

# Vulnerability in north-central Vietnam: do natural hazards matter for everybody?

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**Abstract** This article examines changes in livelihood strategies in response to flooding. It does so on the basis of a household survey which was undertaken in three provinces in north-central Vietnam. All households in the survey were regularly affected by flooding, but only poor households experienced long-term negative effects. The research showed that a high impact of natural disasters is correlated with decreases in income over time. As the disaster relief offered by the authorities is marginal compared to economic losses, some households react by increasing off-farm incomes (including remittances from overseas-migrated household members). We observed that the poor households do not switch to off-farm income strategies in response to income losses; this is perhaps because they have inadequate skills. However, on average households in our survey are becoming richer over time, despite the impact of flooding in the provinces. The article ends by looking at the vulnerability–resilience debate concluding that the poorer households could enter a vulnerability loop, unless new strategies to cope with natural hazards are suggested.

**Keywords** Vietnam · Flooding disasters · Economic losses · Adaptation strategies · Natural hazards

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## 1 Introduction

Vietnam is among the 15 countries most at risk to natural disasters stemming from climate change, in terms of both exposure and number of people affected (McElwee 2010). In order to reduce social vulnerability to climate-based natural disasters, it is imperative to understand current hazards, institutions, and local adaptation strategies (Bastakoti et al. 2014). Knowledge of existing strategies provides insight into relevant challenges or opportunities for improving the adaptive capacity of vulnerable communities over the long term, especially as impacts from climate-related natural disasters such as flooding are predicted to increase. For instance, Dang et al. (2014) found that recent climatic changes have had little persistent effect on local people's livelihood strategies in the Mekong Delta. Approximately 10 % of the households had been driven out of agriculture due to climatic changes, and even fewer (less than 5 %) had decided to migrate as a result of climate events. A possible explanation could be the overwhelming majority of households have reverted to private insurance coverage against expected losses from natural disasters—a strategy that may not be viable over the long term.

In this study, we discuss the impact of natural hazards—namely the devastation of rice fields due to flooding—and we explore how households adapt their livelihood strategies to flooding, or fail to do so. Specifically, we examine the link between natural hazard impacts and poverty and provide empirical evidence for the link between poverty and vulnerability, and the lack of government support to the most vulnerable households. This study is based on data gathered from three provinces in north-central Vietnam: Nghe An, Ha Tinh and Quang Binh. Though relatively well off in terms of economic prosperity, these three northern central provinces are predicted to experience higher temperatures and proportionally more rainfall by 2020 compared to other provinces in Vietnam, potentially increasing the frequency and severity of natural disasters such as flooding (Iponre 2009; McElwee 2010). Understanding existing social and institutional context is important for understanding potential adaptive capacity to natural hazards.

The article attempts to answer three questions:

1. Can we see a pattern in which certain types of households are most affected by natural hazards (flooding)?
2. How do households adapt to the flooding problems and do they react in a uniform way?
3. Are local government policies effective at supporting adaptation strategies?

The subsequent sections are organized as follows. First, we describe the study area and outline our methods for data collection. Second, we examine the concept of vulnerability and discuss the relative strengths and weaknesses of different frameworks and approaches for vulnerability analysis. We also briefly discuss the distinction between short-term vulnerability and long-term resilience—the two concepts that are central to our analysis. Fourth, we examine household vulnerability in the context of flood events in Vietnam and provide an overview of local adaptation strategies, governmental policies, and relevant empirical findings from our study. We define natural hazards as the destructive natural phenomenon households at our study sites refer to as most important. We do not attempt to discuss the link between climate change and natural hazards and therefore prefer to use the term natural hazards. Linking household livelihood strategies to local policies was a particularly difficult task, and we do not claim causality or even correlation between household strategies and local policies. However, we try to discuss the adequacy of local

policies—in terms of their support for the most vulnerable households—and whether or not we could detect any differences between the three provinces. We conclude with a discussion of key findings, highlighting existing challenges for household adaptation to natural hazards within the study area.

## 2 Methods

Nghe An, Ha Tinh, and Quang Binh provinces have a total population of about 5.2 million inhabitants, of which 70 % reside in the coastal and lowland areas. The primary economic activities are rice cropping and aquaculture—the latter of which has been slowly increasing in economic importance. Ranking the 63 provinces in Vietnam by headcount poverty, the three provinces are positioned among the top third having approximately 15 % of the population living under the poverty line (UNDP 2011).

Nghe An, Ha Tinh, and Quang Binh provinces are located in north-central Vietnam. They are characterized by diverse topographic features, including high and low mountains in the west and coastal plains in the east. The rivers flow from the northwest to the sea, and the watersheds are generally distinguished by narrow riverbeds, steep slopes, and small catchment areas. Consequently, heavy rains caused by storms frequently result in flash flooding events in the eastern lowland areas. The flood season usually runs from June to October in the upper portion of the watersheds and from July to November in the lower reaches.

The rainy season—which accounts for 68–75 % of the rainfall in the year—often causes significant flooding and damage to production, properties, people, and the ecological environment. While the flood regimes of Nghe An and Ha Tinh are more severe as a result of the steep topography of the Lam River basin, those of Quang Binh are more moderate due to the hydraulic characteristics of the Nhat Le River. As a result of topographic differences between the Lam River, and the Nhat Le River watersheds, flooding in Nghe An and Ha Tinh is often more severe than in Quang Binh. We chose three communes and three provinces according to their geographical location (coastal area and lowland areas in north-central Vietnam), namely Hung Nhan (Nghe An), Yen Ho (Ha Tinh), and Vo Ninh (Quang Binh). These areas are typically affected by flooding, which is perceived to be the primary disaster phenomenon in north-central Vietnam (McElwee 2010).

In the Nghe An, Ha Tinh, and Quang Binh provinces, a household survey was conducted in 2014. In Nghe An Province, Hung Nhan commune (pop. 4630) was selected for data collection based on its location outside the dike, and its proximity (2–3 km downstream) to the Lam River mouth. There are nine villages in the commune, out of which we selected two villages with a total household count of 188. Our survey included 148 households out of this total. In Ha Tinh Province, Yen Ho commune, which has a population of 5250, is located just on the other side of Lam River. It was chosen because the commune lies within the dike. There are six villages in the commune, of which two were chosen for the household survey. Our survey included 187 households out of a total of 407 in the two villages. In Quang Binh, the Vo Ninh commune contains 9345 people and seven villages. This commune was selected because its inhabitants depend not only on rice cropping, but also on aquaculture. We choose two villages of 615 households, of which 135 were interviewed.

In total, 470 households were selected for the survey, and they represent households in the coastal area that has been subjected to varying degrees of impact from natural hazards.

The survey design allows us to compare the impact on livelihoods from natural hazards at different levels of exposure to natural hazards. While the statistical tests are reliable for gaining inference into the impact of natural hazards within the study site, they are not intended to provide inference into impacts at a national level.

Figures 1 and 2 show the location of the research areas in the vicinity of the rivers.

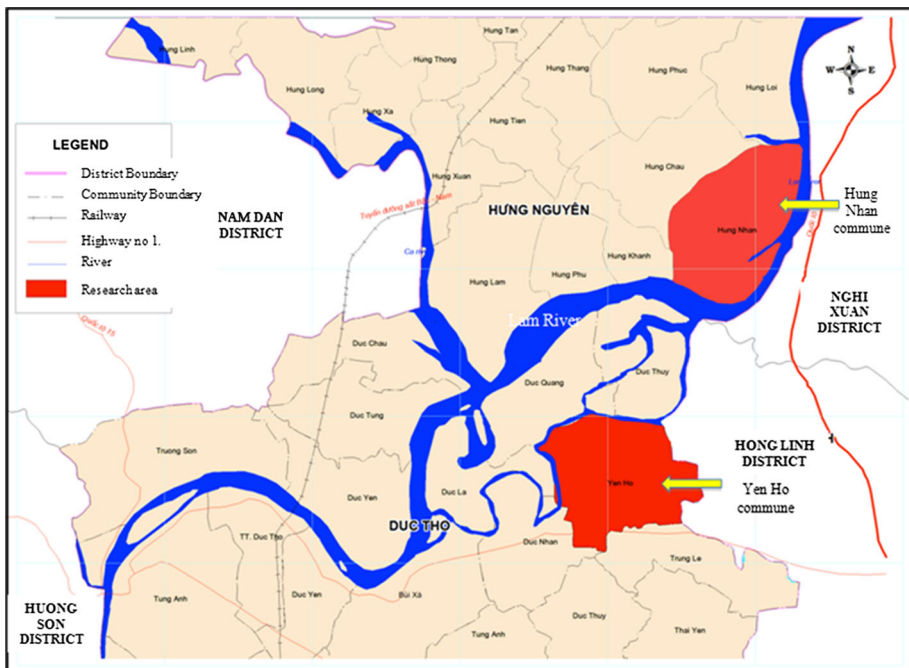
Two of three villages chosen from Hung Nhan (Nghê An Province) were heavily affected by flooding due to their low-lying terrain, while the third village was less affected.

Six villages were chosen in Yen Ho municipality (Ha Tinh Province), of which two were heavily affected by flooding due to their topographic location. The other four villages suffer from an inefficient sewage system, so that despite being located inside the dike, these villages also face challenges from weather conditions.

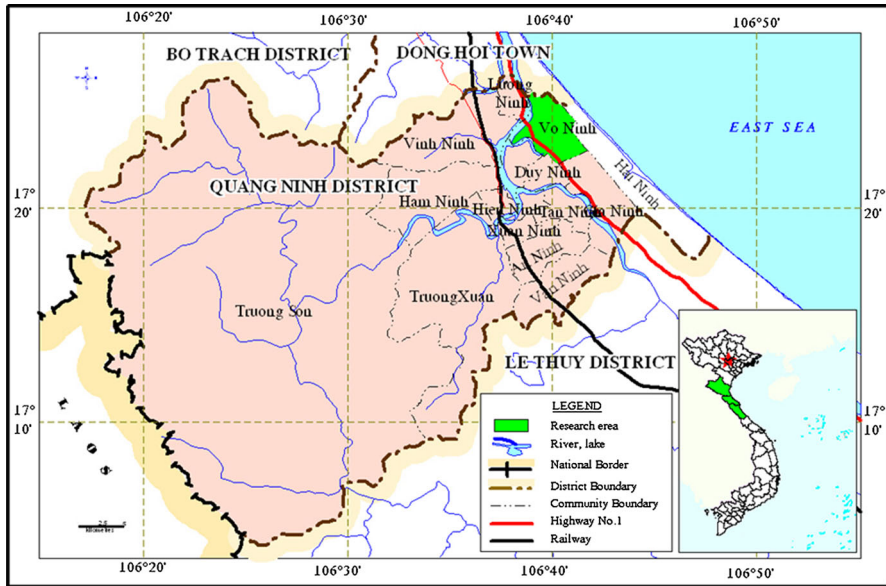
In Vo Ninh (Quang Binh Province), water flows from the mountains stream down to the narrow valley at high speed during the rainy season. In the dry season, however, the water level in the river is low. Consequently, an increase in salinity is taking place which causes adverse impacts on agriculture.

Surveys were designed to evaluate the degree of impact from flooding perceived by different households. We did not attempt to estimate the total impact of natural hazards on local people, but to assess the degree of impact in relative terms among different income groups (poor, nearly poor, or not poor).

The main objective was to collect data on income sources (agricultural and non-agricultural), households' own perception of vulnerability, and how they reacted to changes in agricultural production. As households often find it difficult to remember their exact income several years back, we asked households to estimate their income for 2013 only. In



**Fig. 1** Hung Nhan (Nghê An Province) and Yen Ho (Ha Tinh Province) communes



**Fig. 2** Vo Ninh commune (Quang Binh Province)

order to gain insight into changes in socioeconomic status over time, we asked households whether they had become richer or poorer during the period 2008–2013.

The questionnaire included a first section on household income and wealth (in terms of possession of durable goods), a second section on agricultural and non-agricultural incomes, and a third section on household perception on the occurrence of natural hazards (flooding, drought, and typhoons). In the final section, we requested households to express in nominal terms (high, medium or low impact) their perception of the effects of natural hazards. Finally, we wanted to know what kind of support households got from the government, family, or village entities to cope with the detrimental effects of natural hazards. As seen by the maps, Figs. 1 and 2, all selected municipalities are situated at the coast.

### 3 Climate vulnerability

The Intergovernmental Panel on Climate Change’s (IPCC) third assessment report (TAR) defines climate change vulnerability as a function of three constituent components: exposure, sensitivity, and adaptive capacity. Flooding is but one example of a climate change-related impact associated with vulnerability. For instance, less solid and precarious homes are more damaged by floods than solid homes (sensitivity), poor people tend to live in places subject to risk of flooding (exposure), and families with lower incomes find it harder to repair their homes or to migrate to safer places (adaptive capacity) (Reed et al. 2013).

The link between poverty, vulnerability, and public policy has been highlighted as an important issue in Vietnam. Adger (1999: 262) has noted that within the country, there is a problematic reliance ‘of the poor on communal and other resources which may be more physically vulnerable to external shocks.’ This issue is also more significant for remote

communities; when compared to inland communes, coastal communes have received a disproportionate share of public resources for infrastructure investments associated with dikes.

Kelly and Adger (2000) argue that poor households are affected not only by the disaster event itself, but equally from the social context in which they are embedded. In addition to poverty and inequality, knowledge of the institutional context associated with adaptation is therefore essential for vulnerability analysis. Building on the views of Kelly and Adger, O'Brien et al. (2007) distinguish between end-point and starting point vulnerability. Füssel and Klein (2006) distinguish between first- and second-generation vulnerability assessments; the latter includes non-climatic drivers such as economic diversification, education, and the strength of social networks. In short, vulnerability is a function of social, economic, environmental, political, and technological assets, and its severity depends on the scale of analysis (Vincent 2007).

One of the major challenges for vulnerability assessment involves identifying and utilizing approaches that can effectively address the complex interactions between climate change and other stress factors. Reed et al. (2013) critically review the existing general approaches to livelihood strategies and argue that an asset-based approach seems promising for understanding household adaptive capacity. However, despite the obvious advantages of working with assets (financial and social), there are numerous shortcomings to the approach. For instance, the availability of stocks (capital and natural resources) is central to an asset-based approach. However, in terms of climate adaptation, understanding of flows and interactions between stocks is essential. In a model looking only at stocks, we do not know anything about flows between different stocks, or the implications flows may have for overall vulnerability and adaptive capacity.

Converting natural forests to plantations, for example, may increase the stock, but the services provided to users may decrease as plantations cannot sustain damages from typhoons the same way natural forests can (Thulstrup et al. 2013). The ecosystem approach likewise suffers from a similar shortcoming in that it only concerns the vulnerability of natural resources and therefore neglects the importance of shifts in man-made capital and political processes for vulnerability outcomes.

In an exception to more reductive approaches, Turner and Daily (2008) include both ecological and economic factors in their analysis. Nevertheless, their suggested analytical tool is nothing more than a traditional cost–benefit analysis. While calculations based on shadow pricing illustrate the need for resource protection or conservation under certain conditions, we are still left with unanswered questions as to why stakeholders continue to overexploit resources when the social benefits of conservation are higher than the social costs. Without enforcement of rules for regulating natural resource use, and few social benefits, cost calculations are of little use in many developing countries.

While Turner and Daily do not offer an alternative to existing approaches, they do highlight stakeholder perception as an important but often overlooked tool for understanding vulnerability when discussing adaptation strategies. While not novel, the authors are right in underscoring the need to understand how individuals evaluate different options associated with their specific social context.

The use of indices—aggregated measures of social, economic, and ecological variables—represents another analytical approach for assessing vulnerability. The strength of indices is that they may be generalizable across many different contexts. However, without repeat measurement over time, there is the risk that they may only provide a snapshot of the variables associated with vulnerability, limiting inference into the dynamic *processes* associated with vulnerability over the long term. This has been noted by Vincent and Cull

(2014) who call for a critical debate on the use of vulnerability indicators, but they add little to the debate in the form of argument or hypothesis.

An illustrative example of the use of indicators is provided by Ahsan and Warner (2014) in their attempt to describe changes in a rural area in Bangladesh. The authors set out to translate the IPCC definition on vulnerability into operational indicators for each of its three components: exposure, sensitivity, and adaptive capacity. Their indicators for adaptive capacity include data on illiteracy and the percentage of the population participating in dike construction and split into demographic and social capacity. The percentage of households below the poverty line defined by the government and the percentage of households lacking access to electricity and water were some of the main factors in defining sensitivity. The indicator for exposure was determined by a number of factors, including the percentage of households without shelter. Using information from a workshop with a number of stakeholders, a weighted score was calculated for each of the three components. As a final step, an overall socioeconomic vulnerability index was calculated by weighting each of three components by one-third.

Not surprisingly, the authors found two dimensions, sensitivity and exposure, to be the most important in developing the ultimate assessment or index of vulnerability. One of the advantages of working with index values is the ability to repeat the vulnerability score exercise in future workshops with other stakeholders, in order to capture the effect of a certain intervention. Furthermore, the authors stressed the independence of secondary data, which is often inflated with measurement errors. Though a convincing argument per se, the authors refrained from comparing their data to secondary data on vulnerability. This could have been done by providing an example.

If indexation is limited in its ability to provide significant insight into the long-term effects of vulnerability, another approach could be to combine aspects of both vulnerability and resilience analysis. Resilience is defined as the capacity of a system to absorb disturbance and still maintain its same controls and key elements of structure and function (Holling 2001). These two approaches are complementary. Whereas a vulnerability approach may utilize indicators to assess weaknesses related to specific actors and issues over short time periods, a resilience approach utilizes a *systems* approach to analyze interactions and dynamics that make social and ecological systems robust or fragile to disturbances and perturbations over long time frames. In a recent article, Maru et al. (2014) developed a combined vulnerability–resilience loop framework which addresses the current debate about the relative resilience or vulnerability of remote communities to impacts from climate change. In a case study from Botswana, they illustrate the link between short-term strategies designed to reduce vulnerability, and the effects these strategies may have on the long-term resilience of remote communities. The government decisions to dig boreholes and introduce settlement programs—decisions that were designed to reduce vulnerability over the short term—actually resulted in an increase in vulnerability for the local pastoralists. A lack of access to finance and loss of land to other stakeholders has actually increased the vulnerability of local people in the Kalahari Desert. These decisions have also had profound effects for the long-term resilience of both local communities as well as the ecological systems they depend on. Due to government decisions, the pastoralists are now forced to stay in very arid conditions during the dry season, rather than being allowed to move to other areas to graze their cattle as they had previously. The local residents are now caught in a ‘vulnerability loop’—as a result of government policies, vulnerability to climate change has increased, and the long-term resilience of both communities and rangelands is threatened, especially in times of drought.



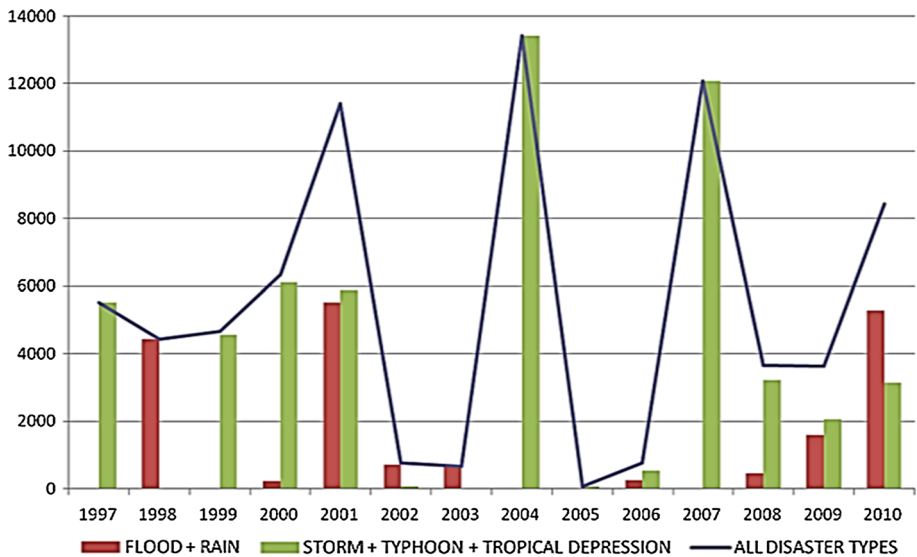
In contrast, aboriginals in central Australia were encouraged to use their own knowledge in the management of bush fires. In discussing the use of local ecological knowledge for management strategies that foster resilience, Maru et al. (2014) highlight the difference between the short-term vulnerability responses of actors, and the long-term strategies that are necessary to ensure social and ecological resilience. Equally important, though less implicitly discussed in the article, was government inclusion or exclusion of local people in the management plans. In our case study, we applied this vulnerability–resilience approach to determine whether local people in our case areas demonstrate signs of increasing vulnerability or improved resilience.

#### 4 Climate vulnerability in central and southern Vietnam

Flooding is the most common natural disaster that the population in the three provinces faces. The World Bank does not provide a precise definition of flood vulnerability in its report on social dimensions of climate changes; rather it distinguishes between general flooding and flash flooding vulnerability (McElwee 2010).

In order to define flood vulnerability precisely and map the most vulnerable populations in Nghe An Province, Veenstra (2013) tries to show the advantage of working with indicators. One of the major challenges is related to the question of whether one should give equal weightings to indicators. In this case, should exposure, susceptibility, and lack of resilience be treated equally, 1/3 each, in calculating a vulnerability index?

Exposure, susceptibility, and lack of resilience are the main categories in the present analysis: a slight departure from the normal IPCC definition of vulnerability (exposure, sensitivity, and adaptive capacity). This thesis does not provide any reason for differing from the IPCC definition. A household survey was conducted to ask the affected



**Fig. 3** Areas of agriculture produce damaged (ha) from 1997 to 2010. Source: Nguyen and Coulier (2012), p. 7



population in the areas about their awareness of flooding threats, their ability to leave their homes rapidly, and finally their access to financial support. In their responses, the households were requested to indicate their level of vulnerability, on a scale from 1 to 5, with 1 indicating low vulnerability. A new feature in calculating the Flood Vulnerability Index was the inclusion of a geographical-specific flooding intensity. Despite the wide spatial coverage of the 23 municipalities in Nghe An, little variation was observed among the municipalities.

In discussing the disaster situation in Quang Binh Province, Nguyen and Coulier (2012) find a positive correlation between the number of disasters and the adverse impact on household livelihoods, though the actual trend seems erratic rather than following a clear trend (Fig. 3). Depending on the type of damage, vulnerability changes from one district to another. In terms of loss of agricultural land, two districts were particularly badly hit by disasters, including Quang Ninh District.

Household actions and decisions are not made in a vacuum; they are contingent upon the broad social and institutional context within which they are embedded. In Vietnam, the development of the Mekong Delta was a strategic decision designed to ensure the support of the local people against North Vietnam during the American War, and large-scale irrigation projects significantly transformed the landscape and the livelihoods of those living around the delta (Miller 2014). Accelerated water developments, including dam construction and the increase in rice production, have contributed to overall economic growth, reducing the incidence of poverty in the delta. However, mono-cropping and high dependency on water access during the dry season make households more exposed to risk. Tran et al. (2013) note an erratic trend in farm-gate rice prices compared to input prices, highlighting the increasing risk for continued rice cropping. Once the land is developed for rice production, it is no longer viable for higher-yielding crops like tea or coffee (during the years of 2010–2012).

By contrast, Miller's (2014) main concern is not the volatility of output prices, but the dwindling area of common land on which the poor and the landless are dependent. Due to the intensification of rice production on an ever increasing mono-cropped land area, poor residents could end up becoming more vulnerable as they can no longer use the common land to hedge against possible risks related to rice production; if rice production fails due to prices, lack of rain, or any other reason, they cannot use the common land as a buffer.

Birkmann (2011) increases the complexity of the analysis by making the case for distinguishing between adaptation and coping strategies—a distinction which is analogous to the difference between short-term vulnerability responses, and long-term strategies that foster resilience. Drawing on research in the Mekong Delta, Birkmann argues that coping strategies are related to a specific hazard event, while adaptation indicates an intentional strategy designed to change the existing livelihood strategy—a strategy that may be feasible only in the event of institutional changes. Building dykes, for example, is normally regarded as an entirely positive sign of adaptation, but subsequent declines in fish production require a change in livelihood strategies for fish-dependent households. Birkmann uses dyke construction as an example of an adaptation strategy which may have negative effects for some of the users. Similarly, shifting to non-farming economic activities is considered a positive coping strategy to most observers, but if households do not master the additional required skills, rural families will be unable to change their existing livelihood strategies and adapt. Consequently, they will struggle with harsher living conditions. One consideration highlighted by this example is that adaptation strategies designed to promote resilience may not always be suitable for all households.

From a public policy perspective, there are clear challenges for effectively reducing the vulnerability of local people to climate change. In a study on land transformation in Nghe An Province, Leisz et al. (2011) conclude that regardless of what new government directives stipulate about changing cropping methods under climate change, the implementation of rules is never uniform. Villages' or hamlets' reactions vary, and under certain circumstances, they even reject the government recommendations. Whether government plans are implemented according to the letter of the directives depends on the relations between villages/hamlets and local officials. In Nghe An Province, for instance, local people regarded market forces as being as important as government regulations. In the next section, we examine the relevant challenges, policies, and local adaptation strategies for each of the study areas.

## 5 Vulnerability and local adaptation strategies in the study area, general adaptation strategies

### 5.1 Hung Nhan

Local authorities in Hung Nhan supported each poor household by providing a 10-year interest-free loan of 10 million VND to build 'chòi' (little barns) that provide shelter for cows and buffalos. In 2013, Hung Nhan municipality received support for building 50 *chòi* from Hung Nguyen District. The local support program enabled people, especially the poor, to protect their assets during flooding. Roads are only partly paved, and they all lie low compared to the water level during floods. Roads are normally inundated during the flood season. Figure 4 gives an illustration of how the little barns look like in the commune.

### 5.2 Yen Ho

In Yen Ho, households have gradually shifted from rice cultivation to aquaculture in low-lying fields because of higher economic yields. However, conversion to aquaculture is complicated by the fact that land lease agreements between the municipality and households stipulate that households must return land to its original land use category (i.e., rice field) when the contract comes to an end after 5 years. As a result, households are reluctant



**Fig. 4** Chòi (little barn) for cows and buffalos in Hung Nhan

to invest money, time, and effort in fish farming, as it requires digging ponds. Interviewees stated that they would be willing to make changes if land leases were extended to 8–10 years. In addition, infrastructure has improved and all roads are paved and not inundated during the flood season.

### 5.3 Vo Ninh

Households in Vo Ninh are slowly switching from rice production to fish and shrimp farming. The primary breeding season is the period without storms or floods, and the secondary season is the rainy season. In the secondary season, households have stretched meshes around ponds to prevent floods from destroying fisheries. In order to protect fisheries from flooding, large-scale farming households have improved infrastructure, building walls, stretching high nets around the ponds, and building artificial lakes.

#### 5.3.1 Vulnerability and local adaptation strategies in the study area, impact of natural hazards on poor households

In this section, we examine differences in perceived impact from natural disasters among households (first research question). We would expect the affected population to react differently to climate-related exposures, based on their relative wealth and resources. Poor households, which often rely entirely on rice cropping, are likely to suffer more than richer households with diversified income sources. Furthermore, households most affected by natural hazards could choose to opt out of agriculture or face decreasing income over time. This being said, switching to non-agricultural economic activities could be impossible for non-skilled families (Birkmann 2011). Families who decide to give up agriculture as a primary income source may be richer and have more income options at their disposal than poorer households.

In order to assess the effect of the vulnerability on income, we asked: ‘How seriously do you consider the following stress factors are impacting your livelihood?’ Households were requested to answer on a scale from 0 (no impact) to 10 (great impact) for all stress factors, including flooding, drought, salt water intrusion, and typhoons. We define low impact from natural hazards as reported values <6, medium impact with scores between 6 and 8, and values greater than 8 belonging to the high-impact category. The goal is to ascertain how vulnerable local people perceive themselves to be when exposed to natural disasters. The link between natural hazards and climate changes is not fully understood, but IPCC reports ‘climate change related risks from extreme events, such as heat waves, extreme

**Table 1** Natural hazards impact and income level, 2013

Impact	Classification of household-2013			
	Nearly poor	Poor	Other	Total
High	23	17	84	124
	18.55	13.71	67.74	
Medium	22	13	175	210
	10.48	6.19	83.33	
Low	14	14	108	136
	10.29	10.29	79.41	
Total	59	44	367	470

precipitation, and coastal flooding is already moderate and high with 1 degree Celsius additional warming' (IPCC 2014:12). Throughout this paper, we have used the term 'natural hazards' and not 'climate change' despite increasing evidence of the existence of such a link. Table 1 shows the impact variable compared to the present household income level in 2013. Numbers in the high row of each cell indicate number of households.

Table 1 indicates that households reporting a high impact from natural hazards consider themselves poor,  $p = 1.6\%$ . Consider the percentages in the lower row of each cell (percentage of each income group within a given impact category). If natural hazards impact had no influence on household income, percentages would be approximately similar for each impact group across income groups. In our case study, a lower percentage of households that experienced high natural hazards impact reported belonging to medium- or high-income groups (other). In fact, only 67% belong to this group, whereas the equivalent shares for low- or medium-impact groups are approximately 80%. For the year 2008, a similar table shows no correlation between the two variables,  $p = 28.0\%$  (Table 2). This could indicate that a high impact of natural hazards tends to impair increasing household incomes. Percentages in the lower row of each cell are approximately equal: 8–9% of the households are nearly poor, 11–19% are poor, and 73–80% are belonging to the group of medium or high incomes. When we test the differences, the test value is insignificant.

Controlling for the impact factor, we can compare the economic status of the households in 2008 and 2013 for the two extreme categories of climate-related factors (low or high impact).

**5.3.1.1 Households reporting a low impact from natural hazards** Table 3 shows that 29% of the poor in 2008 have become wealthier (lower row in cells are percentages) in 2013. By contrast, only 6% of the non-poor in 2008 have become poorer in 2013 (high right cell).

**5.3.1.2 Households reporting a high impact from natural hazards** Table 4 displays the change from poor/non-poor in 2008 to poor/non-poor in 2013. Around 37% of poor households in 2008 have become non-poor in 2013, and 19% of non-poor in 2008 are saying they were poor in 2013.

If we compare the two tables, more poor households in 2013 are found to have experienced a high impact from natural hazards (40 households in the high-impact group vs. 28 households in the low-impact group). The proportion of changes in poverty status is highest for households that have experienced a high impact from natural disasters.

**Table 2** Natural hazards impact and income level, 2008

Impact	Classification of household-2008			
	Nearly poor	Poor	Other	Total
High	10	23	86	119
	8.40	19.33	72.27	
Medium	19	22	169	210
	9.05	10.48	80.48	
Low	11	19	105	135
	8.15	14.07	77.78	
Total	40	64	360	464

Frequency missing = 6

**Table 3** Poor/not poor 2008 and 2013, households facing low impact

<i>p</i> _2008	Controlling for impact = low		
	<i>p</i> _now		
	Not poor in 2013	Poor in 2013	Total
Not poor in 2008	99 94.29	6 5.71	105
Poor in 2008	9 29.03	22 70.97	31
Total	108	28	136

**Table 4** Poor/not poor 2008 and 2013, households facing high impact

<i>p</i> _2008	Controlling for impact = high		
	<i>p</i> _now		
	Not poor in 2013	Poor in 2013	Total
Not poor in 2008	70 81.40	16 18.60	86
Poor in 2008	14 36.84	24 63.16	38
Total	84	40	124

Despite the proximity of the three provinces, the social and economic situation among our studies sites is far from uniform. The province of Nghe An is home to more high-impact households than the two other provinces (Table 5), and more households in Nghe An experienced an improvement or worsening in economic status from 2008 to 2013 (Table 6).

A Chi-square test for the third-order interaction term between poverty in 2008, in 2013 and impact of natural hazards being zero (null hypothesis) shows significance,  $p = 2.67\%$ . This significant third-order interaction term tells us that families facing high impact of climate changes are more likely to change poverty status than families facing low or medium impact. It has to be stressed that social mobility goes both ways, from poor to non-poor and vice versa.

**Table 5** Province by impact

Province	High	Impact		
		Medium	Low	Total
Nghe An	88 59.46	38 25.68	22 14.86	148
Ha Tinh	15 8.02	99 52.94	73 39.04	187
Quang Binh	21 15.56	73 54.07	41 30.37	135
Total	124	210	136	470

**Table 6** Province by change

Province	Change				Total
	Better	Unchanged not poor	Unchanged poor	Worse	
Nghe An	19 12.84	83 56.08	32 21.62	14 9.46	148
Ha Tinh	9 4.81	151 80.75	20 10.70	7 3.74	187
Quang Binh	10 7.41	95 70.37	20 14.81	10 7.41	135
Total	38	329	72	31	470

### 5.3.2 Vulnerability and local adaptation strategies in the study area, poor households adaptation strategies

In this section, we examine results associated with the second research question on household reactions to flooding problems. Many households left rice growing and other cash crops during the period 2008–2013. A total of 45 households have changed their main sources of income. Of these, eight identified other sources of non-farming income (this includes three households receiving income from aquaculture). The remaining group of 37 households receives their main income from various types of non-agricultural economic activities.

The decision to search for alternative income sources is not correlated with the impact of natural hazards or changes in poverty status. Contrary to common sense, poor households do not see their income base dwindling because of natural disasters. They do not rush out of rice cropping to embark on non-farm economic activities; rather, they continue their agricultural activities and invest more money and labor force in rice farming. A little less than two of three of the households that state they are seriously hit by natural disasters

**Table 7** Change in social status from 2008 to 2013 and money transfers in 2013

Change from 2008 to 2013	Received money		
	No money received	Received money	Total
Better	28 73.68	10 26.32	38
Unchanged not poor	265 80.55	64 19.45	329
Unchanged poor	61 84.72	11 15.28	72
Worse	31 100.00	0 0.00	31
Total	385	85	470

(impact factor is high) reacted by investing more time in cropping rice and other agricultural products.

Lack of access to financial resources is a severe constraint that households highly impacted by natural hazards must grapple with. In a different scenario, leaving aside the crucial issue of access to financial resources, 35 % of the worst hit households would invest in better production equipment and 85 % or more would purchase a boat if given the opportunity. Only 16 % of households slightly affected by natural hazards express an interest in further investment in production equipment, and they had almost no desire to purchase a boat.

Remittances play an important role in household livelihood strategies, and if poor households fail to secure additional funds from outside their community, they risk a decline in their already precarious situation. Once again, the variable used in the study is based on the households' reported perception of whether they are better or worse off today (2013) compared to year 2008. All 31 households that indicated they had a lower income in 2013 compared to 2008 did not receive any money transfers from outside their community (Table 7).

Finally, no difference was noted in the migration behavior between poor and non-poor households. Many households that have experienced high impacts from natural hazards decided to stay in the area, despite the risk associated with continuing rice cropping activities.

### 5.3.3 *Government response to natural hazards*

In this section, we discuss the results associated with the third research question on governmental policies for vulnerable household problems. Households that have been highly impacted by natural hazards are struggling to sustain their living standards in the villages, as a situation that would normally result in substantial support or assistance from governmental actors. Through interviews with local authorities and randomly selected households, we were left with an impression that all households receive a minimum relief package from the local government in the event of natural disasters. However, figures from our survey show a different story.

Households from the medium-impact group and the non-poor group benefit the most from immediate public relief through the provision of rice and noodles. In 2008, 85 medium-affected households received noodles or rice disaster packages compared to 28 households facing high impact from flooding disasters. In comparing public relief for different income status groups, the bias toward non-poor households is even more profound. In total, 55 households remaining non-poor after the disaster in 2008 received rice or noodles. In contrast, only ten households which became poorer benefitted from these immediate disaster packages.

## 6 Discussion

Comparing Tables 1 and 2, there is evidence of a positive trend in incomes from 2008 to 2013. The category 'poor' is smaller in 2013, and the number of non-poor households has increased slightly. More than 70 % of the households in the sample that reported being affected by natural hazard-related stress factors in the three regions experienced short-term negative effects due to the devastation of rice fields following the natural disasters in 2008,



and later in 2010 (the worst year during the period). In the long term, the average household fared better in 2013 than in 2008.

The worst affected household group represented a quarter of all households, and overall this group experienced a small reduction in income from 2008 to 2013, while the two other groups (low- and medium-impact households) moved up the ladder from being poor in 2008, to being non-poor in 2013. Poor families highly affected by natural hazards became increasingly dependent on supplementary income in the form of remittances, and they did not switch to other economic activities. If the general picture from the three regions is a slight increase in living standards, the poor and highly impacted households are becoming the long-term losers.

Climate-related natural hazards are erratic events, and only a small amount of flooding damage has occurred since 2010. Therefore, we do not know whether the problems encountered by the poor and high-impact households will continue to have an effect on the sites covered in this study. It is likely that climate change-related disasters will increase in frequency, and the Vietnamese authorities will intensify their search for viable solutions for the most vulnerable households. Within the study area, Maru et al.'s (2014) distinction short-term actor-oriented vulnerability responses as opposed to long-term system-level resilience responses are particularly relevant. Poor or highly impacted households in our sample from north-central Vietnam are experiencing a growing reliance on remittances to make up for declining income from rice production. In this sense, the vulnerable households' responses are short-term, individually centered solutions that may be less viable over the long term. High-impact households tend to continue relying on rice cropping as their major livelihood strategy—a strategy that may be problematic in the long term due to predicted increases in hazard and risk stemming from climate change. In addition, there is limited guidance or support from local government regarding strategies for effectively reducing vulnerability. The fundamental question is whether we are witnessing a vulnerability loop-livelihood strategy in which an increasing reliance on remittances or rice cropping may further undermine the poor's long-term prospects for a better future. In addition, the vulnerability of the poorer households may also increase if disaster relief provided by local government continues to favor the non-poor and medium-affected households.

Climate-related natural hazards had an uneven impact on rural households along rivers in north-central Vietnam. While medium-income households managed to increase their incomes over time, and slightly diversify their income base, the poor households got poorer due to the effect of natural hazards. In addition, local governments in our sample area supported the medium-income households more than the poor and heavily impacted households. A key challenge for Vietnamese authorities is the promotion of a comprehensive transition from a monoculture-based livelihood strategy to a diversified livelihood strategy that promotes resilience. Among households, respondents provided different perspectives on how local authorities have reacted to the flooding problems. The infrastructure was better in Yen Ho municipality than in Hung Nhan, though the Yen Ho local authorities were still reluctant to encourage a genuine transformation of the livelihood strategies from a pure monoculture-based economy (rice cropping). As can be seen in Fig. 1, the two municipalities are located very close to each other. Without claiming any correlation, let alone causality, we find it remarkable that Hung Nhan has the dubious honor of being the poorest. Poor households represent 40 % of the population (less than 400,000 VND per person) compared to only 17 % in Ha Tinh.

Household adaptation to more resilient livelihood strategies is also constrained by governmental land use regulations. Converting any given rice field to other crops requires

an approval from both the commune and the district, and above a certain threshold (more than 2000 m<sup>2</sup>), a land transformation plan ends up at the provincial level (communication with the Department of Cadastral, Hanoi). However, we have seen better off households respond to natural hazards not by abandoning their rice fields, but by diversifying their livelihood strategies. For instance, household members may be encouraged to go abroad or seek jobs in urban areas. Poor households have refrained from embarking on such economic diversification strategies.

## 7 Conclusion

Although the natural disasters are recognized as stress factors by the local people in our study area, the overall reaction to climate-related impacts varies significantly among different types of households. Households most affected by natural hazards did not migrate, and they did not turn to other non-agricultural economic activities. In fact, they seem to increase their dependence on income from rice cropping. Even if this approach may appear irrational due to the sensitivity of rice production to natural disasters, it may nevertheless be the only option in light of the absence of other real alternatives; diversifying livelihood strategies may be difficult for poor households that lack the skills to search for employment in new job functions.

Government agencies are promoting alternative livelihood strategies, but the rules are often ineffectively implemented, as if the government does not really support a wholesale transformation of the existing widespread rice cropping strategy (Yen Ho example). One explanation is that counterproductive land laws preclude the effective overhaul of the rice cropping strategy in rural Vietnam. The disaster relief offered by the authorities is also marginal compared to economic losses, so richer households react by increasing off-farm incomes, which they have the resources to accomplish, even in the absence of government assistance. Poor households, on the other hand, receive virtually no public compensation when they are affected by natural disasters, and government policies and existing regulations are inadequate for effectively promoting the pursuit of alternative livelihood strategies. One positive example of a government adaptation strategy, however, is dyke construction. Yen Ho municipality is better off in terms of vulnerability and poverty than Hung Nhan commune. Yen Ho commune is located inside the dyke, whereas Hung Nhan is established outside the dyke.

In general, the households in our study fare better today (2013) than before (2008), despite the economic losses households have to withstand as a result of dramatic natural disasters. But climate-related natural disasters seem to increase the income disparity among households in the villages—a trend that may continue or increase if natural disasters increase in frequency and severity as a result of climate change. This is presumably not a situation the Vietnamese government is eager to see happen.

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**Compliance with ethical standards**

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