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The Impact of Natural Disasters on the Livelihood Outcomes of Households in Rural Vietnam: The Regulator Role of Adaptive Capacity

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Abstract:
This study focuses on the impact of natural disasters on the livelihoods of households in rural Vietnam. By using VHLSS data 2014, 2016, 2018 of the General Statistics Office of Vietnam with the support of STATA software version 14.0, the results show that all three catastrophic floods, floods and droughts have negative impacts on the per capita income and expenditure of households. In particular, the per capita income of households living in a commune that is affected by disaster reduces by about 76.3% due to storms, 106.4% due to floods and 163.6% due to droughts. Similarly, per capita expenditure decreases due to storms, floods, and droughts 88.2%, 128.4% and 194.5%, respectively. Natural disasters cause detrimental effects to households, but when they have the capability to adapt better then disasters will have less harmful effect on them. The findings in this study may be useful inputs for policies to enhance resilience to natural disasters.

Keywords: *Natural disasters, livelihood outcomes, adaptive capacity, Vietnam*

1. Introduction

The frequency and severity of extreme weather events and natural disasters has increased over the past decades worldwide (Diffenbaugh et al., 2005; Solomon et al., 2007; Garbero A. & Muttarak R., 2013). The World Health Organization points out that each year natural disasters kill approximately 90000 people and affect nearly 160 million people worldwide (WHO, nd). In fact, global losses from disasters have almost quadrupled in the past few decades, from an average of $50 billion a year in the 1980s to nearly $200 billion a year in recent years (World Bank, 2016a). A new report from the GFDRR shows that the impact of extreme disasters is equivalent to global losses of $520 billion in annual consumption and puts about 26 million people in poverty every year (World Bank, 2016b).

Recognizing the importance of studying natural disasters to livelihood outcomes, many scholars around the world have studied this issue. Masozera et al. (2007) finds Hurricane Katrina to cause serious damage to households in New Orleans and surrounding areas in terms of income, promotion and other social factors. Meanwhile, Baez and Santos (2008) estimate that two strong earthquakes in El Salvador reduced a third of household income there. In addition, Mottaleb et al. (2013) show the onset of the Aila storm on coastal Bangladesh in 2009, leads to more spending for children attending school by households in the region than households which are not affected. The impact of natural disasters on households depends on the level of recovery of households and communities on natural disasters (Shah et al., 2020). Households with better adaptive capacity may suffer less damage (Arouri et al., 2015) than households with low adaptive capacity. However, research on adaptive capacity tends to focus on transnational and macro-economic research (Canon, 2008; Briguglio et al., 2009). At the household level, assets, livelihood strategies, public transfers, and credits are important factors to enhance resilience to shocks (Bruneau et al., 2003; Davies, 2013).

Vietnam is one of the few countries severely affected by natural disasters. According to estimates, not to mention human losses, natural disasters cause annual economic losses of about 1 - 1.5% of GDP between 1989 and 2008 (World Bank, 2013). Natural disasters cause economic losses of 1.5% of gross domestic product annually (World Bank, 2013) and put over 70% of Vietnam's population at risk of natural disasters, floods and isolation, especially the poor in rural and urban areas (World Bank, 2012). There are a number of studies on the impact of natural disasters on households in Vietnam. Anh Tuan Bui (2015) uses the 2008 VHLSS to examine the impact of natural disasters on different aspects of livelihood outcomes. The results show that natural disasters result in a significant reduction in GDP of affected households in Vietnam. Examining the impact of adaptive capacity on adverse shocks has also been considered, but studies often focus on the single issues of adaptive capacity. In particular, Wainwright and Newman (2011) consider coping strategies of rural households against adverse shocks. They find that current assets, public transfers and private transfers can help households reduce consumption fluctuations due to natural shocks. Similarly, Arouri etal. (2015) uses the Vietnam Household Living Standards Survey (VHLSS) in 2004, 2006, 2008, 2010 and the results show that three types of disasters including storms, floods and droughts have negative impacts on household income and outcome, household and commune characteristics enhances the resilience of households to disasters.

Thus, our paper is different from previous studies on the impact of natural disasters in Vietnam in three respects. First, our paper measures the impact of the three most common disasters in Vietnam, including storms, floods and droughts on household livelihood outcomes using the VHLSS in 2014, 2016 and 2018. Secondly, we assess the impact of adaptive capacity on household livelihood outcomes of Vietnam. And finally we look at the regulatory role of adaptive capacity in enhancing resilience of households to disasters. The results from these studies can provide useful information to policy makers on the adverse impacts of natural disasters on household livelihood outcomes in rural Vietnam. If natural disasters result in major economic losses for households, the government should have stronger and more effective policies and programs to reduce the adverse effects of natural disasters in Vietnam. Findings from the adaptive capacity related to the resilience of households to natural disasters can be a useful input to policies to enhance resilience to natural disasters.

2. Literature Review

2.1. Impacts of Natural Disasters on Livelihood Outcomes

Most documents use the terms “disaster’ and “natural disaster’ synchronously. However, not all disasters are natural disasters (Berren, M. R., Beigel, A., & Ghertner, S., 1980). Daniel P. Aldrich (2012) defines disaster as an event that suspends normal activities, threatens and causes serious damage throughout the community. This definition of disaster does not include traffic jams, delayed aircraft or traffic accidents but includes earthquakes, tsunamis, nuclear explosions, volcanic eruptions, fires, floods. While CRED (2006) defines disaster as a natural event that overwhelms local capacity, requires an external support request, and these disasters are divided into three main categories: natural disasters, technological disasters and artificial disasters (UNISDR, 2005). Natural disasters occur both seasonally and without warning, leaving the country frequently in a state of insecurity, disruption and economic loss. Some authors measure natural disasters using disaster severity reports, including: the number of deaths, the number of affected people, the amount of direct damage, the financial loss ... (Noy et al., 2009; Makena Coffman and Ilan Noy, 2011; Garbero, A., & Muttarak, R., 2013; Jeremie Gignoux, Marta Menendez, 2015). In addition, some authors have considered whether or not the occurrence of disasters in localities to measure disasters (Anh Tuan Bui et al., 2014; Arouri et al., 2015). Strobl, E. (2012) measures the strength of hurricanes that hit Central America and the Caribbean from 1950 onwards using drawings depicting the path and wind speed of storms, sorted by the levels from 1 to 3.

Livelihood outcomes are increasing income and happiness, reducing vulnerability, improving food security and sustainable use of natural resources (Scoones, 1998). Based on this point of view, Jeckoniah, J. (2019) have considered that livelihood outcomes are increasing income and shares. The livelihood outcomes can be calculated based on a variety of approaches, for example based on income and the value of household ownership shares (Jeckoniah, J., 2019), or based on income and total household assets (Myroniuk, TW, & Vearey, J., 2014). However, most authors use household income and expenditure per capita to reflect livelihood outcomes, example, Tuyen, T. Q et al., 2014 uses this measure in researching on land loss and livelihood outcomes in Vietnam. Households' livelihoods are greatly affected by natural disasters such as floods, drought, earthquakes and other related events (Skoufias, E, 2003). Specifically, natural disasters adversely affect household expenditure and income (Dercon, 2004; Masozera et al., 2007; Mottaleb et al., 2013; Minotet al., 2006; Imai and Gaiha, 2007; Bui Anh Tuan et al., 2014). The per capita income of Vietnamese households suffering from storms, floods and droughts decreased by 1.9%, 5.9% and 5.2%, respectively. Similarly, expenditures decreased by about 1.5%, 4.4% and 3.5%, respectively (Arouri et al., 2015). In Lagos State - Nigeria, 81.8% of the people surveyed in the disaster-affected area admit that they have lost income due to floods (AI Adeoti et al., 2010). Therefore, we make 2 hypotheses:

- H1: Disaster has a negative impact on the per capita income of Vietnamese households.
- H2: Disaster has a negative impact on the per capita expenditure of Vietnamese households.

2.2. Adaptive Capacity

2.2.1. Definition and Measurement

Adaptive capacity has been an important element of long-term adaptation to climate change and also the central point of recent developing research (A.R.Siders, 2018). The concept of adaptive capacity has been approached in different ways. Simply put, adaptive capacity describes the ability to adapt (Nathan L. Engle, 2011). Another aspect, Stephen R. Carpenter et al. (2008), argued that adaptive capacity is the ability of a living system, such as a social ecological system, to

modulate responses to changing internal and external needs. Specifically, Nick Brooks and W. Neil Adger (2004) asserted that adaptive capacity is the property of a system to adjust its characteristics or behavior, to broaden its scope of response in Current climate change conditions or future climate conditions. Similarly, USThathsarania and his teammates (2017) pointed out that adaptive capacity demonstrates the ability of an area or community to cope and thrive in the face of change.

Up to now, there have been many studies on adaptive capacity and the way to measure adaptive capacity. The views of researchers in measurement are quite similar. A number of studies identified adaptive capacity indicators, often collating and aligning magnetic indicators of vulnerability and resilience. In Australia, researchers analyzed the overall adaptability of rural communities to global change using rural livelihoods framework (Ellis 2000), including an assessment of data of society, people, construction and natural capital provided by the Australian Bureau of Statistics (Nelson et al. 2005, 2007, 2010a). This opinion is consistent with Chen (2015)they also measured adaptive capacity through resources: Human capital, social capital, natural capital, financial capital and engineering/physical capital. Park et al. (2012) also developed a process that allows adaptive capacity assessment through: human capital, social capital, natural capital, physical capital and financial capital. Raymond and Cleary (2013) further clarified this measure by developing a tool and a process on the strength of indicators related to five types of capital. In addition, we find that in a number of studies, scholars also refer to household characteristics as a factor of adaptive capacity (Shah et al., 2020). Therefore, in this study, we also measured adaptation capacity through 6 main components including: Natural capital, human capital, physical capital, financial capital, social capital and household characteristics.

2.2.2 Impacts of Adaptive Capacity on Livelihood Outcomes

For this relationship, we synthesize the impact of adaptive capacity on livelihood outcomes by looking for the impact of six components on livelihood outcomes. Firstly, human capital, or more specifically education, is one of the factors that strongly affects household incomes and expenditure (Sekhampu, T., & Niyimbanira, F., 2013) because adult education plays an important role in determining the livelihood outcomes of households through increased wage income (Sudhanshu Handaet al., 2004). A high level of education will help households better adapt to the market, apply techniques to production and thereby increase household income (El-Osta, H., 2011). Besides, cognitive skills (another element of human capital) are also thought to have a positive effect on income for households in Ghana (Jolliffe, D., 1998). On the other hand, some studies add that social capital also has strong impacts on household income (Maluccio et al., 1999; Ruben and Strien, 2001, Van Ha et al., 2004). There is very little research on the impact of natural capital, physical capital and financial capital on average household income and expenditure. In particular, a study by Aragón, FM, & Rud, JP (2013) in Peru finds strong evidence that the region's gold mines have a positive effect on real incomes for residents in the city, surrounding countryside and promoting local development. Another study by Barbier, E. B. (2007) in Thailand shows that most of the household income in the vicinity of mangrove forest comes from the direct or indirect exploitation of mangrove forest resources. In addition, forest environmental resources are also considered to be a significant source of prosperity for many rural people in Tigray, Northern Ethiopia (Babulo, B. et al., 2008). Therefore, we make 2 hypotheses:

- H3: Adaptive capacity has a positive impact on the per capita income of Vietnamese households.
- H4: Adaptive capacity has a positive impact on the per capita expenditure of Vietnamese households.

2.2.3. The Regulator Role of Adaptive Capacity

Annually, countries around the world suffer from the severe damage caused by natural shocks (Natural disasters). However, some researchers pointed out that, before a catastrophic event, human efforts can be able to minimize damage to the effects of disasters such as injuries, loss of life and property (Raya Muttarak & Wolfgang Lutz, 2014). Most communities and regions are able to cope with (or adapt to) normal climatic conditions with moderate deviations from the standard. However, exposure related to extreme events may surpass the adaptive capacity of the community (Barry Smit & Johanna Wandel, 2006). When exposed to similar disasters, households with better coping and resilience capacity may suffer less damage than those with coping and resilience. Low (Arouri et al., 2015). The impact of natural disasters varies for different countries, regions, communities and individuals resulting from differences in exposure and vulnerability to natural disasters (Clark, et al. 1998). Studies in turn demonstrated the important role of adaptive capacity that increases households' resilience to disasters, thereby minimizing damage.

Several studies have shown the role of adaptive capacity components in the impact of increasing human resilience to natural disasters, thereby reducing the impact on household incomes and expenditures. In the case of human capital, studies suggested that educational attainment increases disaster preparedness (Wamsler et al. 2012; Muttarak and Pothisiri, 2013; Pichler and Striessnig 2013). Case studies of households in Brazil and El Salvador showed that residents of high-risk areas have a lower average education level than education in households in low-risk areas (Wamsler) et al. 2012). Similarly, research on tsunami risk areas in southern Thailand indicated that individuals and households with higher education have greater disaster preparedness, they stock up on supplies for emergency and family evacuation planning (Muttarak and Pothisiri, 2013). For example, Cuba, with higher average education compared to neighboring countries, is more effective in risk management, risk communication systems as well as disaster preparedness. (Pichler and Striessnig, 2013).Therefore, we hypothesize as follows:

- H5: The adaptive capacity reduces the negative impact of natural disasters on the average income of Vietnamese households.
- H6: Adaptive capacity reduces the negative impact of natural disasters on average expenditure of Vietnamese households.

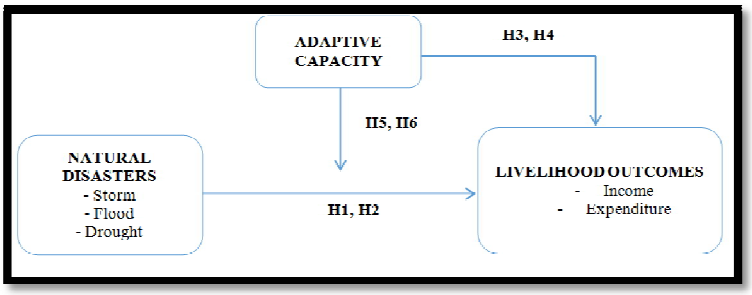

Figure 1: Research Model

3. Data and Processing Analysis

3.1. Data Sets

This study uses the Vietnam Household Living Standards Survey (VHLSS) in 2014, 2016 and 2018. The VHLSSs were conducted by the General Statistics Office of Vietnam (GSO) with assistance from the World Bank. The surveys in the VHLSSs were conducted within the selected households and communes within 63 provinces. Data on households include a number of demographic characteristics, household income, expenditure, educational level, technical qualifications of each household member, health, fixed assets and household participation in poverty reduction programs. Commune data includes some general demographic, ethnic, socio-economic infrastructure, economic status and some basic information on social order and safety and environmental protection.

Commune data can be merged with household data. Each of the VHLSSs can include more than 9000 households. The data are representative for urban / rural and six geographic areas. In this study, we use data in rural areas because urban disaster data is not available in the surveys. The 2014, 2016 and 2018 VHLSSs covered 1,699 communes in rural areas.

Data on disasters are collected from questionnaires in the rural communes. Commune leaders are asked about different natural disasters that happened most recently in 2014, 2016, 2018. There is no information on the number of disasters in these 3 years. Thus, in this study we define disaster variables as dummy variables indicating whether any disaster (storms, floods, droughts) occurred within 2 consecutive years. We identify the disaster variables within two years for the purpose of regression because the VHLSSs data we use have a gap of two years. Table 1 describes in detail the variables used in the study.

Variables	Main component	Sub-component	Explanation
1.Natural disasters	E1: Commune affected by storm		E1,2,3=0 if the commune is not affected by the disaster E1,2,3=1 if the commune is affected by the disaster
	E2: Commune affected by flood		
	E3: Commune affected by drought		
2.Adaptive capacity (A)	Natural capital (A1)	A11: Per capita agricultural and forestry land	Agricultural and forestry land area / Household size
		A12: Soil diversity index	1/ (number of soil type +1)
		A13: Per capita rice land area	Rice land area / Household size
		A14: Per capita cropland area	Crop land area / Household size
	Human capital (A2)	A21: Percentage of household members having a job	Number of members employed/ Household Size
		A22: Head of household has technical expertise	1: Head of household has technical expertise, 0: Head of household does not have technical expertise
		A23: Head of household completes primary school or above	1: Head of household completes primary school or above, 0: Head of household does not complete primary school or above
	Physical capital (A3)	A31: Durable goods diversity index	1/ (number of durable goods +1)
		A32: Average value of remaining assets	Value of remaining assets / Household size
		A33: Per capita living area	Living Area / Household Size
		A34: Main house type	1: Permanent house, 0: Temporary house
	Financial capital (A4)	A41: Access to savings	1: Having access to savings, 0: Do not have access to savings

Variables	Main component	Sub-component	Explanation
		A42: Access to loans with money and goods	1: Having access to loans, 0: Do not have access to loans
		A43: Household pays off the loan	1: paid off the loan, 0: have not paid off the loan yet
	Social capital (A5)	A51: The percentage of household members joining the association	Number of members participating in the association / Household Size
		A52: Number of forms of support	Number of forms of support (educational support, medical assistance, housing, clean water,)
		A53: Number of media	Number of media(TV, radio, telephone, laptop…)
		A54: Loan-to-value ratio	Rate (borrowed capital + 1) / (saving +1)
	Household characteristics (A6)	A61: Proportion of adults from 15 to 60 in households	Number of members from 15 to 60 years old / household size
		A62: Female ratio	Number of female members / household size
		A63: Poor household	1: Non-Poor household, 0: Poor household
		A64: Gender of household head	1: Male, 0: Female
		A65: Age of household head	Age
3. Livelihood outcomes	Income		Ln(Income)
	Expenditure		Ln(Expenditure)

Table 1: Variables Used in the Study
Source: Summary of the Authors

The adaptive capacity variable includes 6 main indices (natural capital, human capital, physical capital, financial capital, social capital and household characteristics). Each indicator has different units, so to calculate the adaptive capacity index, the main indicators should be taken to the same unit, specific steps are as follows:

Step 1: Standardize the index to make the sub-components into datanot depending on the unit according to formula (1). This study applies the standardization method used in the HDI Human Development Index (United Nations Development Program, 2006). This method is also used by many authors (Hahn et al., 2009); Shah et al., 2013) ...

$V' = (Vi - Vmin)/(Vmax - Vmin)$ (1)

In which: V ': standardized value; Vi: observed value i; Vmin: minimum value of observed data; and Vmax: maximum value of observed data.

Step 2: Determining weights for each sub-index: In fact, value of each sub-component's contribution to the main component as well as value of the main component's contribution to the adaptive capacity variable are different. Therefore, it is necessary to standardize the input data after determining the weight for each factor. According to the method of Iyengar and Sudarshan (1982), weights are calculated by the formula (2):

$Wj = C/\sqrt{var(xij)}$ (2)

Where c is the standardized constant defined by the formula:

$C = [\sum_{j=1}^{K} \frac{1}{\sqrt{var(xij)}}]^{-1}$ (3)

Step 3: Identify new sub-components: After standardization, a new sub-index is constructed by multiplying the weight by all standardized indicators and it is determined by the following formula (4):

$X_{ij''} = w_j * X_{ij'}$ (4)

In which:

$X_{ij''}$: The ith sub-component in the jth household has weight;

W_j: Weight is calculated in formula (2)

$X_{ij'}$: The ith sub-index in the jth household is standardized

With the new sub-component, we get the main indices defined by the sum of the corresponding sub-indices. Finally, after calculating the six values of six main indices (5 sources of livelihood capital + household characteristics), continue normalizing and then calculate weights for the main component, we have w1 - w6 that is the weight of the 6 main indicators.

In which: $w_1 + w_2 + w_3 + w_4 + w_5 + w_6 = 1$

The final adaptive variable is calculated by the following formula:

$A = A_1*W_1 + A_2*W_2 + A_3*W_3 + A_4*W_4 + A_5*W_5 + A_6*W_6$ (5)

3.2 Estimation Method

The main estimation method used in this study is econometric regression. We define the model as follows:

$Ln(Y_{ijt}) = B_0 + B_1X_{ijt} + B_2D_{jt} + B_3D_{jt}X_{ijt} + B_4G_t + \varepsilon_{ijt}$ (6)

Where Y_{ijt} is the index of household livelihood outcomes i in commune j in the year t, the livelihood outcomes include average income and expenditure of the household; X_{ijt} is a vector of adaptive capacity , D_{jt} is a vector of three dummy variable representing three types of natural disasters such as floods, storms and droughts happened in communes in 2014, 2016 and 2018; G_t is the dummy variable of years; $\varepsilon_{ijt}$are unobserved variables. The impact of natural disasters and adaptive capacity on household livelihood outcomes is expressed by parameters $B_1$and B_2. The regulatory role of households' adaptive capacity is expressed through B_3.

4. Results

4.1. Data Descriptive Statistics

Figure 2 presents the proportion of rural households affected by different disasters that happened in 2014, 2016, 2018. Specifically, in 2014 rural households living in areas affected by floods, storms, and droughts occupied 43%, 36.2%, and 20.8% respectively. In 2016, the number of households affected by floods and storms decreased sharply compared to 2014 (down 11.8 and 10.4 percentage points), but this ratio increased sharply among households affected by droughts (up 22.2%). By 2018, there was a sharp increase in the number of households affected by floods, storms and a decline in households affected by droughts. Thus, it can be seen that there is no clear trend in disasters during 2014-2018.

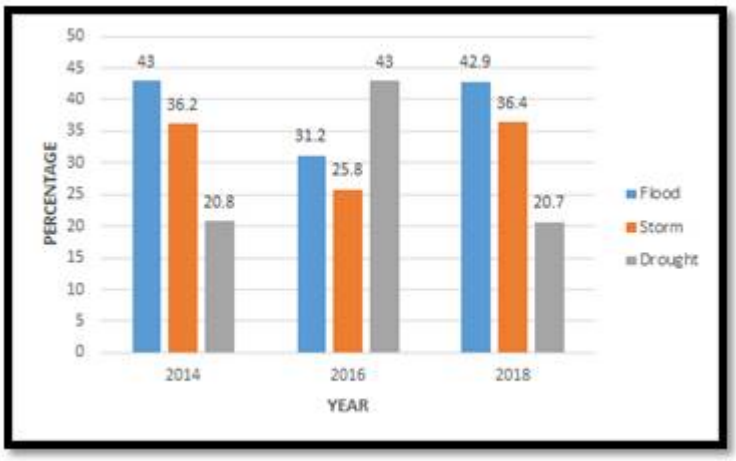

Figure 2: The Percentage of Rural Households Affected by Natural Disasters
Source: Authors' estimations from the VHLSSs

4.2. Effects of Natural Disasters and Adaptive Capacity on Household Livelihood Outcomes

In Table 2, we present the commune fixed-effects regression of log of per capita income, log of per capita expenditure of households. All three types of disasters (storms, floods and droughts) have a negative effect on household income and expenditure. The effects of storms tend to be smaller than the effects of floods and droughts. Table 2 shows that the per capita income of families living in a commune with storms, floods and droughts decreased by about 76.3%, 106.4% and 163.6% respectively. Storms, floods and droughts also reduced household expenditure and income per capita 88.2%, 128.4% and 194.5%, respectively. Thus hypotheses H1 and H2 are proved.

Table 2 also shows that the six components of adaptive capacity have a positive effect on the per capita household income and expenditure at statistical meaning of 1%, (except physical capital that has the opposite effect). More specifically, of the 6 components, natural capital tends to have a strongest impact on household income and expenditure per capita, when natural capital increases by 1 unit, it will improve average per capita income and expenditure by 279.1% and 195.7%. This is entirely consistent with the characteristics of Vietnamese smallholdings when agricultural production activity is the main form of production, and it depends greatly on their existing agricultural land. Compared to other components of adaptive capacity, social capital tends to have the lowest impact on a household's income and per capita expenditure, if social capital increases by 1 unit, the average of household income and expenditure per capita will increase by 22.5% and 79.2%. This can be partly explained by the poor social networks of the households and the inadequate local government assistance. Among the six components, physical capital tends to have a negative impact on livelihood outcomes, which shows that the use of durable appliances and investment in houses is reducing spending to invest in livelihood activities that lead to a reduction in household income. Thus hypotheses H3 and H4 are proved.

VARIABLES	(1) Log of per capita income	(2) Log of per capita expenditure
Commune affected by storm	-0.763**	-0.882***
	(0.316)	(0.331)
Commune affected by flood	-1.064***	-1.284***
	(0.298)	(0.312)
Commune affected by drought	-1.636***	-1.945***
	(0.387)	(0.405)
Natural capital	2.791***	1.957***
	(0.393)	(0.411)
Human capital	0.912***	0.762***
	(0.045)	(0.047)
Physical capital	-1.848***	-1.504***
	(0.207)	(0.217)
Financial capital	1.060***	0.942***
	(0.046)	(0.048)
Social capital	0.225***	0.792***
	(0.066)	(0.069)
Household characteristics	1.112***	1.205***
	(0.062)	(0.065)
Commune affected by storm * adaptive capacity	0.896**	1.088***
	(0.372)	(0.390)
Commune affected by flood * adaptive capacity	1.226***	1.489***
	(0.350)	(0.367)
Commune affected by drought * adaptive capacity	1.872***	2.244***
	(0.453)	(0.475)
2016.year	0.116***	0.113***
	(0.020)	(0.021)
2018.year	0.315***	0.353***
	(0.021)	(0.022)
Constant	9.480***	8.309***
	(0.068)	(0.071)
Observations	9,992	9,997
R-squared	0.214	0.180
Number of communes	1,699	1,699

Table 2: Commune Fixed-Effects Regressions of Household Outcomes
*Note: *** P<0.01, ** P<0.05, * P<0.1*
Robust Standard Errors Are In Parentheses
Source: Authors' Estimation from the Vhlsss 2014, 2016, 2018

4.3. The Moderator Role of Adaptive Capacity

To study the moderator role of adaptive capacity in minimizing adverse impacts of the disaster, we add the variable interactions between disaster and adaptability in the regression of income and expenditure. For example, the estimate 0.896 in Table 2 is the estimated coefficient of the interaction between adaptive capacity and storm variable in the regression of per capita income. Table 2 shows, all three types of disasters (storms, floods and droughts) have a negative affect over income and expenditure of households. However, households with better adaptive capacity will reduce the negative impact of the disaster. Particularly, the adaptive capacity increase on the same 1 unit will minimize the adverse impact of the disasters; drought is the largest, followed by floods and storms in both income and expenditure. Thus hypotheses H5 and H6 are proved.

5. Conclusions

This study uses the latest Vietnam Household Living Standard Surveys 2014, 2016 and 2018 to estimate the impacts of storms, floods and droughts on household livelihood outcomes, at the same time, assesses the impact of adaptive capacity on Vietnam's household livelihood outcomes. Specifically, we consider the regulatory role of adaptive capacity in enhancing resilience of households to natural disasters. The results show that all three catastrophic floods, storms and droughts have a negative impact on per capita income and expenditure of households. In particular, the per capita income of households living in a commune that is affected by disaster reduces by about 76.3% due to storms, 106.4% due to floods and 163.6% due to droughts. Similarly, per capita expenditure decreases due to storms, floods, and droughts 88.2%, 128.4% and 194.5%, respectively. This is entirely reasonable because Vietnam is an upward country from

agriculture, so agricultural, forestry and fishery production activities depend heavily on natural disasters. The study also shows that natural capital, human capital, financial capital, social capital and household characteristics positively influence the household income and expenditure per capita with statistical meaning at 1%. However, physical capital has a negative impact on the livelihoods of households. Also, studies have confirmed the regulator role of adaptive capacity in minimizing adverse impacts of disasters.

The findings in this study may suggest some policy implications. Natural disasters cause detrimental effects to households, but when they have the capability to adapt better then disasters will have less harmful effect on them. Therefore, the investment in human capital, social capital, financial capital and natural capital are essential.

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