with negative coefficients (<0), meaning they hinder the sustainable livelihood development of households in coastal areas. As these factors increase in value, livelihoods become more vulnerable and unsustainable. This group includes three main categories: (i) factors related to social and environmental trends such as coastal tourism development, migration to industrial zones, new rural construction, vocational training for farmers; (ii) factors related to shock

and crisis such as depleted aquatic resources, increased marine pollution, climate change, changes in land use planning, and changes market demands; and (iii) factors related to natural resources such as aquaculture water surface area, forests and forest land, cultivated and production land, and crop and aquatic varieties. These factors pose significant challenges to the stability and sustainability of livelihoods in Quang Tri's coastal forest areas, making it essential to develop strategies that mitigate their negative effects.

Numerous studies have highlighted , natural resources as a key factor in promoting sustainable livelihood development [10,39–41]. Natural resources serve as a crucial and indispensable input for sustainable livelihood development [3,42]. However, the results of this study indicate that in the context of coastal forest areas in Quang Tri, natural resources have a negative impact on the sustainable livelihood of households due to several reasons.

First, in terms of unfavorable soil conditions: the forest and agricultural land in Quang Tri's coastal areas consists primarily of sandy soils, which are poor in nutrients and difficult to cultivate. As the forested area expands, the available land for cultivation shrinks, negatively impacting livelihoods. Second, in terms of limited economic benefits from forests: coastal forests in Quang Tri are classified entirely as protective forests, and most of the trees are still young. Consequently, households do not generate income from timber or non-timber forest products. Additionally, they do not yet receive payments for forest protection or environmental services, limiting economic opportunities from forest resources. Third, in terms of low productivity of forest plant varieties: the current forest plant species are not well suited to the site's environmental conditions, resulting in low productivity and minimal economic value for local households. Final, in terms of limited engagement in aquaculture: most households in Quang Tri's coastal forest areas engage in crop cultivation, livestock farming, and the capture and processing of aquatic products rather than aquaculture. As a result, aquaculture-related natural resources provide little benefit, further reinforcing the negative impact of this factor on livelihoods. Overall, while natural resources are typically seen as a driver of sustainable development, the specific conditions in Quang Tri's coastal forest areas make them a constraint rather than an asset for local livelihoods.

4.5. Impact Levels of Factors on the Sustainable Livelihoods of Coastal Forest Households in Quang Tri

From equation [3.6], the findings indicate that various factors influence the sustainable livelihoods of coastal forest households in Quang Tri different impact levels. These factors are categorized into positive and negative impact groups and ranked across six levels, with Level 1 representing the highest impact (corresponding to the largest coefficient) and Level 6 representing the lowest impact (corresponding to the smallest coefficient) (Table 7).

Table 7. Impact levels of factors on sustainable livelihoods of coastal forest households in Quang Tri.

#	Factors	Items	Coefficient Value	Impact Level (Highest: 1 and lowest is 6)
A	**POSSITIVE IMPACT**			
A1	**Social resources and community (S)**	**S**	**0.255**	**1**
1	Customary law	S1		
2	Kinship relations	S3		
3	Power structures	S4		
4	Religion/beliefs	S6		

5	Connecting communities, businesses, and the state	S10		
6	Administrative procedures	S11		
7	Laws	S12		
A2	**Seasonal fluctuations**	**D**	**0.244**	**2**
1	Production seasons	D1		
2	Seasonal changes in weather/climate	D2		
3	Market fluctuations	D3		
A3	**Financial resources**	**F**	**0.206**	**3**
1	Household assets	F2		
2	Regular income	F3		
3	Credit	F4		
4	Supports from State	F5		
5	Savings	F6		
A4	**Human resources**	**H**	**0.196**	**4**
1	Number of members in family	H1		
2	Number of labors	H2		
3	Age	H3		
4	Percentage of men and women	H4		
5	Health	H5		
6	Production experiences	H6		
A5	**Physical resources (public and private)**	**P**	**0.089**	**5**
1	Infrastructure: Roads, electricity, healthcare, schools	P1		
2	Barns and processing plants	P4		
3	Technology/engineering (Aquaculture, livestock, etc.)	P5		
4	Tools, means of production (Boats, means of transport, processing equipment)	P6		
A6	**Livelihood strategies**		**0.030**	**6**
1	Choosing crops/products	C1		
2	Participating in new activities/Changing activities	C2		
3	Adjusting the scale of activities	C3		
B	**NEGATIVE IMPACTS**			
B1	**Social and environmental trends**		**- 0.089**	**1**
1	Coastal tourism development	X1		

2	Migration due to industrial zones	X2		
3	New rural construction	X3		
4	Vocational training for farmers	X6		
B2	**Natural resources**	**N**	**- 0.057**	**2**
1	Aquaculture water surface area	N2		
2	Forests and forest land	N3		
3	Cultivation land	N4		
4	Crop varieties and aquatic breeding	N5		
B3	**Shocks**	**K**	**- 0.027**	**3**
1	Depleted aquatic resources	K1		
2	Increased marine pollution	K2		
3	Climate change	K4		
4	Disputes in the East Sea	K5		
5	Land use planning changes	K6		
6	Market requirements for changes	K7		

In addition, to exploring the factors that positively or negatively effect on the sustainable livelihoods of households in the coastal forest areas of Quang Tri, this study also assesses the impact level of these factors (Table 6). The analysis results show that, among the positive factors, social and community resources have the most significant influence on the sustainable livelihoods of households. In many societies, particularly in East Asian cultures, cultural and religious values, along with community bonds, serve as the foundation for sustainable social development, including livelihood stability [43–45]. In Vietnam, the social structure is deeply rooted in the village networks and kinship ties, reflected in traditional sayings such as "The king's law is weaker than the village's law" or "Sell distant brothers to buy close neighbors", emphasizing the importance of local community relationships. Therefore, if agricultural or development staff do not understand these community relationships, supporting households in achieving sustainable development becomes highly challenging. At the same time, a sustainable society cannot function without a legal foundation, power structures, and administrative procedures [46–48]. These elements from the super-structure, helping to regulate, balance and stabilize society that are the foundation of sustainable development. As a result, the development of sustainable livelihoods of households in coastal forest areas is positively affected by these factors. The connection between the communities, businesses and the state services as a driving force of development [2,49,50]. This collaboration facilitates efficient supply chains, ensuring smooth operations across supply, production, and distribution. Consequently, it enhances the value of the products and creates the market accessibility [51,52]. Moreover, transferring technologies plays a vital role in increasing labor productivity, reducing product costs, and enhancing product competitiveness. Therefore, these factors are fundamental to the sustainable development of the economy in general and the coastal forest areas in particular.

Seasonal fluctuations have the second largest impact on the sustainable livelihoods of households in Quang Tri's coastal forest areas. Climate change always has consistently posed serious challenges toagricultural, forestry, and fishery production [53–55]. Therefore, changes of seasonal calendar have significant influence on result livelihood of households. If the seasonal calendar does not align with changing weather and climate conditions, the livelihood outcomes may be severely affected or even reduced to zero [56,57]. This situation is consistency with the conditions of the coastal forest areas of Quang Tri. If the crops and trees grow in the southwest monsoon season that blows in

summer with hot and dry nature, they have been seriously affecting all crops and other agricultural activities. Additionally, if farmers harvest crops or livestock after October and November, they face a high risk of productivity losses due to floods, storms, and heavy rains.

With the rise of commodity production and deep international integration, the market demand for products increasingly dictates production supply [58–60]. The fluctuations in the product consumption market play a crucial role in regulating and adjusting production [28,61,62]. As a result, these market fluctuations ultimately determine whether production leads to profit or loss.

Financial resources including: family assets, regular income, credit, state support and savings are essential for sustaining household livelihoods. This is particularly true for households in coastal forest areas, where the average income per capita is low, making financial resources even more important. However, given that the primary livelihood activities in these areas revolve around small-scale agriculture, livestock farming, and aquaculture, financial capital, while necessary, is not the sole determining factor for livelihood sustainability.

Both public and private material resources play a crucial role in supporting livelihoods. Infrastructural development typically precedes and facilitates livelihood growth. However, in the coastal region of Quang Tri, challenging terrain characteristics and site conditions, it is very difficult to develop infrastructure. Additionally, due to the small-scale and fragmented nature of production, which has not yet reached a commodity-based level, the impact of material resources on livelihood activities remains limited. Nevertheless, with the ongoing economic development trend of coastal areas, this factor is expected to play an increasingly significant role in shaping the sustainable livelihoods of residents in the near future.

Livelihood strategies encompass the combinations of activities and choices people make to achieve their livelihood objectives [63,64]. These strategies vary depending on resources availability, with households in different conditions adopting different approaches. In some cases, they serve as short-term responses to shocks or risk management. When effective, livelihood strategies enhance household resilience and stability. In the coastal forest areas of Quang Tri province, where infrastructure has been underdeveloped, terrain conditions are challenging, and production remains small-scale and self-sufficient, livelihood strategies are primarily focused on coping with harsh weather conditions. Households rely on adaptive production activities to withstand storms, floods, and extreme droughts, ensuring the survival of crops and livestock. As a result, these strategies remain simple and lack diversity.

Among the negative impact factors, social and environmental trends play a significant role in influencing household livelihood outcomes. While these trends can have both positive and negative effects on sustainable livelihoods, their impact in the coastal forest areas of Quang Tri province has been largely unfavourable. Tourism remains underdeveloped in the region, with only Cua Tung and Cua Viet towns experiencing limited growth, primarily in the form of drinking and karaoke establishments. These businesses have introduced social issues from other areas, negatively affecting local youth and, in turn, impacting their livelihoods. Additionally, due to limited agricultural land, low income, and scarce job opportunities in their hometowns, many young workers seek employment elsewhere. This labour migration weakens local livelihood activities, which primarily rely on agriculture and forestry. The movement to build new rural areas and vocational training for farmers in the Quang Tri province have also faced challenges. A lack of budget funding, combined with the low income of residents, has hindered progress, making contribution to rural development a financial burden for many households.

Natural resources are a very important factor for localities in all aspects of development, including livelihood development [65]. However, for local communities, natural resources are only potential rather than immediate benefits for livelihood improvement. In Quang Tri province's coastal forest areas, while the land area is extensive, much of the terrain consists of sandy soil and flood-prone zones. Therefore, despite the seemingly large land availability the actual cultivated land per household remains limited. Moreover, Moreover, the forests in this region are designated entirely as protective forests, restricting their use for economic activities. In some cases, forest protection

responsibilities become a burden for households, as they receive minimal benefits, with compensation amounting to only 500,000 VND per hectare per year. Consequently, both in the present and the short term, natural resources exert a negative impact on household livelihoods rather than serving as an asset for development. The study results indicate that the majority of households engage in farming and animal husbandry (80.56%); 20.14% in fishing and aquaculture, and 6.25% in forestry. With this occupational structure, several factors have directly and negatively impacted household's dependent on aquatic resources-based livelihoods. These include depletion of aquatic resources, increasing marine pollution; territorial disputes in the East Sea; and climate change. Additional, changes inland use planning such as the development of economic zones and tourism—along with evolving market demands for products and pricing, have had immediate and adverse effects on household livelihoods in the region. To mitigate these impacts, the State should implement appropriate and equitable policies to support households that have lost their land, helping to counteract these challenges and promote sustainable livelihoods.

5. Conclusions

Sustainable livelihoods of households in developing countries, particularly in the context of extreme weather events and socio-economic fluctuations, depend on multiple factors and resources. Specially, livelihoods of households in coastal forest ecological zones are influenced on not only by their abilities to access livelihood capital but also by external factors such as soil, water, markets, and production experience. However, identifying which factors contribute positively and which have negatively impacted remains a key area of research. The research finding present the theoretical model of factors affecting sustainable livelihoods of households in coastal forests areas of Quang Tri province The study identifies 58 independent variables influencing livelihoods and four dependent variables. After conducting KMO and Bartlett's tests, as well as an exploratory factor analysis (EFA), the practical model was refined to include 42 independent variables..

The analysis reveals two key groups of factors influencing sustainable livelihoods in coastal forest areas. The first group consists of factors with a positive coefficient (>0), meaning they positively impact sustainable livelihood development. These include: (i) human resources, (ii) physical resources, (iii) financial resources, (iv) social and community resources, (v) seasonal fluctuations, and (vi) livelihood strategies. The second group consists of factors with a negative coefficient (<0), indicating adverse effects on sustainable livelihood development. These include: (i) social and environmental trends, (ii) shocks and crises, and (iii) natural resource constraints. Results of research also analyze the influence levels of different factors on the sustainable livelihoods of households. In there, social and community resources factors are the highest positive influence, whereas social and environmental trends exert the most significant negative impact. Moving forward, the study suggests that enhancing labor productivity, reducing production costs, and increasing product competitiveness should be key priorities. These goals should be pursued within a framework that considers transformative social learning. Additionally, policymakers should develop targeted and appropriate interventions to support households significantly affected by climate change and socio-economic transitions.

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