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ORIGINAL PAPER

Why do people not learn from flood disasters? Evidence from Vietnam's northwestern mountains

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Abstract This article explores how the causes and impacts of a flood event as perceived by local people shape immediate responses and future mitigation efforts in mountainous northwest Vietnam. Local flood perception is contrasted with scientific perspectives to determine whether a singular flood event will trigger adjustments in mitigation strategies in an otherwise rarely flood-affected area. We present findings from interdisciplinary research drawing on both socioeconomic and biophysical data. Evidence suggests that individual farmers' willingness to engage in flood mitigation is curbed by the common perception that flooding is caused by the interplay of a bundle of external factors, with climatic factors and water management failures being the most prominent ones. Most farmers did not link the severity of flooding to existing land use systems, thus underlining the lack of a sense of personal responsibility among farmers for flood mitigation measures. We conclude that local governments cannot depend on there being a sufficient degree of intrinsic motivation among farmers to make them implement soil conservation techniques to mitigate future flooding. Policy makers will need to design measures to raise farmers' awareness of the complex interplay between land use and hydrology and to enhance collective action in soil

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conservation by providing appropriate incentives and implementing coherent long-term strategies.

Keywords Flood response · Agro-environmental perception · Mitigation strategies · Interdisciplinary research · Vietnam

1 Introduction

Flooding is the most common environmental hazard worldwide and appears to be occurring ever more frequently around the globe, intensifying in some areas and also spreading into new regions (Douben 2006; IPCC 2007). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) predicts that the number of people affected by flooding worldwide will continue to rise from 13 million currently to a staggering 94 million annually in the course of this century; almost 80% of those affected live in disaster-prone areas in south and southeast Asia (Cruz et al. 2007 in IPCC; see also ADRC 2002). Apart from the loss of human lives and increased health risks, the impact of flooding on people's economic livelihood has also been a major issue, especially in rural areas, where agriculture and aquaculture together make up a high proportion of household income (Few 2003; Moench and Dixit 2004). A series of recent studies, especially in the flood-prone countries of Asia, have focused on understanding how local communities cope with flooding and the increasing risk of flood hazards (Phong et al. 2008; Shaw 2006; Paripurno 2006; Few 2003; Eakin and Appendini 2008; Kundzewicz and Kaczmarek 2000). Many of these studies point to a tendency to "live with the flood" rather than calling for costly engineering solutions, as has often been done in the past (Blaikie et al. 1994; Mileti 1999). However, the majority of cases concentrate on larger river basins and valley locations, while little scientific attention has been paid to mountainous regions.

Situated in the tropical monsoon zone close to the typhoon center of the Western Pacific, Vietnam is one of the most disaster-prone countries in the Mekong region. Floods are an almost annual event for people living in coastal and lowland regions and the central highlands of Vietnam. By contrast, they occur much less frequently in the northwestern mountains of the country, where in autumn 2007, the typhoon "Lekima" confronted people and local institutions with a flood of extraordinary dimensions, the like of which they had never previously experienced. In this mountainous region, the degradation of natural resources associated with deforestation and the intensive cultivation of annual crops on hill slopes are widely regarded as major factors that exacerbate runoff (Dung et al. 2008). These factors, together with increasing demand for water in agriculture and the complex irrigation systems created to meet this demand, substantially alter the hydrological cycle. In the past, several long-term development projects conducted by foreign donor agencies (such as GTZ or Action Aid Vietnam) as well as a long-term research project exploring sustainable land use practices had promoted an array of soil conservation and sustainable land use techniques. The success of these efforts was limited, however, reflected in low adoption rates and the frequent discontinuation of such practices when subsidies or other incentives were phased out (SFDP 2001; Saint-Macary et al. 2010).

Drawing on a case study conducted in one flood-affected commune, we explore to what extent the causes and impacts of an unusual flood event as perceived by local people shape immediate responses and future mitigation efforts and what lessons can be derived from this for future sensitization strategies and policy making. More specifically, the article seeks to answer the following questions: How did people perceive the flooding, what causal relations did they observe, and how did they assess the flood's impacts? How do these perspectives relate to a scientific analysis of the causes and effects of flooding? What lessons can be learned for the future regarding mitigation and risk minimization? In order to find answers to these questions, we present findings from an interdisciplinary research team composed of agricultural and environmental scientists, development economists, and rural sociologists.

The remainder of this paper is organized as follows: In Sect. 2, we briefly describe the context in terms of the nature of floods and their influence on the agro-environment and the rural population. In Sect. 3, we provide details of the research area and the flood event, followed by a description of the interdisciplinary methodology and conceptual framework in Sect. 4. Section 5 discusses local stakeholders' perceptions of the causes and impacts of the flood and contrasts them with scientific explanations. Moreover, in this section, we identify coping strategies and behavioral changes among local people aimed at addressing future flood events. We discuss our results in light of other authors' findings in Sect. 6 and conclude with some policy implications in Sect. 7.

2 Excess water, anthropogenic interpretation, and interference

Flooding is something of a catchall term, referring to an array of events varying in magnitude and underlying causes. As a physical event, floods vary greatly depending on geography, onset, velocity, and flow dynamics (Parker 1999). Handmer et al. (1999) put together a typology of flooding comprising overflow of rivers produced by prolonged seasonal rainfall, rainstorms, snowmelt, and dam breaks, accumulation of rainwater in low-lying areas with high water tables or inadequate storm drainage, and intrusion of seawater onto the land during cyclonic or tidal surges. Most broadly, a flood can be described as "too much water at a certain location within too short a time." Analogous to the perception of water as *too much*, otherwise irreplaceable water needed for household consumption and agriculture becomes excess water, endowing the word with the meaning "something to get rid of" (Blaikie et al. 1994).

Heavy rainfall is deemed the most common cause of floods. Magnitude, speed of onset, and duration of the flood are—among other factors—influenced primarily by topography, river course and alteration, vegetation, and soils. Different kinds of soil coverage affect the permeability of ground surfaces and the water buffer capacity of the soil, and alter runoff rates significantly (Chaplot et al. 2005; Dung et al. 2008; Pansak et al. 2008; Valentin et al. 2008). Anthropogenic interference is a major factor in altering hydrological characteristics. Land use changes, such as forest conversion into intensive types of agriculture, have been considered a primary factor in this respect (Bruijnzeel 2004). In south and southeast Asia, due to increased drought periods and the necessity of an increase in cropping seasons to nurture growing populations (Cruz et al. 2007), the area of irrigated agriculture is also steadily increasing. Local irrigation systems are often poorly maintained, which leads to an accumulation of sediment deposits and reduced water buffer capacity; this exerts an additional negative impact on the hydrological characteristics of a catchment.

More than any other environmental hazard, floods bring losses as well as benefits (Smith and Ward 1998). Particularly in agriculture, flooding is by no means regarded as a hazard of solely negative consequences. Beneficial side effects—such as refilling reservoirs used for irrigation, leaching salts and toxins off the soil and nutrient deposition—are acknowledged in many influential studies (e.g., Zhang et al. 2003). It is crucial to recognize this two-faced nature of flood effects. The meaning of harm and benefit has a subjective component and thus varies between places and individuals (Hewitt 1997). Few (2003 p. 46) notes that the recognition of subjective and thus varying perceptions "helps explain why many residents of developing countries take an ambivalent attitude toward flood events, and partly underpins the logic of policies of 'living with floods' rather than attempting to prevent them through large-scale engineering interventions."

Another major cognitive factor determining how people deal with floods and what conclusions they draw for future flooding is what causes people attribute to it and—conversely—what role people attribute to their own actions in terms of influencing the scope and dimension of the flood. This perspective is rooted in the attribution theory of motivation (Heider 1958; Weiner 1974, 1986). From the attribution theory perspective, the way people perceive the causal relationships and impacts of a flood and explain them by attributing responsibility to themselves, to others, or simply to "destiny," will make them conclude how influential their personal abilities and efforts might be in the future mitigation of similar events, thus influencing their behavioral responses (Baldassare and Katz 1992). For example, people who believe their land use practices have a direct impact on the area's hydrology are more likely to undertake direct action to prevent or mitigate such impacts.

Measures aimed at tackling the impacts of flooding can be divided into actions taken before, during, and after the flood event. Actions before the event are commonly denoted *preventive*, actions during it are called *emergency interventions*, and actions after it may be called *reconstruction* or, more precisely, *adaptation* (Lebel et al. 2006). Seminal papers that have studied people's coping strategies make a distinction between "structural" and "non-structural" responses to flood (e.g., Smith 2004). The former generally refers to engineering interventions, such as river canal modifications and reservoirs designed to control the flow of rivers or dams to restrict the spread of flooding. The latter have gained greater prominence as structural measures have proven limited; they refer to measures designed not to prevent floods but to reduce their impacts (Smith 2004). Some examples of non-structural responses are the declaration of polder areas with adapted land use, vegetation that increases soil infiltration, water governance closely geared toward local conditions, and improved insurance schemes, to name but a few. A range of studies report increased attention to non-structural flood reduction at the community and household level (e.g., Eakin and Appendini 2008; López-Marrero and Yarnal 2010; for SE-Asia, e.g., Hoang et al. 2007; Phong et al. 2008).

3 Mountainous northwestern Vietnam in October 2007

The study was carried out in the commune of Chieng Khoi, Son La province, which is located on a mid-level plateau at an altitude of approximately 350 m a.s.l., between a steep mountain range and the valley of Yen Chau, where the district capital of the same name is located (Fig. 1). The flat plateau is used exclusively for paddy rice (*Oryza sativa* L.) cultivation, mainly for farming families' own consumption, while the peripheral upland fields on the steep hill slopes (up to 86% of the total area) are planted with various annual crops, with a major emphasis on maize (*Zea mays* L.) as a cash crop partly intercropped with cassava (*Manihot esculenta* Crantz). Fishponds for aquaculture play an important role in the availability of proteins for human consumption, with almost each household having at least one fishpond. With both its topography and current land use, the structure of the commune is typical of the wider area. Chieng Khoi is one of 13 communes in the district and comprises 6 villages with a total of 2,885 people (Yen Chau People's Committee

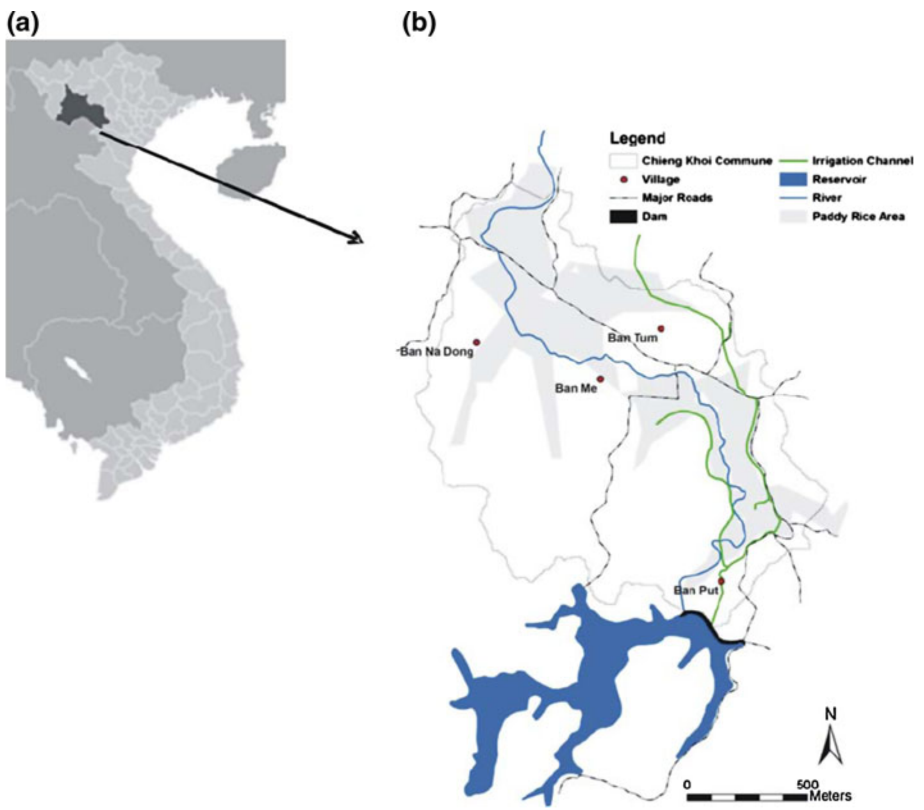

Fig. 1 **a** Location of Son La province in Northern Vietnam. **b** Overview of the Chieng Khoi catchment. *Source*: Modified after Lamers et al. (2011) and Schmitter et al. (2010)

2006). The area is inhabited largely by people belonging to the Black Thai ethnic group, with settlements having a history of several 100 years.

The 800 ha watershed studied has an average annual precipitation of 1,200 mm (average 1998–2007) and is located in the tropical monsoon belt, characterized by a rainy season from April to September (Fig. 2). Taking into account the total rice crop area of 60 ha, the water required for an entire rice crop period in Chieng Khoi amounts to 1.0×10^6 m^3. Long-term weather data recorded close to Chieng Khoi reveal that average precipitation during the spring and summer crop season is 360 and 650 mm, respectively, thus accounting for only about 30 and 50%, respectively, of the amount of water needed.

In order to meet the high demand for water, a reservoir was built between 1962–1968 by damming up a stream that originates from the nearby karst mountains. The height of the main dam was increased at one point in the mid-1970s, with a later extension of two smaller dams that turned the original river into an artificial lake. This now endows Chieng Khoi relatively well with water resources for irrigation and pond water supply. Irrigation water from the lake supports two rice crops per year, with the first crop (mainly irrigated) grown from February to May ("spring crop") and another—mainly rain-fed—crop from

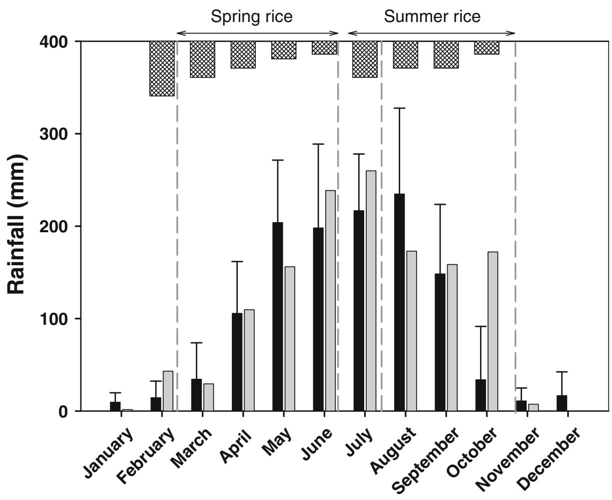

Fig. 2 Comparison of the rainfall distribution for 2007 (*dark gray bars*) and average (1998–2007) rainfall (*black bars*) during the two rice crop seasons (spring and summer crop) in Yen Chau. *Source*: Modified after Schmitter et al. (2010). *Note*: Standard deviation of the rainfall from 1998 to 2007 is given by *error bars*. The *cross hatched bars* indicate the water requirement, where the height of the bars represents the high to low water requirement classes during rice cultivation

July to October ("summer crop") (see Fig. 2). A spillover controls the water level and feeds the old river from the mid-rainy season onwards as an additional source of irrigation for paddy areas in the lower part of the catchment (see Fig. 1b, upper part). In normal years with precipitation amounts and distributions around average, the lake can buffer large amounts of water from the upper catchment and release or store it in a controlled way.

The degradation of natural resources through accelerated deforestation and intensive cultivation of annual crops often leaves hill slopes bare and unprotected in the winter season from late September to March, exacerbating surface runoff and underscoring the importance of the lake as a buffer for water storage and controlled release. This seasonal problem gained momentum in the course of the national reform policy *doi moi* ("renovation"), which started in 1986, when land titles were allocated to households and deforestation activities on upland plots were intensified in order to create space for farmland (Sikor and Truong 2002; Ward and Trimble 2004).

A major flood hit Vietnam in October 2007, caused by typhoon Lekima, which triggered 3 days of intensive rainfall. While flooding is regarded as a more or less chronic disaster phenomenon in the two deltas of the Mekong and Red River and in the central part of the country, it rarely happens in the mountainous northwest of Vietnam, where rainfall triggered by Lekima caused the biggest flood within living memory. The attention of the international press and foreign relief work was focused on the central provinces of Ha Tinh and Quang Binh, where there was a human death toll of 71 and more than 70,000 residential houses were destroyed (Vietnam News 14/10/2007); little attention was paid to the situation in the uplands in northwestern Vietnam. Apart from the unusual amount of rainfall and the intensity of the event, it was also its off-seasonal occurrence that surprised people (Fig. 2). According to the damage report compiled by the Yen Chau district administration, Chieng Khoi Commune was among the four most severely damaged communes (Yen Chau People's Committee 2007).

4 Interdisciplinary approach to data collection and analysis

Investigating flooding poses a particular challenge in the mountainous regions of northern Vietnam, where complex ecological, economic, and socio-cultural conditions determine and influence each other, as outlined in Sect. 2 and depicted in Fig. 3. Traditional disciplinary boundaries needed to be expanded and bridged in this respect. First, researchers from hydrology, crop and soil science, economics, and rural sociology are involved in an interdisciplinary approach where interactions between disciplines range from jointly formulating hypotheses to harmonizing methodology and carrying out joint data analysis. Second, local farmers' perceptions and their intimate knowledge of the environment are brought into the picture and compared with the research findings. And third, interaction was actively sought with national research and policy implementation institutions, extension services, and local authorities.

In June 2007, a weather station (Campbell Scientific, Inc., USA) was installed in the center of the Chieng Khoi catchment. The weather station provides data on air temperature, relative humidity, solar radiation, wind speed, and precipitation. In direct proximity to the spillover of the reservoir, water heads are measured continuously in the natural stream by means of automatic pressure sensors (ecoTech, Bonn, Germany) (Lamers et al. 2011). The water heads are converted to flow rates using stage–discharge relationships determined by means of the velocity–area method (Herschy 1995). Furthermore, the effect of flooding on rice production was investigated by measuring soil fertility and rice performance on fields

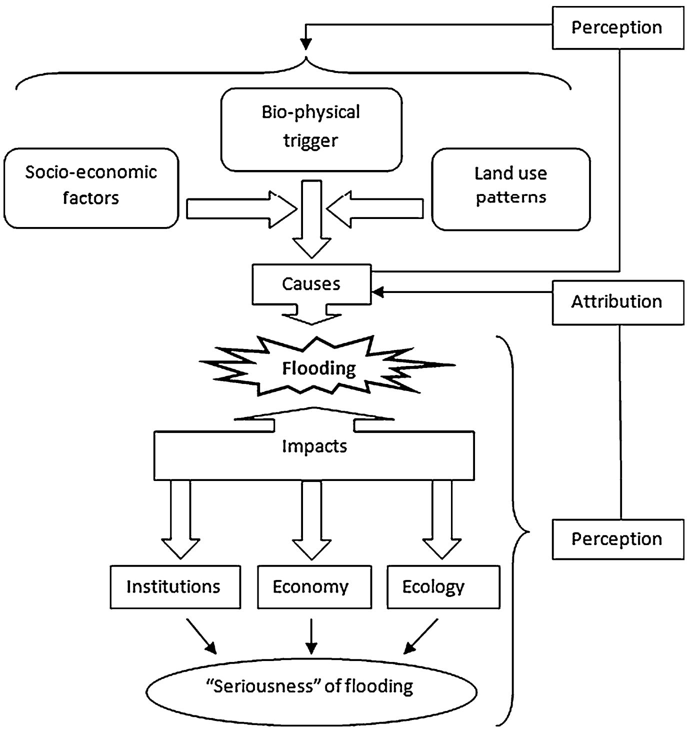

Fig. 3 Biophysical, economic, and social factors to be considered in studying causes and effects of flooding

situated close to the river and compared with non-flooded fields. A more detailed overview of methods used can be found in Schmitter et al. (2010).

The microeconomic consequences of the flood were assessed using a dataset constituted from a survey of 300 randomly selected households throughout Yen Chau district and an additional sample of 36 households situated in Chieng Khoi. Households in Chieng Khoi were selected in order to allow a merging of data with the aforementioned crop science and soil science research and thereby increase upscaling capacity. Selected households manage paddy fields that are located within two villages—Ban Put and Ban Me (see Fig. 1)—where a substantial number of households' fields were affected by the flooding. While the survey did not directly focus on farmers' risk coping mechanisms, its implementation in four separate rounds in 2007–2008 enabled researchers to add several questions assessing household level consequences of the flood in the last survey round (conducted a few weeks after the Lekima rainfall). Results of this quantitative part of the data collection are described in Sect. 5.5.

For the qualitative part of the social research, respondents were selected by purposive sampling with the aim of representing the perspectives of the whole range of stakeholder groups at the household, village, and commune level, i.e., flood-affected households, village and communal authorities, and administrative staff beyond the commune level. Data collection for this part of the study comprised two stages: The first involved a series of qualitative research methods, such as semi-structured interviews (16 in total) and focus group discussions (5 in total), supported by ranking exercises and risk mapping in order to examine modes of governance of excess water as well as perceived causes, preventive measures, impacts, and responses to the flood at household and community levels. In the second stage of the research, a local assistant speaking the local dialect asked another 10 members of flood-damaged households and 2 key representatives of the village management board to write narrative essays on any aspect of the flood they regarded as important. This information was cross-checked with that obtained in the interviews, to see whether any important aspects had been left out in the first stage of research. All events were recorded, translated into English, and transcribed, followed by qualitative data analysis supported by the use of MAXQDA software.

Table 1 provides an overview of the types of data collected for the purpose of this study and links it to the respective subsections of the results part.

5 Flood perceptions and governance: local perspectives and scientific findings

5.1 Institutions of water management and flood handling

The communal water governance system—known locally as *muang-fai*—of the Black Thai in Chieng Khoi has developed over centuries and represents a technologically and socially sophisticated setup.[1] In the Black Thai society, the *muang-fai* was traditionally chaired by the *Liep (Nam) Na*, a water manager whose responsibilities included coordination of the construction of weirs and canals and their maintenance. While disaster prevention and risk

[1] The *muang-fai* system, common among most Thai/Tay groups in the northern uplands of Vietnam, Thailand and Laos PDR, is used on fast flowing streams, across which weirs (*fai*) are built. The *fai* holds back water and directs it into major and minor canals (*muang*) in which gates control flow rates. The way *fai* are built allows water to pass through and over the barrier while restricting the rate of flow sufficiently to raise the water level.

Table 1 Type and use of data

Origin of data			Use of data corresponding to results subsections					
	Discipline	*Type of data*	5.1[a]	5.2[b]	5.3[c]	5.4[d]	5.5[e]	5.6.[f]
Bio-physical	Hydrology	Water flow characteristics		■				
Bio-physical	Hydrology	Weather data		■				
Bio-physical	Crop/Soil science	Soil fertility				■		
Bio-physical	Crop/Soil science	Rice performance				■		
Socio-economic	Development economics	Household survey (336 households)					■	
Socio-economic	Rural sociology	Semi-structured interviews	■	■	■	■		■
Socio-economic	Rural sociology	Group discussions			■	■		■
Socio-economic	Rural sociology	Farmer essays			■	■		■

[a] Description of water and flood management structures

[b] Hydrological explanation for the flood event

[c] Local explanations for the causes of the flood event

[d] Facts and perceptions of agro-environmental impacts

[e] Impact of flood on household economics

[f] Local responses and coping strategies

mitigation were not explicitly assigned to any of the legal bodies, responses to any damage caused by floods were coordinated by the *Liep Na*, who was authorized to solicit sufficient labor from each household.

Since the agricultural collectivization in the 1970s when new economic and administrative units were formed, the traditional institutions of water governance have undergone major changes (Neef et al. 2006). As a consequence, the position of the *Liep Na* was either abandoned or integrated into the new management boards on different administrative levels, the so-called *Ban Quan Ly*. After the de-collectivization process in the mid-1980s, the village management board emerged as the decision making and executive institution responsible for most social, political, and agro-economic issues at the village level. Despite maintaining the strict top-down hierarchy, in which the local authorities are obliged to follow recommendations made at higher levels, the management of water systems remained relatively autonomous (Neef et al. 2006), with the village headman setting priorities in water system maintenance activities and serving as head of the respective *Ban Phong Chong Lut Bao*, translated literally as "disaster committee" (see Fig. 4).

The completion of the Chieng Khoi dam in 1975 and the laying out of the reservoir accelerated the formation of more pluralistic water governance structures. The Provincial Department for Irrigation created the position of the "lake manager" under its direct supervision. Together with his two coworkers, the lake manager represents the provincial level in communal water affairs, bringing in an additional layer of hierarchy, as Fig. 4 illustrates. The lake management team consists of residents of places other than Chieng Khoi, with less developed contacts within the local villages, thus estranging the locals further from their traditional involvement in water management. The major duties of the lake manager are to follow the weather forecast and adjust water management accordingly,

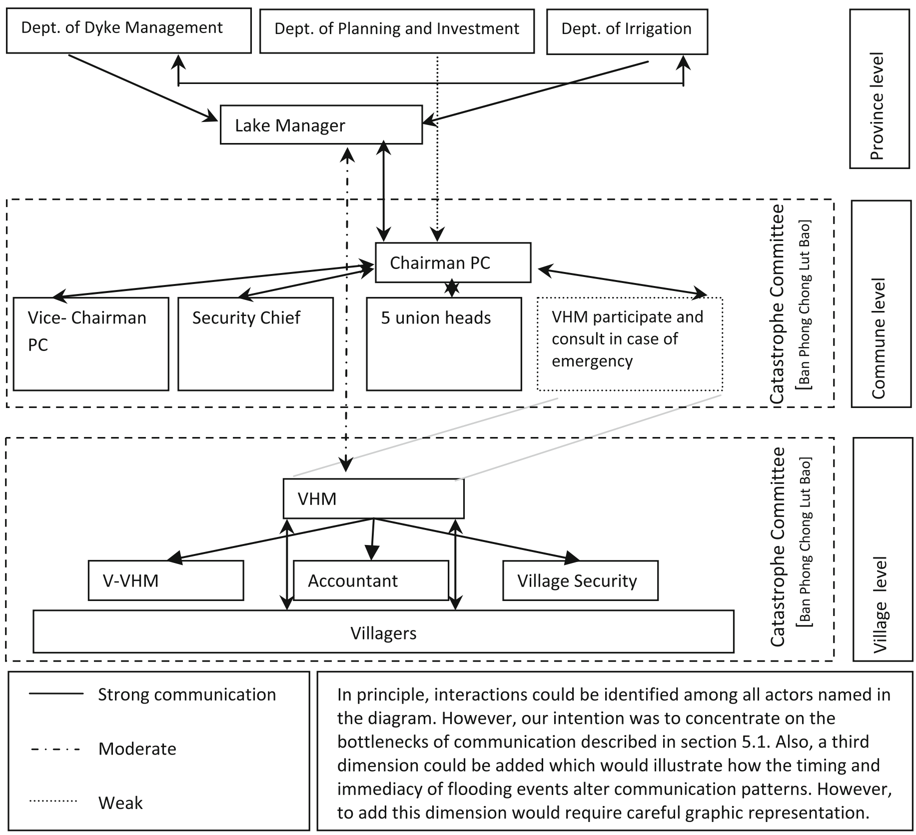

Fig. 4 Water governance and institutions involved in coping with the flood

to measure the water level on a daily basis, to regulate the water outflow of the lake, and to maintain and repair the lake's infrastructure, particularly the dam. A contract between the user villages in Chieng Khoi and the provincial department for irrigation determines moderate fees for irrigation water. 40% of this money is given to the lake management team as remuneration and 60% is used to maintain the communal *muang-fai* system. The communal chairman decides on how much water is fed through the canals and allocated to farmers' fields. Villagers can request larger allocations or suggest a different timing that allows them to participate to some degree in water management decisions.

One major institutional innovation has been the establishment of a department of dyke management, flood, and storm control at the national level, with provincial branches and disaster management units. Its primary duties include the annual stipulation and implementation of disaster mitigation plans down to communal level. Although these plans do not go beyond allocating responsibilities in case of hail or flash flooding, this appears to indicate a growing concern about disasters and also formalizes the terms of reference for all members of the *Ban Phong Chong Lut Bao*. Along with the new department, a disaster relief fund system was implemented in 2001. Its objective is to provide quick loans for reconstruction, both to communities as well as to individuals (Lebel et al. 2006). Each citizen has to contribute an annually variable but relatively low fee on a mandatory basis.

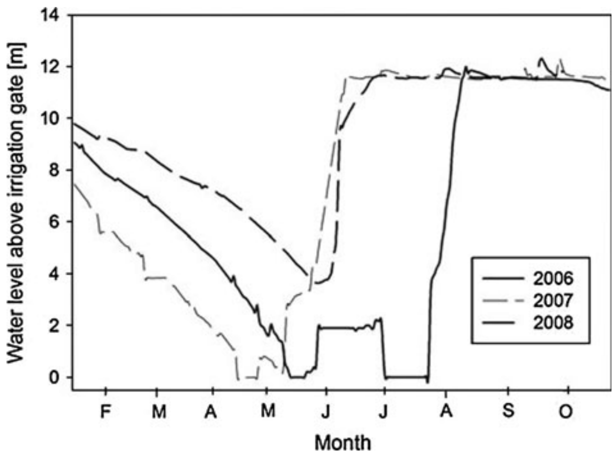

Fig. 5 Water levels of Chieng Khoi reservoir measured for the years 2006, 2007, and 2008

5.2 Hydrological explanation for the flood of 2007

The usual seasonal fluctuation of the reservoir level is determined mainly by the annual precipitation pattern. Typical water level patterns for the reservoir are depicted in Fig. 5. In general, the reservoir level declines continuously throughout the dry season, reaching its annual minimum in May. With the onset of the rainy season in May/June, incipient rain events yield to a rapid refilling of the reservoir within a few weeks. Throughout the rainy season, the water level of the reservoir remains fairly constant. Runoff from the reservoir to the receiving stream is triggered once the reservoir water level exceeds about 11.9 m, which is the critical level at which unregulated outflow is initiated by means of spillover. However, 2006 was an extraordinarily dry year so that the reservoir did not refill until the end of July. Therefore, the lake manager decided to pile up sandbags at the spillover "in order to store additional water for the dry season because I [the lake manager] recognized that water levels have steadily decreased over the past years" (interview with the lake manager). This was done in consultation with both higher (Department of Dyke Management) and lower level (Communal PC) bodies, although the final decision was taken by the lake manager under consultation of his coworkers.

In early October 2007, a series of meteorological events created unprecedented and unforeseen flooding along the Chieng Khoi catchment. On October 4th, a rainfall event occurred as a result of the typhoon "Lekima" with a duration of 36 h and an amount of 165.8 mm with intensities reaching 20 mm h^{-1}. Prior to this rain event, the reservoir was already filled to a level of 11.5 m, that is, only 0.4 m below the critical control level. As preceding rainfall events earlier that month had already saturated the soils surrounding the reservoir, most of the water drained directly into the reservoir as overland flow (Fig. 6).[2]

As a consequence of the intensive rainfall pattern, the water level of the reservoir rose at the rapid rate of 2.5 cm h^{-1}. About 24 h after the onset of the rain event, the reservoir water exceeded the critical level of 11.9 m, initiating overflow of the spillover. Within a

[2] It is worth noting that this amount of rainfall is equivalent to five times the average monthly rainfall in October.

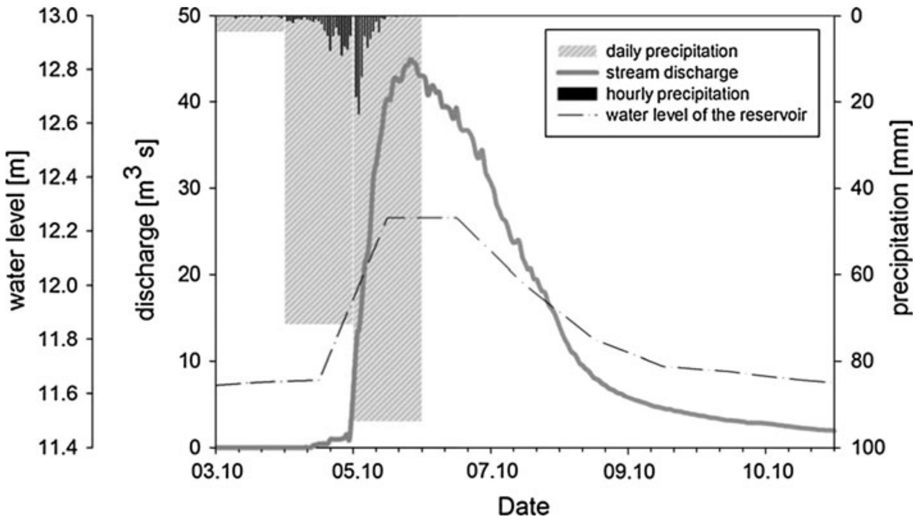

Fig. 6 Daily and hourly precipitation, water level of the reservoir, and stream discharge recorded in Chieng Khoi catchment during typhoon Lekima

period of 24 h, the stream discharge rose sharply from less than 0.5 $m^3\ s^{-1}$ to a maximum of 45 $m^3\ s^{-1}$, causing one of the biggest flood events within the local living memory.

5.3 What triggered the event from the local people's point of view?

For ordinary people in Chieng Khoi, the flooding meant that water from the river and irrigation canals inundated rice fields and fishponds and eventually damaged residential areas, as well as flushing high quantities of sediments into the fields. The flood was triggered by what people described as "bad rain," given its duration, intensity, and amount. A further criterion was its timing: At the end of the rainy season, the lake is usually filled up and there is little space left to buffer and store additional water, which in turn would require the lake manager to release water through the spillover gate. In the farmers' point of view, the more water the soil can absorb, the more rain is desired. Absorption capacity is observed to have decreased over the past few years, a fact that locals attribute to intensifying deforestation, which started from the mid-1980s onwards. Villagers' sound understanding of this causal relationship is manifested in an argument expressed in one farmer's essay: "When it rains a little and soil moisture increases, it is good for the crop. But if it rains too heavily, top soil from the upland fields will be washed away because there are now fewer forests and perennials than in the past, so the water-holding capacity of the soils in upland fields has been reduced. For this reason, top soil will be easily washed away when there is heavy rain and it will harm agricultural development. So what was 'good' rain in the past might be considered a 'bad rain' today."

The flooding took people by surprise, although all interview partners who own a TV stated they had heard about the irregularly high rainfall in the weather forecast at least 1 day in advance. Most interviews in the study area confirmed that people underestimated the warnings because "the weather is so diversified in the northern mountains of Vietnam, and the forecast is never really precise. Also, in October we do not get rain, and if it does happen, it is usually only a little" (a farmer in an interview). Nevertheless, the flooding was attributed by the locals to general weather changes causing irregularities in rainfall amounts that are observed to have gained speed over the past 10 years. All commune level representatives interviewed stated that heavy rain occurring later than September would almost automatically have disastrous impacts on people's livelihoods, if abundant precipitation occurs within a short time only, given the lake would be full by then and excess water cannot be drained off in a controlled manner.

However, the majority of farmers interviewed attributed partial responsibility for the flood to mismanagement on the part of the lake manager. The accusations were even stronger in the narrative essays, which is particularly remarkable in the Vietnamese context, given that written opinions are more likely to be regarded as "sensitive" than in non-socialist southeast Asian countries (Scott et al. 2006). Farmers accused the lake manager of not having followed the weather forecast, as well as not having taken seriously recommendations from the Department of Dyke Management to preventively increase the buffer capacity of the lake by discharging water through the spillover. All village headmen in Chieng Khoi agreed with this view when the interviewers confronted them with their fellow villagers' opinion. A lack of experience owing to his young age was thought to have determined the lake manager's perceived failure in preventing the flood.

The lake manager, by contrast, identified the meandering of the river—which is mainly caused by the construction of fishponds and which he believed had narrowed the stream artificially—as the main reason why draining unusually high amounts of water accelerated the flooding. Hence, in contrast, the examples of lake management in two neighboring communes revealed that in both cases, the lake managers decided to dam up the water and that not unloading the sandbags helped to prevent major damages. Although this is an effective and commonly practiced tool for storing additional water, past experiences like the dam breaks in the Red River Delta following the major flooding in 1975 have proved the risks of this measure (CCFSC 2006).

The reduced capacity of the lake due to sediment accumulation is considered another important factor in the inability to buffer flash floods, something recognized only by the lake manager and a few individual communal officials. Following the initiative of the former, a meeting was held with communal officials and the village headmen in early March 2008 on "the future of the lake." Together with his assistants, the lake manager proposed to restrict cultivation of annual crops around the lake and suggested planting "economically attractive perennial crops such as rubber trees or pineapples" (the lake manager) as promising options to prevent erosion and induced sedimentation into the lake and maintain economic benefits at the same time. Moreover, he proposed to use the dry winter season to dig out sediments from the lake in order to increase water buffer capacity for the next season.

However, these suggestions appear to be in sharp contrast with his fatalistic stance toward flood mitigation: "Every year, the commune announces a plan to prevent flooding [the "disaster mitigation plan", as introduced under 5.1] but when it really comes to a strong rain, you can forget about the plan and we cannot do anything" (the lake manager). The lake manager moreover predicted that, as a consequence, the intervals between flood events will be reduced and economic damages will increase as a consequence of further population growth and a lack of economic alternatives to intensive upland fields use.

5.4 Facts and perceptions of agro-environmental impacts

As Schmitter et al. (2010) have shown that the flooding had both short and long-term impacts on the agro-environment. The rice yields of the flooded fields were 5% lower in

Table 2 Effects of sedimentation/erosion in different agricultural contexts

Characteristics	Paddy area	Fishponds	Upland fields
Chemical	Varying fertility indicated by color, granulation, field position	Fish may die because of sediments loaded with agrochemicals	Loss of fertility
Physical	Harmful to plants in March/April and August/September	Fish may die because of reduced oxygen in water, siltation of ponds	Shrinking layer of topsoil may result in loss of arable land
Management	High labor requirements in very short time	Fast reconstruction in many cases only feasible using expensive machinery	Leveling of rills and ditches

the summer season compared to the yields obtained in the same fields during the spring season earlier that year when no flooding occurred. In addition to these direct effects of flooding on rice cultivation, soil fertility parameters were altered, which can affect rice cultivation adversely on the long run. Total nitrogen and soil organic carbon were decreased by 40 and 24%, respectively, after the flooding occurred. Alongside the decrease in soil fertility, the deposited sediments found on the flooded fields were dominated by sand. Increasing the sand fraction by 41% alters infiltration on these fields and has impacts on water use efficiency regarding irrigation practices during rice cultivation. However, when soil fertility is reduced drastically by infertile sedimentation, fertilizer application in succeeding rice crop seasons needs to be increased in order to meet the rice requirements of the households.

During the flooding, several fishpond dykes broke and the water level of the river rose beyond the neighboring ponds, causing significant losses of fish. All respondents unanimously regarded the loss of fish after pond inundation, the damage to rice plants in paddies close to the river and to irrigation canals, and infrastructure damage as severe. Yet, whether sedimentation—mentioned as the most important impact of flooding during several ranking exercises within group discussions—was beneficial or harmful, was a matter of lively debate among the interviewees. Paddy field owners agreed that a modest amount of sediments can have fertilizing effects on the paddies, with the fertility depending on the origin of the sediments. Table 2 provides a summary of the various impacts discussed by the farmers.

Controversy arose during group discussions when farmers debated the hydrological effects of soil conservation techniques such as the permanent re-greening of upland areas on the occurrence of flooding. Some believed that the amounts of excess water would decrease, reducing flood events, while others felt the only effect was the reduction in sediment transport and deposition. A similar perspective was presented by the deputy head of the communal People's Committee after he was asked whether the perennial greening of upland fields might alter the impacts of future heavy rainfall. While he stated that amounts of excess water would remain the same, he was sure "soil flooding" (as locals referred to sediment-loaded runoff water) would be reduced. It was common sense that heavy rainfall causes loss of topsoil on sloping fields and transports sediments to lower parts of the catchment. While farmers referred to upland plowing as enhancing erosion, they held that zero tillage was impossible since it would "cut yields by half at least and double labor requirements for weeding" (interview with a village headman).

Table 3 Yield losses due to the flood

	Yen Chau sample ($n = 300$)				Chieng Khoi sample ($n = 36$)			
	Number HH[a] negatively affected	Harvest loss (%)	Min (%)	Max (%)	Number HH[a] negatively affected	Harvest loss (%)	Min (%)	Max (%)
Paddy rice	8	20.8	6	40	2	25.5	21	30
Upland rice	1	10.0	–	–	0	–	–	–
Maize	17	14.5	1	50	1	10.0	–	–
Cassava	0	–	–	–	1	20.0	–	–
Fishpond	15	72.0	30	100	4	52.3	0	99

[a] *HH*, Sample household

5.5 Flood impact on household economy

Economic consequences of the flooding on the household economy were addressed during structured interviews with farmers a few weeks after the flood. Farmers' responses suggest that there was only little damage at an individual household level. Of all the households interviewed in Yen Chau, 16% stated they had suffered negative effects from the floods, compared to 17% of farmers among the Chieng Khoi sample. Most damages occurred on agricultural production in general and on fishponds in particular (Table 3).

In total, there was little direct damage to household incomes: those who were affected in Yen Chau declared a 6.4% loss on annual cash income on average and those in Chieng Khoi a 3.3% loss. This corresponds to 1.5 million VND (about 95 USD) and 0.9 million VND (about 56 USD) for an average household income in Yen Chau and Chieng Khoi, respectively. While the losses are substantial in absolute terms, they are not likely to have a long-term consequence for households' livelihoods.

The figures appear surprisingly low at first glance, given the strength of the flood and its exceptional character as perceived by the farmers themselves. An initial explanation is given in Fig. 7, which shows that the typhoon occurred after most farmers had already harvested their maize fields. Maize is by far the most important source of cash income for farmers in the district, accounting for 65% of annual cash income on average in Yen Chau (27% in Chieng Khoi). Based on these results, we expect that the flood would have incurred higher losses, if it had occurred a few weeks earlier. The contribution of paddy rice to annual income is more difficult to estimate as most of the production is used for home consumption. Nevertheless, despite the occurrence of the flood before the main harvest of paddy rice, the yield was not greatly affected. Regarding damage to fish production, the effects on household finances were minor, as selling fish contributes only a moderate share to overall incomes. The loss of animal protein for household consumption was not taken into consideration by locals.

In sum, our data indicate that the flood only had a limited impact on household incomes and consumption. In contrast to these findings, the damage reports collected from commune and district departments show that significant damage occurred to public infrastructure, which affected communities more than individuals (Yen Chau People's Committee 2007).

5.6 Local responses and non-responses

The quick onset of the flood prevented people from taking action that may have reduced the spread and penetration of flood waters through physical means. Instead, emergency

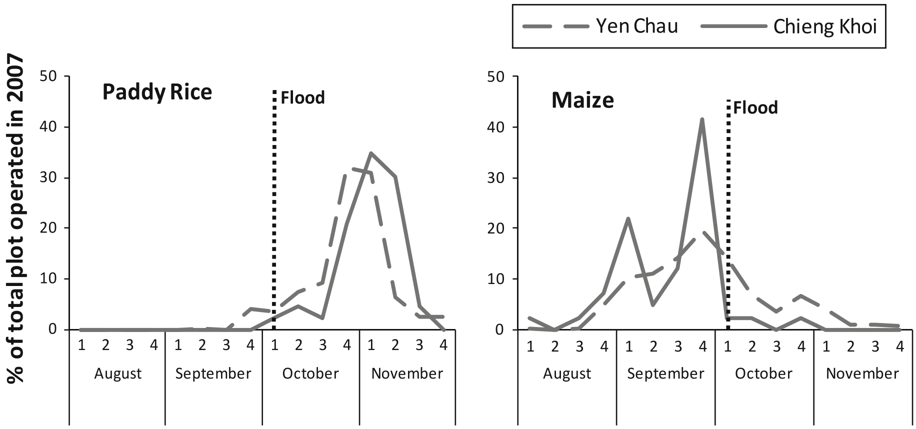

Fig. 7 Harvest timing of paddy rice and maize—rainy season 2007

interventions concentrated on protecting public infrastructure, such as community houses and bridges. A compilation of private and public damages conducted by the village disaster committees marked the initiation of reconstruction activities. The survey method differed throughout the villages between individual reporting and group appraisals. After transmission to the communal People's Committee and some 20 spot checks of farmers by delegates of the commune, a general assessment report was forwarded to the district administration. Reconstruction of streets and public buildings was started right after the flood by the communal PC, which authorized village headmen to mobilize labor and reconstruction material as well as money needed to recover damages within the village from village resources. Each household had to contribute one person to work for an indefinite period of time on the reconstruction of streets and major irrigation canals. Required materials, especially wood and bamboo, were obtained from community forests, while in one village, each household that owned a section of forest had to contribute a specified amount of material.

Physical recovery measures had to be done without support from any institution beyond the communal level. District authorities' efforts concentrated on restoring traffic infrastructure around the district capital and national road No. 6 to Hanoi. In one group discussion, the farmer participants even accused the Department of Dyke Management of directing commune officials not to engage in these issues so "farmers are just on their own; even the communal officials do not find enough time to care for the villagers any longer." Hence, the farmers' considerable frustration was targeted at the national disaster fund, which did not put any support at the communes' disposal. Moreover, people from Chieng Khoi criticized the fund's non-transparency in terms of the allocation of money and its final use. In a group discussion with three senior villagers who had witnessed the flood of 1975, assumptions were expressed that the fund money was more likely to be given to central and economically more influential provinces. It was stated that even a small contribution might "make us recognize the state remembers us" (a farmer during a group discussion). The rapid appraisal and conciseness of the damage report raised expectations that there may potentially be compensation available. The spot checks of delegates from the commune further fuelled hopes for financial assistance, although the national press did not make any promises or intimations of damage compensation. The single concession to farmers was the remission of the irrigation water fee for the spring rice crop in 2008.

In sum, respondents at the village level lamented an overall lack of support—both in terms of resources and expertise—from the administration side, while the little assistance provided showed a clear tendency toward restoring the pre-flood conditions rather than helping to adapt to future flood risks. The momentum of increased risk awareness that might have been used to work out land use maps of flood-prone areas or to re-integrate farmers into water governance schemes was largely wasted. Minor changes, like the conversion of some fishponds into rice fields to prevent fish loss in case of future flooding, were driven by private initiatives and confined to a few cases only.

6 Discussion

Flood prevention and mitigation are perceived mainly as a public concern rather than an issue the individual can address. Rather than encouraging individuals' engagement in flood adaptation as an inherent property of the social and ecological geography of Chieng Khoi, a combination of public interventions in the region's hydrology and growing institutional pluralism has substantially estranged farmers from water governance and their sense of personal responsibility within it. The shift of local power to higher levels in particular, arising from the introduction of the lake manager's position, has reduced the accountability of local people in water governance and, as a consequence, induced a withdrawal from community action.

Apart from some village elders that witnessed the last comparably severe flood incidence in 1975, it was the first time for most people in Chieng Khoi to suffer flooding of such seriousness. The recent history of the area does not provide evidence of how to prepare for flooding and handle its incidence. Experience is likely to alter perceptions of the necessity to undertake preventive measures, as Keller et al. (2006) assert. According to Baldassare and Katz (1992), direct experience not only affects how individuals learn about and perceive risks but also influences their behavioral responses. In our particular case, evidently, individual potential to exert influence on flood mitigation is superimposed by the common conviction among farmers that flooding is caused by the interplay of a bundle of external factors, with water management failures being the most prominent one. The majority of locals concluded the rainfalls, which were regarded as unusual in terms of intensity and duration, struck the area at an "inconvenient" time, where "inconvenience" referred broadly to the limited buffer capacity of excess water at that time of the season. The overall problem of structural inadequacies in the engineering of irrigation and drainage, however, and the need to alter land use systems were only acknowledged by higher level authorities. Those who ascribe the flood to management failures (external attribution) are less likely to recognize their own potential influence on flood mitigation than those few locals who credited their land use systems and top soil management (internal attribution) with having favored or intensified the flooding. These findings correspond with scholarly work that applied attribution theory to behavioral responses to flooding (Griffin et al. 2008; Grothmann and Reusswig 2006). Additional support can be found in Slovic's (1987) thesis that (mal-) attribution of a singular event experienced can lead to risks and individual influence on it being misjudged. Following his thesis, once individuals have determined an assessment of a particular risk (and the factors by which it is triggered), their opinions can prove difficult to change; this can help explain the seemingly paradoxical phenomenon that direct experience of a disaster can exert a negative influence on the response or willingness to adapt to future ones (cf. Botterill and Mazur 2004).

On the conceptual side, the use of attribution theory outside its original field of learning motivation research proved its usefulness in understanding that people's short and long-term reactions to a flood event are heavily influenced by their understanding of causal relations. It was shown that due to the reasons ascribed to the flooding, the majority of people do not consider land use systems as having any substantial impact on the severity of flooding. It needs to be recognized that each individual or organizational actor behaves entirely rationally under the given administrative and incentive structures. By taking into account the way in which people estimate their own options and abilities to prevent future flooding, along with the effectiveness of these options, one can get a much clearer picture of why people do not make any significant changes in their land use practices. Instead of a prolonged discourse on long-term adaptation measures—with altering land use systems and soil conservation at its center—discussions within the local community revolved around management failures and the lack of preventive actions on the officials' side (Hoang et al. 2007; Phong et al. 2008).

The discrepancy between attention to and perceived severity of flooding ("biggest flood catastrophe within living memory") and the lack of motivation to implement mitigation measures in the upland case described in this article as well as in the lowland studies cited can be explained by both the relatively low flood-related impact on yield losses and household level, respectively. This is not to say that flooding does not represent a material and crop loss to households. Yet, the numbers appear too small to create sufficient incentives for individual households to change agricultural practices or even invest in costly soil conservation measures.

At the same time, even if there had been heavier economic losses at household level, Lin et al. (2008) maintain that the threshold of losses affecting individuals' willingness to adopt mitigation measures is higher than that of the public in general. López-Marrero and Yarnal (2010) find that individuals rank a number of different risks (e.g., weather extremes other than flood, family health) higher than flooding, whereas society as a whole tends to attribute higher risk levels to flooding. In this light, given the damage to public infrastructure, concerted political and/or collective strategies for action seem more likely to respond effectively and with greater lasting effect to increasing flood risks.

Soil conservation techniques such as contour hedgerows, cover crop systems, grass strips, and agroforestry have been studied intensively and are continuously promoted in the wider region in order to reduce erosion and runoff (Nyssen et al. 2009; Pansak et al. 2008; Ziegler et al. 2006). Pansak et al. (2008), for instance, showed over a period of 3 years that minimum tillage and mulching reduced soil loss up to 95% and runoff was reduced up to 70% with Ruzi grass barriers in northeast Thailand on slopes ranging from 21 to 28%.

The farmers did agree on the effect of soil conservation on reducing erosion, while they did not reach a consensus regarding runoff reduction. The adoption of soil conservation measures by farmers remains low as they are often perceived as economically unattractive and labor intensive (Knowler and Bradshaw 2007; Wezel et al. 2002), which was confirmed within the group discussions. Additionally, land tenure insecurity and reallocation threats in the study area and the wider northern mountain region adversely affect the adoption of soil conservation techniques (Saint-Macary et al. 2010). Put together, these factors also provide an explanation why the suggestion of the lake manager to plant more perennials on sloping fields was not taken into account in the group discussions.

7 Conclusions and policy implications

Causal relations of flooding in upland areas are more complex than in lowland regions. The intensive cultivation of annual crops on sloping land and the related impact on lower lying areas is a serious problem from both ecological and economic perspectives. Although the relevance of upland field cultivation and its effects on water buffer capacity were recognized in their essential features by local stakeholders, the overall understanding of the local ecology and its linkages to flood disasters proved to be fuzzy.

As this study shows, the administration cannot count on a sufficient degree of intrinsic motivation alone, and there are also no additional motivational triggers from a flood disaster that make farmers implement soil conservation techniques to mitigate future flooding. Hence, effective policies will have to provide appropriate incentives, and a coherent long-term soil conservation strategy needs to be designed and implemented with the participation of all local stakeholders. As this study revealed, the inaction of farmers can in parts be explained by an institutional setting in which responsibilities are not assigned relative to the role of actors in flooding, but rather follow a hierarchical administrative structure. Payment for environmental services (PES) schemes, whereby downstream residents compensate upstream land managers for their flood mitigation efforts, may be a promising tool for raising the motivation of farmers to establish soil conservation measures in sloping land (Neef and Thomas 2009). A study in northern Vietnam found that farmers are only likely to set land aside for conservation if they receive adequate in-kind compensation or productivity-enhancing technologies on their remaining farm area (Jourdain et al. 2009).

Ultimately, information and training on soil–water interdependencies as well as disclosure of crucial information among stakeholders are key to appropriate flood responses at both institutional and practical levels. Decision makers need to understand how local people develop their own causal explanations of flood events and how they seek information and make decisions, rather than designing mitigation strategies based solely on expert findings and narrow hierarchical structures and economic constraints. While structural measures, such as small dams and spillovers, are crucial in preventing floods or reducing their devastating impacts, they need to be creatively combined with non-structural measures, such as community-based zoning in flood-prone areas and the development of land use plans that build on both expert and local knowledge.

On a methodological note, the interdisciplinary research design of this study gave a more complete picture of the controversy about the interrelation of land use and hydrological characteristics. Moreover, it pointed to the need to integrate environmental and socioeconomic findings with cognitive factors determining flood mitigation and coping mechanisms. The narrative essays, in particular, provided a beneficial opportunity for multiple perspectives to emerge and highlighted the most important aspects of flooding from the individuals' points of view. The writers' disregard for political correctness, which researchers tend to face when doing face-to-face interviews, was remarkable, suggesting that the tool is an appropriate one for future application and methodological research.

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