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Variations in climate change adaptation among households of different ethnicities in mountainous areas of Vietnam

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Abstract

This study assesses differences in climate change adaptation among households of different ethnicities in two mountainous provinces in Northeast Vietnam. A structured questionnaire was used to interview 108 households of the Kinh ethnic majority and 182 households of various ethnic minorities, which were selected randomly. Results showed that the ethnic minority households relied on reducing expenditures, selling assets or on external support before adjusting their agricultural practices while the Kinh households tended to adjust their agricultural activities to adapt over the long-term, including both adjustments in agricultural activities and diversification away from agriculture. The main reasons for the ethnic minority households not to apply adaptive strategies were more closely linked to their perception and awareness of climate change rather than economic factors such as financial constraints, lack of technology or lack of information. Meanwhile, these economic factors were the main barriers to application of adaptive strategies for the Kinh households.

Introduction

Research increasingly shows the adverse impacts of climate change on people's livelihoods and the importance of adaptation strategies for people affected. Assessment of adaptive capacity and quantification of driving forces of adaptation would provide essential data to develop efficient coping and adaptation strategies to climate change (Adger, Huq, Brown, Conway, & Hulme, 2003). A lack of adaptive capacity leaves households defenseless and vulnerable to external shocks (Smit, Burton, Klein, & Wandel, 2000). Adaptive capacity is defined as "a vector of resources and assets that represents the asset base from which adaptation actions and investments can be made" (Vincent, 2007). Therefore, stakeholders with limited resources would have low adaptive capacity to climate change and require more attention in the field of risk reduction, impact mitigation and adaptation.

Vietnam has been ranked among the five countries which are most severely affected by climate change. The coastal and delta areas are normally affected by climate stimuli such as sea level rise, storms, floods, landslides and saltwater intrusion. Meanwhile, the mountainous areas are sensitive to natural disasters such as hoarfrost, droughts, storms, floods, and landslides. During the past decades, Vietnam has experienced considerable changes of climate. The annual average temperature has increased 0.5°C nationwide over the past 50 years. Temperatures in the north of the country have increased faster than those in the south and winter temperatures have increased faster than those of summer. Rainfall has become more erratic in almost all regions and annual rainfall has decreased in the north and increased in the south (Ministry of Natural Resource and Environment [MONRE], 2012).

In Vietnam, ethnic minority groups are usually linked to images of people being poor, disadvantaged, backward-thinking, dependent, and lacking knowledge (Institute for Studies of Society, Economy and Environment [ISEE], 2011). Despite government assistance policies and programs, ethnic minority groups have not benefited from the rapid national economic growth to the same extent as the Kinh-the majority

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group. While the national poverty rates have decreased significantly in recent decades, that rate remains high among the ethnic minorities. The ethnic minorities constituted less than 15 percent of the national population but accounted for 47 percent of Vietnam's poor people in 2010 (Tran, 2015). Most economic activities undertaken by the ethnic minority people are related to agriculture with high dependence on swidden agriculture. Other livelihood activities such as aquaculture and forestry collection also heavily depend on natural resources and are sensitive to weather and climate conditions. Due to these disadvantaged characteristics, the ethnic minorities in Vietnam are among the most vulnerable groups to climate change and climate variability, thus, the issue of ethnicity is important in the climate change debate.

There have been numerous empirical studies addressing vulnerability or adaptive capacity (Adger, Kelly, & Ninh, 2001; Below et al., 2012; Paavola, 2008), coping and adaptive strategies to climate change (Adger et al., 2003; Gentle & Maraseni, 2012; Makuvaro, Walker, Masere, & Dimes, 2018) and factors influencing adaptation at household levels (Deressa, Hassan, Ringler, Alemu, & Yesuf, 2009). Despite the numerous references on vulnerability and adaptation to climate change, those on specific vulnerable groups are limited. There has been little attention on ethnic minorities, one of the most vulnerable groups, and relatively little is known about the difference in adaptive capacity and adaptation between ethnic groups. Such research is essential to gain an insight into adaptation at household level and develop targeted policies for different ethnic groups in order to reduce vulnerability and well adapt to future climate change. This study aims to address these knowledge gaps by assessing the adaptation of different ethnic groups in the mountainous areas of Northeast Vietnam. A comparative analysis between the ethnic minority and ethnic majority group (the Kinh, who account for over 80% of Vietnam's population) was used to identify the main driving forces of the adaptation of each group.

Methodology

Study Area

Northeast Vietnam experiences a monsoon-influenced humid subtropical climate with dry winters. The average annual temperature is high (around 23°C) with a large number of sunny days. The coldest month has an average temperature of 16°Cand the hottest month has an average temperature of 28°C (General Statistics Office [GSO], 2017). Long periods of low rainfall make drought a common issue, particularly during the winter while the summer regularly experiences short heavy downpours, which result in landslides and flash floods. Tuyen Quang and Bac Kan were selected as the study areas because they are among the most vulnerable mountainous provinces to climate change in Northeast Vietnam. The two provinces are characterized by high incidence of poverty, low living standards, poor infrastructure, high dependence on agriculture and large proportion of ethnic minority residents in the population (Table 1).

During the past 10 years, these two provinces have been exposed to risks of yield losses due to mountain climate changes and variability such as temperature extremes, increase in average temperature but with widening gap between summer and winter, drought, increased incidences of flood, storm and hoarfrost, extreme decrease in rainfall during the dry season, and reduced predictability in rainfall. The average annual temperature and precipitation in these provinces have changed dramatically in the past 10 years (Figure 1).

Data and Methods

Data used in this study were collected from a household survey conducted in 2016. The household survey covered 108 Kinh households and 182 ethnic minority households. To ensure the credibility and representativeness, in each province, three communes were selected randomly from the list of those

Table 1 Socio-economic and physical characteristics of the study areas

Variable	Tuyen Quang	Bac Kan	Vietnam
Rate of poor households (%)	27.81	26.61	9.2
Contribution of agricultural sector to GDP (%)	26.17	34.15	15.34
Rural population (% of total population)	86.38	81.23	65.56
Ethnicity minority population (% of total population)	> 50.00	> 80.00	14.60
Agricultural land area (hectare)/% of total land area	540,405/92.10	459,705/94.59	27,284,900/82.37
Type of climate	Humid subtropical climate	Humid subtropical climate	Humid subtropical climate, Tropical monsoon climate, Tropical savanna climate
Average annual temperature (°C)	24.40	23.30	24.73
Average annual precipitation (mm)	1,484	1,235	2,115
Total sunshine duration per year (hour)	1,633	1,650	2,000
Serious climate hazards	Temperature extremes, drought, flash floods, hoarfrost, storm, changing rainfall patterns	Temperature extremes, drought, flash floods, hoarfrost, storm, changing rainfall patterns	Temperature extremes, drought, flash floods, hoarfrost, storm, changing rainfall patterns, sea level rise, landslides, saltwater intrusion

Source: Bac Kan Statistics Office (2017); GSO (2017); Tuyen Quang Statistics Office (2017).

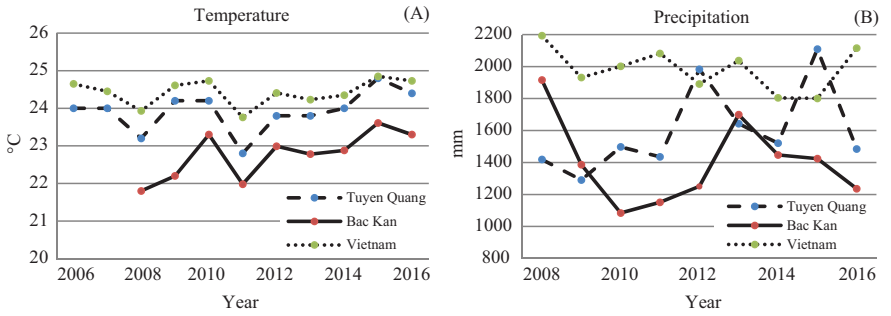

Figure 1 Variation of average annual temperature and annual precipitation in the last 10 years in the study areas
Source: Bac Kan Statistics Office (2017); GSO (2017); Tuyen Quang Statistics Office (2017).

being affected by climate hazards which had been defined through discussions with the local officials. In each commune, 17–19 Kinh households and 28–31 ethnic minority households were randomly selected. The survey instrument was then distributed to the selected farm households. The questionnaire covered aspects of households' adaptive capacity and determinants affecting adaptive capacity (Table 2). Besides, a rapid rural appraisal (RRA) and expert interviews were conducted to gain a deeper insight into the local context, personal characteristics of villagers and households' adaptive capacity and strategies. Through the interviews held with experts, including experienced farmers, extension staff and related local leaders, adaptation practices in the study areas were identified.

Based on literature review and discussion with experts, a set of 24 variables was used to evaluate determinants that shape the adaptive capacity of farm households (Table 2). Descriptive statistics were used to analyze the key characteristics of different ethnic groups.

Table 2 Variables determining adaptive capacity of the farm households

Determinants	Variables	Explanation	Code
Age	Age of hh head	Years	V1
Education	Education level of hh head	Number of years of education	V2
Farming experience, knowledge and skills	Participation in training programs	Dummy variable used to show whether the hh head has participated in training programs about agricultural extension	V3
	Farming experience	Number of years spent farming	V4
Extension service	Access to extension service	0 = No; 1/3 = Seldom; 2/3 = Occasionally; 1 = Often	V5
Labor	Farm labor supply	Number of working adults	V6
Farm size	Quantity of farmland	Area of paddy land and sloping land (in hectare)	V7
Assets	Farm animals	Farm animals per hh.	V8
	Durable consumption assets	Total value of durable consumption assets (in million VND)	V9
	Durable production assets	Total value of durable production assets (in million VND)	V10
Financial capital	Available hh savings	Available savings in the form of cash, bank deposits and jewels (in million VND)	V11
	Number of credit sources	Number of credit sources that can be accessed in case of need	V12
Social capital	Membership of associations	The number of registered associations belonged to	V13
	Safety nets	Number of hhs that can be turned to when in need of help during or after disasters	V14
Access to information	Access to information about risk and impacts of CC	Number of sources of information	V15
	Access to information about coping strategies and adaptation measures	Number of sources of information	V16
Income	Hh income level	Total hh income level (in million VND)	V17
	Income composition	Contribution of off-farm/nonfarm income source	V18
Perception of CC and related issues	Perception of symptoms of CC	Number of symptoms of CC perceived by hhs	V19
	Perception of causes of CC	Dummy variable used to show whether the hh head perceived that causes of CC are related to human activities	V20
	Perception of impacts of CC	Number of impacts related to CC perceived by hhs	V21
Market access	Distance to central market	Distance to central market (in kilometer)	V22
Wealth	Wealth level	Wealth level of hhs according to the list provided by the village leaders. Four categories: Poor, near poor, moderate and rich hh	V23
Nonfarm employment	Nonfarm employment	Number of persons employed	V24

Note: hh = household; CC = climate change.

Results and Discussion

Farmers' Experience and Perception of Climate Change

The surveyed households were asked if their lives and agricultural production had been affected by climate hazards during the past 10 years. Figure 2 shows that flash floods, floods and heavy rains were the three most serious climate hazards experienced by both the Kinh and ethnic minority households. Besides, both groups also experienced significant effects of other climate hazards such as drought or persistent sunshine trends.

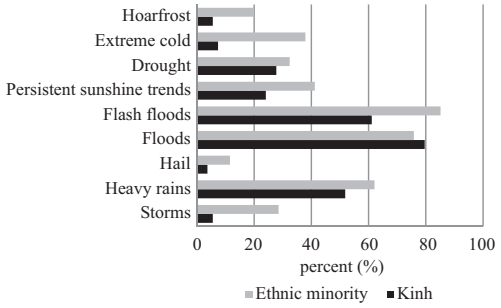

Figure 2 Climate hazards affecting farm households' lives

The Kinh households had a better perception of climate change issues in terms of causes, symptoms and impacts compared with the ethnic minority households (Table 3). The results indicate that 77 percent of the Kinh households were aware of the change in temperature and 58percent of them were aware of the change in rainfall in the region over the past 10 years, while those figures were 58 percent and 45 percent, respectively, for the ethnic minority households. There were many symptoms of climate change perceived by the households. The most common symptoms perceived by both groups were increased floods, persistent sunshine trends, increased summer temperatures and extreme cold. Most of the symptoms of climate change were frequently perceived by the Kinh households. In terms of causes of climate change, 78 percent of the Kinh households perceived that climate change was due to both natural causes and human activities such as deforestation, soil degradation or burning of fossil fuels, while this figure was 57 percent for the ethnic minority households. In addition, 11 percent of the Kinh households thought that climate change was caused only by natural changes in the environment and was not related to human activities, compared to 27 percent for the ethnic minority households. There was a small difference in the perception of impacts of climate change between the two groups.

Table 3 Farm households' perception of climate change, in percent of households

Perception	Kinh (n = 108)	Ethnic minority (n = 182)	χ^2 test
Awareness of climate change			
Awareness of change in temperature	76.85	58.24	**
Awareness of change in rainfall	58.33	45.05	**
Symptoms of climate change			
Increase in storms	55.56	48.90	
Increase in heavy rains	55.56	65.38	
Increase in hail	55.56	46.70	
Increase in floods	96.30	84.07	**
Persistent sunshine trends	90.74	79.67	*
Persistent drought	61.11	51.10	
Extreme cold	90.74	71.98	***
Increase in summer temperatures	90.74	76.92	**
Decrease in winter temperatures	87.04	79.12	
Increase in pests and diseases	87.04	74.17	***
Decrease in river flows	90.74	61.54	***
Causes of climate change			
No idea	1.85	8.24	*
Natural causes	11.11	27.48	**
Human activities	9.26	7.14	
Both natural and human causes	77.78	57.14	***
Impacts of climate change			
Change in varieties of crop and livestock	66.67	54.95	
Decrease in quantity and quality of crop and livestock	98.15	95.05	
Change in crop season	81.48	69.78	*
Increase in risk of pests and diseases	96.30	89.01	*
Change in livestock reproduction	70.37	70.88	
Increase in soil erosion	94.44	96.70	
Decrease in water sources	96.30	96.15	
Health problem	74.07	60.99	*
Increase in risk of fire	16.67	15.93	

Note: Significance tests refer to a χ^2 test of difference for binary variables: *$p < .10$. **$p < .05$. ***$p < .01$.

Adaptive Capacity

There was a significant difference in the adaptive capacity of Kinh and ethnic minority households (Table 4). The ethnic minority households' adaptive capacity was lower than that of the Kinh in terms of education level, participation in training programs, farming experience, access to extension service, durable consumption assets, available household savings, safety nets, access to information related to climate change, income level, perception of climate change, access to markets, wealth and employment. Less access to resources and information would limit their alternatives in selecting and applying strategies to adapt to climate change and variability.

However, the ethnic minority group was higher in farm labor supply compared with the Kinh households. The reason was because of the prevalence of early marriage and high birth rates among the ethnic minority people. In addition, as the ethnic minority households generally lived further in remote areas, they had a larger area of farmland, especially sloping land.

Coping and Adaptation Practices

Table 5 shows the different coping responses to climate hazards that were applied by the Kinh and ethnic minority households during and after climate hazards. Coping mechanisms related to reducing expenditures, selling assets or borrowing

Table 4 Adaptive capacity indicators for the farm households

Code	Variables	Kinh (n = 108)	Ethnic minority (n = 182)	Kinh as % of ethnic minority
V1	Age of household head	51.22 (10.93)	48.06 (11.85)	7 *
V2	Education level of household head	8.13 (2.94)	7.15 (3.57)	14 *
V3	Participation in training programs	0.85 (0.36)	0.72 (0.45)	18 *
V4	Farming experience	32.83 (11.54)	28.40 (11.76)	16 **
V5	Access to extension service	2.44 (0.63)	1.85 (0.75)	32 ***
V6	Farm labor supply	2.68 (0.95)	2.874 (1.20)	-7
V7	Quantity of farmland	0.90 (1.28)	1.10 (1.32)	-18
V8	Farm animals	3.04 (3.10)	1.68 (1.91)	81 ***
V9	Durable consumption assets	406.76 (386.36)	123.69 (192.25)	220 ***
V10	Durable production assets	7.44 (19.02)	5.66 (8.02)	31
V11	Available household savings	139.07 (191.63)	30.76 (97.09)	352 ***
V12	Number of credit sources	1.26 (1.31)	1.20 (1.23)	5
V13	Membership of groups or associations	2.35 (0.62)	2.08 (1.07)	13 *
V14	Safety nets	3.21 (0.66)	2.86 (0.69)	12 ***
V15	Access to information about risk and impacts of climate change	2.57 (1.22)	1.29 (0.85)	99 ***
V16	Access to information about coping and adaptation measures	2.24 (1.20)	1.27 (0.85)	76 ***
V17	Household income level	127.61 (91.34)	65.48 (82.96)	95 ***
V18	Contribution of off-farm income	45.65 (26.83)	46.56 (31.75)	-2
V19	Perception of symptoms of climate change	11.07 (3.01)	9.62 (3.59)	15 ***
V20	Perception of causes of climate change	87.03 (33.90)	64.29 (48.05)	35 ***
V21	Perception of impacts of climate change	8.19 (1.12)	7.88 (1.23)	4 *
V22	Distance to central market	2.68 (6.84)	5.76 (4.82)	-53 ***
V23	Wealth level (%)			
	Poor	5.56 (23.12)	15.93 (36.70)	-65 **
	Near poor	14.81 (35.86)	18.68 (39.08)	-21
	Moderate	38.89 (49.21)	55.49 (49.83)	-30 **
	Rich	40.74 (49.60)	9.82 (29.94)	315 ***
V24	Nonfarm employment	0.96 (1.05)	0.66 (0.94)	45 **

Note: Averages per household. Standard deviations in parentheses. Significance tests refer to a Student's t-test of the difference in means for continuous variables and a χ^2 test for binary variables: *$p < .10$, **$p < .05$, ***$p < .01$.

Table 5 Frequencies of coping practices, in percent of households

Code	Coping strategies to react to climate hazards	Kinh (n = 108)	Ethnic minority (n = 182)	χ^2 test
CS1	Selling consumption assets during the climate hazards	1.85	5.49	
CS2	Selling production assets during the climate hazards	0	3.30	
CS3	Selling consumption assets after the climate hazards	0	4.95	
CS4	Selling production assets after the climate hazards	0	3.85	
CS5	Borrowing money during the climate hazards	5.56	17.58	**
CS6	Borrowing money after the climate hazards	5.56	19.78	**
CS7	Reducing home consumption expenditures	9.26	51.10	***
CS8	Withdrawing children from school to reduce expenditures	0	2.20	

Note: Significance tests refer to a χ^2 test of difference for binary variables: *$p < .10$, **$p < .05$, ***$p < .01$.

money were more frequently exercised by the ethnic minority households. These coping practices would help the households offset threats in times of hardship due to climate hazards but could not guarantee an effective adaptation over the long-term. Some practices might even harm their livelihoods in the future (CS1 - CS4). These responses of ethnic minority households mainly resulted from a lack of options to cope with difficulties and risks during and after climate hazards, which was associated with a lack of resources.

In order to adapt to climate hazards and to mitigate their negative impacts, both the Kinh and ethnic minority households applied adjustments in agricultural and non-agricultural activities (Table 6). However, the Kinh households tended to make adjustments which helped them to adapt to climate change stimuli over a long time but required knowledge, experience or investments (AS1–AS15). Meanwhile, the ethnic minority group also adopted these practices but with a significantly lower frequency. These differences can be explained by the fact that the Kinh households had an advantage over the ethnic minority households in terms of education level, skills and financial resource. For instance, improving irrigation systems is an important adaptation measure that can considerably help mitigate the negative impacts of climate hazards, but this measure requires a financial resource to meet associated costs.

It should be noted that the risks to agriculture and food production created by climate variability encouraged households to shift their livelihood strategy away from agriculture. Income diversification by increasing non-farm income-generating activities and migration were frequently used strategies to live with climate change and variability among the ethnic minority and Kinh households. A convergence was found between these two groups in socio-economic adjustments regarding diversification beyond the farm and migrating to find jobs elsewhere, and this was mainly circular migration. However, these strategies were more frequently applied by the Kinh than the ethnic minority households. The collection of forest fruits, vegetables, bamboo shoots and other products was a wide-spread adaptive strategy of ethnic minority households (45%) when their agricultural production failed due to climate variations. Meanwhile, only 11 percent of the Kinh households applied this strategy to diversify their livelihoods because of their limited access to forests.

Noticeably, the ethnic minority households seemed to be relatively dependent on external assistance with 13 percent of them deciding to wait for external financial supports as a response to climate hazards and their impacts, while none of the Kinh households did so. Mountainous farmers in the North of Vietnam usually receive support in the form of cash or in-kind donations from the government, non-governmental organizations and individuals after the climate hazards. The quantitative data show that 23 percent of the ethnic minority households received such financial support while this was only seven percent for the Kinh.

It should be noted that a significantly larger share of ethnic minority households used indigenous knowledge in their adaptive strategies to climate hazards compared with the Kinh households. Forty-six percent of ethnic minority households used local resistant varieties of crops while that figure was only 17 percent for the Kinh. As responded by the villagers, the local varieties were used due to their suitability to local physical environment, adaptability to local agro-ecological

Table 6 Frequencies of adaptive strategies, in percent of households

Code	Adaptive strategies	Kinh (n = 108)	Ethnic minority (n = 182)	χ^2 test
	Adjustments in agricultural activities			
AS1	Change partially/fully from crop cultivation to livestock rearing	11.32	8.79	
AS2	Change partially/fully from livestock rearing to crop cultivation	24.07	8.24	***
AS3	Mixing crops	75.93	35.16	***
AS4	Crop rotation	33.33	23.63	
AS5	Switching to resistant crops	62.96	29.12	***
AS6	Switching to resistant varieties of crops	37.04	31.32	
AS7	Applying new techniques in crop cultivation	42.59	32.97	
AS8	Reducing chemical fertilizers and applying more manure/ organic fertilizers	9.26	8.24	
AS9	Changing cropping calendar	90.74	64.84	***
AS10	Soil conservation	5.56	3.85	
AS11	Improving irritation system	27.78	11.54	***
AS12	Switching to resistant livestock	5.56	3.85	
AS13	Applying water-saving, energy-saving and land-saving in livestock rearing	3.70	2.20	
AS14	Applying new techniques in livestock rearing	38.89	23.63	**
AS15	Diversifying foods for livestock Socio-economic adjustments and diversification beyond agricultural activities	85.19	46.70	***
AS16	Transfer to non-farm income-generating activities (petty trade, carpentry, handicraft, etc.)	48.15	35.16	*
AS17	Wage work outside of the commune (circular migration)	51.85	41.76	
AS18	Permanent migration to find a wage work	7.41	16.48	*
AS19	Collecting forest products	11.11	44.51	***
AS20	Waiting for support from the government	0	13.19	**

Note: Significance tests refer to a χ^2 test of difference for binary variables: *p < .10, **p < .05, ***p < .01.

conditions and their resistance to local climate extremes. Both groups also applied other adaptation strategies such as mixing crops, crop rotation or changing cropping calendar based on their traditional knowledge and their own experience.

Reasons for not Applying Adaptive Strategies

Figure 3 shows a significant difference in reasons for not applying adaptive strategies between the Kinh and ethnic minority households. The main reasons for not applying adaptive strategies among the ethnic minority households were not only related to economic issues, but also to noneconomic factors. It was surprising that the adoption of adaptive strategies of the ethnic minority households relied heavily on noneconomic factors such as culture, perception and personal characteristics.

A large number of ethnic minority households (38%) did not apply adaptive strategies because they found them unnecessary to apply. According to Fankhauser and Tol (1997), farmers' awareness of the necessity to adapt is the first important factor determining a successful adaptation to climate change followed by their knowledge about available strategies and the ability to employ the most suitable ones. Recognition of the need to adapt is closely linked to farmers' awareness of climate change and adaptation issues. In the study areas, ethnic minority households' knowledge and awareness of climate change issues were relatively limited (as presented in Table 3). In addition, compared with the Kinh, the ethnic minority people are generally considered more passive and dependent on external guidance and support rather than finding ways themselves to overcome difficulties. These characteristics somehow prevented the ethnic minority households from making adjustments or applying new technologies.

Another large share of ethnic minority households (20%) did not apply adaptive strategies due to their fear of risk and fear of change. In the context of climate-related hazards, they simply maintained traditional farming practices. This can be attributed to the long-standing farming practices and culture which are deeply rooted in the ethnic minority farmers' thinking. From the group discussions and expert interviews, it was observed that the ethnic minority people were relatively risk-averse and easily gave up. They are often conservative and reluctant to experiment by trying new farming technologies and taking the risk of losing everything, and easily give up if the new farming technologies are not immediately effective.

Lack of information on adaptation methods and technology was also a barrier for the ethnic minority households to the application of adaptive strategies. In the mountainous areas of Northeast Vietnam, training programs as well as extension services are held to provide farmers with the knowledge, technical advice and information they need to adapt to climate hazards. However, the ethnic minority households had less access to information related to changes in climate and adaptation measures compared with the Kinh (Figure 4). Most of the ethnic minority households accessed information through media communications such as television or radio, while the role of formal channels (training courses and extension services) was quite modest. Lack of finance and labor supply, and shortage of agricultural land were the next factors that hindered the ethnic minority households from applying adaptive strategies.

The results also show that for Kinh households, lack of technology (21%) and information (19%) were the most prominent barriers to application of adaptive strategies, followed by financial constraints, lack of labor and lack of productive land. Compared with the ethnic minority households, a significantly smaller share of the Kinh households explained that they did not apply the adaptive strategies because of the fear of risk and the concerns that the strategies would fail to deliver their expected outcome (12%) or because they found no necessity of application (14%).

Conclusion and Recommendation

This study examines the adaptation to climate change of different ethnic groups in Northeast Vietnam. Under different climate hazards, the Kinh and ethnic minority households had diverse responses and applied various adaptive strategies. The ethnic minority group was observed to rely on reducing expenditures, selling assets or external support before adjusting their agricultural practices while the Kinh households tended to adjust their agricultural activities to adapt over the long-term. This is because the ethnic minority households were more disadvantaged in almost all aspects of adaptive capacity compared with the Kinh, therefore, targeted policies for this group are needed to improve their adaptive capacity to climate change and variability. The policies to promote ethnic minority development can contribute to improving adaptive capacity of

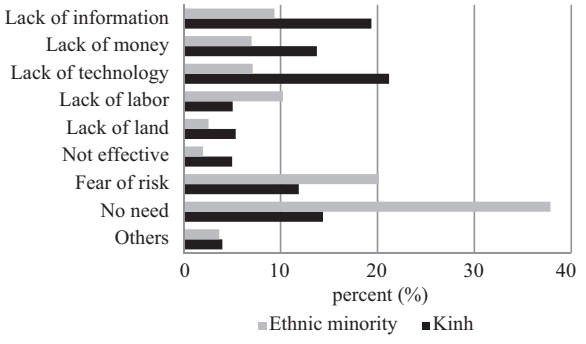

Figure 3 Reasons for not applying adaptive strategies, in percent of households

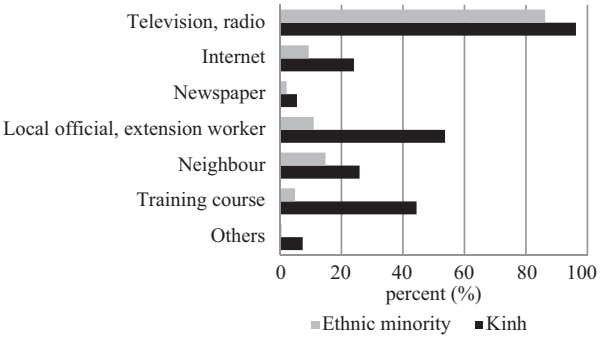

Figure 4 Source of climate change and adaptation information, in percent of households

the ethnic minority groups but cannot alone guarantee a successful adaptation to climate change. Policymakers should take into account the enhancement of knowledge and awareness to climate change issues for the ethnic minority people when designing policy instruments that aim at supporting their adaptation. Awareness building measures should be implemented before adaptive capacity building measures. Besides, indigenous knowledge should be integrated into the design and implementation of adaptation measures for farm households in mountainous areas.

Conflict of Interest

There is no conflict of interest.

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