

LITERATURE REVIEW ON LIVELIHOOD VULNERABILITY ASSESSMENT TO CLIMATE CHANGE AND RECOMMENDATION OF THE ASSESSMENT METHOD FOR THE NORTH CENTRAL COAST OF VIETNAM

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Abstract

Households' livelihoods are particularly vulnerable to the increased impacts of climate change. Assessment of livelihood vulnerability to climate change will help to identify suitable adaptive livelihood strategies that balance risks and opportunities to allow continued development while ensuring adaptive capacity to climate shocks. Sustainable livelihood approach associated with climate change vulnerability assessment framework can help assess the livelihood vulnerability to climate change in order to maintain sustainable livelihood in the context of increased climate change. This paper presents a literature review on livelihood vulnerability assessment to climate change, and propose the method for climate change vulnerability assessment to livelihood for the North Central Coast of Vietnam.

Keywords: *climate change, livelihood, vulnerability*

1. Introduction

Climate change tends to increase in terms of magnitude, extent and scope of impacts which requires actions on a global scale on both mitigation and adaptation (IPCC, 2014). Gibbs (2020) pointed out that the growing evidence of increased risks from climate change makes it necessary for global adaptation efforts to mitigate and manage climate change risks. Identifying how natural and human systems are sensitive and vulnerable to the impacts of climate change have become important inputs for setting goals and formulating policies to adapt to climate change.

Theories and methods of vulnerability assessment have been developed over the past decades in areas related to natural hazards, food security, poverty, and human livelihoods. Climate change vulnerability assessment can be undertaken at international, national, sectoral, local, and community levels. It serves to provide a strong scientific foundation to support the identification and implementation of practical strategies and solutions for climate

change adaptation activities.

Household's livelihoods are particularly vulnerable to the increased impacts of climate change. Adaptive livelihood strategies may be ineffective without accurately assessing and identifying livelihoods vulnerability to climate change. The sustainable livelihood approach associated with climate change vulnerability assessment framework can help assess the vulnerability of climate change to household's livelihoods and then determine sustainable livelihood options for people in the context of increasingly severe climate change worldwide.

The coastal zone is an area of great potential for development, but also a place that experiences great and immediate impacts from changes in the nature and human activities. At global level, coastal areas are considered to be hot spots suffering severe impacts of climate change, including sea level rise, coastal erosion, flooding, drought, and saline intrusion (IPCC, 2007). The livelihoods of coastal residents are severely affected by climate change impacts. Vulnerability assessment to climate change of coastal livelihoods plays an important role in proposing appropriate adaptive livelihood strategies.

Vietnam is assessed as a country that has suffered heavy damages from long-term and continuous changes in the climate over the past years. The Vietnam North Central Coast region, including 6 provinces/cities namely Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri and Thua Thien – Hue, has been heavily affected by extreme weather events in recent years. Assessing the vulnerability of climate change to livelihoods will help identify suitable adaptive livelihood strategies for the region in order to balance the risks and opportunities for continued socio-economic development while maintaining resilience to the climate shocks.

2. Method

Using a desk-based approach combined with statistical, descriptive, and comparative methods, this paper presents a literature review on climate change vulnerability assessment to livelihoods and proposes the method for climate change vulnerability assessment to livelihoods for the North Central Coast region of Vietnam.

The study uses secondary data and information which were collected from a variety of sources, including reports from Intergovernmental Panel on Climate Change (IPCC), Vietnam's Ministry of Natural Resources and Environment (MONRE), books, journals, papers, and research reports of individuals and organizations (DFID, UNDP, UNEP...) related to the research topic.

3. Results

3.1. Literature review on vulnerability assessment to climate change

Since the 1990s, theories and methods of climate change vulnerability assessment

have been developed and applied at international, national, sectoral, local, and community levels. In general, climate change vulnerability assessment frameworks focus on sectors most affected by climate change impacts such as agriculture, water resources, coastal areas, human health, and livelihoods. According to IPCC (2001), vulnerability to climate change is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity and is calculated by an index. Depending on the research object, a suitable set of indicators and statistics can be used to calculate the index. The most common indexes are Climate Change Vulnerability Index (CVI), Social Vulnerability Index (SVI), and Livelihood Vulnerability Index (LVI). Once climate change adaptation measures are strengthened, vulnerability to climate change will therefore decrease (IPCC, 2007).

Frameworks for assessing vulnerability to climate change serve as a solid scientific foundation to support the identification of plans and solutions for society's climate change adaptation activities. Vulnerability assessment to climate change impacts are applied to geographical areas (e.g. coastal areas, urban areas, forest land, agricultural land), sectors (e.g. agriculture, fisheries, tourism, industry, human health, poverty, natural resources), vulnerable groups (e.g. farmers, the poor, children, women), or type of hazards (e.g. storms, floods, droughts, saline intrusion). Typical climate change vulnerability assessment frameworks have been developed by IPCC (1992), UNEP (1998), UNDP (2004), and USAID (2016). Although the implementation process of these assessment frameworks may vary, key elements of climate change vulnerability assessment include the identification of vulnerable groups, assessment of current and future vulnerability to climate change impacts of different groups, and usage of the vulnerability assessment results to propose policies and strategies to adapt to climate change.

3.2. Literature review on livelihood vulnerability assessment to climate change

At local level, climate change vulnerability assessment helps people understand how climate change affects people's lives and livelihoods. Household livelihoods are particularly vulnerable to the increased impacts of climate change. Gibbs (2020) argued that adaptation of local people is slowing down compared to the rate at which climate risks are exposed. When government support is not timely and inadequate, households must mobilize their own resources based on their experience and knowledge in implementing adaptive livelihood strategies. However, adaptive livelihood strategies can be ineffective without accurately assessing and identifying climate change vulnerability to livelihoods. The Sustainable Livelihood Approach (SLA) associated with the Vulnerability Assessment (VA) can help assess the vulnerability of livelihoods to climate change, and then suitable adaptive livelihood strategies can be proposed.

The Sustainable Livelihood Approach (SLA) analyzes the livelihood resources, livelihood activities and livelihood outcomes under the impact of external context and institutions and policies. Typical sustainable livelihood frameworks have been developed by Scoones (1998) and UK Department for International Development DFID (2001). Generally, the sustainable livelihood approach shows how people access, control, and use inherent resources to improve their livelihoods and reduce vulnerability to natural disaster shocks and diseases. Livelihood resources (including 5 categories: human capital, natural capital, financial capital, physical capital, and social capital) and the ability to access these resources have a major impact on sustainable livelihood outcomes (Figure 1).

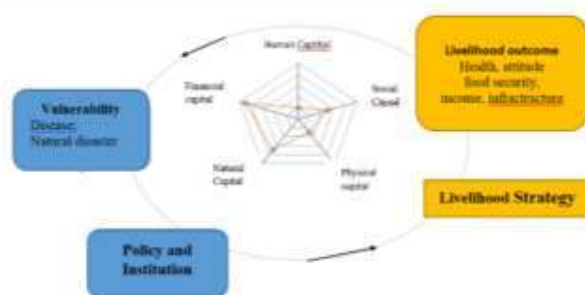


Figure 1: Sustainable Livelihood Framework

Source: Birkmann (2006)

To assess the vulnerability of household livelihoods to climate change impacts, Hahn et al. (2009) developed a livelihood vulnerability index (LVI) comprised of 7 components based on the framework of climate change vulnerability assessment of IPCC (2001) and the Sustainable Livelihood framework of DFID (2001). Hahn (2009) examined different aspects of vulnerability and differences in household efforts and adaptive capacity to sustain livelihoods. Household’s resilience and the ability to access livelihood resources to recover from climate shocks depend on many factors, including magnitude of impact (external factors) and internal factors within the household (Bohle, 2001). There are three main factors that determine the vulnerability of a household’s livelihoods, including exposure (E), sensitivity (S) and adaptive capacity (AC). The LVI value ranges from 0 to 1 and is calculated by using the partial weighted indexes to compare the vulnerability among different objects/groups. LVI – IPCC is calculated via using the function as $LVI = f(E, S, AC)$.

Subsequent studies have adjusted and supplemented the determinants of vulnerability in the LVI. For example, Shah (2013) analyzed the gender difference, the ability to access to livelihood resources with support from local authorities to minimize the vulnerability. Madhuri et al. (2014) used LVI to compare the vulnerability of livelihoods

between 7 different regions in Bihar and added indicators of skill to change planting schedules, loans, main water sources, available adaptation measures, public and private hospitals, and sanitary facilities. In particular, natural resources (including access to forest products, land fertility and arable land ownership) play an important role in the lives of rural people. When people have difficulties in accessing these natural resources, agricultural livelihoods will be vulnerable. Therefore, it is necessary to add the factor of cultivated land to calculate the LVI.

Ankita Paul's study (2019) aimed at vulnerability assessment of poor people living in urban areas and disadvantaged communities. The research question was the role of livelihoods in adjusting and mitigating vulnerability. The study compared three different approaches to vulnerability assessment, including (i) the LVI index - a composite of 6 equally weighted components, (ii) the LVI - IPCC including 7 individually weighted components and (iii) the Climate Change Vulnerability Index (CVI) estimating the climate change vulnerability of eight other livelihood groups in the city of Guwahati, Assam, India. A survey was conducted for construction workers, shop keepers, farmers, taxi driver/rickshaw drivers/trailers, drink shops/fast food vendors, gas delivery people, street vendor/shopkeeper, traffic police/policeman, doctor, and boatman. The results showed that farmers were the most vulnerable communities suffering the most economic losses, because they had a high sensitivity to health and are exacerbated by poor adaptability. Doctors were the least vulnerable because of their higher cognitive and adaptive levels. This again confirms the importance of awareness and access to livelihood resources in reducing vulnerability.

In Vietnam, there have been studies related to mitigating vulnerability from floods and storms in Quang Ngai, Thanh Han river (Quang Tri), Thu Bon river basin (Quang Nam). Studies calculated flood vulnerability index by weighting method to build a set of flood vulnerability index for Quang Nam province. However, there are few studies on livelihood vulnerability assessment to climate change impacts. In 2016, Tran Quoc Nghi applied the LVI index developed by Hahn (2009) to calculate 7 components that make up the LVI. Similarly, in 2016, Phan The Cong et al published an article applying LVI to the case of Nam Dinh province. Although this study has limitations on how to apply the formula to calculate the LVI, it showed the flexible application of the LVI values to rank vulnerability of different types livelihoods.

Overall, the Livelihood Vulnerability Index (LVI) is a method that has been used extensively recently to assess the livelihood vulnerability of climate change impacts. LVI is derived from the theoretical foundation of climate change vulnerability framework of IPCC (2001), then developed by Hahn (2009) into LVI index, and further edited and supplemented by other studies such as Shah (2013), Madhuri (2014), and Paul (2019). It has been applied widely in many other studies. The outstanding advantage of the LVI is that it uses primary

data from household surveys instead of using climate and socio-economic development scenarios. With focus on local and household level, LVI has taken advantage of the informational value due to the combination of expert consultation, flexibility in research subjects and research scope. Therefore, the research results derived from LVI have practical implications for the livelihood vulnerability of households and communities. The essence of LVI is built on three important points of view. Firstly, LVI is based on information of indigenous knowledge and practical experience of local people to select the elements constituting the LVI. Although it has limited predictive power, this index can identify vulnerable factors. Secondly, LVI is grounded on the argument that vulnerability and resilience are constrained by available resources, contextual conditions, and accessibility to livelihood resources. Thirdly, climate change vulnerability assessment to livelihoods is based on empirical observations and field studies to deeply analyze local climate change adaptation and mitigation planning. With these advantages, using the LVI to assess the climate change vulnerability of household's livelihood in the North Central Coast coastal region is of high scientific and practical significance.

3.3. Recommendation of the method for climate change vulnerability assessment to livelihoods for the North Central Coast of Vietnam

Vietnam is considered to be a country that has suffered heavy impacts and damages from long lasting changes in the climate over the past years. Storms and floods are typical types of natural disasters in the country. Natural disaster risks are forecasted to continue increase in the near future. The coastal region is the center of dynamic economic activities that provide livelihoods for millions of people. Key economic sectors in coastal areas of Vietnam, such as agriculture, fisheries, tourism and industry, will experience risks from floods and storms annually. It is estimated that approximately 316,000 workers will be directly affected by coastal and river flooding each year in Vietnam (World Bank, 2020).

The North Central Coast of Vietnam consists of 6 coastal provinces, including Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri and Thua Thien-Hue which share common climate and socio-economic characteristics. Livelihood activities in this area are diverse, but have similar characteristics of coastal livelihoods. The natural topography of this area is relatively steep, fast-flowing river water and frequent floods causing difficulties for life and production. On average, the six provinces suffer from 3 to 5 storms from August to November annually. Several provinces such as Ha Tinh, Quang Binh, and Quang Tri experienced the harshest climate conditions (e.g. intense heat, heavy rains, severe storms, and frequent floods). In the context of increasingly complex and unpredictable climate change, it is crucial to assess the vulnerability of climate change impacts to livelihoods in this region.

Applying the method of calculating the LVI developed by Hahn (2009) and other

researchers, the data collected from the household survey need to be encoded and calculated into the indicators as shown in the Table 1.

Table 1: Major components and sub-components comprising the Livelihood Vulnerability Index (LVI)

Major components	Sub-components	No
(1) Socio-demographic profile	<ul style="list-style-type: none"> - % of female-headed households (HHs) - % of HHs where head of family has not attended school - % of HHs with orphans - % of HHs with members needing dependent care 	4
(2) Health	<ul style="list-style-type: none"> - % of HHs with family member with chronic illness - % of HHs receives treatment in hospitals - % of HHs receives proper facilities for child delivery and immunisation - % of HHs that do not have toilet facilities 	4
(3) Food	<ul style="list-style-type: none"> - % of HHs primarily dependent on self farmed food - % of HHs struggle to find food when disaster occurs - Crop Diversity Index - % of HHs that do not save crops - % of HHs that do not save seeds 	5
(4) Water	<ul style="list-style-type: none"> - % of HHs utilizing natural water source - % of HHs reported conflicts over water when natural disaster happens - % of HHs that have to store water - % of HHs that do not have consistent water supply 	4
(5) Natural disaster and climate variable	<ul style="list-style-type: none"> - Average number of floods and droughts in the past year - % of HHs that did not receive warning about natural disasters - % of HH members with an injury or death as a results of the most severe natural disasters in the past year - Mean standard deviation of the daily average maximum temperature by month - Mean standard deviation of the daily average minimum temperature by month - Mean standard deviation of the average precipitation by month 	6
(6) Livelihood strategies	<ul style="list-style-type: none"> - % of HHs with family members working outside the community - % of HHs solely dependent on agricultures as source of income - Average agricultural livelihood diversification 	3
(7) Social network	<ul style="list-style-type: none"> - % of HHs receives and given by households in kind - % of HHs who borrowed and lent money - % of HHs that have not gone to their local government for assistance in the past 12 months 	3
(8) Natural Capital	<ul style="list-style-type: none"> - % of houses with weak storm resistant construction (floor, roof) - % of HHs without fertile land - % of HHs without ownership of the lands they live on 	3

Sources: Hahn (2009), Shah (2013), Madhuri (2014)

There have been many studies applying LVI in many different ways. Combining vulnerability assessment of IPCC (2001) and Sustainable Livelihood Framework of DFID (2001), LVI can be calculated as indicated in the Table 2. Overtime, the components of LVI have been increasingly supplemented and completed to the study context. T. Lung et al (2013), Islam (2013), and Huafeng (2016) have implemented empirical studies to determine components of LVI and investigated significance of the components contributing LVI as well. Paul (2019) compared LVI values among different groups of livelihood. In Vietnam, LVI has been applied and adjusted by Phan The Cong (2016).

Table 2: Major components of LVI contributing factors to vulnerability

LVI contributing factor to vulnerability	Major components
Exposure (E)	(1) Natural disaster and climate variable (NDCV)
Adaptation Capacity (A)	(2) socio-demographic profile (SDP)
	(3) Livelihood strategies (LS)
	(4) Social network (SN)
Sensitivity (S)	(5) Health (H)
	(6) Food (F)
	(7) Water (W)
	(8) Natural Capital (NC)

To calculate LVI, there are 4 main following steps:

Step 1: Standardizing the sub- components when calculating the LVI. Because the crude data is in different units (number of people, age, percentage...), it is necessary to standardize index. Each of sub- component is called S_d , where d is district.

$$index_{S_d} = \frac{S_d - S_{\min}}{S_{\max} - S_{\min}}$$

where S_{\min} , S_{\max} are the minimum and maximum values, respectively, for each sub-component determined using data from collecting. For variables that measure frequencies, they are set from 0 to 100.

Step 2: Calculate the value of each major component, the sub-components were averages using:

$$M_d = \frac{\sum_{i=1}^n index_{S_{di}}}{n}$$

where: M_d is one of eight major components for LVI. These are NDCV, SDP, LS, SN, H, F, W, NC; (n) is number of sub-components in each major component.

Step 3: The major components are combined according to the categorization scheme in Table 2 using the following equation:

$$CF_d = \frac{\sum_{i=1}^n W_{M_i} M_{di}}{\sum_{i=1}^n W_{M_i}}$$

Where: CF_d is one of contributing factor Exposure, Adaptation, Sensitivity for district (d); M_{di} are the major component; E (includes NDCV), A factor (includes SDP, LS, SN), S factor (includes H, F, W, NC)

W_{Mi} is the weight of each major component

Step 4: Using equation LVI= (E+ S-AC). Value of LVI ranges at (-1; 1) representing the least vulnerable and the most vulnerable respectively. There are some different equations to calculate LVI, but Paul (2019) shown that the above equation is best used to analyze vulnerability to different areas of human livelihood and evaluate the effects of climate change. Antwi- Agyei et al. (2012), Cinner et al. (2012) and Silva & Lucio (2014) used this equation instead of others.

4. Discussion and Conclusion

Firstly, the paper reviewed both theoretical and practical studies relating to livelihood vulnerability assessment to climate change impacts. Global climate change has been causing increasingly unpredictable impacts which requires assessment of the vulnerability caused by climate change to different socio-economic groups and sectors. Paul (2019) asserted that assessing vulnerability to climate change impacts involves the application of combined methods and data to analyze human and social interactions within the environment. At household level, assessing the climate change vulnerability to livelihoods needs to make full use of information related to human capacity, necessary resources, and physical assets to implement livelihood strategies (Chambers and Conway, 1992) and data on human development index (HDI), living standards, and characteristics of natural resources and environment (Paul, 2019). Assessment of climate change vulnerability to livelihoods informs decision-making process on planning and proposing appropriate adaptation solutions to address vulnerability, poverty, and sustainable development goals.

Secondly, the paper pointed out advantages of using LVI to assess livelihood vulnerability to climate change impacts. Studies on climate change vulnerability assessment to livelihoods around the world will be a useful reference for assessing climate change vulnerability to livelihoods in the North Central Coast of Vietnam. However, sound results of vulnerability assessment and recommendations need to be performed by selecting proper method. Progress of collecting data and calculating LVI are written clearly, which can be applied for different regions, types of livelihood, and vulnerable groups.

5. References

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