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The Role of Coastal Environmental Characteristics in Shaping Local Food Access and Household Food Security in Pasirido, Manokwari

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A B S T R A C T

Household food security in coastal communities is influenced by complex interactions among environmental conditions, local food resources, and socioeconomic characteristics. This study aimed to examine the role of coastal environmental characteristics in shaping local food access and household food security in Pasirido, Manokwari, West Papua, Indonesia. A quantitative cross-sectional survey was conducted involving 80 household heads selected from coastal households. Data were collected through structured questionnaires and analyzed using descriptive statistics and Structural Equation Modeling–Partial Least Squares (SEM-PLS). The results revealed that fisheries remain the primary source of local food and household livelihoods, while most households depend on purchased food as their main food source. Household food security was categorized as relatively good, indicated by year-round food availability, adequate food reserves, and regular meal frequency. SEM-PLS analysis showed that coastal environmental characteristics significantly influenced socioeconomic characteristics ($\beta = -0.667$; $p < 0.001$) and local food access ($\beta = 0.795$; $p < 0.001$). Socioeconomic characteristics had a positive and significant effect on household food security ($\beta = 0.689$; $p < 0.001$). However, the direct effects of coastal environmental characteristics ($\beta = -0.247$; $p = 0.057$) and local food access ($\beta = 0.161$; $p = 0.340$) on household food security were not statistically significant. The model explained 28.6% of the variation in household food security. The findings suggest that coastal environmental conditions affect household food security primarily through socioeconomic pathways rather than through direct food access mechanisms. Strengthening household economic resilience, livelihood diversification, and sustainable coastal resource management is therefore essential for improving food security in coastal communities. These results contribute to the understanding of food security dynamics within coastal social-ecological systems and provide evidence for integrated coastal development and food security policies in Papua and similar coastal regions

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INTRODUCTION

Food security remains one of the most critical challenges confronting coastal communities worldwide (Indouw, Maturbongs, and Prabawardani 2022; Kabir and Islam 2023). Although coastal areas are often endowed with abundant marine resources and rich ecological assets, many coastal households continue to experience varying degrees of food insecurity due to environmental degradation, climate variability, economic vulnerability, and limited access to sustainable food systems. The concept of food security encompasses four interrelated dimensions: food availability, food access, food utilization, and food stability. Achieving food security is particularly challenging in coastal regions where household livelihoods are closely linked to natural resource availability and environmental conditions. In Indonesia, coastal communities play a significant role in supporting national food systems through fisheries, aquaculture, and coastal agriculture (Anna 2019; Pathan et al. 2012). However, many coastal households remain vulnerable to poverty, fluctuating incomes, environmental hazards, and resource depletion. Coastal populations often depend on fishing activities as their primary livelihood, making them highly sensitive to changes in marine ecosystems, weather conditions, and market dynamics. Consequently, the sustainability of coastal ecosystems directly influences local food access and household food security.

The relationship between environmental characteristics and food security has gained increasing attention in recent years. Environmental characteristics such as water availability, coastal ecosystem quality, marine resource productivity, pollution levels, and climatic conditions influence the capacity of households to obtain food from local sources. In coastal areas, environmental degradation can reduce fish catches, limit access to food resources, and undermine household resilience. Conversely, healthy coastal ecosystems can provide stable food supplies and support sustainable livelihoods, thereby enhancing household food security. Pasirido, located in Pasir Putih Village, Manokwari Regency, West Papua Province, represents a typical coastal community where household livelihoods depend heavily on fisheries and marine resources. The area possesses significant coastal resource potential; however, local households also face environmental challenges including marine pollution, weather variability, and increasing dependence on market-based food systems. Understanding how coastal environmental characteristics influence local food access and household food security is therefore essential for designing effective food security and coastal development policies.

Globally, the Food and Agriculture Organization (FAO) estimates that more than 700 million people continue to experience hunger, while billions remain vulnerable to food insecurity due to economic, environmental, and climatic shocks (Pandey, Mahendra Dev, and Jayachandran 2016; Shukla et al. 2018; Stellmacher and Kelboro 2019; Gomiero, Pimentel, and Paoletti 2011). Coastal communities are among the most vulnerable populations because their livelihoods are closely tied to natural resources that are increasingly affected by climate change and environmental degradation. Indonesia possesses one of the world's longest coastlines, extending over 95,000 km and supporting millions of

households whose livelihoods depend on marine and coastal resources. Fisheries contribute significantly to household nutrition and income generation, particularly in eastern Indonesia. Nevertheless, coastal communities often face multiple challenges, including declining fish stocks, marine pollution, fluctuating food prices, and limited livelihood diversification.

Empirical findings from Pasirido indicate that fisheries remain the primary source of local food and household income. Most households rely on purchased food despite living in resource-rich coastal environments. The study also reveals that marine pollution, particularly from household waste and coastal litter, has become a widespread environmental concern. Although food is generally available throughout the year, households frequently experience rising food prices and remain vulnerable to environmental disturbances such as adverse weather conditions that affect fishing activities and food acquisition. The preliminary results further demonstrate that coastal environmental characteristics strongly influence local food access, while socioeconomic conditions significantly affect household food security. These findings suggest that environmental sustainability and socioeconomic resilience are closely interconnected in shaping food security outcomes among coastal households. Previous studies have extensively examined household food security from socioeconomic, agricultural, and livelihood perspectives. Many studies have identified income, education, household size, and employment as important determinants of food security. Other studies have explored the impacts of climate change, fisheries productivity, and environmental degradation on coastal livelihoods (Ogello 2013; Saraswati 2023; Enkin Asrawijaya 2024).

However, several gaps remain in the existing literature. First, relatively few studies have simultaneously investigated the relationships among coastal environmental characteristics, local food access, socioeconomic conditions, and household food security within a unified analytical framework. Second, most food security studies in Indonesia focus on agricultural regions, while empirical evidence from coastal communities in eastern Indonesia, particularly Papua, remains limited. Third, previous research often treats environmental factors as external conditions rather than examining their direct and indirect pathways influencing food security outcomes. Furthermore, limited attention has been given to understanding how environmental characteristics shape local food access and subsequently influence household food security. The potential mediating role of local food access in linking environmental conditions to food security remains underexplored. Therefore, a more comprehensive analytical approach is required to explain these complex interactions within coastal social-ecological systems (Donner and Rodríguez 2008; Gómez-Baggethun et al. 2012; Li 2018).

This study aims to examine the role of coastal environmental characteristics in shaping local food access and household food security in Pasirido, Manokwari. Specifically, the study seeks to Analyze the characteristics of coastal environments, local food resources, socioeconomic conditions, and household food security in Pasirido, examine the influence of coastal environmental characteristics on local food access, to assess the influence of

coastal environmental characteristics on socioeconomic conditions, evaluate the effects of socioeconomic conditions on household food security, investigate the direct and indirect relationships among coastal environmental characteristics, local food access, socioeconomic factors, and household food security using the Structural Equation Modeling–Partial Least Squares (SEM-PLS) approach. The findings are expected to contribute to the growing literature on coastal food security and provide evidence-based recommendations for strengthening sustainable food systems, environmental management, and livelihood resilience in coastal communities of Papua and other developing coastal regions.

LITERATURE REVIEW

Food Security Theory

Food security is a multidimensional concept that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life (Trendov 2018; Hervas 2020). The concept is commonly structured around four interconnected dimensions: food availability, food access, food utilization, and food stability.

Food availability refers to the presence of sufficient quantities of food from production, fisheries, trade, or other sources. Food access concerns households' ability to acquire food through purchasing, production, exchange, or social support. Food utilization focuses on the effective consumption and nutritional use of food, while food stability addresses the continuity of food availability and access over time despite economic, environmental, or climatic shocks.

In coastal communities, food security is strongly influenced by both environmental conditions and household socioeconomic capacity. Although coastal ecosystems may provide abundant food resources, households can remain food insecure when environmental degradation reduces resource productivity or when economic limitations restrict access to available food. Therefore, food security outcomes emerge from interactions between ecological systems and socioeconomic conditions.

Sustainable Livelihoods Framework

The Sustainable Livelihoods Framework (SLF) (Salafsky and Wollenberg 2000; Yang et al. 2019) developed by the Department for International Development (DFID) provides an important theoretical lens for understanding how households secure food and maintain livelihoods. The framework emphasizes that livelihood outcomes are determined by access to multiple forms of capital, including natural, human, financial, physical, and social capital.

In coastal communities, natural capital includes fisheries resources, coastal ecosystems, water resources, and environmental quality. Human capital encompasses education, knowledge, and labor capacity. Financial capital refers to income, savings, and access to financial resources. These capitals collectively influence households' ability to obtain food and respond to environmental or economic disturbances.

Within this framework, coastal environmental characteristics represent a critical component of natural capital that directly affects local food availability and livelihood opportunities. Environmental conditions influence fishing

productivity, access to marine resources, and food-producing activities. Consequently, households with stronger livelihood assets are generally better equipped to maintain food security despite environmental uncertainties.

Social-Ecological Systems Perspective

The Social-Ecological Systems (SES) Framework provides a complementary perspective by emphasizing the dynamic interactions between human societies and ecological systems (Hervas 2020; Junquera et al. 2022; Reyes-García et al. 2014). According to this framework, food security outcomes cannot be understood solely through economic or environmental variables; rather, they emerge from complex interactions between environmental resources, institutions, socioeconomic characteristics, and human behavior.

Coastal communities represent classic social-ecological systems because livelihoods depend heavily on ecosystem services generated by marine and coastal environments. Changes in environmental conditions such as marine pollution, weather variability, ecosystem degradation, and resource availability affect household access to food resources and economic opportunities. At the same time, human activities influence the condition and sustainability of coastal ecosystems.

The SES perspective suggests that household food security is influenced not only by environmental productivity but also by households' capacity to adapt to environmental changes through socioeconomic resources and livelihood strategies. This perspective is particularly relevant to coastal regions where environmental vulnerability and livelihood dependence are closely interconnected.

Conceptual Relationship among Variables

Drawing upon Food Security Theory, the Sustainable Livelihoods Framework, and the Social-Ecological Systems perspective, this study proposes that household food security is shaped by interactions among coastal environmental characteristics, local food access, and socioeconomic conditions.

Coastal environmental characteristics influence the availability and accessibility of local food resources by affecting fisheries productivity, environmental quality, and resource utilization opportunities. Environmental conditions also affect socioeconomic characteristics because household livelihoods and incomes depend substantially on coastal resources. Socioeconomic characteristics, including education, occupation, income, and household expenditure capacity, determine households' ability to acquire, utilize, and stabilize food consumption.

Within this framework, local food access functions as an intermediary mechanism linking environmental resources to household food security. However, access to food resources alone may not guarantee food security if households lack sufficient economic capacity to utilize those resources effectively. Therefore, socioeconomic characteristics are expected to play a central role in translating environmental opportunities into improved food security outcomes.

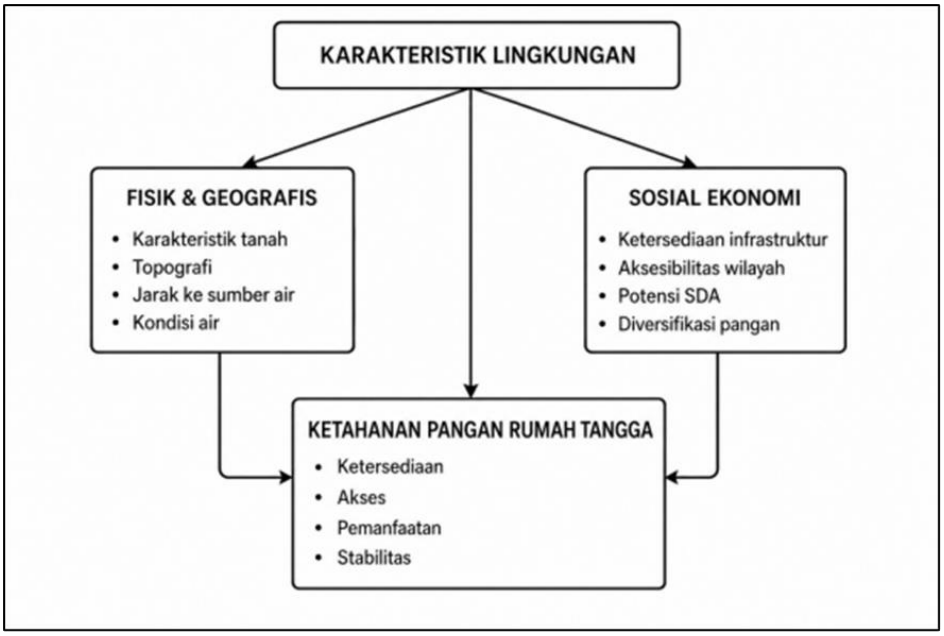

Figure 1. Concept of research framework

Based on this theoretical reasoning, the study hypothesizes that coastal environmental characteristics influence household food security both directly and indirectly through their effects on local food access and socioeconomic conditions. The conceptual model positions coastal environmental characteristics as the primary exogenous variable, local food access and socioeconomic characteristics as intermediary variables, and household food security as the ultimate outcome variable.

Conceptual Framework

This framework assumes that environmental sustainability, socioeconomic resilience, and local food systems collectively determine the level of household food security in coastal communities (Figure 1).

METHODOLOGY

Study Area and Research Design

This study was conducted in Pasirido, Pasir Putih Village, Manokwari Regency, West Papua Province, Indonesia (Figure 2). Pasirido is a coastal settlement whose residents depend primarily on fisheries, marine resources, and small-scale livelihood activities. The area was selected purposively because of its strategic coastal location, reliance on marine resources, and increasing environmental pressures that potentially affect household food security. The research employed a quantitative cross-sectional survey design. Data were collected during a single survey period to capture household socioeconomic conditions, environmental characteristics, local food access, and food security status. The study adopted a socio-ecological perspective, recognizing that household food security is shaped by interactions between environmental conditions and socioeconomic factors within coastal communities.

Figure 2. Sites of field research in Pasirido village, Subdistrict of Pasir Putih, Manokwari

Population and Sampling

The study population consisted of all households residing in Pasirido. A total of 80 household heads participated as respondents. Household heads were selected because they possess comprehensive knowledge regarding household livelihood activities, food acquisition strategies, environmental conditions, and food security experiences. The sample size was considered adequate for Structural Equation Modeling–Partial Least Squares (SEM-PLS) analysis, which is suitable for exploratory studies and relatively small sample sizes. SEM-PLS is particularly appropriate when the research objective is prediction and theory development rather than strict theory confirmation.

Data Collection

Primary data were collected through structured interviews using a questionnaire. The questionnaire was developed based on previous food security and coastal livelihood studies and consisted of four major sections, i.e. Socioeconomic characteristics of households; Coastal environmental characteristics; Local food access and food sources; and Household food security indicators. Field observations were also conducted to verify environmental conditions, coastal resource utilization, water availability, marine pollution, and food-related activities within the study area. Secondary data were obtained from government reports, statistical publications, village administrative records, and relevant scientific literature concerning food security, coastal resource management, and sustainable livelihoods.

Variables and Measurement

Four latent constructs were included in the research model.

Socioeconomic Characteristics (X1)

This construct describes household demographic and economic conditions and was measured using indicators including gender, education level, occupation, household income, household size, and household expenditure (Waaswa et al. 2021; Castiblanco, Etter, and Ramirez 2015).

Coastal Environmental Characteristics (X2)

This construct reflects environmental conditions affecting coastal livelihoods and food systems. Indicators included water availability, environmental quality, marine resource availability, fish catch acquisition, marine pollution, weather influence, and other coastal environmental factors.

Local Food Access and Sources (X3)

This construct measures household access to locally available food resources. Indicators included ownership of food-producing land, frequency of fishing activities, availability of local food resources, and utilization of local food sources (Indow et al. 2021; Hervas 2021; Ginting, Yulifianti, and Jusuf 2014).

Household Food Security (Y)

Household food security was assessed using indicators representing the four dimensions of food security: availability, accessibility, utilization, and stability. These indicators included food availability throughout the year, food stock duration, difficulties in purchasing food, meal frequency, food reserves, food acquisition strategies, and household coping mechanisms during food shortages (Ferdous et al. 2016; Yiridoe and Anchirinah 2005; Paul et al. 2018).

All indicators were transformed into ordinal scales before analysis. Higher scores represented more favourable conditions for each construct.

Data Analysis

Data analysis was conducted in two stages, i.e. descriptive statistics were used to summarize respondents' characteristics and describe environmental conditions, local food access, and household food security status. Frequencies, percentages, means, and categorical distributions were used to present the data. To examine the relationships among constructs, Structural Equation Modeling–Partial Least Squares (SEM-PLS) was applied using SmartPLS software (Figure 3). SEM-PLS was selected because it can simultaneously evaluate complex relationships among multiple latent variables and is robust for exploratory research with relatively small sample sizes (Ali, Ramayah, and Cheah 2021; Santoso and Indrajaya 2023; Maha Putra and Nasution 2024; Safitri, Suharno, and Fariyanti 2017).

The analysis followed a two-step approach, i.e. Measurement Model Evaluation (Outer Model). The measurement model was assessed using Outer Loadings (>0.70 preferred); Cronbach's Alpha (>0.70); Composite Reliability (>0.70); Average Variance Extracted (AVE >0.50); and Variance Inflation Factor (VIF <5.0). Indicators with low loading values were evaluated and removed where necessary to improve model quality. The structural model was evaluated using Path Coefficients (β); Coefficient of Determination (R^2); Bootstrapping significance tests; t-statistics (>1.96); and p-values (<0.05).

The significance of hypothesized relationships among coastal environmental characteristics, local food access, socioeconomic characteristics, and household food security was assessed through a bootstrapping procedure with 5,000 subsamples.

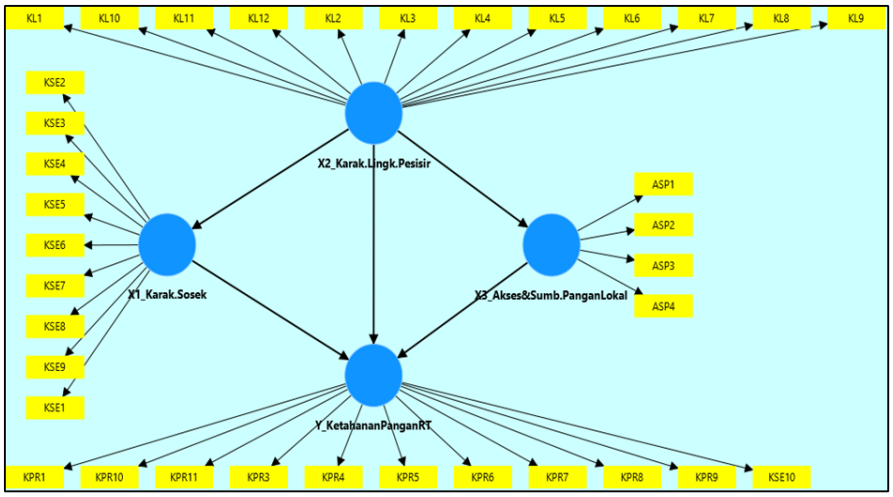

Figure 3. Model of the systems using SemPLS

Research Hypotheses

The study tested the following hypotheses: H1: Socioeconomic characteristics positively influence household food security. H2: Coastal environmental characteristics influence household food security. H3: Coastal environmental characteristics positively influence local food access and food sources. H4: Coastal environmental characteristics influence socioeconomic characteristics. H5: Local food access and food sources positively influence household food security.

Ethical Considerations

Participation in the study was voluntary. Prior informed consent was obtained from all respondents before interviews were conducted. Respondents were assured that information collected would be used solely for academic purposes and reported in aggregate form to protect confidentiality and anonymity.

RESULTS *AND* DISCUSSION

Respondent Characteristics

Table 1 presents the socioeconomic characteristics of respondents in Pasirido, Manokwari. The age distribution indicates that the study population was dominated by economically productive individuals. Nearly half of the respondents (48.75%) were between 31 and 50 years old, while 47.50% were older than 50 years. Only 3.75% belonged to the younger age group of 20–30 years. This distribution suggests that coastal livelihoods in Pasirido are primarily maintained by middle-aged and older household heads who possess extensive experience in fishing and resource-based economic activities. The relatively small proportion of younger respondents may also reflect the tendency of younger generations to pursue alternative employment opportunities outside the traditional fisheries sector.

Regarding occupation, fishing remained the dominant livelihood activity, accounting for 41.25% of respondents. Additional respondents combined fishing with farming (6.25%) or port labor activities (1.25%), highlighting the importance of livelihood diversification within coastal households. A considerable

proportion of respondents worked as civil servants, military personnel, or police officers (20%), while others were engaged as casual laborers (11.25%), port laborers (5.00%), small shop owners (3.75%), security guards (2.50%), and contract employees (2.50%). These findings indicate that although fisheries continue to be the primary economic sector, households increasingly rely on multiple income sources to cope with economic uncertainty and fluctuating marine resource availability (Purwanto et al. 2021; Pattiselanno and Lubis 2014; Prasetyo 2019).

Table 1. Socioeconomic Characteristics of Respondents

Parameter	Frequency (n)	Percentage (%)
Age		
20–30 years	3	3.75
31–50 years	39	48.75
>50 years	38	47.50
Main Occupation		
Fisherman	33	41.25
Fisherman/Farmer	5	6.25
Fisherman/Port Laborer	1	1.25
Telecommunication Employee	1	1.25
Civil Servant/Military/Police Officer	16	20.00
Retired Civil Servant/Military Officer	2	2.50
Retired Radio Broadcaster	1	1.25
Security Guard	2	2.50
Contract Employee	2	2.50
Casual Laborer	9	11.25
Port Laborer	4	5.00
Small Shop Owner	3	3.75
Motorcycle Taxi Driver	1	1.25
Educational Attainment		
Primary School	14	17.50
Junior High School	19	23.75
Senior High School	38	47.50
Higher Education	8	10.00
No Formal Education	1	1.25

Educational attainment was generally moderate, with senior high school graduates representing the largest proportion of respondents (47.50%). Respondents with junior high school education accounted for 23.75%, while 17.50% had completed only primary school. Individuals with higher education represented 10.00% of the sample, whereas only 1.25% reported having no formal education. The predominance of secondary education suggests that most households possess basic educational capital that may facilitate access to information, technology, and alternative livelihood opportunities. Education is widely recognized as an important determinant of household welfare and food

security because it enhances decision-making capacity, resource management skills, and adaptive responses to environmental and economic changes.

Overall, the respondent profile depicts a coastal community characterized by a mature labor force, strong dependence on fisheries-based livelihoods, and moderate educational attainment. These socioeconomic characteristics provide important contextual information for understanding household food security dynamics in Pasirido. The predominance of fishing activities, combined with relatively limited educational advancement and varying income sources, underscores the vulnerability of coastal households to environmental changes while simultaneously highlighting the importance of socioeconomic resilience in sustaining household food security.

Coastal Environmental Characteristics

Table 2 presents the environmental characteristics of the coastal area in Pasirido, Manokwari. The results indicate that the physical environment is dominated by sandy soils (52.50%) and rocky sandy soils (46.25%), reflecting typical coastal geomorphological conditions. Such soil characteristics influence vegetation growth, water retention capacity, and the potential for small-scale agricultural activities. Despite these limitations, coastal households have adapted to the local environmental conditions through fishing activities and limited cultivation of suitable crops. The predominance of sandy coastal soils also highlights the community's strong dependence on marine resources rather than intensive land-based food production. Access to freshwater resources was found to be highly favorable. All respondents (100%) reported that water was always available, with well water serving as the primary source of freshwater. Furthermore, every household had access to a water source located within 50 meters of their residence, indicating excellent physical accessibility to freshwater. Water quality was also reported as highly satisfactory, with all respondents describing their water as clear, odorless, and non-saline. Only a small proportion of households (6.25%) reported having experienced freshwater contamination, while the vast majority (93.75%) had never encountered such problems. These findings suggest that freshwater availability is not a major constraint to household well-being or food utilization in the study area.

Table 2. Coastal Environmental Characteristics of Respondents in Pasirido, Manokwari

Parameter	Indicator	Frequency (n)	Percentage (%)
Soil Type	Sandy Soil	42	52.50
	Rocky Sandy Soil	37	46.25
Water Availability	Always Available	80	100.00
Main Water Source	Well Water	80	100.00
Distance to Main Water Source	< 50 m	80	100.00
Water Quality	Clear, Odorless, and Non-Saline	80	100.00
Freshwater Pollution	Experienced	5	6.25

	Never Experienced	75	93.75
Sea Water Condition	Very Good	2	2.50
	Good	59	73.75
	Fair/Poor	19	23.75
Marine Pollution	Polluted	80	100.00
Forms of Marine Pollution	Garbage, Domestic Waste, and Turbid Water	4	5.00
	Garbage and Domestic Waste	56	70.00
	Garbage and Turbid Water	2	2.50
	Garbage Only	18	22.50

In contrast, environmental conditions in the marine ecosystem reveal a more complex situation. Although most respondents perceived seawater conditions as good (73.75%), and a small proportion rated them as very good (2.50%), nearly one-quarter (23.75%) considered marine conditions to be less favorable. More importantly, all respondents (100%) acknowledged the presence of marine pollution in coastal waters. This indicates that environmental degradation has become a widespread concern despite generally acceptable perceptions of overall seawater quality. The coexistence of relatively good marine conditions and widespread pollution suggests that the coastal ecosystem remains productive but faces increasing anthropogenic pressures. The dominant forms of marine pollution were garbage and domestic waste, reported by 70.00% of respondents. Additional respondents identified combinations of garbage, domestic waste, and turbid water (5.00%), garbage and turbid water (2.50%), or garbage alone (22.50%). These findings highlight the growing environmental burden associated with improper waste disposal and household activities along the coast. Such pollution can negatively affect marine biodiversity, fisheries productivity, and long-term food security by degrading the natural resources upon which coastal livelihoods depend. Consequently, sustainable waste management and coastal environmental conservation should be prioritized to maintain ecosystem health and strengthen food security resilience among coastal households in Pasirido.

Local Food Resources and Availability

Table 3 presents the characteristics of local food resources available to households in Pasirido. The findings indicate that marine resources remain an important source of local food, with fish being the most commonly obtained seafood product, reported by 48.75% of respondents. This finding reflects the strong dependence of coastal households on fisheries resources for both food consumption and livelihood activities. Fish serves as a primary source of animal protein and contributes significantly to dietary quality and nutritional security among coastal communities. Fishing activities were conducted with varying levels of intensity. The largest proportion of respondents (30.00%) reported going to sea one to two times per week, while 7.50% engaged in fishing three to four times per week and another 7.50% fished five to six times weekly. Only 3.75% reported fishing every day. These patterns suggest that although fishing remains

an important livelihood activity, many households do not rely exclusively on daily fishing operations. Variations in fishing frequency may be influenced by weather conditions, fishing capacity, household labor availability, and the diversification of livelihood strategies. The relatively moderate fishing intensity observed among respondents may also reflect increasing dependence on alternative income-generating activities and market-based food acquisition.

Table 3. Local Food Resources and Availability among Coastal Households in Pasirido, Manokwari

Parameter	Frequency (n)	Percentage (%)
Local Food Sources		
Type of Marine Products Obtained	39	48.75
Fishing Frequency per Week		
1–2 times	24	30.00
3–4 times	6	7.50
5–6 times	6	7.50
Every day	3	3.75
Ownership of Agricultural Land/Garden		
Yes	43	53.75
No	37	46.25
Types of Crops Cultivated		
Vegetables, tubers, and fruits	14	17.50
Vegetables and tubers	8	10.00
Tubers and fruits	14	17.50
Tubers only	7	8.75
Availability of Local Food Resources		
Very Adequate	32	40.00
Adequate	45	56.25
Less Adequate	3	3.75
Inadequate	0	0.00

Beyond marine resources, local food availability is supported by household gardening activities. More than half of the respondents (53.75%) owned agricultural land or home gardens, while 46.25% did not possess any cultivation area. Among households with gardens, the most common crop combinations included vegetables, tubers, and fruits (17.50%) as well as tubers and fruits (17.50%). Other households cultivated vegetables and tubers (10.00%) or tubers alone (8.75%). These findings indicate that small-scale agriculture complements fisheries-based livelihoods by providing additional food resources and enhancing dietary diversity. Tubers, vegetables, and fruits represent important local food commodities that contribute to household resilience, particularly during periods when fishing activities are constrained. Overall, local food availability in Pasirido was assessed positively by respondents. More than half of the households (56.25%) considered local food availability to be adequate, while 40.00% regarded it as very adequate. Only 3.75% perceived local food

availability as less adequate, and none reported inadequate food availability. These results suggest that the combination of marine resources and small-scale agricultural production provides a relatively stable local food base for the community. Nevertheless, maintaining this condition requires sustainable management of coastal ecosystems (Klooster 2002; Pasaribu, Vanclay, and Zhao 2020; Ramakrishnan 2007) and continued support for household food production systems to ensure long-term food security and resilience in the face of environmental and economic challenges (Enkin Asrawijaya 2024; Zeng et al. 2022; Kerubo 2016).

Food Availability and Food Access

Table 4 presents the dimensions of food availability and food access among coastal households in Pasirido, Manokwari. The results indicate that food availability was generally favorable, with 83.75% of respondents reporting that food was always available throughout the month. Another 15.00% stated that food was only occasionally available, while only 1.25% experienced frequent food shortages. These findings suggest that most households were able to maintain a relatively stable food supply despite their dependence on fisheries-based livelihoods and exposure to environmental uncertainties. The availability of food throughout the year reflects the combined contribution of market access, fisheries resources, and local food production systems in supporting household food security. Food stock duration further illustrates the ability of households to maintain food reserves. Half of the respondents (50.00%) reported maintaining food stocks sufficient for one to two weeks, while 26.25% had food reserves lasting more than two weeks. Only 23.75% possessed food stocks sufficient for three to seven days. The presence of relatively long food stock durations suggests that many households have developed coping strategies to anticipate fluctuations in income, fishing productivity, and food prices (Hamilton et al. 2020; Verma and Pant 2021; Widayati et al. 2018). However, the absence of households reporting food stocks lasting less than three days indicates a generally acceptable level of food preparedness within the community.

Table 4. Food Availability and Food Access among Coastal Households in Pasirido, Manokwari

Parameter	Indicator	Frequency (n)	Percentage (%)
Food Availability			
Monthly Food Availability	Always Available	67	83.75
	Sometimes Available	12	15.00
	Frequently Unavailable	1	1.25
Duration of Food Stocks			
	3–7 days	19	23.75
	1–2 weeks	40	50.00
	>2 weeks	21	26.25
Main Food Source			
	Purchased Food	80	100.00

Food Access			
Monthly Income	< IDR 1,000,000	21	26.25
	IDR 1,000,000–2,500,000	24	30.00
	IDR 2,600,000–5,000,000	22	27.50
	> IDR 5,000,000	3	3.75
Monthly Food Expenditure	<25% of Income	5	6.25
	25–50% of Income	60	75.00
	51–75% of Income	15	18.75
Difficulties in Purchasing Food	Never	44	55.00
	Rarely	4	5.00
	Sometimes	29	36.25
	Often	3	3.75

Despite the availability of local food resources, all respondents (100%) identified purchased food as their primary source of food. This finding highlights a significant dependence on market-based food systems among coastal households. While fisheries and home gardens contribute to local food production, they appear to function mainly as supplementary food sources rather than replacing purchased food. Such dependence on market purchases may increase household vulnerability to food price inflation and economic shocks, particularly among lower-income households. Food access was closely associated with household income and expenditure patterns. Approximately 56.25% of respondents earned less than IDR 2.5 million per month, indicating that a large proportion of households operated under relatively modest economic conditions. Nevertheless, most households allocated between 25% and 50% of their monthly income to food expenditure (75.00%), suggesting a substantial commitment of household resources to food acquisition. Although 55.00% of respondents reported never experiencing difficulties in purchasing food, a considerable proportion (36.25%) occasionally encountered such difficulties, and 3.75% experienced them frequently. These findings indicate that while food is generally available in Pasirido, economic accessibility remains a challenge for some households, reinforcing the importance of socioeconomic capacity as a key determinant of household food security (Midmore, Nine~z, and Venkataraman 1991; Ferdous et al. 2016; Paul et al. 2018; Márquez and Schwartz 2008).

Measurement Model Assessment: Reliability and Convergent Validity

The final measurement model indicates that Household Food Security (Y) demonstrated the strongest reliability, achieving acceptable values for both Cronbach's Alpha (0.701) and Composite Reliability (0.798). The Socioeconomic Characteristics (X1) construct exhibited acceptable reliability based on its Composite Reliability value (0.718), although its AVE remained below the recommended threshold (Table 5).

Table. Reliability and Validity Assessment

Construct	Cronbach's Alpha	Composite Reliability (CR, ρc)	Average Variance Extracted (AVE)	Interpretation
X1 Socioeconomic Characteristics	0.555	0.718	0.355	Acceptable reliability; convergent validity not fully achieved
X2 Coastal Environmental Characteristics	0.398	0.636	0.319	Moderately reliable and moderately valid
X3 Local Food Access and Sources	0.047	0.579	0.504	Convergently valid, but moderately reliable
Y Household Food Security	0.701	0.798	0.365	Reliable, with moderate convergent validity

The Coastal Environmental Characteristics (X2) construct showed moderate measurement quality, with reliability and validity values below ideal standards but still acceptable for exploratory research. Meanwhile, Local Food Access and Sources (X3) achieved acceptable convergent validity (AVE = 0.504), although its internal consistency remained relatively weak. Overall, the revised model demonstrated substantial improvement compared with the initial model and was considered adequate for subsequent structural model analysis.

Hypothesized relationships in the structural model

The bootstrapping results indicate that not all hypothesized relationships in the structural model were statistically significant (Table 6). Three paths were found to be significant, namely the effects of Socioeconomic Characteristics (X1) on Household Food Security (Y), Coastal Environmental Characteristics (X2) on Socioeconomic Characteristics (X1), and Coastal Environmental Characteristics (X2) on Local Food Access and Sources (X3). Conversely, the direct effects of Coastal Environmental Characteristics on Household Food Security and Local Food Access on Household Food Security were not statistically significant at the 5% significance level. The strongest positive effect on household food security was observed for Socioeconomic Characteristics (X1 → Y), with a path coefficient of 0.689, a T-statistic of 6.605, and a P-value of 0.000. This result demonstrates that improved socioeconomic conditions significantly enhance household food security. Households with better income, employment opportunities, educational attainment, and economic resources are more capable of securing food, maintaining food reserves, and coping with fluctuations in food prices and environmental disturbances. This finding highlights socioeconomic resilience as a key determinant of food security in coastal communities.

The analysis further revealed that Coastal Environmental Characteristics (X2) exerted a significant influence on both Socioeconomic Characteristics (X1) and Local Food Access and Sources (X3). The relationship between

environmental characteristics and socioeconomic conditions was negative and significant (β = −0.667; T = 14.301; P < 0.001), suggesting that environmental pressures or unfavorable coastal conditions may adversely affect household socioeconomic well-being. At the same time, environmental characteristics had a strong positive effect on local food access (β = 0.795; T = 20.332; P < 0.001), indicating that the quality and productivity of coastal ecosystems play a crucial role in determining the availability of local food resources, particularly fish and other marine products.

Table 6. Structural Model Path Coefficients and Hypothesis Testing Results

Structural Relationship	Original Sample (β)	Sample Mean (M)	Standard Deviation (STDEV)	T-Statistic	P-Value
X1 Socioeconomic Characteristics → Y Household Food Security	0.689	0.714	0.104	6.605	0.000
X2 Coastal Environmental Characteristics → X1 Socioeconomic Characteristics	-0.667	-0.682	0.047	14.301	0.000
X2 Coastal Environmental Characteristics → X3 Local Food Access and Sources	0.795	0.780	0.039	20.332	0.000
X2 Coastal Environmental Characteristics → Y Household Food Security	-0.247	-0.260	0.130	1.900	0.057
X3 Local Food Access and Sources → Y Household Food Security	0.161	0.129	0.169	0.955	0.340

Decision Criteria: Relationships are considered statistically significant when T-statistic > 1.96 and P-value < 0.05.

In contrast, the direct effect of Coastal Environmental Characteristics on Household Food Security (X2 → Y) was not statistically significant (β = −0.247; T = 1.900; P = 0.057). Although the relationship approached significance, the result suggests that environmental conditions alone do not directly determine food security outcomes (Figure 4). Similarly, Local Food Access and Sources (X3 → Y) did not significantly influence household food security (β = 0.161; T = 0.955; P = 0.340). These findings imply that the presence of local food resources does not automatically translate into improved food security unless households possess sufficient socioeconomic capacity to access, purchase, and utilize those resources effectively. Overall, the results suggest that coastal environmental characteristics affect household food security primarily through indirect pathways, particularly by influencing socioeconomic conditions and local food access. Among all constructs, socioeconomic characteristics emerged as the most important direct

predictor of household food security. Therefore, policies aimed at strengthening food security in coastal communities (Anna 2019; Indouw, Maturbongs, and Prabawardani 2022) should not focus solely on environmental conservation and food resource availability but should also prioritize income generation, livelihood diversification, education, and broader socioeconomic development initiatives (Maroyi 2009; Amer and Hovey 2007; Adimihardja 2006).

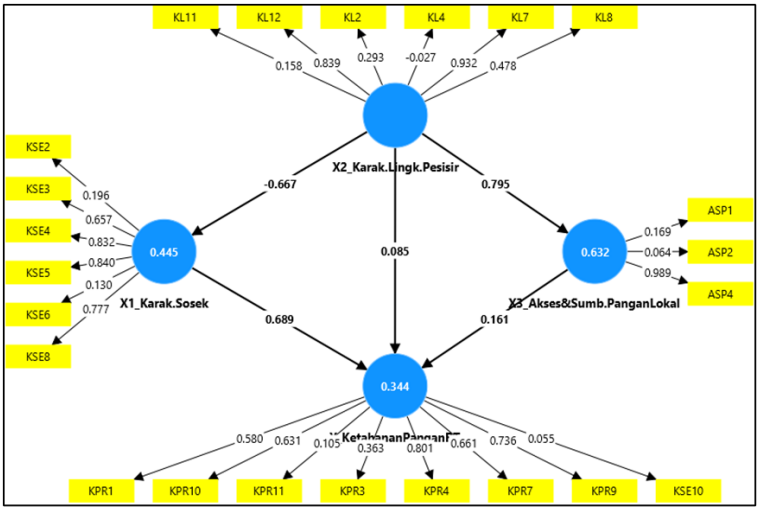

Figure 4. Final Model of Coastal Environmental Characteristics on Household Food Security

Predictive Power of the Structural Model

The coefficient of determination (R^2) was used to evaluate the predictive power of the structural model and to assess how much variance in each endogenous construct could be explained by its predictor variables (Table 7). According to Chin (1998) and Hair et al. (2022), R^2 values of approximately 0.75, 0.50, and 0.25 may be interpreted as substantial, moderate, and weak explanatory power, respectively. The construct Socioeconomic Characteristics (X1) obtained an R^2 value of 0.427 and an Adjusted R^2 value of 0.420, indicating a moderate level of explanatory power. This result suggests that 42.7% of the variation in socioeconomic characteristics is explained by coastal environmental characteristics, while the remaining 57.3% is influenced by factors not included in the model. The finding demonstrates that environmental conditions play an important role in shaping socioeconomic conditions in coastal communities, particularly where livelihoods are closely linked to marine and coastal resources (Summary, n.d.; Agustang 2021; Proença and Pereira 2013).

The construct Local Food Access and Sources (X3) recorded the highest explanatory power in the model, with an R^2 value of 0.699 and an Adjusted R^2 value of 0.696. This indicates that nearly 70% of the variation in local food access is explained by coastal environmental characteristics. The result falls within the strong category and highlights the critical importance of environmental quality, marine productivity, and coastal ecosystem conditions in determining the availability and accessibility of local food resources (Paul et al. 2018). Healthy coastal ecosystems appear to provide substantial support for local food systems through fisheries and other natural resource-based food sources.

Table 7. Summary of Coefficient of Determination (R^2) Results

Endogenous Construct	R^2	Adjusted R^2	Category
Socioeconomic Characteristics (X1)	0.427	0.420	Moderate
Local Food Access and Sources (X3)	0.699	0.696	Strong
Household Food Security (Y)	0.286	0.258	Weak–Moderate

In contrast, Household Food Security (Y) showed an R^2 value of 0.286 and an Adjusted R^2 value of 0.258, indicating weak-to-moderate explanatory power. This means that the combined effects of Socioeconomic Characteristics (X1), Coastal Environmental Characteristics (X2), and Local Food Access and Sources (X3) explain only 28.6% of the variation in household food security. Consequently, approximately 71.4% of the variation remains attributable to other factors outside the model. These factors may include social capital, institutional support, food consumption behavior, government assistance programs, market accessibility, household coping strategies, and climate adaptation capacity. Overall, the R^2 results demonstrate that the model is particularly effective in explaining local food access, moderately effective in explaining socioeconomic characteristics, and less effective in explaining household food security (Wijka et al. 2018; Azhar et al. 2017; Tuturop, Nugroho, and Warawarin 2022). These findings suggest that food security in coastal communities is a multidimensional phenomenon influenced by a broader set of social, economic, environmental, and institutional factors than those captured in the current model (Santika et al. 2019; Min-Harris 2009). While environmental conditions strongly determine access to local food resources, socioeconomic capacity remains the most important pathway through which these environmental advantages are translated into improved household food security outcomes.

CONCLUSIONS AND RECOMMENDATIONS

Based on the research objectives and SEM-PLS findings, the following conclusions can be formulated:

1. Coastal environmental characteristics significantly influence socioeconomic conditions and local food access in Pasirido. The SEM-PLS analysis showed that coastal environmental characteristics had a significant effect on socioeconomic characteristics ($\beta = -0.667$; $p < 0.001$) and local food access and sources ($\beta = 0.795$; $p < 0.001$). This finding confirms that environmental quality, marine resource availability, water conditions, and coastal ecosystem characteristics play an important role in shaping household livelihoods and food acquisition opportunities.
2. Socioeconomic characteristics are the strongest determinant of household food security. Socioeconomic characteristics exerted a positive and significant effect on household food security ($\beta = 0.689$; $p < 0.001$). Households with better education, employment, income, and economic capacity demonstrated a greater ability to secure food availability, maintain food reserves, and withstand fluctuations in food prices and environmental disturbances.

3. Coastal environmental characteristics and local food access do not directly determine household food security. Although environmental conditions significantly affected local food access, neither the direct effect of coastal environmental characteristics ($\beta = -0.247$; $p = 0.057$) nor local food access ($\beta = 0.161$; $p = 0.340$) on household food security was statistically significant. This suggests that environmental resources and food availability alone are insufficient to improve food security without adequate socioeconomic capacity to utilize and access those resources effectively.
4. Households in Pasirido generally exhibit moderate to good food security conditions despite environmental challenges. Most respondents reported continuous food availability throughout the year, adequate food reserves, regular meal frequency, and low incidence of food deprivation. However, dependence on purchased food, frequent food price increases, and widespread marine pollution indicate potential vulnerabilities that may threaten long-term food security if not addressed through integrated environmental and socioeconomic interventions.

These findings collectively indicate that socioeconomic resilience serves as the primary pathway linking coastal environmental conditions to household food security, emphasizing the need for integrated coastal development strategies that simultaneously strengthen environmental sustainability, livelihood diversification, and household economic capacity.

FURTHER STUDY

This research still has limitations, so it is necessary to conduct further research related to the topic of The Role of Coastal Environmental Characteristics in Shaping Local Food Access and Household Food Security in Pasirido, Manokwari in order to perfect this research and increase insight for readers.

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