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**ASSESSING THE LIVELIHOOD VULNERABILITY OF RESIDENTS
IN COASTAL FISHING VILLAGES OF DA NANG CITY IN VIET NAM
UNDER THE IMPACT OF CLIMATE CHANGE:
CASE STUDY IN MAN THAI AND NAM O**

Abstract: This article focuses on assessing the level of livelihood vulnerability under the impact of climate change of residents in coastal fishing villages of Da Nang city – Viet Nam with a case study in Man Thai and Nam O based on constructing the Livelihood Vulnerability Index (LVI). We surveyed 190 households in two villages to collect data on household characteristics, livelihood strategies, social networks, health, food, household living conditions, natural disasters and climate change. A composite index was used to combine the data, and differential vulnerabilities were compared. The assessment results show that Nam O is somewhat more vulnerable than Man Thai, especially in terms of food, household living conditions. This research contributes to raising awareness against climate change and at the same time, it helps management agencies to have appropriate policies to ensure synchronous development and improve all aspects of the community's life.

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Key words: Livelihood Vulnerability Index (LVI), LVI – IPCC, fishing village, climate change, Da Nang City, Viet Nam

INTRODUCTION

Climate change is a global issue that has been considered one of the biggest challenges and risks that humans have faced throughout their history of development (Ministry of Natural Resources and Environment 2021). Viet Nam is a country that is particularly vulnerable to the impacts of climate change. In recent years, under the impact of climate change, extreme weather events have tended to increase in both number and intensity, seriously affecting the stability and sustainable development of the country (Ministry of Natural Resources and Environment 2022). Manifestations of climate change such as increased droughts, storms, floods, saltwater intrusion, rising sea levels, rising global temperatures, etc. have negatively affected the economy, environment, and daily livelihoods of residents, especially residents of coastal fishing villages. Inherently, the lives of coastal residents depend greatly on natural conditions and sea areas, but in recent years, the strong impact of climate change has negatively affected their livelihoods and quality of life.

Over the past decade, in response to the impacts of climate change, researchers have developed and applied various approaches to assess livelihood vulnerability, each offering unique insights into the factors influencing household resilience. One widely used framework is the Sustainable Livelihood Framework (SLF), which analyzes livelihood assets and how they interact with external factors such as policies, institutions, and processes (DFID 1999). Another prominent method is the Livelihood Vulnerability Index (LVI) proposed by Hahn et al. (2009). The authors considered LVI a composite index comprising seven key components: socio-demographic profile, livelihood strategies, social networks, health, food, water, and natural disasters and climate variability. These seven components were then integrated into three contributing factors, as defined by Intergovernmental Panel on Climate Change (IPCC), for vulnerability assessment: exposure, sensitivity, and adaptive capacity (Hahn et al. 2009). Based on these methods, numerous studies on livelihood vulnerability assessment have been conducted worldwide, including in Viet Nam. In Viet Nam, many research on livelihood vulnerability have predominantly focused on rural areas, ethnic minority communities, and coastal regions. Notable studies include: the assessment of livelihood vulnerability of the Thái and H'mông ethnic groups in Son La province (Nguyen 2018); the proposal of a method for assessing farming household livelihood vulnerability (Ha et al. 2018); the evaluation of fishers' livelihood vulnerability in Huong Phong district (Giang et al. 2018); the assessment of climate change vulnerability in the Tam Giang–Cau Hai lagoon system (Hue Center for Social Sciences and Humanities 2018). These studies provide crucial evidence on the impacts of climate change on local livelihoods, supporting the development of appropriate adaptation policies.

Da Nang city is a coastal city located in the central of Viet Nam with a 92 km long coastline (Da Nang City Statistics Office 2021). It is a large urban area, a major socio-economic center with many advantages in terms of transportation, infrastructure, human resources that are favorable for the development of diverse economic sectors such as industry, services, trade, especially marine economic sectors. However, the coastal area of Da Nang is currently facing a series of major risks, typical of fishing villages, originating from the ongoing urbanization process and the increasingly obvious impacts of climate change. Climate change is not only theoretical through scenarios but has become a worrying reality, directly affecting the livelihoods of people in coastal fishing villages. This article focuses on assessing the level of livelihood vulnerability of residents in the coastal fishing villages of Da Nang city under the impact of climate change with a case study in Man Thai and Nam O based on constructing the Livelihood Vulnerability Index (LVI). A survey of 190 households in both fishing villages was conducted to collect data on seven components, including: household characteristics, livelihood strategies, social networks, health, food, household living conditions, natural disasters and climate change. Man Thai and Nam O were selected as research sites because they are two representative fishing villages in Da Nang, characterized by a long history and a high dependence on marine-based livelihoods. These communities are increasingly vulnerable due to climate change, ur-

banization, and economic policies. Studying these villages not only provides a clearer understanding of the livelihood vulnerability of coastal residents but also serves as a crucial scientific foundation for proposing appropriate adaptation strategies.

CONCEPT AND INDICATORS OF LIVELIHOOD VULNERABILITY

The idea of vulnerability and its definition are not new. They are the result of extensive study and application of climate impacts, risks and hazards, and resilience (Turner et al. 2003). Many research in the literature have made reference to the concept of vulnerability (Turner et al. 2003; Hinkel 2011). The Intergovernmental Panel on Climate Change (IPCC) of the United Nations defined vulnerability as “the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt” (Intergovernmental Panel on Climate Change 2014). According to IPCC, vulnerability is considered as a function of three main components: exposure, sensitivity, and adaptive capacity (Figure 1). Exposure refers to “the nature and degree to which a system is exposed to significant climatic variations”. Sensitivity is defined as “the extent to which climate-related stimuli impact a system, either negatively or positively.” Adaptive capacity is known as “the ability of a system to adapt to climate change, including its variability and extremes, in order to mitigate possible harm, seize opportunities, or deal with the fallout”.

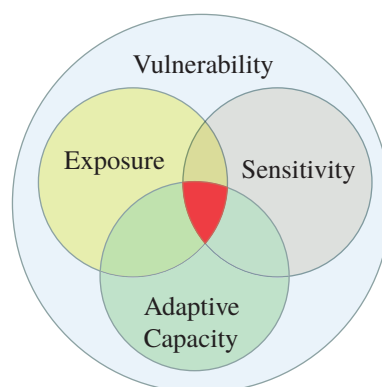


Fig. 1. Concept of vulnerability to climate change

Source: Intergovernmental Panel on Climate Change (2014).

Livelihoods encompass existing capacities, assets, and essential activities required to sustain a living. Livelihood vulnerability is understood as the insecurity of individuals, households, and communities in maintaining their livelihoods when facing external environmental changes, such as epidemics, natural disasters, floods, and droughts (IMOLA Project 2006).

This study applies the Livelihood Vulnerability Index (LVI) approach proposed by Hahn et al. (2009). To evaluate livelihood vulnerability, the authors construct a framework with criteria that comprehensively capture the key aspects of vulnerability in the two fishing villages, Man Thai and Nam O. This framework is largely adapted from Hahn’s original model. However, given that the study focuses on fishing villages, the authors have adapted the framework to better reflect the local context. The modified framework consists of seven main components: household characteristics, livelihood strategies, social networks, health, food, household living conditions, natural disasters and climate change (see Table 1).

Table 1. Components and indicators for assessing the Livelihood Vulnerability Index in Man Thai and Nam O fishing villages, Da Nang, Viet Nam

Key components/indicators	Explanation of the indicators	Source
1. Household characteristics		
Dependency ratio	Number of people <15 years old and >60 years old/ total family members	Hahn (2009)
Percentage of female household heads	Percentage of female household heads. If the household head is male and not at home most of the time, the household head is considered female.	Hahn (2009)
Percentage of households with illiterate heads	Percentage of households with illiterate heads	Hahn (2009)
2. Livelihood strategies		
Percentage of households whose livelihood depends mainly on fishing	Percentage of households that consider fishing as their main source of income	Additional authors
Percentage of households with family members working outside the local area	Percentage of households reporting that at least one family member goes elsewhere (other city/province) to earn a living	Hahn (2009)
Percentage of households with working-age members unemployed/underemployed	Percentage of households reporting that at least one working-age household member is unemployed/underemployed	Additional authors
3. Social Network		
Percentage of households without access to information sources	Percentage of households without at least one type of communication device such as television, radio, telephone, internet...	Additional authors
Percentage of households that did not receive support from government agencies in the past 12 months	Percentage of households that have not received support from government agencies in the past 12 months.	Author modified from Hahn (2009)
Average travel time to commune administrative agency	Average travel time to commune administrative agency (minutes)	Additional authors
4. Health		
Percentage of households with family members suffering from chronic or serious illnesses	Percentage of households with family members suffering from chronic diseases such as diabetes, heart disease, asthma, cancer, etc.	Hahn (2009)
Percentage of households with someone requiring regular care	Percentage of households with people requiring daily care (elderly, young children, disabled)	Author modified from Hahn (2009)
Average travel time to nearest medical facility	Average travel time to commune health station (minutes)	Hahn (2009)
5. Food		
Percentage of households lacking food sources/ food produced by the family itself	Percentage of households lacking food sources mainly from family farming and livestock	Hahn (2009)
Average number of months without food	Average number of months the family had difficulty making food	Hahn (2009)
Percentage of households with no food reserves	Percentage of households not storing food (excluding what is sold)	Hahn (2009)
6. Household living conditions		
Percentage of households not using clean tap water for domestic use	Percentage of households using domestic water mainly from natural sources such as ponds, lakes, rivers, streams, rainwater, etc.	Hahn (2009)
Percentage of households with no savings money	Percentage of households without savings to facilitate overcoming negative impacts from natural disasters	Additional authors
Percentage of households without permanent housing	Percentage of households with unstable houses (dilapidated, weak houses) that are easily blown off or collapsed by whirlwinds and storms	Additional authors
Percentage of poor households	Percentage of households with income below the prescribed poverty threshold	Additional authors
7. Natural disasters and climate change		
Average number of natural disasters affecting families in the past 5–7 years	Average number of natural disasters (flood, storm, drought, saltwater intrusion) affecting families in the past 5–7 years	Author modified from Hahn (2009)
Percentage of households do not receive early warning of impending natural disasters	Percentage of households that do not receive information about impending natural disasters (floods, storms, etc.) to have a response plan.	Hahn (2009)
Percentage of households with property damage due to natural disasters in the past 5–7 years	Percentage of households with property damage affecting family life due to natural disasters in the past 5–7 years	Hahn (2009)
Percentage of households with people injured/dead due to natural disasters in the past 5–7 years	Percentage of households with someone injured or killed by a natural disaster in the past 5–7 years	Hahn (2009)

Source: own elaboration.

RESEARCH METHOD

Data collection method

According to the data of the People's Committee of Man Thai Ward, there are a total of 4,821 households, of which Man Thai fishing village has 850 households. The People's Committee of

Hoa Hiep Nam Ward has 1,254 households, of which the Nam O fishing village has 800 households. The research was conducted on a sample with a margin of error of 10% and selected households along the coast of Man Thai, Nam O because most of the residents here depend largely on fishing for their livelihoods. The formula for calculating the sample to be interviewed is as follows:

$$n = \frac{N}{1 + N \cdot e^2}$$

where: **n** is the sample size; **N** is the total number of households in the study area and **e** is the error level of the study.

Based on the above formula and the proportion of households at the research site, we conducted a survey on 190 households in two fishing villages to collect data (with 100 households in Man Thai and 90 households in Nam O). The questionnaire was designed based on the information collected in Table 1. Household selection combined purposive and stratified random sampling to ensure representativeness and capture the livelihood characteristics of fishing communities in Man Thai and Nam O. Purposive sampling targeted households based on fisheries dependence, livelihood diversity, and vulnerability to natural disasters and climate change. Stratified random sampling then ensured balanced representation across economic status, occupation, fisheries reliance, and geographical location.

Primary data was collected through field surveys, questionnaires, interviews and discussions with residents and local officials. Household interviews took place in April and August 2023. However, several significant challenges arose during the implementation phase. Some residents were hesitant to share information. Adverse weather conditions and the demanding work schedules of fishermen disrupted the data collection process. Furthermore, constraints related to time and resources made it difficult to access complete information, requiring flexible adjustments in the research methodology.

Method of calculating the livelihood vulnerability index (LVI)

Livelihood Vulnerability Index (LVI)

LVI is the term used to describe the livelihood vulnerability index. It is an open-ended composite index with seven main components: household characteristics, livelihood strategies, social networks, health, food, household living conditions, natural disasters and climate change. Each main component includes indicators (see table 1). LVI uses the same weighting method for the main components, meaning that each main component is equally important in calculating the overall index, no main component is given priority over another. The values of the LVI range from 0 (lowest vulnerability) to 1 (highest vulnerability). Indicators are measured in different units, so they need to be normalized to bring the values to the same scale, so that they can be compared and used to calculate the LVI. The normalization formula is as follows:

$$S_d = \frac{S_t - S_{\min}}{S_{\max} - S_{\min}} \quad (1)$$

in which: **S_d** is a specific indicator of the community **d**; **S_t** is the actual value, **S_{min}** and **S_{max}** are the minimum and maximum values reflecting the lowest and highest levels of vulnerability respectively.

The main components are calculated by averaging the standardized indicators, we have the following formula:

$$M_d = \frac{\sum_{i=1}^n \text{index} S_{di}}{n} \quad (2)$$

where: **M_d** is the index of the main vulnerability components of the community **d**; **S_{di}** represents the normalized value of indicator **i**; **n** is the number of indicators being used to calculate the main component index. To calculate the average value of the main vulnerability index considered as LVI:

$$LVI_d = \frac{\sum_{i=1}^7 W_{mi} M_{di}}{\sum_{i=1}^7 W_{mi}} \quad (3)$$

in which: LVI_d is the LVI of the community d ; W_{mi} is the number of indicators used to determine the main components; M_{di} is the index of main vulnerability components for the community d .

Livelihood Vulnerability Index LVI according to IPCC approach (LVI – IPCC)

The study then applies the IPCC's method for measuring the vulnerability of communities to climate change (which is LVI – IPCC). LVI – IPCC is an index used to assess the vulnerability of a sensitive system that is unable to cope with negative impacts caused by climate change. To assess the LVI – IPCC index, it is necessary to combine 7 main components and divide them into 3 elements: exposure, adaptive capacity, and sensitivity (Hahn et al. 2009) (see table 2).

Table 2. Elements in the LVI – IPCC

Elements of LVI – IPCC	Key elements of LVI
Exposure	Natural disasters and climate change
Adaptive capacity	Household characteristics
	Livelihood strategies
	Social Network
Sensitivity	Health
	Food
	Household living conditions

Source: Intergovernmental Panel on Climate Change (2014).

To calculate 3 elements above we have the following formula:

$$CF_d = \frac{\sum_{i=1}^n W_{mi} M_{di}}{\sum_{i=1}^{8n} W_{mi}} \quad (4)$$

in which: CF_d is one of the elements that make up the LVI – IPCC for the community d , which includes: exposure (e), sensitivity (s) and adaptive capacity (a); W_{mi} is the weight for each principal component; M_{di} is the principal component of community d .

Then the research use the calculated values from the above step to find the LVI – IPCC index of community d by calculating the average of the three principal component indices (Ahsan & Warner 2014):

$$LVI - IPCC_d = \frac{(e + s + a)}{3} \quad (5)$$

in which: $LVI - IPCC_d$ is the Livelihood Vulnerability Index of the community d using the IPCC's framework; e is the exposure; a is the adaptive capacity; s is the sensitivity. LVI-IPCC ranges from 0 (least vulnerable) to 1 (most vulnerable).

OVERVIEW OF THE RESEARCH AREA

Da Nang is a city directly under the Central Government in the Central Coast region of Viet Nam. Da Nang city has 8 administrative units including 6 districts, 2 counties, 45 wards, 11 communes. The

city is located in the coordinates of 15°15' to 16°40' North latitude and from 107°17' to 108°20' East longitude, with a natural area of 1,285.43 km². The population of Da Nang is about 1.22 million people (Da Nang City Statistics Office 2021). The city has many coastal villages that are hundreds of years old, such as: Man Thai, Nam O, Nam Tho, Dong Hai, Tho Quang, Tan Thai, Tan An, Tan Tra, Xuan Ha, Thanh Khe, Xuan Duong. Fishing activities in fishing villages contribute to providing an important food source for the people of Da Nang and make significant contributions to the income of local communities.

Nam O fishing village, famous for its fish sauce making, is an ancient fishing village with a history of over 700 years, located at the foot of Hai Van pass, northwest of Da Nang Bay, in Hoa Hiep Nam ward, Lien Chieu district. This land is located at the southern gate of country, so it was called Nam O. With the advantage of a favorable location, close to the sea and near the Cu De River basin, making it convenient for catching seafood, Nam O fishing village gradually developed into what it is today (Viet Nam National Authority of Tourism 2023).

Man Thai fishing village is about 300–400 years old. Since the time of Le dynasty, the King came to explore this land and established Nam An village with a very small number of people at first, but over time due to many problems such as proliferation and migration, the number has increased day by day. Nam An village was changed to Thanh Thai village during the reign of King Thanh Thai of Nguyen dynasty, and then during the period when our country was divided, the Saigon government merged Tan Thai village and Co Man village into Man Thai village, and this has been maintained to the present day. Currently, Man Thai fishing village belongs to Man Thai ward, Son Tra district with a natural area of about 109 hectares. Man Thai sea area has a very favorable location, bordering the East Sea, where there are abundant aquatic resources, large space, creating favorable conditions for strong development of fisheries (Ministry of Culture, Sport and Tourism 2021).

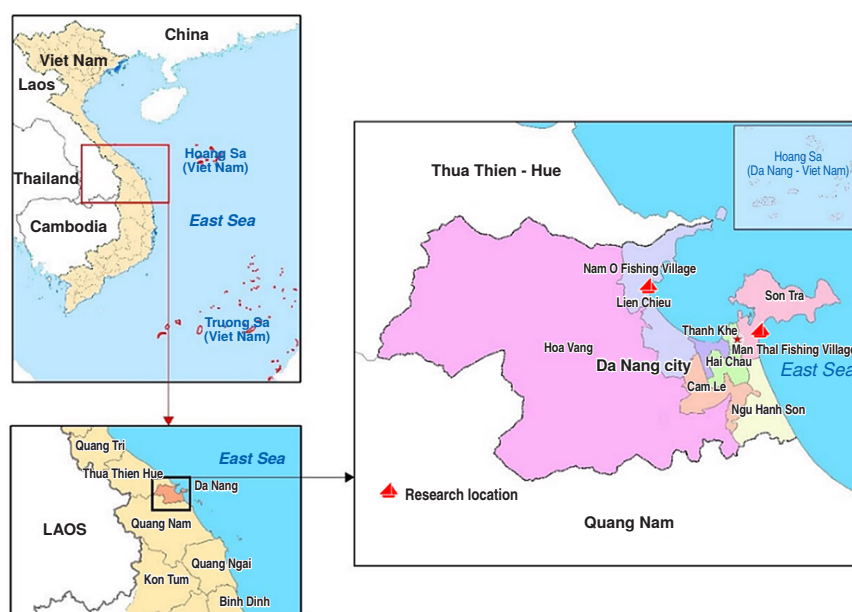


Fig. 2. Location of the study area

Source: own elaboration.

RESULTS AND DISCUSSION

Manifestations of climate change in Da Nang city

Regarding temperature and rainfall: under the impact of climate change, the average temperature of Da Nang city is increasing compared to many previous years. When analyzing climate data in the

period 2016–2020, the temperature of Da Nang city increased by 0.7°C compared to the average value of many years (the whole country 0.62°C). According to statistics from the Department of Natural Resources and Environment of Da Nang City, over the 58 years from 1961–2018, the temperature trend showed an increase of about 1°C. From 2016 to 2022, the average annual rainfall in Da Nang was 2,516 mm, showing a slight decrease of 0.085% per year compared to the average of previous years. The division of rainfall between seasons is clearer, with the dry season experiencing lower rainfall and the rainy season also showing a decrease compared to previous years (People's Committee of Da Nang City 2020).

Evaporation: the average annual amount of water evaporated in Da Nang city is 1,045 mm, with the highest levels occurring during the summer – the period when the southwest Foehn wind passes from Laos to Viet Nam and at the beginning of the rainy season, the amount of water evaporated is low. Because the climate of Da Nang city is long-lasting heat and heavy rain, when entering the rainy season, due to continuous rain, the air temperature decreases, the evaporation rate also decreases. In the dry season, due to long-lasting heat, the air temperature is high, the evaporation rate also increases. However, under the impact of climate change today, the average annual air temperature increases, leading to an increase in the amount of moisture in the air that evaporates compared to the multi-year average, causing many negative effects on human livelihood activities and health (People's Committee of Da Nang City 2020).

Number of sunny days: according to the Department of Natural Resources and Environment of Da Nang City, the average number of sunny days has shown an increasing trend during the period from 1961 to 2018. The increase in the number of sunny days is about 0.3643 days/year. And over the 58-year period, the average has increased by about 21.2 sunny days. In each specific period from 1961–1989, the number of sunny days increased by about 14.1 days/year. By the period 2010–2018, the average number of sunny days reached 33.4 days/year (People's Committee of Da Nang City 2020).

Storms and tropical depressions: from 1998–2023, according to data provided from annual summary reports of the General Department of Hydrometeorology, the frequency of storms and tropical depressions in the East Sea is up to 340, with 63 of them affecting Da Nang city (Ministry of Natural Resources and Environment 2023).

Floods: In the period from 1998–2020, there were 57 floods, of which a total of 17 floods caused damage to the entire Da Nang city. Under the impact of climate change, rainfall has increased beyond the historical average and has led to extensive inundation across multiple areas of Da Nang City. Notably, the unusually severe flood in October 2022 caused significant damage to infrastructure and agriculture, particularly in the area along the Cu De River, where we conducted our survey (Ministry of Natural Resources and Environment 2023).

Livelihood vulnerability assessment using LVI

Household characteristics

Generally, in terms of household characteristics, the heads of households in both fishing villages are male, there are some female heads of households but in special cases such as single mothers and elderly women over 60 years old whose husbands have passed away. According to survey data, the number of female heads of households in Nam O fishing village accounts for about 18.2% of the total number of households, while in Man Thai fishing village, it is only 2.9% of the total number of surveyed households, equivalent to that, the number of male heads of households in Man Thai fishing village is also higher than in Nam O fishing village.

The rate of dependent population (<15 and >65 years old) in Nam O fishing village (61.4%) is higher than that in Man Thai fishing village (57.1%). In general, in both fishing villages, the rate of illiteracy eradication carried out by Da Nang city is very high. In Man Thai fishing village, there is no illiterate household head. Although in Nam O fishing village, there are still 3 households (2.9%)

Table 3. Indicator values for the assessment of Livelihood Vulnerability Index in Man Thai and Nam O fishing villages

Major component	Indicator	Units	Man Thai	Nam O	Minimum value	Maximum value
Household characteristics	Dependency ratio	%	57.1	61.4	0.0	100
	Percentage of female household heads	%	2.9	18.2	0.0	100
	Percentage of households with illiterate heads	%	0.0	2.9	0.0	100
Livelihood strategies	Percentage of households whose livelihood depends mainly on fishing	%	60.9	36.4	0.0	100
	Percentage of households with no family members working outside the locality	%	82.6	87.9	0.0	100
	Percentage of households with working-age members unemployed/underemployed	%	13.0	31.8	0.0	100
Social Network	Percentage of households without access to information sources	%	0.0	0.0	0.0	100
	Percentage of households that did not receive support from government agencies in the past 12 months	%	84.1	74.2	0.0	100
	Average travel time to commune administrative center	Minute	3	8.4	2	20
Health	Percentage of households with family members suffering from chronic or serious illnesses	%	4.3	13.6	0.0	100
	Percentage of households with someone requiring regular care	%	15.9	25.8	0.0	100
	Average travel time to nearest medical facility	Minute	10.0	8.4	5.0	20.0
Food	Percentage of households lacking food sources – food produced by the family itself	%	33.3	63.6	0.0	100
	Average number of months without food	Month	2.9	1.7	0.0	12.0
	Percentage of households without food reserves	%	2.9	39.4	0.0	100
Household living conditions	Percentage of households not using clean water/tap water for daily activities	%	0.0	0.0	0.0	100
	Percentage of households with no savings money	%	13.0	36.4	0.0	100
	Percentage of households without permanent housing	%	21.7	53.0	0.0	100
	Percentage of poor households	%	2.9	10.6	0.0	100
Natural disasters and climate change	Average number of natural disasters affecting families in the past 5–7 years	Number	64.0	47.1	0.0	91.0
	Percentage of households that did not receive early warning of impending natural disasters	%	0.0	0.0	0.0	100
	Percentage of households with property damage due to natural disasters in the past 5–7 years	%	8.7	51.5	0.0	100
	Percentage of households with people injured/dead due to natural disasters in the past 5/7 years	%	0.0	0.0	0.0	100

Source: own elaboration.

whose heads are illiterate and cannot write, it proves that the government has done a good job in this work.

The general vulnerability index of demographic characteristics of Nam O fishing village residents (0.275) has a higher index than that of Man Thai fishing village (0.200). This means that, in terms of household characteristics, Nam O fishing village is more vulnerable than Man Thai fishing village due to factors such as the gender of the household head, dependency ratio, and educational level of the household head. As a result, the vulnerability index in Nam O fishing village is higher.

Livelihood strategies

There are certain differences in livelihood activities in both fishing villages. In Man Thai village, people's livelihoods depend mainly on fishing, with about 60.9% of households engaged in livelihood activities such as fishing, trading seafood, making fish sauce, exploiting and producing seaweed jam, etc. As for Nam O village, people's main livelihood activities were previously from fishing. Nam O is famous for its ancient fish sauce fishing village. However, due to the impact of urbanization, people's livelihoods have gradually shifted to other occupations such as workers, traders, etc., so currently, the level of livelihood activities mainly based on fishing in Nam O fishing village accounts for only 36.4% and 63.6% of households have non-fishing livelihood activities.

The vulnerability index of livelihood strategies in both Nam O and Man Thai fishing villages is quite high (0.522 and 0.520 respectively). This is because in both Nam O and Man Thai fishing villages, the population is engaged in fishing activities, which are highly dependent on the weather. Man Thai is more vulnerable to livelihoods because there are more households whose main livelihood is fishing. In addition, the number of household members who do not work outside the locality is also quite high in Man Thai, accounting for 82.6% of the total number of households, meanwhile there are no members working outside the locality or working in non-fishing occupations, households are more vulnerable to the impacts of current climate change.

Social networks

Social networks are indicators representing the level of access to information, the level of cooperation and assistance within the community and with organizations and governments of the community. The better the access, the easier it is to adapt to events that happen to the community. The survey results show that the access to information in both fishing villages is very good. There is no household that does not have access to information about natural disasters and climate change from local authorities, telephones, newspapers, and television. However, the time to get to the commune administrative agency in Nam O is quite long, about 8.4 minutes on average. Meanwhile, Man Thai is closer with an average of about 3 minutes of travel. Regarding the level of support from local authorities, the survey showed that 84.1% of households in Man Thai and 74.2% of households in Nam O said that there are virtually no significant social support activities for residents' livelihoods.

Based on the analysis of the level of support received from local authorities and the time to go to the commune administrative agency, it can be seen that the adaptability of the social network index in Nam O is better than that of Man Thai, with the index values of 0.299 and 0.366, respectively.

Health

The vulnerability index for public health issues in both fishing villages is low, with Nam O being more vulnerable (0.207) compared to Man Thai village (0.179). This index is specifically shown through the percentage of people in households requiring regular care (elderly and children), and people with chronic diseases (cancer, liver disease, cardiovascular disease, asthma, etc.). In particular, Nam O has both a high percentage of people requiring regular care and a higher number of people with chronic diseases than Man Thai. However, and access to the nearest medical facility in Man Thai is further than in Nam O (10 minutes compared to 8.4 minutes).

Food

In terms of food, Nam O with the score of 0.391 is more vulnerable than Man Thai (0.201). This difference mainly comes from the number of residents working mainly from fishing in both fishing villages, which shows a noticeable difference. Nam O has fewer households working in fishing than Man Thai. Fishermen often store a part of the amount of seafood harvested after each trip, dry it to reserve food for the rainy season, and sell the rest to serve the family economy. Therefore, when a natural disaster occurs, Nam O will be more vulnerable than Man Thai, because there is no source of food produced and stored by the family. However, because fishing economic activities depend deeply on the weather, the rainy season (from September to December) is also the rough sea season, so almost all fishing activities cannot take place, leading to food shortages for several months in both fishing villages.

Living conditions

The vulnerability index of living conditions in Nam O is much higher than that of Man Thai (0.25 and 0.09 respectively). In both fishing villages, 100% of households have access to clean water. However, Nam O has a much higher rate of poor households and households with fragile houses that are easily destroyed by whirlwinds, storms, etc. than Man Thai. Most of the houses in Nam O are degraded, covered with rusty corrugated iron sheets, and the houses are often low-lying, making them very susceptible to flooding. Some households do not even have main doors.



Photo 1. Image of Nam O resident's house
Source: Photo by the Authors.



Photo 2. Image of Man Thai resident's house
Source: Photo by the Authors.

There is also a significant difference in the number of households without savings money in both fishing villages – in Man Thai it is 13.0% and in Nam O it is 36.4% of the total number of households without savings money. When natural disasters occur, households with financial reserves in advance are better able to adapt and recover from natural disasters. This difference is mainly due to the fact that in Man Thai, livelihood activities mainly depend on fishing. During rough seas it is impossible to go out to sea to fish, which forces people to use their previous savings to cover household expenses.

Natural disasters and climate change

Overall, in terms of this characteristic, Nam O is more vulnerable than Man Thai (0.258 vs. 0.198). Statistics show that the number of natural disasters affecting the livelihoods and lives of residents of

the two fishing villages is different in the period 2017–2023. On average, each year during this period, Nam O was affected by 6.72 natural disasters and Man Thai was affected by 9.14 natural disasters. Storms, heavy rains, floods, and intense heat are the main types of natural disasters that cause damage, although people receive early warnings of impending natural disasters from local authorities and information on the media. Most recently, rising water in the historic flood in October 2022 swept away fishing equipment, flooded residences, causing heavy damage to households, especially in Nam O (Ministry of Natural Resources and Environment 2023).

General Livelihood Vulnerability Index (LVI)

The comparison results of livelihood vulnerability of the main components of the two fishing villages of Nam O and Man Thai are shown in Figure 3. It shows that the level of livelihood vulnerability in both fishing villages is at the low level, but in general, Nam O is more vulnerable due to climate change than Man Thai (LVI of Man Thai is 0.234; LVI of Nam O is 0.318). The reason is that Nam O is more vulnerable in terms of food, household living conditions, and household living characteristics.

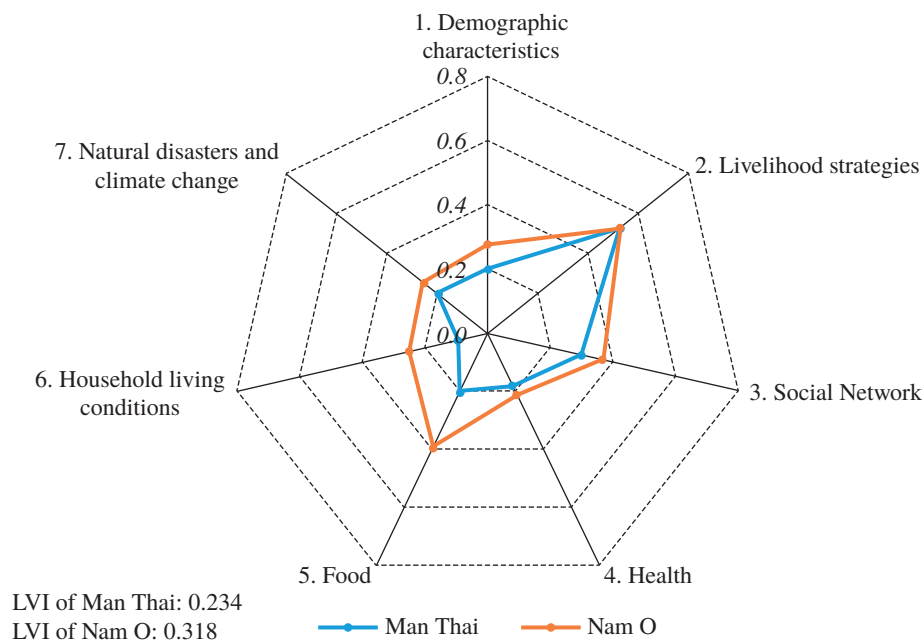


Fig. 3. Comparing components of LVI of Man Thai and Nam O fishing villages
Source: own elaboration.

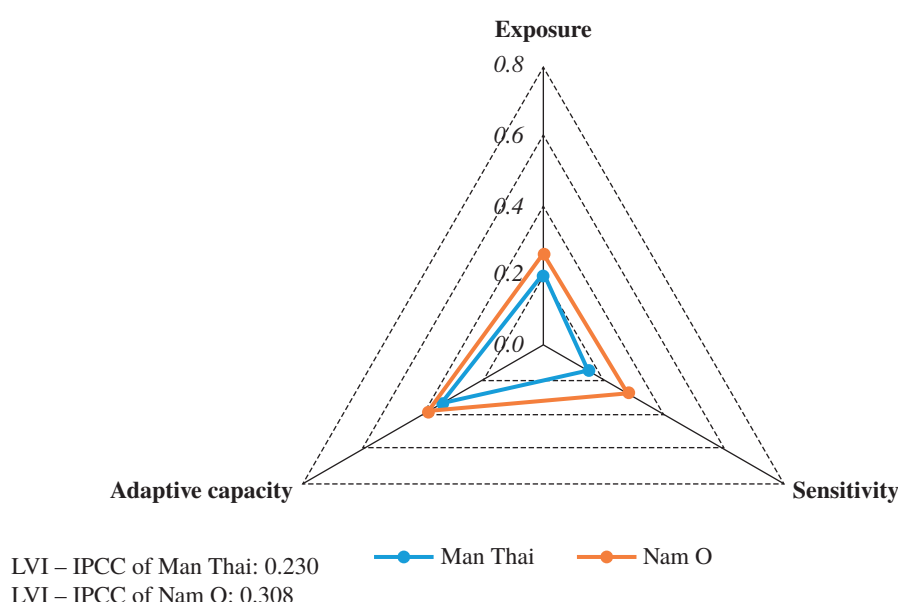
Livelihood Vulnerability Index according to IPCC (LVI – IPCC)

The results of the livelihood vulnerability according LVI – IPCC of Man Thai and Nam O are shown in Figure 4 and Table 4. They indicate that both communities have moderate to low livelihood vulnerability, with the Nam O community (LVI – IPCC: 0.308) being more vulnerable than the Man Thai community (LVI – IPCC: 0.230). The vulnerability level in terms of adaptive capacity (household characteristics, livelihood strategies, social networks) is similar in both fishing villages, but the exposure and sensitivity levels (health, food, household living conditions) in Nam O are higher than in Man Thai (0.279 vs. 0.152 for sensitivity; 0.258 vs. 0.198 for exposure).

Table 4. Indicators and components of Livelihood Vulnerability Index according to IPCC of Man Thai and Nam O

Factors contributing to IPCC vulnerability	Number of indicators	Man Thai	Nam O
Adaptive capacity		0.340	0.387
Demographic characteristics	3	0.200	0.275
Livelihood strategies	3	0.522	0.520
Social Network	3	0.299	0.366
Sensitivity		0.152	0.279
Health	3	0.179	0.207
Food	3	0.201	0.391
Household living conditions	4	0.094	0.250
Exposure		0.198	0.258
Natural disasters and climate change	4	0.198	0.258
LVI – IPCC		0.230	0.308

Source: own elaboration.

**Fig. 4.** The components of LVI (adaptive capacity, sensitivity, and exposure) according to IPCC (LVI-IPCC) of Man Thai and Nam O

Source: own elaboration.

CONCLUSION

The research has applied the LVI and LVI-IPCC as integrated methods for assessing relative livelihoods vulnerability of communities to climate change impacts in Nam O and Man Thai fishing villages of Da Nang City. The assessment results show that both fishing villages are facing low livelihood vulnerability and Nam O is somewhat more vulnerable than Man Thai, especially in terms of food, household living conditions. In general, residents in both fishing villages have recognized the negative impacts of climate change on their livelihoods, so they always take proactive measures to limit risks.

The analysis of the LVI and LVI-IPCC indicators not only highlights the importance of assessing livelihood vulnerability to climate change, but also contributes to the development of measures to reduce risks from the negative impacts of climate change or enhance the adaptive capacity of fishing villages. The assessment also shows which areas are vulnerable to what extent, thereby providing more plans to prioritize more vulnerable areas. From these issues, it will support residents in improving their quality of life and sustainable development. Based on the analysis of the main and sub-components of the livelihood vulnerability index to climate change, the authors propose some recommendations as follows:

For residents of the two fishing villages: (i) It is necessary to develop a reasonable spending and saving plan, actively gain experience, participate in training courses on knowledge of fisheries economic activities, climate change, application of science and technology in economic activities, etc., thereby improving economic life and enhancing adaptability; (ii) Exploit aquatic resources reasonably and sustainably, do not use electric pulses and negative methods in exploitation to maintain aquatic resources and thereby fish long-term.

For local authorities: (i) Organize training sessions for residents in fishing villages on how to adapt to the impacts of natural disasters, how to minimize the negative impacts of climate change or some actions to minimize climate change and protect the environment. This is very important because increased awareness will increase the ability to adapt, thereby minimizing damage to property and people caused by natural disasters and climate change. (ii) Strengthen and improve the quality of medical services and scale to improve community health, thereby increasing resilience to extreme weather. (iii) Develop and implement policies to support finance, life jackets, fishing tools, etc. to make it easier for residents of fishing villages to engage in economic activities. (iv) Create other jobs in the local area for residents to reduce dependence on fishing.

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