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Adaptation to Flash Floods and Landslides of Rural Households in the Northern Vietnam: An insight into the key drivers

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Introduction

The Northern Mountainous of Vietnam is one of the most exposed areas to flash floods and landslides. These natural hazards are adversely affecting rural households whose livelihood subordinate primarily on agricultural production and natural resources. Among the Northern regions, Yen Bai province was one of the most hard-hit with many deaths and injuries triggered by flash flooding and landslides, and became unreachable due to storm caused floods. As recorded, there are 101 flash flood events and uncounted landslides in the mountainous regions of the country from 2006 to 2016 (MONRE, 2017). Consequently, losing crops, properties, and homes due to flash floods and landslides keeps many rural households in the regions trapped in a cycle of poverty (Marconi, Marincioni, & Tran, 2011).

In order to reduce farmers´ vulnerability and strengthen their livelihoods on the negative impacts of flash floods and landslides, adaptation measures should be taken. IPCC (2001) highlighted that adaptation is one of the crucial policy decisions that can significantly reduce vulnerability to climate change by making rural communities better able to adjust climate variability, moderate potential damages, and cope with adverse consequences. Farmers´ adaptation to climate variability has attracted a variety of researchers across different disciplines (Le Dang, Li, Bruwer, & Nuberg, 2014). As pointed out by Adger & Vincent (2005); Below et al. (2012) and Smit & Wandel (2006), it is necessary to have a better understanding of farmers´adaptation processes in order to pinpoint vulnerability individuals and develop well-targeted adaptation plans. In this context, by applying Multivariate Probit (MVP) model, this paper identifies the determinants of household´s choices as responses to flash floods and landslides and the barriers of farmers during their adaptation process.

Material and Methods

Data were collected from a household survey, conducted from February to April 2016 in Van Yen district, Yen Bai province. The total surveyed samples are 405 households in three commune namely: An Binh (154 households), An Thinh (105 households), and Dai Son (146 households). By using a detailed questionnaire for interviewing, the survey took roughly from 1 hour to 1.5 hours for

each respondent. The collected information consists of household profile, land use, access to irrigation, extension services, households´ income, adaptation options, and climate information.

In order to determine which factors influence on farmers´ adaptation choices, the MVP is employed in this study. The MVP has been used to pinpoint the determinants of farm-level adaptation strategies to climate change in different regions (Feleke, Berhe, Gebru, & Hoag, 2016; Nhemachena & Hassan, 2008; Piya, Maharjan, & Joshi, 2013; Yegbemey, Yabi, Tovignan, Gantoli, & Haroll Kokoye, 2013). The model includes a set of binary dependent variables A_1 and contains a set of household attributes as explanatory variables. The MVP is, then, shown as:

$$A_1 = \beta_0 + \sum_j \delta_j z_{1j} + k_1$$

Where: β_0 stands for the constant term; δ_j is the parameters to be estimated; z_{1j} stands for j farmers´ attributes such as age, education level, ethnicity, farm and non-farm income, access to irrigation, extension services, climate information and so forth; k_1 is error terms.

This research modeled adaptation behavior of farmers to flash floods and landslides by using discrete dependent variables with multiple choices. Five groups of adaptation strategies are classified based on the frequency of applying adaptation measures: change cropping pattern, crop diversification, use of different crop varieties, soil management and plant protection, and others.

Results and Discussion

Farmer´s ongoing adaptation responses to flash floods and landslides

Table 1: Adaptation options implemented by households in the research areas

Adaptation options	Percentage of farmers applying the option
Changing in cropping pattern	37,04
Crop diversification	51,36
Use of different crop varieties	81,23
Soil management and plant protection	86,91
Other adaptations	69,88

Source: Own calculation

Changing in cropping pattern has been applied by local farmers. For instance, in order to avoid landslides, instead of growing cassava like in the past, people now plant acacia and cinnamon on the hills. The survey results show that about 37% of total respondents changed their cropping pattern. This practice, in addition, brings higher income for the households. Crop diversification, also known as multiple cropping systems, is adopted by over half of interviewee (51,36%). Here we have some example for crop diversification in the study areas: In the past, farmers just cultivated two seasons of rice yearly, however, now they grow one more season of maize after gathering rice. Alternatively, in the hilly land, cassava is intercropped with cinnamon when cinnamons are small and have not spread. Changing crop varieties, adapted by 81,23% of the households, include for example varieties with shorter cycles or water resistant.

Furthermore, there are some policies undertaken by the local government to encourage farmers to alter the crop varieties such as farmers can buy at a lower price for varieties that promoted by the local authority. Among these strategies, soil management and plant protection are the most implemented (almost 87%). To improve the soil fertility and to limit the damage of pets, farmers in the study areas not only adopt mulching technique but also apply more pesticides, plant protection products, and fertilizers on their fields. Also, farmers who have fields next to the stream, in order to

avoid landslides, they also make embankments, weave stone baskets and plant bamboo trees to keep the fields from being a landslide and to prevent land erosion. Other adaptations consisting of changing land use, selling land/livestock/asset, receiving assistance from friends/relatives/government, and borrowing money have also been taken by local farmers.

Key drivers of farmers´adaptation strategies

The results of the adaptation model show that the MVP is highly significant (Wald chi2 (65) = 139.32; Log likelihood = -1050.1532; P > chi2 = 0.000). In addition, the Chi-square results of Likelihood ratio test are statistically significant at 1% (Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho32 = rho42 = rho 52 = rho43 = rho 53 = rho 54 = 0; chi2(10) = 49.2968; Prob > chi2 = 0.000) meaning that the equations in the model are connected and suggesting that the adaptation model have a strong explanatory power. The main factors determining the farmers´adaptation are the age of the household head, education level, ethnic group, household status (poor household), land ownership, farm size, access to irrigation, contact to extension services, distance to market, farm income, and climate information.

Table 2: Multivariate probit model of determinants of farmers´adaptation choices

Explanatory variables	Changing in crop pattern	Crop diversification	Changing in crop varieties	Soil management and plant protection	Others
Age of household head	0.18	-0.41***	0.11	-0.11	-0.08
Education	-0.15*	-0.03	0.02	0.07	-0.06
Ethnic group	0.36**	-0.26	0.40**	-0.33	0.13
Household status	-0.33**	0.07	0.13	-0.05	0.03
Land ownership	-0.04	0.40**	0.04	0.12	0.10
Farmsize	-0.07**	0.02	-0.01	0.11*	-0.03
Irrigation	0.28*	-0.21	0.06	0.15	0.31**
Contact extension	-0.06	-0.28*	-0.18	-0.26	-0.17
Distance to market	0.03	-0.10***	0.03	-0.03	0.03
Farm income	0.09	0.25***	0.13*	-0.01	-0.02
Non-farm income	0.02	0.00	0.05	0.04	-0.02
Access to credit	0.12	0.23	0.10	0.09	0.10
Climate information	0.56**	-0.03	0.09	-0.04	-0.08
Constant	-2.52*	2.27*	-0.87	1.66	1.03

Source: Own calculation

Barriers in adapting to flash floods and landslides

The farmers in the study areas were asked to classify obstacles that they are facing in adapting to flash floods and landslides. The most commonly identified difficulties affecting people are listed as follow: lack of capital, lack of machinery and technical equipment, lack of knowledge about flash floods and landslides, insufficient supports from local government, lack of weather information, shortage of labour in family, social and cultural barriers, and do not know what to do.

Table 3: Farmers ´difficulties in coping with and preventing flash floods and landslides

	An Binh	An Thinh	Dai Son	Average	P-value
Lack of weather information	40.91%	36.19%	34.25%	37.28%	0.473
Lack of capital	77.92%	58.10%	79.45%	73.33%	0.000
Lack of local government supports	40.26%	48.57%	40.41%	42.47%	0.339

Social and cultural barriers	16.23%	9.52%	45.21%	24.94%	0.000
Lack of knowledge about climate change	47.40%	46.67%	58.90%	51.36%	0.074
Lack of machinery and technical equipments	53.90%	46.67%	86.99%	63.95%	0.000
Shortage of labour in family	37.91%	23.81%	42.77%	35.89%	0.008
Do not know what to do	16.23%	28.57%	13.70%	18.52%	0.007

P-value according to Pearson´s chi-squared test

Source: Field survey, 2016

Conclusions and Outlook

The analysis results revealed that the most important factors to explain specific adaptation choices are the ethnic minority, farm income, and farm size. Besides, the age of household head, level of education, household status, irrigation, distance to market, and climate information also considered in influencing the farmers´ decisions to adapt to flash floods and landslides.

Consequently, investment in education systems, sufficient input supply at a reasonable price and assist in selling products can be considered as a solution in helping people adapt to adverse impacts of flash floods and landslides. Future policies should aim at promoting irrigation systems and providing information on climate more in time. Upgrading infrastructure such as roads should be taken into account to encourage farmers in adapting to flash floods and landslides.

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