Working Paper

Vulnerability and adaptive capacity of smallholders in Ho Ho sub-watershed, north-central Viet Nam

Rachmat Mulia, Bac Viet Dam, Delia Catacutan

World Agroforestry Centre

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About the authors

Rachmat Mulia is a statistician and modeller. He has a PhD from Montpellier University, France and more than 10 years' experience in modelling tree and crop interactions in agroforestry systems and analysing trade-offs between environmental services, household incomes and food security during land-use changes. He is currently analysing data of smallholders' vulnerability and the role of trees in livelihoods and environmental services and modelling simulations of river flow in central Viet Nam.

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Abstract

Climate change and variability create large uncertainties for agricultural production and smallholders' livelihoods. Understanding smallholders' vulnerability and their adaptive capacity to these factors is the key to appropriate interventions to mitigate the impact of climate-related shocks and hazards. In Ho Ho sub-watershed, north-central Viet Nam, smallholders reported a high degree of exposure and sensitivity to climate change and variability owing to the frequency of weather-related extreme events, such as flooding and drought, during the last decade (2005–2014), with a concomitant impact on households and agriculture. When comparing up- and downstream communes, biophysical factors such as topography, land-use patterns and the presence of a hydropower plant in the downstream commune played important roles in creating differences in exposure, sensitivity and adaptive capacity between the two communes. The results showed that while the upstream commune was not more vulnerable to weather-related extreme events compared to the downstream, its adaptive capacity was much lower, making the upstream generally more vulnerable than the downstream commune. We concluded that serious effects of climate change and variability during the last decade were experienced by smallholders in Ho Ho sub-watershed. We recommend that while enhancing the adaptive capacity of smallholders can include improvement both on- and off-farm, growing trees is a solution for improving both the landscapes and smallholders' resilience.

Keywords: Adaptive capacity, central Viet Nam, extreme weather events, sub-watershed, vulnerability

Acknowledgements

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1. Introduction

Climate variability and long-term changes has a diverse impact on the hydrology of watersheds through increasing the risk of floods, drought sand landslides and negatively affect agricultural production and human livelihoods (Devkota and Gwayali 2015). These effects will be felt mostly by the poor in rural communities, whose livelihoods are largely reliant on agricultural and natural resources (Chen et al 2013, Jamir et al 2012). Biophysical shocks and hazards caused by natural processes are usually intertwined with socio-economic and political ones (Dewi et al 2013a).

The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as 'the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and weather-related extreme events, and it is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity' (IPCC 2001). The term exposure refers to the 'nature and degree to which a system is exposed to significant climatic variations' whereas sensitivity is 'the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli'. Adaptive capacity is defined as 'the ability of a system to adjust to climate change (including variability and extreme events) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences'. Van Noordwijk et al (2011) stated that vulnerability depends on the buffering capacity of the landscape and its inhabitants as well as the intensity of a shock or hazard that might exceed the buffering capacity. While shocks or hazards cannot be controlled, potentially buffering capacity can be.

Depending on the study area, assessments of vulnerability range from global and national scales to the local, using qualitative participatory approaches (IPCC 2012). In order to capture the different aspects and complexities of vulnerability, both qualitative and quantitative approaches should be conducted.

In Viet Nam, some studies have already reported the impact of climate change and variability on multiple sectors (Asian Development Bank 2013). However, these studies were mostly conducted at the national level. A focus on local conditions, based on local knowledge, is rare (for example, Simelton et al 2015). Local perceptions of climate variability and extreme weather events include understanding the causes, characteristics and impact on livelihoods as well as the adaptive capacity and strategies of the people. Understanding local perceptions of vulnerability to climate change is the key to developing appropriate interventions for enhancing adaptive capacity of smallholders (Bhave et al 2013). Among different interventions, a long-term strategy that provides preventive measures, rather than survival efforts after a shock, is more effective (Dewi et al 2013b).

In this working paper, we present knowledge about the vulnerability and adaptive capacities of smallholders in Ho Ho sub-watershed, Ha Tinh province, north-central Viet Nam. Specifically, we compare the exposure, sensitivity and adaptive capacity of the smallholders in the up- and downstream areas of the sub-watershed. Our hypothesis was that owing to differences in biophysical conditions, such as topography, land-use mosaic and the presence of a hydropower plant in the downstream commune of the sub-watershed, the degree of vulnerability in the up- and downstream communes would be different and be reflected in local knowledge. We make some recommendations to improve local resilience to climate variability.

2. Location and method

2.1 Study sites

The Ho Ho sub-watershed (Figure 1) is located between 105°42’16.49” E and 18° 5’25.41” N within the administrative boundaries of Huong Khe district of Ha Tinh province and Tuyen Hoa district of Quang Binh province, north-central Viet Nam. The 2014 population was 10,000 people (equivalent to 3500 households). The average population density was 41.5 people per km^2 in the upstream (Huong Lam and Huong Lien) commune and 30.2 people per km^2 in the downstream (Huong Hoa) commune. The hydrology in the sub-watershed largely depends on two main rivers, namely Ngan Sau and Rao Boi, that flow across the sub-watershed. A dense stream system and high elevation in the upstream accelerate surface flow, especially in the rainy season between August and October.

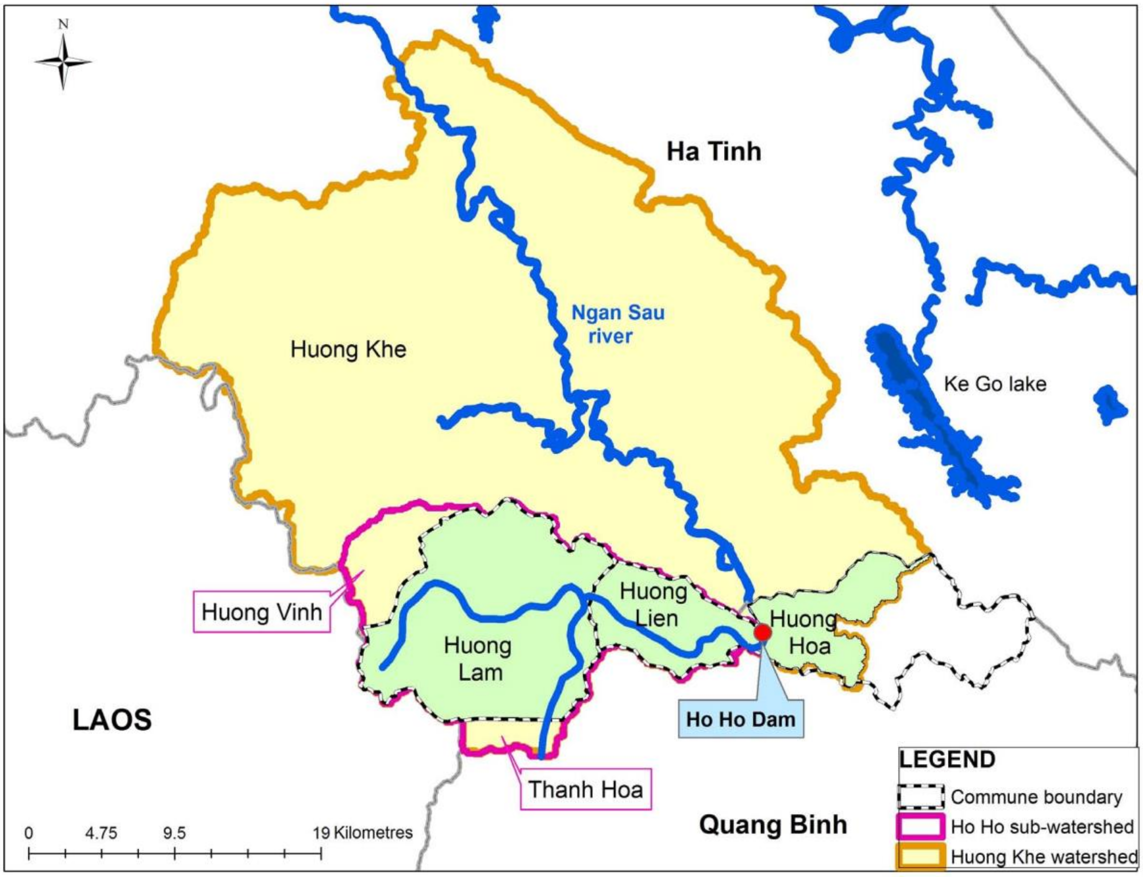


Figure 1. Location of Ho Ho sub-watershed in north-central Viet Nam

The sub-watershed is influenced by the tropical monsoon both in the summer and winter seasons. Summer generally starts from April to August with low humidity. In particular, the area is largely affected by a southwestern wind in June and July. Winter extends from November to March with the northeastern monsoon and rainfall. Based on the 1982–2011 weather data record of Huong Khe district obtained from the Institute of Meteorology, Hydrology and Climate Change, the average temperature in the area was 25 °C with 28.7 °C as the average maximum and 21.2 °C the average minimum. The average annual rainfall was 2500 mm. The rainy season falls between August and September with average total rainfall of 1425 mm, equivalent to 60 % of the region's annual rainfall. January and February are the driest months, with average total monthly rainfall of 96.6 mm. The topography of the sub-watershed is dominated by rivers and streams.

The study site includes two villages in Huong Lam (upstream commune) and three villages in Huong Hoa (downstream commune) of the Ho Ho sub-watershed. The village selection was preceded by consultation with district and commune officials to cover spatial variation in water scarcity and impact of weather-related extreme events, such as floods, drought, storms, cold spells and landslides. Since 2013, Ho Ho hydropower plant, located on the border of the middle and downstream communes, has provided electricity and irrigation for the downstream commune. Construction began in 2004 to intercept water flow from Ngan Sau River. The hydropower plant draws on 276 km^2 of the basin and features 2.35 $km^2$of reservoir. The average annual flow is 19.6 m^3s^{-1} with a full capacity of 38 million m^3. Estimated average annual electricity output is 54 million kWh.

2.2 Method

In our study, exposure was represented by the number of years in the last decade (2005–2014) the sub-watershed was affected by extreme weather events and the number of those occurrences. Sensitivity was measured by the number of affected households and plots of annual crops with wet rice ('paddy') and maize as the main annual crops. Adaptive capacity was measured by the size of the landholding, on-and off/non-farm income, years of schooling, number of family members and amount of savings.

Local knowledge of exposure and sensitivity to weather-related extreme events was captured through focus-group discussions conducted in 2014, with two separate female and two separate male groups in both the up- and downstream commune of the Ho Ho sub-watershed. Local knowledge was defined as 'a collection of facts that relates to the entire system of concepts, beliefs and perceptions that people hold about the world around them. This includes the way people observe and measure their surroundings, how they solve problems and validate new information. It includes the processes whereby knowledge is generated, stored, applied and transmitted to others' (FAO 2004). Each group consisted of five people to total 10 female and 10 male respondents per commune. The respondents were sampled from different villages in the communes and the groups were interviewed separately in the commune office to ensure independence between groups. Data for examining adaptive capacity were gathered through a household survey in 2014 that covered 100 households in the upstream and 100 households in the downstream commune. A stratified random design was applied to sample households from different villages in the communes.

3. Results

3.1 Exposure to extreme weather events

According to local knowledge, in the last decade storm occurrence was more frequent in the upstream than downstream commune (Figure 2a). An inverse trend was observed for landslides. Landslides were clearly more frequent in the downstream than the upstream. The presence of the Ho Ho dam likely induced more landslides in the downstream commune. For other extreme weather events, like drought and cold, no clear differences in occurrence was found between the two communes (Figure 2a). Locals reported slightly more frequent flash floods in the upstream commune.

In the upstream, on average, four flooding events occurred within the studied years (Figure 2b). This was almost double the frequency of floods in the downstream commune. More rivers in the upstream and their proximity to settlements most likely made more frequent flooding noticeable by smallholders. Storms and cold spells were reported to occur more often within a year in the downstream than the upstream (Figure 2b). Interestingly, although in the last decade landslides occurred more frequently in the downstream, the frequency within a year was higher in the upstream than the downstream (Figure 2b).

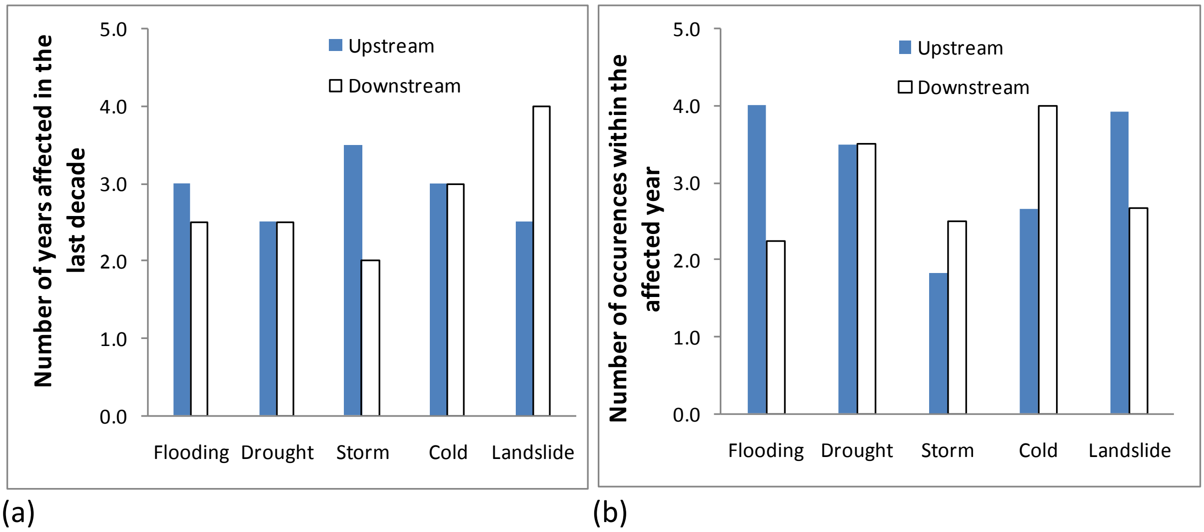


Figure 2. a) Years in the last decade (2005–2014) when extreme events occurred**;** and b) the frequency of occurrences within the studied years according to local knowledge

3.2 Sensitivity to extreme weather events

The effect of flash floods on households was reported to be more severe in the upstream than the downstream commune (Figure 3a). This is not surprising since flash floods occurred more often during the last decade and more frequently within a year in the upstream. Storms and landslides affected more households in the downstream than upstream (Figure 3a). For landslides, the presence of the Ho Ho dam likely induced a stronger impact on the downstream commune.

Flash floods and landslides caused serious damage to plots of annual crops in the downstream (Figure 3b). On average, about 82% (from landslides) and 70% (from floods) of the total area under annual crops in the downstream commune were damaged each time either event occurred.

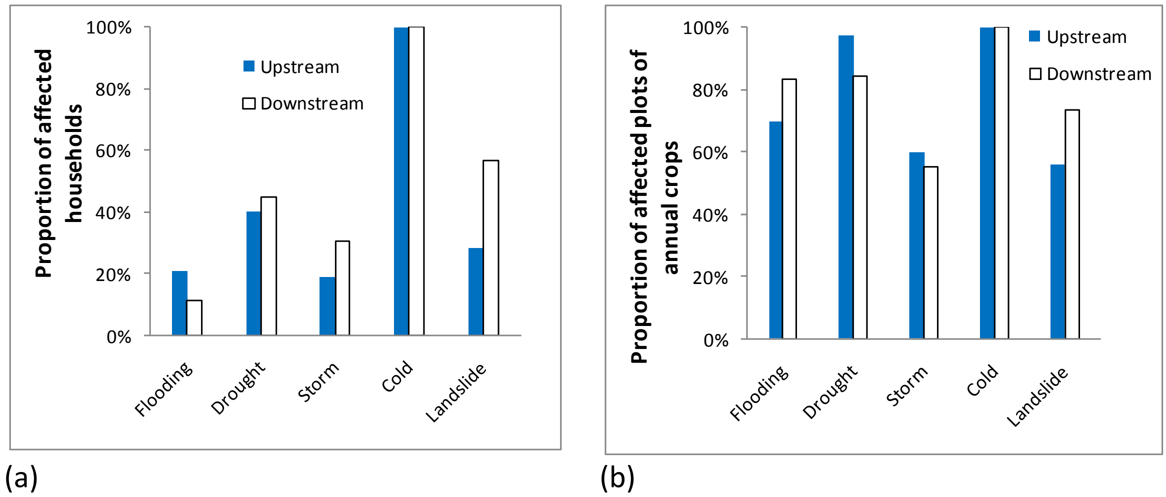


Figure 3. a) Proportion of households; and b) plots of annual crops affected by extreme events, according to local knowledge

3.3 Adaptive capacity to extreme weather events

Smallholders in the downstream commune cultivated more plots of wet rice and annual crops compared to those in the upstream (Figure 4a). The average number of plots of wet rice and annual crops per household in the downstream were 3.2 and 2.8, respectively, but were scattered in different locations of relatively small area. In terms of area, the dominant landuse was production or planted forest in the form of acacia plantation for pulp (Figure 4b). Both in the upstream and downstream, on average, the size of landholdings for production or planted forest was more than 1 ha per household (Figure 4b). For other land-use types, such as wet rice, annual crops and homegardens, on average, the size of the landholding per household was larger in the downstream than the upstream commune.

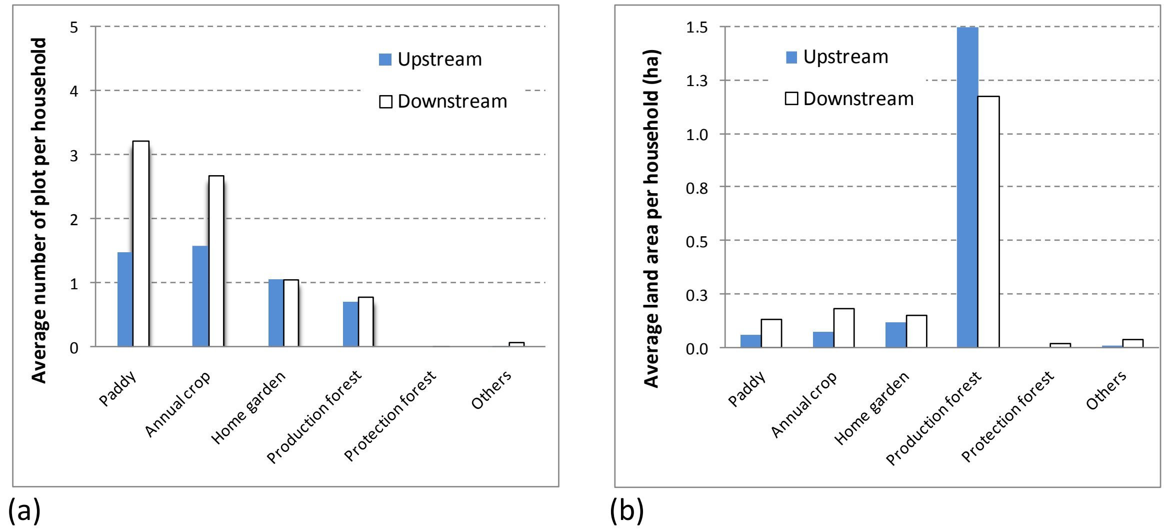


Figure 4. Landholding per household in the upstream and downstream communes in 2014 represented by a) the average number of plots; and b) average land size.

For smallholders in the downstream, the contribution to their incomes from annual crops and production forests was more significant than that from wet rice or homegardens (Figure 5a). Interestingly, although in terms of number of plots and land size, wet rice in the downstream was more dominant than in the upstream, income from wet rice was much lower in the downstream than the upstream. This was because the rice productivity rate in the downstream was lower than in the upstream, possibily owing to water shortages and a higher portion of production used for private consumption. Income from various off-/non-farm sectors was clearly higher, with more options available, in the downstream than the upstream (Figure 5b).

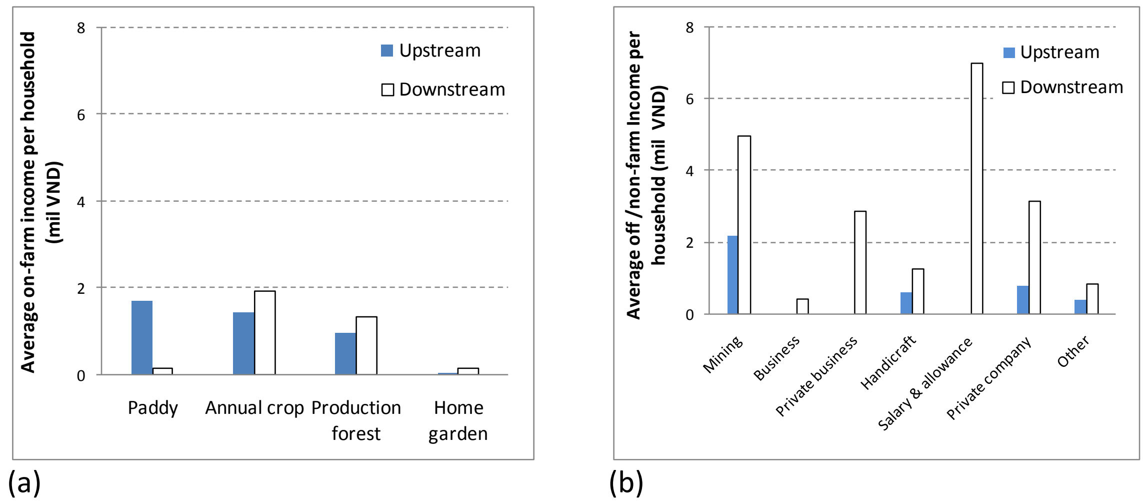


Figure 5. Average household incomes in the upstream and downstream communes in 2014 from various a) on-farm; and b) off/non-farm sources

In 2014, only 10% of the sampled households in the downstream had savings (Figure 6a). This included money saved as cash by individuals, with non-family members or in the local bank. In the upstream, the percentage was much lower (around 2%), most likely linked to lower annual incomes in this communes. In terms of education, on average, locals in the upstream and downstream both had about 7.5 years of schooling (Figure 6b). The average number of total household members was comparable between the upstream and downstream, with about four people per household (Figure 6c). The figure only takes into account family members living in the same house.

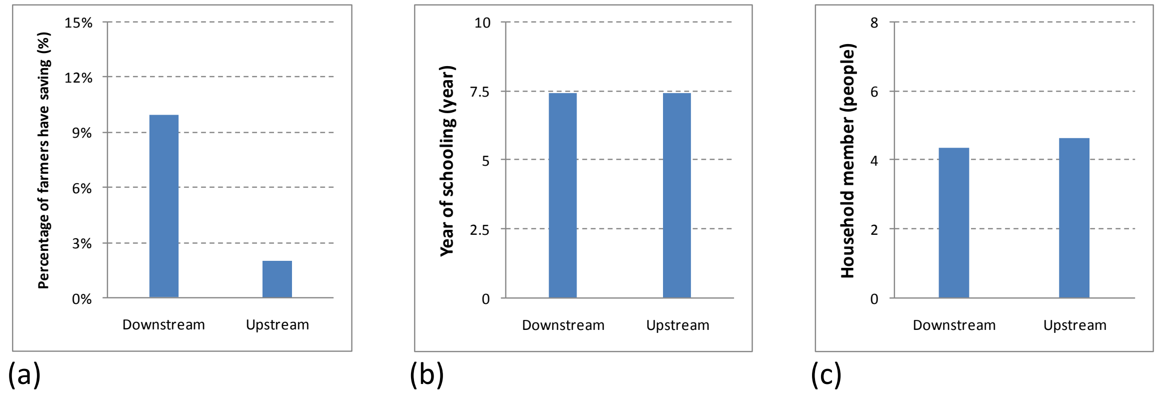


Figure 6. a) Percentage of smallholders with savings in 2014;b) average years of schooling; and c) total number of household members, based on local knowledge, in the upstream and downstream communes

4. Discussion

4.1 Impact of flash floods and landslides

Of all the extreme weather events, only flash floods and landslides wreaked differing impacts on the upstream and downstream communes. More rivers running through the upstream commune, at closer distances to settlements, affected more households through flash floods. Annual crops, however, were more affected in the downstream than the upstream commune, which was most likely related to the presence of the hydropower plant. The dam is situated at a higher elevation, about 75 m above the downstream land, and releases water to the commune for around seven hours per day in a normal season, through two turbines. During the rainy season, usually between August and October, heavy flow into the dam is usually managed by longer dam and turbine operation times but, nevertheless, the continuously strong flow out of the dam brings flash floods and landslides to households and plots of annual crops. Owing to the destructive effect of floods in both the upstream and downstream, locals generally cannot cultivate annual crops situated within 100 m of both sides of the riverbanks. Flash floods are also the main constraint to planting trees along riverbanks. Communication with key informants in the communes revealed that locals only see concrete construction as a way to overcome landslides along riverbanks.

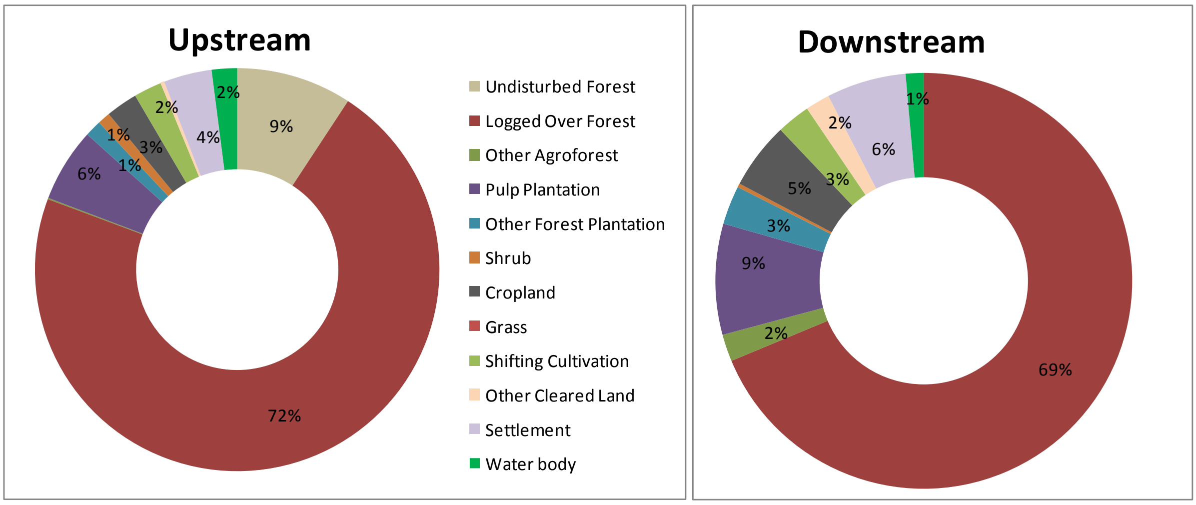
4.2 Adaptive capacity to mitigate impact of extreme weather events

Income, savings, education level and number of household members are four variables proportional to adaptive capacity. On-farm income from wet rice, other annual crops, production or planted forests and homegardens was relatively the same between downstream and upstream. Off/non-farm income, however, was higher in the downstream where jobs were more available. Most likely, this also contributed to the number of smallholders who had savings in 2014, which was about 10% and 2% in the downstream and upstream, respectively, of the total populations in the communes. Based on household incomes and savings in 2014, smallholders in the downstream commune had a higher adaptive capacity than those in the upstream.

4.3 Possible interventions to mitigate effect of flooding and landslides

Interviews with informants represented by commune/village leaders and representatives from the local Department of Agriculture and Rural Development as well as with smallholders revealed that the key to mitigating the effects of flash floods and landslides was to improve the quality of natural forests, especially in upstream. In 2014, the area of poor natural forests (logged-over forests) in the upstream and downstream were 72% and 69%, respectively (Figure 7a, b). Locals claimed that forest restoration was beyond their authority since natural forests were managed by a state body called Ngan Sau Forest Management Board.

Negotiation with the forest management board is critical, especially given plans to convert poor natural forests into monocultural acacia plantations rather than conserving the areas for forest restoration. A ‘payment for forest environmental services’ scheme is necessary, along with forest restoration, that involves the various stakeholders in the sub-watershed. Interviews with the Ho Ho dam’s management board also confirmed the need to restore upstream forests to mitigate the effects of flash floods and landslides. They also mentioned the need to plant trees along both sides of riverbanks. This, however, can be done following restoration of upstream forests since planting along riverbanks is not possible when severe flash floods still occurs during the rainy season, damaging areas within 100 m of both sides of the banks. A detailed land-cover analysis in Ho Ho sub-watershed can be seen in Nguyen et al (2015).



(a) (b)

Figure 7. Relative land-cover area in 2014, based on satellite images, in the a) upstream; and b) downstream communes

5. Conclusions and recommendations

Serious impact of climate change and variability during the last decade were experienced by smallholders in Ho Ho sub-watershed. Taking into consideration analysis of exposure and sensitivity data, we cannot conclude that the upstream commune experienced more frequent and stronger destructive impact of extreme weather events compared to the downstream but the adaptive capacity of smallholders in the upstream was much lower, making the upstream commune generally more vulnerable than the downstream.

Among other efforts to mitigate the impact and enhance resilience of smallholders to climate change and variability—such as increasing off/non-farm income—we would like to highlight the important role of trees in enhancing both the socio-economic and environmental resilience of smallholders in Ho Ho sub-watershed. Trees are important sources of longer-term and stable income and can modify micro-climates. At a larger scale, they improve environmental services in a landscape, such as the capacity to store water in soils. Communication with smallholders indicated enrichment with trees in poor natural forests as the main solution but planting trees in plots of annual crops and homegardens would also contribute to increased resilience to climate change and variability.

In other working papers, we will describe the use of a simulation model to assess the impact of forest restoration on hydrology in the sub-watershed and discuss a study that identified local knowledge ofthe role trees play in livelihoods and the environment, in both the upstream and downstream communes of the sub-watershed.

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