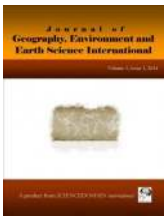

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Assessing Adaptive Capacity to Flood in the Downstream Communities of the Lam River

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Authors' contributions

All authors designed the study, conducted the field work together, read and approved the final manuscript. Author TPN managed and wrote the hypothesis framework and the institutional adaptation. Author TTHN managed and wrote the livelihood analysis and made the map of the first draft. Author HQM hosted the field work, wrote the study areas, and made the map of the final manuscript.

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ABSTRACT

Aims: North Central Vietnam is an area that may be heavily affected by climate change induced water disasters like flood, drought and salinity. This paper focuses on investigating the impacts of water disasters on, and analyzing community-based adaptation of, affected communities in the Central provinces of Vietnam.
Place and Duration of Study: Hung Nhan commune (in Nghe An province) and Yen Ho commune (in Ha Tinh province), with surveys being conducted in August, 2013 and June, 2014.
Methodology: Hung Nhan commune and Yen Ho commune on the Lam River were selected as study areas since they are typical localities affected by flood. Although the two areas are affected by flood due to heavy rain, the underlying cause of flood in each commune is different. While the former is outside the dyke and suffers flood due to the Lam River, the latter is inside the dyke and

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endures inundation due to poor drainage. In doing this research, two methodologies were employed: A household survey to understand impacts of water disaster and adaptive capacity in the two study cases, with total participantion of 164 households in Hung Nhan commune and 190 households in Yen Ho commune; and the CVCA methodology (Climate Vulnerability and Capacity Analysis) of the CARE organization in assessing adaptation strategies from the perspective of community.

Results: We found that people in Hung Nhan are more physically vulnerable than in Yen Ho due to its location (outside the dyke) and the capitals of livelihood of people here are not as good as that in Yen Ho. Not surprisingly, the number of poor households in Hung Nhan is higher than in Yen Ho.

Conclusion: Through a bottom-up approach, the study found differences between adaptive capacities of the communities and identified the top priorities in each community that need to be addressed to increase their adaptive capacity.

Keywords: Adaptive capacity; community-based adaptation; vulnerability; flood; Vietnam.

1. INTRODUCTION

Vietnam is one of the world's most disaster-prone countries where floods have caused extensive damage to infrastructure, significant losses in the agriculture and fishery sectors, as well as a large number of fatalities. The impacts of flood are evident in Vietnam through the number of people and scale of exposure. Vietnam's Emergency Events Database (EMDAT) shows that floods alone affected 35 million people between 1960 and 2006 [1]. Not surprisingly, Vietnam is considered one of the top 15 countries in the world heavily affected by natural hazards like drought and storms [2]. Geographical location and topographical features result in predisposition to flood in Vietnam. Being located on the East Sea, Vietnam is part of a tropical monsoon sea belt with total rain ranging from 1500 to 2000 mm per year. In addition to the monsoon rains, 6 to 8 typhoon storms hit the coast every year. The combination of the typhoon and the monsoon seasons produce the flood season which starts in July and ends in November.

In addition, climate change is expected to compound disasters in Vietnam in the form of typhoons, floods and droughts. According to scenarios developed by the Vietnam government, if the sea level rises by 1m, about 5% of the country's area will be inundated, 12% of its population will be directly impacted, and around 10% of the GDP will be lost (http://www.chinhphu.vn/portal/page/portal/English/strategies/strategiesdetails?categoryId=30&articleId=10051283). Climate change also may be a factor exacerbating future flood losses [3].

To limit the adverse impacts of climate change as well as flood, adaptation together with mitigation and compensation are viewed as a fundamental policy in the world today. Adaptation is the process that moderates the adverse effects of climate change through a wide range of actions that are targeted at a vulnerable system or population [4]. Consequently, studying adaptation options to reduce flood impacts has an important role to play in response strategies in vulnerable countries like Vietnam.

Adaptation to climate change in general and adaptation to flood more specifically are attracting great attention from international organizations. This issue requires multi-dimensional approaches and the participation of many stakeholders. Until recently, most efforts to help countries adapt to climate change focused on national planning and top-down approaches based on climate change modeling and capacity building [5]. However, a number of NGOs and academics have argued that to ensure the effectiveness, comprehensiveness and sustainability in adaptation to climate change not only a top-down but also a bottom-up approach should be implemented [5-8].

1.1 Community-Based Adaptation (CBA)

CBA is a bottom-up approach and usually starts with communities. Reid et al. [5] defined it as follows:

> *"CBA is a community-led process based on communities' priorities, needs, knowledge, and capacities, which should empower people to plan for and cope with the impacts of climate change. It must draw on the knowledge and priorities of local people, build on their capacities, and empower them to make changes themselves".*

In general, CBA starts by identifying communities in poor countries that are most vulnerable to climate change, or these communities may themselves ask for assistance [9]. There have been many organizations and researchers working on building the framework and tools for CBA as well as implementing CBA projects. The CARE International Organization has developed standards for CBA analysis, and constructed a new methodology named CVCA (Climate Vulnerability and Capacity Analysis, CARE [8]). Macgee et al. [5] also studied the construction of the basic steps to conduct a specific CBA project. However, the current theoretical and practical research implementing CBA is still in its infancy [7]. CBA, although conducted in a particular community, still needs the support from the national and international levels; CBA is a work requiring the participation of many stakeholders and many experts in different fields. There is no existing CBA tool that works for every community.

Adaptation in general is a process focusing on reducing vulnerability, which usually involves building adaptive capacity. That is the reason why vulnerability analysis is a key aspect in CBA research as well CBA projects.

1.2 Vulnerability

There are many different ways to define the concept of "vulnerability". Vulnerability is understood in very different ways by scholars from different knowledge domains, and even within the same domain. There is no perfect definition of vulnerability for all contexts. Vulnerability should be defined in relation to specific hazards, outcomes, and time horizons [4]. However, vulnerability generally includes the attributes of persons or groups that enable them to cope with the impact of disturbances, like natural hazards [10]. According Fussel [4], there are three main approaches in researching vulnerability to climate change, namely the risk-hazard approach, the political approach, and the integrated approach. The first approach refers primarily to physical systems and it is descriptive rather than explanatory while the second one focuses on analysing people, identifying the most vulnerable people. In this tradition, Adger and Kelly [11,12] defined vulnerability as *"the state of individuals, groups or communities in terms of their ability to cope with and adapt to any external stress placed on their livelihoods and well-being. It is determined by the availability of resources and, crucially, by the entitlement of individuals and groups to call on these resources''*. The third approach is a combination of the risk-hazard and the political economy approach and it is extended in various integrated approaches. A widely accepted concept of vulnerability in the third approach is the one proposed by the IPCC - *"Vulnerability defines the extent to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. It depends not only on a system's sensitivity but also on its adaptive capacity"* [3]. Evaluating vulnerability, in general, is very complicated. Lindley [13] noted that up to now there was no special tool for vulnerability assessment, especially for specific communities. However, the IPCC's definition can be viewed as a conceptual framework for assessing vulnerability.

1.3 Adaptive Capacity

In this study we considered adaptive capacity as a component of vulnerability and the aim of evaluating adaptive capacity is to assess vulnerability in communities in North Central Vietnam. As can be seen from the concept of the IPCC, vulnerability is a function of three variables: Exposure, sensitivity and adaptive capacity. Adaptive capacity is defined as *"The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences"* [3]. While exposure and sensitivity are proportional to vulnerability; adaptive capacity is inversely proportional to vulnerability.

Due to the diverse methodologies in assessing vulnerability, until now there has not existed a specific tool to evaluate adaptive capacity. According to CARE International in the CVCA, one of the most important factors shaping the adaptive capacity of individuals, households and communities is their access to and control over natural, human, social, physical, and financial resources. Resources that may be important to adaptive capacity in rural Vietnam would be: Human (knowledge of climate risks, conservation agriculture skills, good health to enable labour), social (women's savings and loans groups, farmer-based organizations), physical (irrigation infrastructure, seed and grain storage facilities), natural (reliable water source, productive land), and financial (micro-insurance, diversified income sources). These factors clearly are

components of a sustainable livelihood framework and fit well with the CARE proposed approach to assessing adaptive capacity based on a sustainable livelihood framework.

In this paper we employed the CBA approach in investigating adaptive capacity of communities in which adaptive capacity is analyzed based on the sustainable livelihood framework under two perspectives: household and community.

2. STUDY AREA

Nghe An and Ha Tinh provinces are located in North Central Vietnam (Fig. 1) which has diverse topographical features including high and low mountains in the west and coastal plains in the east. Complex characteristics of terrain together with the effects of climate change bring adverse natural disasters causing dramatic damage to this area.

The total population in the two provinces is about 4.2 million (2011, http://gso.gov.vn/default.aspx?tabid=714) of which 70% live in the coastal and lowland areas. Most of these inhabitants depend on revenues from the agricultural sector. Due to the geographical and socio-economic conditions, these provinces have the second lowest GDP per capita in Vietnam. With about 240 km of coastline along with the East Sea, coastal and lowland areas of these provinces are inherently affected by severe disasters such as typhoons, floods, droughts and salinity intrusion.

Hung Nhan commune (in Nghe An province) and Yen Ho commune (in Ha Tinh province), separated by the Lam River, were selected as study areas since they are typical local communes suffering from frequent flooding. Although the two areas are affected by flood due to heavy rain, the underlying cause of flood in each commune is different. Hung Nhan is a commune located entirely outside the dike system with relatively flat terrain (average height is 2.5 m) and the primary livelihood here is agriculture. Heavy rains caused by storms and the low terrain feature bring frequent flooding with a quick rise to peak. In the most recent severe flood in 2010, average rain of more than 300mm resulted in a fast rising water level on the Lam River which devastated agricultural activities in the commune.

There are 9 villages in Hung Nhan, and two, Village 1 (with 74 households) and Village 2 (with 114 households), are most heavily affected by flood due to a lower terrain in comparison with other villages. These two villages suffer flood nearly every year. Therefore, we focused on these two villages to investigate adaptive capacity to flood.

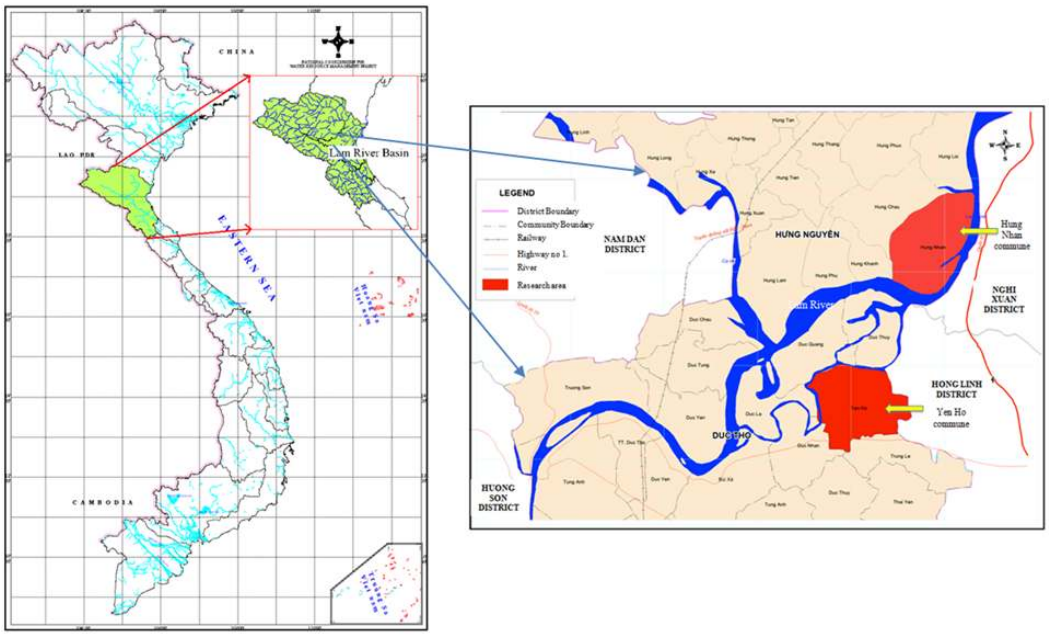

Fig. 1. Location map of study areas

Yen Ho commune is located entirely within the dike system, but has the lowest terrain of the Duc Tho district. Although located inside the dike system, the commune often experiences flood due to poor drainage. There are two conduits namely Trung Luong and Duc Xa to provide drainage; however, they seem to be not very efficient. If average rain reaches more than 200 mm, water level in the Lam River is higher than inside the dike (more than 50 mm). Consequently, the Trung Luong conduit must be closed and water cannot drain through it, causing inland inundation. Flood duration usually is from 3-6 days longer than in Hung Nhan.

There are 6 villages in Yen Ho commune, in which Village 5 (202 households) and Village 6 (205 households) are the most affected by flood. In comparison with the other villages of the commune, these two villages are the lowest in elevation. This factor together with an inefficient drainage system makes them the most flood-prone of the whole commune. We chose Village 5 to conduct the survey, in order to study their adaptation to flood and to compare to the villages in Hung Nhan.

3. METHODS AND DATA

As noted above, in this study adaptive capacity was considered as a component of vulnerability and assessed under two perspectives: household and community. Therefore, fieldtrips were carried out in the two communes in August 2013 and June 2014 that included collection of secondary data, household surveys, and community surveys of key informants. Secondary commune-level data of Hung Nhan and Yen Ho were collected for socio-economic status and population. These data also provided an overview of institutional adaptation.

The household survey on flooding was conducted under a collaborative research project on climate change-induced water disaster and participatory information system for vulnerability reduction in North Central Vietnam. The survey was implemented in all households in the most flood-affected villages in the two communes, including Village 1 and 2 in Hung Nhan and Village 5 in Yen Ho in August 2013. However, due to some absences, finally, 164 households in Hung Nhan and 190 households in Yen Ho participated in the survey conducted by face-to-face interviews. Respondents were asked about their perception of flood impacts, accessibility to resources, agricultural activity, income, assets, and participation in social organisations. Collected data were the basis of adaptive capacity analysis from the perspective of household through five kinds of capital (human, physical, financial, natural, and social) as defined under the sustainable livelihood framework.

Furthermore, we applied the CVCA methodology of CARE, in conducting the community surveys in June 2014 to investigate adaptive capacity from the perspective of community institutions. For this assessment, 20 key informants from Hung Nhan and 15 key informants from Yen Ho were surveyed. The participants were selected to represent different income groups in the villages. Informants were asked to be involved in the following activities: Hazard mapping, historical timeline, seasonal calendar and group discussion to identify the top problems related to flood impacts that need to be addressed in the community and through institutional adaptation. The overall study structure is summarized in Table 1.

Table 1. Summary of data sources for analyzing adaptive capacity in communities

Data source	Scope	Purpose
Secondary data of communes	Data on socio-economic status of commune and reports on disaster.	Understanding communities' background and institutional adaptation.
Household survey	Survey a total of 354 households on flood impacts, economic resources, agriculture activity, income, assets, participation in social organizations.	Investigating people's perception on flood impacts. Analysis of adaptive capacity under perspective of households and compare livelihood difference between villages.
Community survey	Key informants identified from previous survey. Survey on historical timeline, institutional adaptation and change in adaptation.	Identifying the top problems of the communities, institutional adaptation.

4. RESULTS

4.1 Impact of Flood in Hung Nhan and Yen Ho (Perception of Community)

Respondents in the household surveys were asked to rank the degree of flood impacts from 1 to 10 in a number of categories: Impact on lives and work, impact on cultivation, and impact on animal breeding. Results showed 81.9% of interviewed households in Yen Ho and 95.3% in Hung Nhan indicated that impacts of flood on their lives and work was the strongest as compared with other natural disasters (such as salinization, sea level rise, extreme cold, extreme hot, drought and big rain). All respondents defined the degree of flood impacts as between 8 and 10 (on a scale of 10), meaning "very strong". Respondents also specifically indicated that cultivation and animal breeding in these areas were considerably affected by flood (see the Table 2).

It should be noted that for the two villages in Hung Nhan, inundation covers almost all of the households while in Yen Ho, it usually happens for low-lying paddies. Not surprisingly, the vast majority of interviewed households in Hung Nhan (89%) and 60% of the people in Yen Ho communes indicated that their crop was totally lost due to flood in typical years (for example 2008 and 2010). Meanwhile, more interviewed households in Yen Ho commune (71%) specified that productivity of plants would be decreased in spite of yearly flooding. Besides, 53% of the interviewed households in Hung Nhan and 63% of the interviewed households in Yen Ho confirmed that frequent flooding resulted in the reduction of natural foods (grass, food crops, etc.) for cattle and poultry. Some other impacts were also identified, such as increasing diseases of plants, cattle and poultry, destroying cages of cattle and poultry, etc. Flood impacts have not only directly reduced households' income in the flood season but also indirectly affected production in further seasons for the reason that they have to consume more labour and money to improve soil, to fix animal cages and etc. Regarding aquaculture, flood impacts were considered not as dramatic as for crops and livestock. Indeed, only 16% of interviewed households in Hung Nhan were concerned that frequent flood had resulted in lower output of fishing. Aquaculture is almost non-existent in Yen Ho.

4.2 Livelihood of Households in Yen Ho and Hung Nhan

4.2.1 Human capital

Education level is recognized as a primary indicator that normally is used to determine human capital as it can be directly proportional to degree of income and the strategic plan of a household. In the two case studies, education level of household heads was quite low. Most household heads in Hung Nhan have just graduated from secondary schools (62.5%), a small percentage graduated from high schools (23.6%)[1]. In Yen Ho, the education level is a bit higher, with 45.5% of heads of households graduating from secondary schools and 35.8% graduating from high schools.

Almost all adults in the villages have no choice in jobs except to become farmers. Due to the uncertainty of agriculture and threats from natural disasters, many families encourage their children to enter university or college and consider this option as an entry ticket to a brighter future. A small proportion of youth after graduating from university chose to stay in cities (mainly Vinh and Hanoi) to earn a stable salary. Many other young people move to Ho Chi Minh or Vinh City to work as labourers. They generally work in the informal service sector, for example housekeeping or construction worker with no contract, low wages and long working hours.

People's knowledge, especially indigenous knowledge also is an important aspect of human capital. We found that people here possess worthwhile experience in forecasting and responding to flood. They observe nature in order to prepare a response to disasters.

4.2.2 Physical capital

From the perspective of community, infrastructure such as roads and irrigation works were taken into account to identify physical capital. Road quality in Yen Ho is good with 100% of roads being concrete. In Hung Nhan, only the main roads connecting communes are paved and a tiny proportion of concrete roads exist inside the villages; the remainder are dirt roads. While roads in Yen Ho are built at an

[1] *General education in Vietnam includes three levels: primary school (1st grade – 5th grade), secondary school (6th grade – 9th grade) and high school (10th grade – 12th grade).*

elevation that avoids floods, roads in Hung Nhan are low in elevation and usually are inundated in the flood season. High roads, on one hand, help people easily move and transfer because there is no flood on the roads. On the other hand, they prevent the flow of water and can exacerbate flooding in other low lying areas (Fig. 2).

The irrigation system in Hung Nhan includes a ditch, 3.5 km length, built in 1988. This ditch, uniquely for this area, was built at the surface not underground (Fig. 3). The reason is that at that time, people were afraid of accumulation of sediment and the purpose of the ditch was irrigation for sugarcane. However, sugarcane now does not exist in the area and the ditch became less useful for current crop cultivation. In addition, it becomes an obstruction when floods happen. Local authorities suggested to lower or re-build the raceway but it has not yet been done. In 2010, a severe flood destroyed 600m of the ditch and it was then replaced by 600m of a new one built underground. Except for this ditch, other drains built later in Hung Nhan are underground (- 40 cm). Therefore, irrigation for paddy and crops are better assured.

Table 2. Perceived impacts of flood in Hung Nhan and Yen Ho (%)

Impact of flood	Hung Nhan	Yen Ho
Cultivation		
Decrease productivity (of plants)	55	71
Totally lost crop in some typical years	89	60
More diseases of plants	37	29
Slow growth (of plants)	13	13
Cattle and poultry breeding		
Reduce natural foods	53	63
Increase disease	34	50
Lower productivity of cattle and poultry	29	46
Destroy cages	29	43

(Source: Household survey in 2013)

Fig. 2. A new road prevents the flow of water and exacerbates flooding in low-lying areas, Yen Ho commune

Fig. 3. At-surface ditch, Hung Nhan commune

In Yen Ho, the irrigation system has not worked effectively in cultivating paddy and crops. Both irrigation and drainage canals are too small. There are 4 pumping stations in the commune, with two of them set up in Village 5 since this locality is the lowest in the commune and is flood-prone. However, local people noted the pump capacity is too weak to pump efficiently. In 2013, ditch construction along the dyke for drainage was implemented but the section running through Village 5 has not been finished and has caused adverse impacts on residents. Due to the concentration of water and waste from other localities, the village has become a dengue outbreak node in the rainy season.

From the perspective of household, three indicators were taken into account as physical capital including: Housing, means of transport, and other assets of each household. These indicators partly indicate living standard of households.

Housing: in the two case studies, it was clearly observed that people still live from a low to medium standard. Most people in the study areas still live in tile-roofed houses (74.8% in Hung Nhan, and 51.4% in Yen Ho). The percentage of households living in two-floored houses is very small, 6.1% in Yen Ho, and 3.2% in Hung Nhan. In general, more households in Yen Ho commune are living in houses with a better standard than households in Hung Nhan.

Means of transport: Motorbike is the most popular transport means both in Yen Ho (72.2% of households owning motorbikes) and Hung Nhan (76.9% of households owning motorbikes). Wagon is another popular means mostly used for work (roughly 48% of households owning this means in each village).

Notably, in relating to frequent and widespread flood, 46.6% of interviewed households in Hung Nhan have bought boats for individual use when it floods. Conversely, in Yen Ho, due to frequent but not widespread flood (it mainly floods in sunken fields and low residential areas), a small proportion of households have a boat, only 7.5%.

Other assets: Television, mobile phone, as well as electric rice-cooker are popular household items of people in Yen Ho and Hung Nhan. Households in Yen Ho tend to own more expensive household items such as a refrigerator, washing machine and computer. This can be another indication that the living standard in Yen Ho is higher than in Hung Nhan.

4.2.3 Financial capital

Financial capital can be described as stocks of money or other savings in liquid form. In this research, we chose average income, accessibility to credit, and debt levels to understand financial capability of interviewed households. Table 3 shows that more households in Yen Ho live with better income than households in Hung Nhan.

Accessibility to credit reflects capacity of mobilizing outside resources to support life and production, where 38.5% of households in Yen Ho and 43.2% of households in Hung Nhan borrowed money. There are different options to obtain a loan: bank, relatives and Women's Union. However, the main source is the bank since the Vietnam Bank for Agriculture and Rural Development (Agribank) has incentives for farmers to access credit to develop their agricultural production. Asking about loans from relatives is a sensitive topic, therefore it is hard to collect information.

Many people complained about the limited access to capital. As can be seen from Table 4, a large proportion of households in the villages just can get a small loan (under 25 million VND). This does not enable them to expand production. Besides, the percentage of people in Yen Ho that can get a loan of more than 50 million VND (from high to very high level), is much greater than that of people in Hung Nhan. They are those trying to invest in larger production or export labor application.

Table 3. Percentage of very poor and poor households by average income/person

Average income/person	Yen Ho (%)	Hung Nhan (%)
Very poor (live under the poverty line, 400,000 vnd/month*)	17.3	39.7
Poor (401,000-500,000 vnd/month**)	13.3	12.3
Medium to rich people (more than 500,000 vnd/month)	69.4	48.0

** ,**: these levels are defined in the Decision 09/2001/QD-TTg of the Prime Minister for the period 2011-2015 (400,000 VND~$17.80 USD, 2015)*

Table 4. Debt level of households

Debt level	Yen Ho (%)	Hung Nhan (%)
Low (0,2-25 million VND)	63.4	76.5
Medium (26-50 million VND)	18.3	17.2
High (51-100 million VND)	12.7	4.7
Very high (more than 100 million VND)	5.6	1.6

4.2.4 Natural capital

All the land, water and biological resources such as trees, pasture, and biodiversity that people own or have access to can be described as natural capital.

In Hung Nhan, annual flooding has brought about a considerable amount of sediment (alluvium) that enriches soil quality. Recently, alluvium has been mixed with sand and this requires more of the farmer's time to eliminate the sand after flooding for cultivation. Yen Ho, inside the dyke, does not receive alluvium. In both localities, inhabitants complained that salinity affected their crops and forces them to use salt-tolerant rice varieties instead of old rice varieties. The salt-tolerant varieties used in the localities require more time and cost for planting and care and are lower yield varieties.

In general, there was no major variation in elevation, therefore, characteristics of paddies in Hung Nhan are quite uniform. Meanwhile, partial flooding leads households owning low-lying paddies in Yen Ho to get into difficulty in production. As reflected by the households, rice in these paddies more frequently suffers disease than in other paddies, and yield is usually lower. Normally, yield in rice in Yen Ho can reach 300kg/360 m^2, but in low-lying paddies, the figure is only 100 – 200/360 m^2. Land ownership is different in the villages. In Yen Ho, 67.3% of households own more than 2500 m^2 of agricultural land area while the proportion in Hung Nhan is 49.6%. The figure for owning less than 1500 m^2 is 18.1% and 22.7% in Yen Ho and Hung Nhan, respectively.

4.2.5 Social capital

Social capital consists of any assets such as rights or claims that are derived from membership of a group. This includes the ability to call on friends or kin for help in times of need, support from trade or professional associations and political claims on the government to provide assistance.

Almost all households have members participating in local social organizations such as Women's Union, Youth's Union, Veteran's Union, and Senior's Union. Women's Union supports members to access credit from the Union's fund. This fund is raised by money contributed by its members. Each person contributes 300,000 VND in a period of 3 months. Youth's Union in communes helps to support households without men. However, mostly people did not appreciate efficiency of these social groups in sustaining their livelihoods.

4.3 Institutional Adaptation

The term "institutions" covers not only formal political structures but also the more diffuse "rule of the game" and social and cultural norms. Therefore, we are interested in changes by communities to adapt to floods and applied the CVCA methodology of the CARE to investigate them. Indeed, respondents were asked to be involved in the activities: Hazard mapping, historical timeline, seasonal calendar and group discussion to identify the top problems related to flood impacts that need to be addressed in the community and through institutional adaptation. From informants' results, a number of important observations can be drawn:

> One first outstanding thing is that in both study areas, people have built their houses higher in comparison to the past since the great flooding in 2010. They also chose alternatives in low-lying paddies. Some households farmed fish instead of cultivating rice. According to opinions collected in the community survey in Yen Ho, economic efficiency from fishing is three times higher than that of cultivating. Besides, people actively cultivated short-day rice varieties in the summer-autumn season to harvest by full moon in July (the lunar calendar). Despite low quality in comparison with long-day rice varieties, short-day varieties are still viewed as appropriate choices.

Some poor households in Hung Nhan commune have been supported to build a little barn (chòi) as a shelter for cows and buffalos (Fig. 4). Cost

for a little barn is about 30 million VND, in which: the State supports10 million VND; each household gets a loan of another 10 million VND with small interest (less than 0.5%/month) over 10 years from the Agribank; and each household must pay by themselves the remaining 10 million VND. In 2013, Hung Nhan commune received the support of building 50 *chòi* from Hung Nguyen district. This policy enabled people, especially the poor, to protect their assets in flooding.

A community house also was built on high ground in 2011 to be a shelter for elderly and children during flooding. In 2013, the "Central" for coordinating and managing natural disasters was built by foreign investment in Hung Nhan due to the fact that this commune is a flood prone area of Hung Nguyen district. This Central is a structural and nonstructural measure for disaster risk reduction in Hung Nguyen district. It contains transceiver systems: A transceiver automatic identification system; video conferencing system, and VHF (very high frequency) and HF (high frequency) systems. This Central, although not yet activated, is expected to significantly mitigate flood impacts in the area through coordinated management and flood warnings.

In Hung Nhan, an evacuation drill to respond to floods and storms is organized every fifth year. Each evacuation drill costs roughly 100 million VND, however the district just funds a tenth of cost for this activity. Hung Nhan commune, thus, cooperated with Hung Chau commune to organize the evacuation drill. However, Hung Chau commune is inside the dike, therefore, the drill more focuses on responding to storms. If Hung Nhan commune can itself organize a drill, it obviously will bring greater efficiency in responding to flooding, which is a serious problem to this locale.

In Yen Ho, the most prominent coping strategy recorded is restructuring plants and livestock. The model farm of rice-fish-duck was deployed in two households with the scale of 10 hectares/farm in Village 5 from 2002, but due to low economic effectiveness, it was stopped in 2010. Besides, in some areas where soil is not of good quality, people have planted corn instead of peanut due to the fact that it takes more effort to cultivate peanut compared to corn. Consequently, although the selling price of peanut is higher than corn, people have stopped cultivating peanut.

Recently, some households have tended to farm fish instead of cultivating rice in low-lying fields for the reason of high economic efficiency. In order to farm fish, they have to dig to turn their fields into ponds. But the land lease agreement between the commune and the households stipulates that the households must return a field but not a pond when terminating the contract. It means that the households have to fill the pond. Moreover, land lease time is very limited, less than 5 years. This makes people reluctant to pour money and effort into building ponds. Respondents said that they would be willing to make changes if land lease time was 8-10 years.

5. DISCUSSION

The adaptive capacity of communities in Hung Nhan and Yen Ho was mainly assessed using qualitative methods. Quantification probably would reduce the subjectivity in the evaluation, for example by identifying an index of adaptive capacity of households and of communities. However, we have not yet derived a thorough method to calculate the total index of adaptive capacity and are in the process of finding the way. Vincent and Cull [14] pointed out that indexation may show us a non-context specific

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

tool like a snapshot of the actual situation but without allowing for a broader comprehension of the process behind the vulnerability. This also is true for adaptive capacity. However, indexation of adaptive capacity may enable us to achieve our aim of modeling vulnerability. Besides, an important aspect of defining adaptive capacity is measuring losses due to flood and comparing losses. However, we have not yet developed a method to quantify this factor. This will be researched in our further study.

Regarding adaptive capacity of community, it is being analysed in the context of natural flood. Human factors causing flood are not taken into account in this study. Take the Ban Ve – Khe Bo Hydro Power Plant for example, which has been operated since 2010 in the upstream of the Lam River, 160 km from Vinh City to the west. Apart from providing electricity for the North Central provinces, it contributes to regulate flow in flood season and diminish the level of flood. However, this plant sometimes suddenly opens the spillway gates of the dams and lets out torrents of water, which creates unexpected floods downstream. This sudden release directly impacts on our study areas. In this circumstance indigenous knowledge in predicting a flood is not appropriate and people may not have proper preparation to respond to the flood. Consequently, we did not analyse their adaptive capacity to flood due to human factors in this study.

In the years that floods come sooner than usual (named "*Tiểu mãn*" in Vietnamese), usually in May in the lunar calendar, almost all crops are lost and people and livestock here have to face a deficit of food. They may have to revert to pure survival strategies or rely on support from outside, mostly from relatives. Only when they suffer severe flood can they be supported by relief from authorities.

6. CONCLUSION AND RECOMMENDA-TIONS

In general, the main livelihood of people in Yen Ho and Hung Nhan is agriculture. Communities here depend heavily on natural resources, especially land and climatic conditions. This makes them more vulnerable when natural disasters occur. Not all elements of capital can be quantified during the process of analysing five kinds of capital, but through our observations and some key indicators, it can be concluded that Yen Ho's residents have a better livelihood. Indeed, their proportion of those graduating from high school is higher than that in Hung Nhan, they have a better living standard, better income and better accessibility to credit. Hung Nhan's location also is more physically vulnerable than Yen Ho making the communities here suffer more frequently from floods.

A bottom-up approach enables us to identify the top priorities in each community to increase adaptive capacity, reduce vulnerability, and finally, to reduce poverty in these communities. In both localities, alternative livelihood strategies to diversify income are needed. In Hung Nhan, developing aquaculture is not an appropriate option as in Yen Ho. Alternatively, breeding cows is a feasible one because of its high economic efficiency as per our observations. However, start-up capital to develop a herd is quite high. Besides, food for cows is a factor that must be considered. Farmers proposed to get larger loans from banks and to be supported in terms of techniques in production. These requirements can be fulfilled by support in terms of policy from the national, provincial and district levels. Additionally, the road system in the communes, especially internal roads connecting villages to the main road need to be upgraded to increase accessibility to evacuate people and assets during floods. However, it should be noted to learn the lesson from Yen Ho; high roads are not always beneficial.

In Yen Ho, the greatest urgency is finalizing the part of the ditch along the dyke running through Village 5 to eliminate petechial fever and pollution in the rainy season. In long-term development, local authorities need to check and change regulations in land lease policy to help farmers promote their production. To be more specific, there is a need to change from cultivation to aquaculture. People also desire support in terms of veterinary care and treating disease in rice.

This paper explored the context of adaptive capacity of typical communities affected by flood in North Central Vietnam. Different societies face different threats, and have different resources as well as coping mechanisms [15,16]. The approach here can be applied in other circumstances to have insight into adaptation strategies in each locality.

CONSENT

All authors declare that written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images.

ETHICAL APPROVAL

It is not applicable.

DISCLAIMER

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. World Bank, World development report: Development and climate change, Washington, DC; 2010.
2. World Bank Vietnam, Economics of adaptation to climate change, Report, Hanoi, Vietnam; 2010.
3. IPCC, Fourth Assessment Report, Report, Geneva, Switzerland; 2007.
   Available:http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm
   (Accessed on 05 March 2015)
4. Fussel HM. Vulnerability: A generally applicable conceptual framework for climate change research. Global Environmental Change. 2007;17:155-167.
5. Reid Hannah, Mozaharul Alam, Rachel Berger, Terry Cannon, Saleemul Huq, Angela Milligan. Community-based adaptation to climate change: An overview. Participatory Learning and Action 60, no. 1. 2009;11-33.
6. Magee Tim. A field guide to community-based adaptation. First published by Routledge, 2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN; 2013.
7. Rajib Shaw. Community-based climate change adaptation in Vietnam: Inter-linkages of environment, disaster, and human security. Multiple Dimension of Global Environmental Changes. TERI Publication; 2006.
8. CARE International. Climate Vulnerability and Capacity Analysis Handbook, Prepared by Angie Dazé, Kaia Ambrose and Charles Ehrhart; 2009.
   Available:http://www.careclimatechange.org
9. Kelman I, Gaillard JC. Placing climate change within disaster risk reduction. Disaster Advances. 2008;1(3):3-5. Available:www.managein.org/manage/disas/Back_Issue/editorial/edit_03_0 html (Assessed on 5 March 2015)
10. Janssen MA, Ostrom E. Resilience, vulnerability, and adaptation: A cross-cutting theme of the international human dimensions programme on global environmental change. Global Environmental Change. 2006;16:237–239.
11. Adger WN, Kelly M. Social vulnerabililty to climate change and the architecture of entitlements. Mitigation and Adaptation Strategies for Global Change. 1999;4(3): 253–266.
12. Adger WN, Kelly PM. Theory and practice in assessing vulnerability to climate change and facilitating adaptation. Climate Change. 2000;47: 325-352.
13. Lindley S. Literature review of climate change vulnerability, risk and adaptation assessment tools, University of Manchester; 2009.
   Available:http://www.grabs-eu.org/downloads/GRaBS4-_Literature_Review_August2009.pdf
   (Accessed on 05 March 2015)
14. Vincent K, Cull T. Using indicators to assess climate change vulnerabilities: Are

there lessons to learn for emerging loss and damage debates? Geography Compass. 2014;8:1-12.

15. Ribot JC, Magalhaes AR, Panagides SS. eds. Climate variability: Climate change and social vulnerability in the semi-arid tropics. Cambridge University Press, Cambridge; 1996.

16. Neil Adger W. Indicators of social and economic vulnerability to climate change in Vietnam. CSERGE Working Paper GEC 98-02; 1998.

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