

The Role Of Household Capital Sources In Climate Change Adaptation In The Central Highlands Of Vietnam: Evidence From Gia Lai Province

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Abstract

Climate change is causing severe and increasingly unpredictable impacts on the livelihoods of residents in Vietnam's Central Highlands. This study evaluates the role of household capital sources in adapting to climate change, based on empirical evidence from Gia Lai province. By integrating quantitative and qualitative methods, the authors conducted a structured survey of 200 households in Bau Can commune, Gia Lai province, during 2025–2026. The analysis used the sustainable livelihoods framework, which encompasses five core types of capital: human, social, natural, physical, and financial. The findings indicate that climate change has significantly disrupted household capital, thereby increasing livelihood vulnerability. Specifically, extreme weather events have caused work interruptions, job losses, and adverse health impacts. Landslides, water shortages, property damage, and the loss of business assets have severely affected natural and physical capital. Financially, unpredictable weather has caused agricultural diseases, reduced crop yields, and declining incomes. However, social capital has proven crucial, with residents actively participating in associations and maintaining mutual community support networks to cope with disasters. The study concludes that households with diversified livelihood strategies and better access to resources demonstrate higher resilience to climate shocks. Therefore, to ensure effective adaptation, policies must prioritize improving access to education, vocational training, financial credit, and strengthening community-based support networks. These measures will help households sustain their livelihoods and preserve ecological integrity.

Keywords: Climate change; Household capitals; Sustainable livelihoods; Adaptation capacity; Central Highlands; Gia Lai province; Viet Nam

1. Introduction

According to the World Meteorological Organization (WMO) 's 2024 Global Climate Report, the average global temperature in 2020 was approximately 1.2°C higher than during the pre-industrial period (1850-1900) (WMO, 2024). 2024 was among the three hottest years ever recorded and marked the end of a decade of unprecedented temperature increases attributed to climate change. In 2024, Greenland, which contains the world's second-largest ice sheet, lost 152 billion tons of ice due to melting, significantly



contributing to recent global sea level rise. Many regions experienced above-average temperatures in 2020 because of heatwaves, droughts, and wildfires. For example, in August 2020, Death Valley in the Mojave Desert (California, USA) recorded 54.4°C, the highest global temperature in at least 80 years. In Europe, 2020 was the hottest year on record, with average annual temperatures 2.2°C above pre-industrial levels and nearly 0.5°C higher than in 2019.

Between 2016 and 2019, many regions experienced record-high temperatures due to El Niño, characterized by ocean warming. In contrast, 2020 was dominated by La Niña, which involves ocean cooling and led to more severe rainy seasons and flooding, particularly in Africa and South Asia, including India, China, and Southeast Asia, affecting millions of people. Frequent floods and storms occurred globally, including in Africa and China. According to the Central Steering Committee for Disaster Prevention and Control, Vietnam experienced 16 types of natural disasters in 2020, including 13 typhoons in the East Sea, 264 thunderstorms, tornadoes, and heavy rains across 49 provinces and cities, and 120 flash floods and landslides. Notably, during the historic period of heavy rain and flooding from mid-September to mid-November in the Central region, the Central Coastal area was struck by nine typhoons (numbered 5 to 13) and two tropical depressions within nearly two months. Typhoon number 9 intensified into a super typhoon and was considered the strongest in the past 20 years. Such events can disrupt millions of lives and cause substantial economic losses in many countries. Furthermore, climate change and extreme weather events have led to a resurgence of food insecurity since 2014, reversing decades of progress.

The Intergovernmental Panel on Climate Change (IPCC) reports that global warming has continued uninterrupted for the past three decades. Greenhouse gas emissions from human activities, the primary driver of global warming, continue to rise annually. Some effects of climate change can be avoided if global warming is limited to 1.5°C. Achieving this target requires rapid, large-scale changes in land use, energy, industry, buildings, transport, and urban systems. Global net carbon dioxide (CO₂) emissions from human sources must decrease by approximately 45 percent from 2010 levels by 2030 and reach net zero around 2050 (IPCC, 2023).

Climate change is intensifying globally, affecting the economy, politics, diplomacy, and security. Countries must proactively adapt to and mitigate negative impacts by reducing greenhouse gas emissions in line with their Nationally Determined Contributions (NDCs) under the Paris Agreement on Climate Change, starting in 2021, to limit global temperature rise to 1.5°C by the century's end.

In 2015, over 190 countries adopted the Paris Agreement on Climate Change, with most pledging to cooperate to keep the increase in global temperatures below 2°C above pre-industrial levels by the end of the twenty-first century. However, five years after the agreement, anticipated progress had not been achieved. The COVID-19 pandemic in 2020 created a dual health and economic crisis, causing many countries to delay their climate change commitments temporarily. Consequently, the 26th United Nations Climate Change Conference (COP) was postponed to November 2021.

The Glasgow Climate Agreement was adopted at COP26 in November 2021 in Glasgow, UK, after a one-year delay due to the COVID-19 pandemic. A total of 197 countries affiliated with the United Nations Framework Convention on Climate Change agreed to the accord. The agreement reaffirmed the commitment to limit the increase in global temperatures to 1.5 degrees Celsius and, for the first time, called for a global reduction in electricity and coal use, the discontinuation of carbon capture technologies, and the elimination of inefficient fossil fuel subsidies.

At COP26, countries made several significant commitments. Leaders from over 120 countries, representing territories that encompass approximately 90% of the world's forests, pledged to halt and reverse deforestation by 2030, aligning with the timeline for achieving the Sustainable Development Goals (SDGs). Nearly 100 countries committed to reducing methane emissions by 30% by 2030 compared to 2020 levels. More than 40 countries, including major coal consumers such as Poland, Vietnam, and Chile, agreed to transition away from coal, a major source of CO₂ emissions. Over 20 countries pledged that all cars and trucks sold by 2035 would be zero-emission vehicles. Notably, the United States and China agreed to enhance climate cooperation over the next decade, issuing a joint statement on actions related to methane emissions, clean energy transition, and decarbonization, while reaffirming the 1.5°C target. On

green transport, more than 100 national governments, cities, states, and major automotive companies signed the Glasgow Declaration on Zero-Emission Cars, and Vansto announced plans to stop selling internal combustion engine vehicles by 2035 in leading markets and by 2040 globally. At least 13 countries also committed to ending sales of fossil fuel-powered heavy vehicles by 2040. Additionally, 450 financial institutions managing \$130 trillion in assets, equivalent to 40% of global private assets, committed to investing in clean technologies such as renewable energy and to discontinuing financing for fossil fuel industries.

The climate change agreement has entered its implementation phase. From 2021 onward, all countries must reduce greenhouse gas emissions in accordance with their Nationally Determined Contributions (NDCs). Countries must prioritize and support climate change responses, focus on achieving global objectives, and implement these actions transparently, subject to international monitoring and evaluation.

Achieving net-zero emissions by 2050 is a global development objective that primarily depends on a substantial energy transition and low-emission development. This target also establishes new standards for global trade and investment, as set forth at the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP26).

Reducing greenhouse gas emissions and transitioning from fossil fuels to clean, renewable energy present opportunities to reorganize economies more sustainably, enhance competitiveness, and expand cooperation in trade and investment. The government is actively promoting clean energy development and the rapid phase-out of coal, along with a gradual transition away from other fossil fuels such as oil and gas. International financial resources are expected to shift from coal-fired power generation to supporting renewable energy development, the circular economy, forest conservation, and ecosystem protection.

Vietnam's Central Highlands are now facing climate effects never seen before, including severe dry-season droughts (November to April) and, at the same time, unusually heavy rains, storms, and intense cold spells in the rainy season (May to October). Climate changes in the Central Highlands are becoming increasingly extreme and difficult to predict, disrupting crop development patterns and significantly affecting socio-economic growth, poverty reduction, human resource quality, and overall human development.

Gia Lai is a province in the northern Central Highlands, with an average elevation of 700-800 meters above sea level. The province covers 15,536.92 km² and extends from 12°58'20" to 14°36'30" north latitude and from 107°27'23" to 108°54'40" east longitude. It borders Kon Tum province to the north, Dak Lak province to the south, Cambodia to the west (the two countries share a 90 km national border), and Quang Ngai, Binh Dinh, and Phu Yen provinces to the east.

Gia Lai province is making considerable progress in both economic and social development. Climate change has already had an impact and continues to change how people in Gia Lai province live. To meet the challenges of climate change, the province has included climate change considerations in its programs and plans relating to environmental protection, the rational use of natural resources, disaster prevention, and, in the short-term, medium-term, and long-term, sustainable development planning in the fields of agriculture, forestry, tourism, and public health protection.

The average annual economic growth rate from 2011 to 2020 was 12.4 percent, 12.8 percent for 2011–2015, and 12.0 percent for 2016–2020. GDP per capita (at current prices) was 34.2 million VND in 2015 and 72.2 million VND in 2020.

In 2015, the shares of agriculture, industry, and services in the economy were 33.0%, 36.7%, and 30.3%, respectively, and are projected to be 28%, 38%, and 34% in 2020. The aim is to achieve an export turnover of about US\$250 million by 2015 and US\$580 million by 2020. Budget revenue is expected to make up about 10% of GDP by 2015 and around 7.2% by 2020.

So far, the Central Highlands economy still relies mainly on agriculture and forestry. Even though the conditions for agricultural and forestry production are relatively favorable when compared with those of other regions, the effects of climate change and extreme weather events, such as greater fluctuations in daily temperatures and humidity, heavier rainfall and storms, more severe floods and landslides, more frequent thunderstorms, tornadoes, hailstorms, and longer droughts, have greatly affected the ability of households in the Central Highlands to maintain their livelihoods.

In Gia Lai, rural livelihoods depend mainly on agriculture, with coffee and other industrial and fruit crops forming the mainstay of the local economy. Droughts, seasonal rainfall variability, and irrigation water demand directly influence agricultural output. Household vulnerability depends on factors such as assets, health, skills, access to infrastructure and credit, and available social support networks. Therefore, in line with the sustainable livelihoods framework, vulnerability assessments should integrate climate hazard data with a comprehensive analysis of household capital, including human, social, natural, physical, and financial resources, rather than treating climate impacts in isolation. This approach provides a more holistic understanding of adaptive capacity and resilience within the context of climate change.

Research into climate vulnerability has moved beyond merely identifying hazards and exposure levels to examining interactions among climate risks, system sensitivities, and adaptation capacity. The sustainable livelihoods approach views households' ability to access and draw on five types of capital: human, social, natural, physical, and financial. The World Bank's report, *Risks of Climate Change and Adaptation in Asian Coastal Cities* (2010), has demonstrated that coastal cities such as Manila (in the Philippines), Ho Chi Minh City (in Vietnam), and Bangkok (in Thailand) are all severely affected by flooding caused by climate change. As a result, these cities have spent billions of dollars on remediation, and their economic growth rates have declined by 2 to 6 percent over the last 30 years, according to the city.

Studies such as those by Adger (2000) and Cutter et al. (2003) also indicated that a population's structural features did not adjust well to climate change. Research by Dulal et al. (2010) showed that poor households were less able to adapt to climate change because they lack capital. These studies define livelihood damage as the extent to which people and systems cannot cope with the negative effects of climate change and their social context.

Hahn et al. (2009) used the livelihood assets framework to develop several household vulnerability indicators, drawing on their research in Mozambique; additional empirical studies carried out in Bihar, Nepal, and Ghana demonstrated that education, livelihood diversification, food security, social networks, and access to resources are all related to coping capacity. However, the significance of each factor varies by local context and livelihood group.

The Intergovernmental Panel on Climate Change (IPCC, 2001) stated that livelihood vulnerability to climate change impacts was determined by three indicator components: *exposure*, *adaptability*, and *sensitivity*.

Shah and others (2013) studied Trinidad and Tobago using LVI analysis, and the IPCC found that how households earn a living, their level of healthcare, their access to clean water, and their land ownership all affect households' capacity to adapt to climate change.

Madhuri and others (2014) examined Bihar. They found that education, livelihood diversity, and expanded household social networks were all associated with the ability to cope with climate change's negative effects. Panthi et al. (2016) found that the strategies people use to make a living and their access to food sources are the most important factors in determining vulnerability to climate change.

Simane et al. (2016), in their analysis of climate change damage to agricultural ecosystems in Ethiopia, found that living standards, technology, and infrastructure matter for adapting to climate change. In their study in Ghana, Adu and others also found that social networks and livelihood strategies are key indicators of household vulnerability when adapting to extreme weather.

Ding et al. (2018) found that social capital and natural capital are two important factors that affect people's livelihoods when adapting to adverse climate phenomena. Majid et al. (2019) combined livelihood vulnerability calculations with geographic information systems (GIS) to show that women-led households, households with no livelihood diversification, and households living by rivers are vulnerable to climate change impacts such as flooding.

Alam et al. (2017) found that climate change significantly affects five sources of household capital by reducing arable land, decreasing forest area, causing people to leave their homes, and lowering income. Monirul Alam and colleagues then assessed people's perceptions of climate change and their adaptation strategies across farming timeframes, crop changes, and livelihood diversification.

Macro-level studies on climate change in Vietnam generally yield negative evaluations. The IPCC (in 2001, 2007, and 2014), the World Bank (2016), and the Ministry of Natural Resources and Environment

of the Vietnamese government (in 2003 and 2016) have evaluated and projected that Vietnam is one of the 84 countries around the world that are severely affected by climate change. According to the climate change scenario issued by the Vietnamese government, by 2070 these changes will jeopardize the country's sustainable development objectives, such as poverty reduction (Ministry of Natural Resources and Environment, 2016). The reports mention effects including reduced arable land, shortages of water for domestic use and irrigation, soil erosion, landslides, floods, and biodiversity loss. Moreover, many crops are affected by diseases with no effective treatments, leading to substantial losses for farmers.

A very important result of climate change is that Vietnam's GDP fell by about 1.5% from 1997 to 2006. The most vulnerable are women, children, and ethnic minorities (OXFAM and UN, 2009). Low-income people grow even poorer because prolonged droughts lead to land loss (Truong, 2015).

Dang et al. (2015) also showed that sea-level rise and extreme weather, including storms and droughts, have negatively affected people's livelihoods, and people have adapted by relocating to other places to find better livelihoods.

Several ministerial and national studies have recently been carried out, including Phan's (2017), Luong's (2014), and Nguyen's (2015) studies on climate change and the development of policy mechanisms to respond to it. These studies provide a foundation for understanding the general background and climate change policies in Vietnam over the past years.

Pham's 2017 study on adapting farming practices to climate change in Da Lat City, Lam Dong Province, found that climate change has been significant, with rising temperatures and rainfall causing lower crop yields, more frequent plant diseases, and slower crop growth. To adapt, people have had to invest in machinery, improve their knowledge, and switch to different crop varieties and farming methods.

Tran et al., in their study on agricultural land, identified specific areas affected by drought due to climate change in Dak Lak province; this study formed the basis for selecting the research sites on livelihood damage. Ha and Ly (2021) showed that climate change has reduced crop yields and shrunk land area, while the livestock industry has seen an 8.2% reduction in the number of animals.

In response to the adverse effects of climate change, the Vietnamese Party and Government have introduced several significant policies at all levels, from the central to the local level, right from the start. This process started in 1998 when Vietnam signed both the United Nations Framework Convention on Climate Change and the Kyoto Protocol. The Ministry of Natural Resources and Environment (2008) then launched *the National Target Program to respond to climate change*. In 2011, the government passed Decision No. 2139/QĐ-TTg, which approved *the National Strategy on Climate Change*. The government raised climate change response to the highest level. The political system became involved in both combating and adapting to climate change as a result of the 7th Conference of the Central Committee of the Party (11th term), which on June 3, 2013, issued Resolution No. 24-NQ/TW on *proactively responding to climate change, strengthening resource management, and protecting the environment*. Since then, regions, provinces, and cities across Vietnam have drafted and published action plans to respond to climate change, aiming to achieve sustainable development and linking these plans to their local socio-economic development plans. The most recent high-level legal document is *the National Climate Change Adaptation Plan for 2021–2030, with a vision extending to 2050*, issued by the Government of Vietnam (Prime Minister, 2020). On December 21, 2021, the Prime Minister of Vietnam signed Decision No. 2157/QĐ-TTg, establishing the National Steering Committee to implement Vietnam's commitments at the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP26).

At the policy level, Vietnam has introduced programs and action plans at central and local levels. These policies are shifting from responding to climate change to building resilience and adaptation.

The review of the research problem indicates that livelihoods in the context of climate change have been the subject of extensive research and the development of numerous policies. Nevertheless, the problem of livelihood damage caused by climate change among ethnic groups in the Central Highlands, such as the Kinh and the minority groups, has still not been widely studied. Furthermore, climate change adaptation policies in this area also require more empirical data, particularly from the population's perspective, to ensure project effectiveness.

In general, many scholars have conducted extensive research on residents' livelihoods in the context of climate change, including in both coastal and mountainous areas. These studies have provided a multidimensional, comparative analytical perspective on the role of capital sources in people's livelihoods. The studies indicate that climate change significantly affects households' capital resources, with the extent of the impact varying by region and country.

The analysis refers only to Gia Lai province within the boundaries that existed before the 2025 administrative reorganization, excluding the former Binh Dinh province. After July 1, 2025, Gia Lai and Binh Dinh were combined to form a new province called Gia Lai; therefore, data and studies before that date should be understood in light of their original historical boundaries.

2. Research Method

Desk-study method

This study uses a qualitative approach with literature study and document analysis (desk study) to examine climate change policies and strategies at the national and provincial levels (Bercht, 2021) and (Park et al., 2022). At the national level, the analysis covers policy and regulatory documents from 1992–2024, including party resolutions, laws, and government decrees and regulations. At the provincial level, the documents reviewed include climate assessment reports, climate change action plans for the 2021–2030 period with a vision to 2050, and provincial development plans for the 2021–2030 period with a vision to 2045–2050. Furthermore, community survey reports are analyzed comparatively to identify alignments and gaps between national policies, provincial plans, and implementation conditions at the local level (Varshney et al., 2024) and (López-Santana & Tanca, 2024).

Field survey data

A structured household survey was designed to systematically assess the five categories of capital—human, social, natural, physical, and financial—within the sustainable livelihoods framework (Natarajan et al., 2022), (Quandt, 2018). The survey instrument included standardized questionnaires and open-ended items to capture detailed household experiences and adaptation strategies in response to climate change, consistent with household survey and mixed-method approaches commonly used in livelihood vulnerability research (Thomas, 2018), (Momtaz, 2016), (Garbole et al., 2026). Data were collected from 200 households in Bau Can commune, Gia Lai province, over two years (2025–2026), enabling an analysis of capital dynamics amid ongoing environmental change.

Research ethics

The survey process was carried out with approval from competent authorities at all levels, including state management agencies, provincial governments, and local governments, and with the local community's consent before implementation. When conducting household surveys, the research team clearly explained the survey's purpose and content to each household; households could agree or refuse to take part in the questionnaire interviews, in-depth interviews, and video recordings. In practice, all households approached in the area agreed to take part; no one refused. While processing the data and presenting the results, the team anonymized participants' personal information.

3. Research Results

3.1. Human Capital

In the survey carried out in Bau Can commune, Gia Lai province, 20.2% of household heads were women, with the remainder being men. This figure is below the national average of 27.4% recorded in the 2018 Household Living Standards Survey.

Of the 200 households surveyed, the average household size was 4, for a total of 2,500 people, of whom 1,418 were of working age. The dependency ratio was 72 percent, meaning each working-age person had approximately 0.6 dependents. Generally, household heads in the area studied were of working age, and household heads at the survey sites were also relatively young and within the working-age group.

The health of the surveyed households was also very good, with only 8 percent of household heads reporting frequent illness. Generally, the household heads in the Bau Can commune area were in good health.

A survey of family health found that 8.9% of household heads had a family member with a chronic illness such as arthritis or cardiovascular disease. The same survey of 200 households also indicated that 10.2% had members aged 6 years or older who did not have, or were not covered by, health insurance.

The findings indicate that households have not paid proper attention to part of their human capital, with human health in particular being a key element. According to the multidimensional poverty criteria issued by the Government in Decree 07/2021/ND-CP of January 27, 2021, for 2015 and 2021, many households in the three provinces under investigation likely lacked access to essential social services and health insurance.

The survey indicated that 3.5% of the households in the province under study reported cases of this disease in the previous year. The same survey, which examined education level, found that 42% of household heads had completed lower secondary education, 28.17% had primary education, and 26.67% had upper secondary education (grades 10 to 12).

The survey also revealed that 26% of households reported having members aged 15 and older who had not graduated from lower secondary school and were not currently attending school. However, the percentage of school-age children (5-15 years old) was very low in the surveyed areas, at only 1%. This suggests that families are highly concerned about their members' access to general education.

The survey results regarding current household employment indicate that 32 percent of household heads operate independent businesses that do not require high levels of expertise, while 25.83 percent engage in trading activities. Furthermore, 7 percent hold positions within government agencies, and 6 percent work in private enterprises and manufacturing sectors. Regarding joblessness, the unemployment survey found that 21 percent of families reported unemployment.

3.2. Social Capital

In the 200 sample households, 75 participated in or belonged to official and unofficial associations in the study province. Overall, all households were very actively involved in these organizations, strengthening family relationships. The figure below shows the concentration of social relationships among households at the study site, where most households participate in fewer than two different associations or groups.

Official associations are legally recognized and implemented through the state, such as farmers' associations, women's associations, youth organizations, veterans' associations, and the Fatherland Front. The survey results show that 62.2% of households participate in women's associations. 37.5% of households have members participating in youth unions. The percentage of households participating in farmers' associations is 34.2%. The lowest percentage is for the Fatherland Front, at 1.8%.

However, when asked whether households regularly receive support from associations, primarily in the form of loans for family businesses, 9.8% of household heads stated that they did receive assistance, and 5.7% of households received assistance immediately after weather-related natural disasters. For non-official associations, which are based on customs and traditions, regulations and operating principles are quite loose, as determined through interviews with residents, including religious associations, hometown associations, business associations, and fishing associations. Statistical results show that 25.3% of households belong to different religious groups. Thus, the results show that significantly more households participate in official associations than in unofficial ones.

Another very important variable is mutual support between families and neighbors. A good, harmonious relationship can help families find employment, secure their livelihoods, and overcome difficulties after adverse weather events such as storms and floods. In the 200 households surveyed, 48% regularly visited neighbors when they were ill. 55% and 37% of households, respectively, helped each other with house repairs or other tasks. Only 6% of households could lend money to neighbors when needed.

Unlike assistance from within the household, fewer households received assistance from neighbors: only 26.8% received visits during illness, 31.5% received assistance with home repairs, and only 1.8%

received loans. In addition, households also borrow money from relatives at a rate of 8.5%. The survey results on household social capital revealed households' social networks in daily life and their ability to cope, to some extent, with negative weather phenomena and risks.

3.3. Natural Capital

In this section, the research team presents some of the most important measurable variables describing the natural capital conditions for the residents' livelihoods in the context of climate change.

Water resources are crucial for the population. Access to clean water is one of Vietnam's Sustainable Development Goals, as committed to the United Nations (Goal 6). Accordingly, in daily life, 48.2% of households use tap water, and 55.7% obtain water from wells and rainwater. For drinking water, 58.7% of households use well water and rainwater, while 43.2% use tap water.

In Bau Can commune, Gia Lai province, 19% of households report access to natural water sources for domestic use. Surveys found ponds, lakes, canals, streams, and rivers in many residential areas. However, few residents utilize these natural water sources for daily activities or drinking. The research team included a question on the use of natural water sources in the questionnaire, but recorded no responses. Thus, the results show that residents of Bau Can commune currently use natural water sources primarily for drinking and household activities.

The study results also showed that only 0.7% of households reported a shortage of drinking and domestic water in the past 12 months. The survey results are quite close to the General Statistics Office results on household tap water use in Bau Can commune. Residents also reported several other environmental factors. The waste situation was the most alarming, with 56% of households stating that "garbage is scattered everywhere." Waste within residential areas was less prevalent, at 25.7%.

Among the natural capital resources available to residents, land ownership and cultivated land area are the most important for livelihood activities. Survey results show that, on average, households own more than 2.2 hectares of cultivated land. Thus, the results show heterogeneity in inhabitants' natural capital.

3.4. Physical Capital

Housing is considered the most important physical asset for households, and also serves as a haven during adverse weather phenomena such as storms, tornadoes, and heavy rain. Based in part on the General Statistics Office's housing classification concept, research results from the Bau Can commune survey site show that temporary, rudimentary houses account for 18%, semi-permanent houses account for 65 %, and permanent houses account for 22%.

According to the General Statistics Office (2020a, p. 355), a house constitutes a residential structure comprising three primary parts: floors, roofs, and walls. The classification system evaluates houses based on the material quality of three main structural components: columns (pillars or load-bearing walls), roofs, and enclosures (walls).

Builders categorize columns as durable when they use reinforced concrete, brick or stone, or durable iron, steel, or wood. Similarly, the guidelines designate roofs as durable if they consist of reinforced concrete or tiles. Furthermore, experts consider a roof durable when it utilizes corrugated iron sheets mimicking tiles, cold-rolled iron, insulated iron, or regular corrugated iron supported by a sturdy iron and wood frame firmly anchored to brick walls and reinforced concrete columns. Finally, enclosures qualify as durable when they incorporate reinforced concrete, brick or stone, or wood and metal.

The classification framework categorizes structural durability based on the condition of its three primary components. A resilient (sturdy) structure is a building in which all three primary components meet durability standards. A moderately resilient structure has two durable components, whereas a poorly resilient structure has only one durable component. A basic structure lacks durability across all three primary components. Furthermore, the operational framework encompasses four on-site elements—command, forces, equipment and materials, and logistics—alongside the "Three Ready" operational principles: proactive prevention, timely response, and prompt, effective remediation.

Thus, to ensure sustainable livelihoods in the context of climate change, households first need stable housing, as the Vietnamese government's policy states that localities and people need to adhere to the

“four on-site” and “three ready” principles. In this context, sturdy housing is a crucial on-site resource that can respond to weather-related disasters.

Thus, this study’s findings, when compared with macroeconomic studies conducted by the General Statistics Office, show both similarities and differences. At the survey site, motorbikes were the most important means of transportation, with almost every household owning one (up to 90%).

3.5. Financial Capital

As described above, Bau Can commune has a relatively high poverty rate. The survey results indicate that the poverty rate among the research group is similar, at 3%.

The average per capita income in Group 1 is 1.33 million VND/person/month; in contrast, the average per capita income in Group 5 is over 5.35 million VND/person/month. Thus, the average per capita income in Group 5 is four times that of Group 1 (Table 1).

Table 1. Average per capita income in households

Group	Total income (Unit: VND)	Number of households	Population	Average monthly income per person (Unit: VND)
1	6,506,000,000	121	406	1,335,385.88
2	5,224,000,000	61	230	1,892,753.62
3	18,893,000,000	174	716	2,198,905.96
4	14,975,000,000	96	384	3,249,782.99
5	43,387,000,000	144	675	5,356,419.75

Source: Survey data for the project. **Note:** Group 1 is the lowest-income group, and Group 5 is the highest-income group.

Survey results on household financial resources in the study areas showed that 23% of households borrowed money and paid interest in the past 12 months. 8.5% of households borrowed money from relatives, and only 1.3% borrowed money from neighbors.

The monetary value of assets at the study sites shows a very high degree of disparity between Groups 1 and 5, and between different localities. Survey results on financial resources in Gia Lai province indicate that household incomes have increased significantly over recent years, leading to notable improvements in living standards and a substantial reduction in poverty rates. These positive changes largely stem from major economic policies implemented by the Vietnamese Party and Government, which have expanded access to stable employment and higher incomes. As a result, communities now benefit from a wider range of livelihood options, as discussed earlier in this study.

4. Discussion

Over the past 10 years, climate change has affected household capital in Bau Can commune, Gia Lai province, in very different ways.

Regarding human capital, erratic weather changes have disrupted (58.3%) or even caused job losses (22.5%) for household members. Changing weather also makes household members more susceptible to illness, impacting human health (7.3%).

Regarding social capital, almost all households received warnings about impending negative weather phenomena in their localities through government agencies at all levels, newspapers, radio, and television (91.7%); however, government support was often limited and mainly concentrated in poor and near-poor households (7.7%). Meanwhile, households and businesses urgently needed assistance from local authorities to access bank capital to restore production and business and continue creating jobs for local workers.

Based on the statistical data (Table 2), this community faces profound, systemic vulnerabilities driven by climate change. Residents' awareness of extreme weather events is remarkably high (unusually high temperatures at 80.7%, frequent storms at 70%, and heavy rain at 64.3%), and these phenomena are striking direct blows to their Financial Capital. With 48.5% of households reporting diseases in farmed aquatic animals, 32.2% experiencing crop failures from storms and floods, and 31.7% facing temperature shocks to shrimp, this region clearly has an economy heavily dependent on agriculture and aquaculture. Erratic weather patterns have exceeded the natural ecosystem's resilience, directly collapsing production chains and eroding the local population's core income base.

The collapse of economic activities triggers a devastating domino effect on both Human Capital and Physical Capital. With natural disasters damaging the homes of nearly half of households (45.8%) and wiping out business capital (38.2%), labor disruption is inevitable. Up to 58.3% of residents experience work interruptions, and 22.5% face complete job loss. This demonstrates the extreme fragility of the local employment structure: when means of production and natural conditions are destroyed, workers immediately lose their livelihoods, turning an environmental disaster into a severe household economic crisis.

Amidst these mounting pressures, Social Capital emerges as a crucial "shock absorber," helping the community survive. The warning network from authorities is highly effective, reaching 91.7%. At the same time, informal community cohesion is strongly expressed through non-financial support: visiting the sick (44.8%), helping repair houses (33.3%), and assisting each other with labor (30.7%). However, a stark paradox remains: financial assistance is exceptionally low (ranging from only 1.8% to 6%). This issue exposes a grim reality: while residents are willing to share their time and physical effort, the community's financial resources are exhausted, leaving no one with enough surplus to provide economic relief to their neighbors.

Overall, this region's livelihood ecosystem is imbalanced and unsustainable. While community mutual aid is invaluable, it cannot address the root causes as Natural Capital continues to degrade through bank erosion and landslides (22.8%) as well as saltwater intrusion (14.8%). To adapt, the community cannot rely solely on informal safety nets. Policymakers must intervene with structural measures: building infrastructure to prevent landslides, transferring climate-resilient agricultural and aquacultural technologies (such as salt- and heat-tolerant varieties), and establishing microcredit funds to help residents rebuild their Financial Capital after disasters.

Table 2. Impacts of climate change on household capital sources

Capital and Climate Change	Problem	Percentage (%)
Human Capital	Work interruption	58.3
	Job loss	22.5
	Illness and its impact on human health	7.3
	The family has a member who is injured, missing, or has died	2.5
Social Capital	Warnings from authorities at all levels	91.7
	Disaster relief	7.7
	Households visit their neighbors when they are sick	44.8
	Families help each other repair their homes	33.3
	Families help each other with work	30.7
	Households receive assistance from neighbors when they are sick	26.8
	Households receive assistance from neighbors when repairing their homes	31.5
	Households lend money to their neighbors when needed	6
	Households receive assistance from neighbors who lend them money	1.8
Natural Capital	Bank erosion and landslides in the community	22.8

	Household water sources for drinking and daily use contaminated with salt	14.8
	Land subsidence	13.8
	Landslides in the area where people live	12.8
	Lack of water for daily use	6.3
	The family's business land area has decreased	5.8
	Lack of water for irrigating crops	3.8
	The forest land area has decreased	3.7
Physical Capital	Loss of business capital	38.2
	The area of houses and land has decreased	4.7
	Landslides destroyed houses	6.2
	Damage to houses	45.8
	Change of residence	4.7
Financial Capital	Disease affecting farmed aquatic animals	48.5
	Crop failure due to rain, storms, and floods	32.2
	Unpredictable weather patterns, such as alternating sunshine and rain, cause temperature shock to shrimp and alter water quality	31.7
	Pests and diseases are more common than before	21.5
	Crop yields have decreased	20.7
	Livestock and poultry are sick or die	16.3
	The crops were flooded and waterlogged	11.8
Climate Change Awareness	High temperatures, unusually hot	80.7
	Storms are becoming more frequent	70
	Unusually heavy rain	64.3
	Drought and drought conditions are worsening	38.2
	More floods	30.7
	Unusually high tide	30.3
	Lower temperatures, colder	28.2
	More lightning	22

Source: Survey data for the project. Note: Group 1 is the lowest-income group, and Group 5 is the highest-income group.

Climate change is negatively affecting Gia Lai province, livelihoods, and local communities. Over the years, the Vietnamese Party and Government's livelihood policy framework has provided families with an enabling environment to change occupations and pursue more stable and productive employment. Notably, more family members now work in industrial zones, factories, and companies, reflecting a structural transformation in the local economy. The findings underscore that livelihood diversification has become a prominent adaptive strategy among households, allowing family members to take on multiple forms of employment for greater income security and mutual support. These trends highlight the need for policy measures that improve access to education, vocational training, and credit to support occupational mobility and strengthen households' resilience to climate change impacts. Policymakers should prioritize programs that promote livelihood diversification, encourage skill development, and improve access to finance, enabling households to withstand better and adapt to weather-related shocks.

Over the past 10 years, climate change has negatively affected incomes, communities' livelihoods, and the lives of coarch. Results show that residents experience different livelihood impacts from climate change. In Bau Can commune, physical capital and natural capital are the most vulnerable components. Access to food is also quite difficult for households in the context of climate change. Under climate change, households with only one livelihood activity are generally more vulnerable than those with diversified livelihoods.

5. Conclusion

This study has elucidated the profound, multidimensional, and increasingly severe impacts of climate change on the livelihoods of residents in the Central Highlands, providing vivid empirical evidence from Bau Can commune, Gia Lai province. Using the sustainable livelihoods framework with five core capitals- human, social, natural, physical, and financial- the findings show that extreme weather events over the past decade have significantly reduced households' capacity to maintain livelihoods and increased their vulnerability in this area.

In terms of human and natural capital, erratic weather patterns have directly disrupted work and even eliminated the daily livelihoods of a substantial portion of the population. Severe climate conditions have also heightened health risks, reducing community well-being as people become more susceptible to illness. At the same time, natural capital faces a critical challenge as the community confronts soil erosion, land subsidence, depletion of irrigation water sources, and pollution and salinization of domestic water supplies.

Regarding physical and financial capital, weather phenomena such as storms, floods, and prolonged droughts have severely devastated infrastructure, damaged homes, and gradually reduced business land areas for the residents. Financially, unpredictable weather (such as alternating sunshine and rain) is a primary driver of disease outbreaks in crops and livestock, resulting in severe yield reductions in aquaculture and agriculture. This climate risk not only destroys livelihoods but also pushes many households into economic hardship as incomes sharply decline.

Despite facing heavy losses, the study also highlights the vital role of social capital in the community's adaptation efforts. In a context where support from local authorities is sometimes limited, delayed, and primarily reaches only poor households, social networks and mutual assistance among neighbors have become a solid foundation. Residents supporting each other during illness, helping repair houses, and sharing disaster-warning information play a crucial role, enabling them to overcome crises together.

Based on these realities, the study concludes that livelihood diversification is an essential and highly effective adaptation strategy. Households with more than one income source and better access to resources generally show more flexible resilience to climate shocks. Therefore, policymakers should prioritize long-term strategic solutions, such as improving access to education, expanding vocational training programs, and facilitating residents' access to credit. The shift of labor to industrial zones or factories is also an inevitable trend that should be facilitated to ensure household income stability.

Finally, sustainable development in the Central Highlands cannot be separated from ecological protection. Development strategies must prioritize forest protection, natural environment conservation, and household economic development, rather than pursuing uncoordinated urban or tourism development projects, which often lead to local flooding consequences as seen in many other localities. A truly sustainable livelihood system can be established only when policies balance human quality of life with ecological integrity, helping the community not only adapt but also actively contribute to protecting the living environment for the future.

5.1 Policy Implications

Based on the research findings on the impacts of climate change on livelihoods in Bau Can commune, Gia Lai province, several important policy implications emerge to enhance the community's adaptive capacity.

First, on financial support mechanisms, authorities at all levels need to broaden target groups and be more flexible with credit packages. In reality, current state support is often limited and mainly focuses on poor or near-poor households. Meanwhile, many households and businesses urgently need local authorities' help accessing bank capital to restore production and business activities and create jobs for local workers after natural disasters. Improving access to finance is key to providing people with sufficient resources to withstand weather-related shocks.

Second, policies should prioritize promoting livelihood diversification strategies. The study indicates that households with only one livelihood activity are generally more vulnerable. Therefore, authorities should focus on measures to improve access to education, vocational training, and skill development for

residents. These programs will support occupational mobility, helping family members find stable jobs in industrial zones or factories and ensuring income security.

Finally, planning and development directions must be closely integrated with ecosystem protection. Localities should emphasize environmental protection, forest conservation, and household economic development rather than pursuing uncoordinated urban and tourism development, which has caused local flooding and reduced adaptive capacity in many provinces and cities. A sustainable livelihood policy must balance human well-being and ecological integrity while strengthening community-based mutual support networks to address the climate crisis together.

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Authors’ Contributions

Conceptualization, VHD, and NBN; methodology, VHD; formal analysis, VHD; writing – original draft preparation, NBN; writing – review and editing, VHD.

Informed Consent Statement

All participants were informed of the study’s purpose, and we obtained informed consent before data collection. Participation was voluntary, and all responses were kept confidential and used solely for academic research purposes.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data Availability Statement

The data presented in this study are available on request from the corresponding author due to privacy reasons.

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