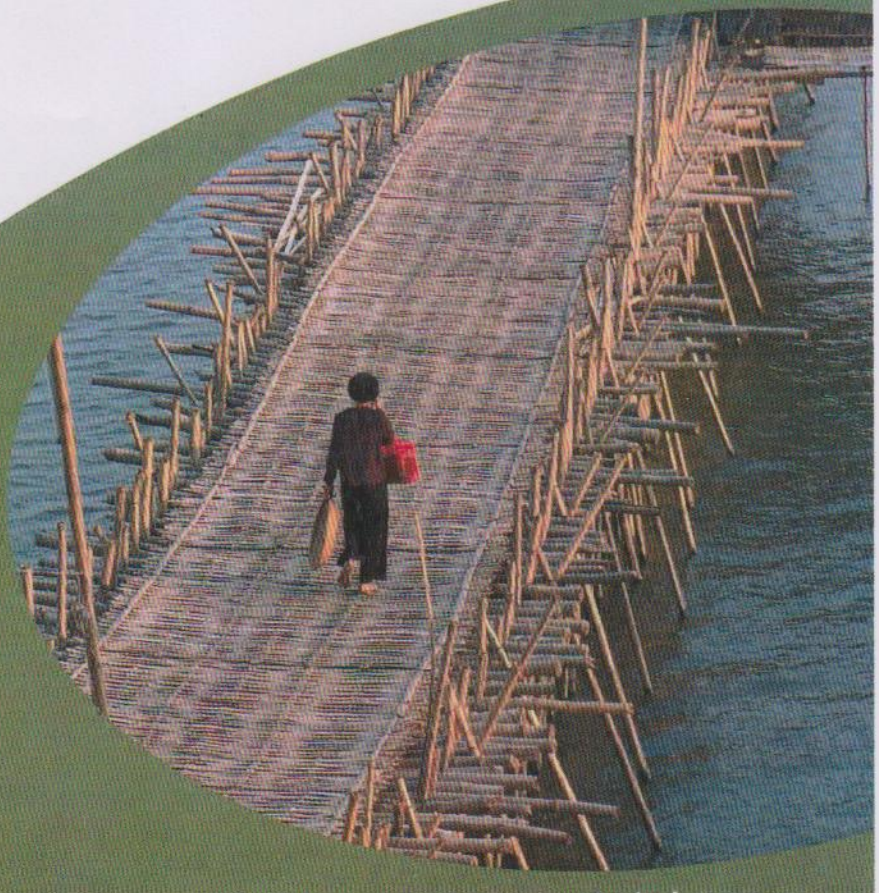
Climate Change and Adaptation



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Strategies for Managing Climate Risks in the Lower Mekong River Basin: A Place-based Approach

Suppakorn Chinvanno, Soulideth Souvannalath, Boontium Lersupavithnapa, Vichien Kerdsuk and Nguyen Thuan

Introduction

Climate risks are not new to farmers of the lower basin of the Mekong river. For smallholder farmers of rain-fed rice, a dominant economic activity of the region, flood, drought and other climate hazards pose substantial threats to their livelihoods (Chinvanno et al, 2008). A variety of strategies and practices are employed to cope with and manage climate risks, which we document through field studies of farming villages in Lao PDR, Thailand and Vietnam. The strategies and specific measures for managing climate risks are broadly similar across the villages, but there are also important differences, despite the similar hazards being faced and the livelihood patterns held in common. In this chapter we examine these similarities and differences and their implications for promoting effective strategies for adapting to climate change.

Farmers' Concerns about Climate

Our study was conducted through household interviews and focus group meetings in farm communities of the Vientiane Plain and Savannakhet Province in Lao PDR, Kula Field and Ubonratchathani Province in Thailand, and the Mekong river delta of Vietnam. More than 1600 households plus local officials participated in the interviews and meetings, which were conducted in 2004 and 2005 and are detailed in Kerdsuk and Sukchan (2005) and Boulidam (2005). The locations of the study sites are shown in Figure 13.1.

The interviews and focus group discussions explored farmers' perceptions of climate hazards, the risks to their farming activities, observed changes in climate and the impacts, strategies and measures used to cope with climate risks, and options for improving the management of climate risks. The climate

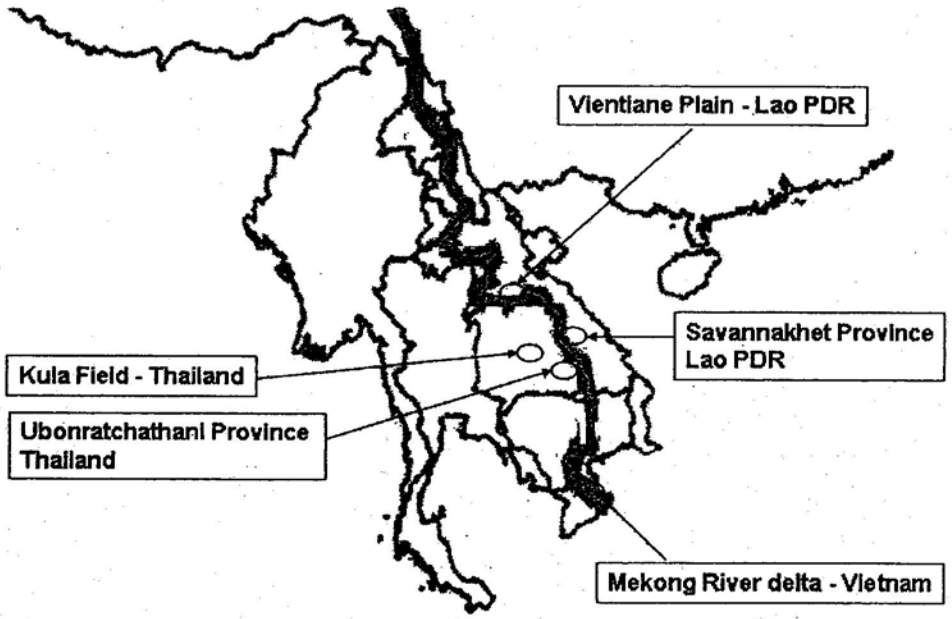

Figure 13.1 *Study sites in Lao PDR, Thailand and Vietnam*

risks found to be major concerns for farmers of the lower Mekong basin vary from location to location, depending on the geographical characteristics of the farmland, farming practices of the community and local features of the climate. However, two climate phenomena are identified by farmers at most of our study sites as significant threats to their livelihoods. These are prolonged midseason dry spells coming after sowing rice seeds or transplanting seedlings and flooding near the end of the crop cycle before harvest time.

With the limited extent of irrigated area in the region, most farmers rely mainly on natural rainfall for growing crops (Barker and Molle, 2004). In most parts of Thailand and Lao PDR, farmers of rain-fed rice practise single wet-season cropping, which normally starts in May and ends in October to November. These farmers start sowing rice at the beginning of the rainy season. Farmers who use a transplanting technique begin the process in mid-June to mid-July and harvest in October to November (Boulidam, 2005). The farmers of the Mekong river delta in Vietnam, where the rainy season is longer due to the influence of two monsoon systems, the southwest monsoon and northeast monsoon, are able to grow two rice crops per year (N. T. H. Thuan, personal communication, 2004).

A midseason dry spell typically occurs after seeding and/or transplanting. If prolonged, the midseason dry spell can seriously damage young rice plants. Such events increase the cost of production, as farmers may have to replant their rice. However, in some cases of delayed or prolonged dry spell, replanting may not be feasible because the rainy season would end before the replanted rice could reach maturity.

Floods that occur late in the rainy season, in October or November, pose serious risks for rice cultivation and farmers' livelihoods. The lower Mekong river basin experiences floods from the major tributary of the river, most

commonly towards the end of the rainy season, when water flow is high and water from tributaries cannot flow into the main stem of the river. Sometimes the situation is made worse when water from the Mekong river is backed up into the tributaries (Mekong River Commission, 2005). This period of high flood frequency is close to harvesting time and for most farmers there would be no time to replant rice for that year if the crop were destroyed or damaged by a late-season flood. Only farmers cultivating areas close by the river or major tributaries and using short-cycle rice varieties have the possibility to replant after a late-season flood. In the discussions with farmer communities in Lao PDR and Thailand, the possibility of increasing flood risk in the future due to climate change raised high concerns among the farmers.

Direct and indirect impacts of floods and midseason dry spells reported to be major concerns by rice farmers in the lower Mekong are presented in Table 13.1. These have been categorized as first-order impacts (biophysical consequences of meteorological events), second-order impacts (crop production consequences of the biophysical impacts) and higher-order impacts that affect human well-being.

Table 13.1 *Multiple orders of climate impacts on rain-fed farms in the lower Mekong region*

Order of impact	Description	Impacts
First-order impacts	Biophysical consequences of meteorological events	Drying of soil due to midseason dry spell, particularly after seeding or transplanting Flooding due to heavy rain, particularly toward the end of the rainy season
Second-order impacts	Crop production consequences of the biophysical impacts	Damage to immature plants Reduced harvest Loss of harvest
Third-order impacts	Consequences of the second-order impacts	Increase in cost of production Food scarcity Decline in household income
Fourth-order impacts	Consequences of the third-order impacts	Degradation in household livelihood and socioeconomic condition (e.g. reduced financial and other wealth, reduced food reserves, malnutrition, increased debt) Migration of member(s) of the household (temporary or permanent) Migration of entire household and exit from farming Change in social status (e.g. change from independent farmer to contracted farmer or hired labour) Conflict among villages
Fifth order impacts	Consequences of the fourth-order impacts	Reduced labour force in farming communities Greater costs for hired labour, machinery to replace labour

Managing Climate Risks: Current Practice and Potential Adaptation

Farmers surveyed in Lao PDR, Thailand and Vietnam identified numerous practices currently in use in their communities which they believe lessened their vulnerability to present-day climate variability and hazards. Some of the measures are motivated by climate risks. Others are primarily motivated by different concerns, yet nonetheless reduce climate risks by increasing the resilience of farmers' livelihoods to multiple sources of stress. They include on-farm and off-farm measures that are implemented at the household level (Tables 13.2 and 13.3), the community level (Table 13.4), and the national level (Table 13.5). Although none of the measures are motivated by perceived needs to adapt to human-induced climate change, many measures that are focused on near-term climate risks could be developed further for longer-term climate change adaptation (Kates, 2001). Implementation and the effectiveness of the measures in the different countries, some of the enabling and limiting factors that give rise to differences across the countries, and their potential as adaptations to climate change are examined below.

Vientiane Plain and Savannakhet, Lao PDR

Most farmers in Vientiane Plain and Savannakhet Province are subsistence farmers, producing rice mainly for their own consumption. They have farms of moderate but sufficient size for producing rice to support the annual consumption of the farm household. They produce a single rice crop each year, and their use of mechanized and advanced farm technology and formal institutional organizations (for example, cooperatives) is limited. The communities are still surrounded by intact natural ecosystems from which natural products can be harvested. This strengthens livelihoods by supplementing and diversifying the farm household's food and income sources (Boulidam, 2005).

Farmers of the Lao PDR study sites tend to rely mostly on farm-level measures for adapting to climate hazards and, to a lesser degree, on collective actions at the community level. Measures at the national level are very limited. Consequently, the capacity of the individual farm household to adapt is a key limiting factor at present for managing climate risks. The responses to climate hazards aim mainly at basic household needs, primarily food security of the household. Common measures implemented by rice farmers include seasonal changes in seed variety, cultivation methods, and timing of farm management tasks based on seasonal climate forecasts made with indigenous knowledge. Also common are raising livestock and harvesting natural products for additional food and income, which are considered major and primary adaptation measures in Lao PDR.

The use of indigenous knowledge to make seasonal climate predictions is still popular. Indigenous knowledge based on observations and interpretations of natural phenomena, for example, the height of ant nests in trees, the colour of frog's legs, the colour of lizard's tails and various indicators of the dry season weather pattern, is used to make forecasts of the

Table 13.2 *Household-level on-farm measures for managing climate risks*

Measure	Objective	Current Implementation	Effectiveness	Enabling and Limiting Factors
Change rice variety – seasonal	Avoid productivity loss from adverse climate conditions, improve food security	Lao PDR: Common practice. Rice grown for own and local consumption, market acceptance not a factor Traditional knowledge used for seasonal forecasting Thailand: Limited use. Local seed varieties not accepted by market Vietnam: Moderate use. Short-cycle seed variety accepted by the market, but at a lower price	Moderate	Forecast accuracy; market acceptance of seed varieties; consumption preference
Change rice variety – permanent	Reduce variability of crop yield and income	Lao PDR: Limited use Thailand: Common practice Vietnam: Common practice – commercial farming	Moderate	Development of new seed varieties; market acceptance; consumption preference
Multiple, spatially separated farm plots	Diversify exposures to climate hazards	Lao PDR: Limited use Thailand: Limited use Vietnam: Limited use	High	Land availability and characteristics; population growth
Match method and timing of cultivation practices to seasonal climate	Avoid productivity loss from adverse climate conditions, improve food security	Lao PDR: Common practice. Use traditional knowledge, not constrained by market considerations. Thailand: Moderate use; change seedling technique. Crop calendar constrained by the market. Vietnam: Moderate use. Long rainy season allows more flexibility in crop calendar.	Low	Forecast accuracy; length of rainy season; market constraints on crop calendar
Manage water with small-scale irrigation, embankments	Water source during dry spells; control flooding	Lao PDR: Limited use Thailand: Moderate use Vietnam: Moderate use	Moderate to high if sufficient resources	Geographical features; financial resources for investment and operating costs

Table 13.2 *(continued)*

Measure	Objective	Current Implementation	Effectiveness	Enabling and Limiting Factors
Grow alternate crops between rice seasons	Increase and diversify food supply and income	Lao PDR: Limited to moderate use Thailand: Limited to moderate use Vietnam: Limited to moderate use; two crop seasons for rice is the normal practice	Moderate	Water availability in dry season; market for alternate crops; size and condition of farm land
Grow crops resilient to wider range of climate conditions than rice	Reduce variability of food supply and income	Lao PDR: Limited use Thailand: Limited to moderate use Vietnam: Limited use	High where feasible	Know-how; markets for other crops; financial reserves; farm size and soil condition; local culture
Livestock	Reduce variability of income, food security	Lao PDR: Common practice at a small scale Thailand: Common practice at a small scale Vietnam: Not available	High	Financial reserves; farm size and condition

onset and cessation of the rainy season, quantity of rain and other climate parameters (Boulidam, 2005). The forecasts are used for seasonally adjusting choices of seed varieties and time and methods for soil preparation, seeding, planting, fertilizing, weeding, harvesting and other tasks (Grenier, 1998). Because farmers in Vientiane Plain and Savannakhet Province grow rice mainly for their own consumption (and selling excess production to the local market for local consumption), they have flexibility to select the seed variety to match local climate conditions without regard for the requirements of the commercial markets of other regions.

Changing seed varieties in accordance with indigenous seasonal climate predictions is considered to be moderately effective by the surveyed farmers; adjusting the methods and timing of farming practices can be effective up to a point, but implementation has been patchy. Performance of these measures for adapting to climate change could potentially be enhanced by implementation of an early warning system based on modern inter-annual and seasonal climate forecasting, coupled with risk communication techniques to reach the populations at risk. Constraints on this measure include the precision of seasonal climate forecasts, ability and institutional network to communicate the forecasts in ways that are useful to farmers, acceptance of the forecasts by farmers, availability of suitable seed varieties, and flexibility for changing the crop calendar for their cultivation.

There is less flexibility for farmers in the Lao PDR sites to change the rice variety on a semi-permanent basis to one that is more climate-resilient or switching to an alternative crop. Constraints on these measures include lack of appropriate seed types, consumption preferences, national dependence on rice for food security, market conditions, lack of know-how and lack of required financial reserves. Consequently, these measures have limited current use. Where they have been used, these measures are considered by farmers to have moderate to high effectiveness for reducing vulnerability to climate and so are potential options for adapting to climate change. But the factors that constrain current use would need to be overcome. Growing a crop other than rice during the dry season is another moderately effective measure that is practised to a limited or moderate degree and can be an effective adaptation to climate change. But its use is restricted to areas where there is access to water and suitable markets.

The community still has an important role in the management of climate risks in the study areas of Lao PDR. For example, in the case of severe loss of rice production, the village leader would establish a cooperative network with other villages located near a river or stream or with irrigation systems, where supply of water is available for dry season crop. Shared farmland would be used for the cultivation of short-cycle rice varieties during the dry season to supplement the community's food supply. In addition, shared resources, such as a community rice reserve contributed to by households in the village or a community fish pond, also act as buffers to climate hazards that sustain the livelihoods and food security of the community. However, some of these collective actions are becoming obsolete, or will be in the near future, because of changes in socioeconomic conditions. Forces that have reduced the role of community-level

Table 13.3 *Household-level off-farm measures for managing climate risks*

Measure	Objective	Current Implementation	Effectiveness	Enabling and Limiting Factors
Harvest natural products	Increase and diversify food supply and income	Lao PDR: Common practice Thailand: Limited use Vietnam: Not available	High in Lao PDR; low to moderate in Thailand and Vietnam	Productivity, diversity and condition of natural ecosystems near villages
Produce and market non-farm products	Increase and diversify income	Lao PDR: Limited use Thailand: Moderate use Vietnam: Not available	Low to moderate in Lao PDR and Vietnam; moderate in Thailand	Know-how; access to market; market conditions
Séasonal migration for off-farm labour	Increase and diversify income	Lao PDR: Limited use Thailand: Common practice Vietnam: Not available	Low in Lao PDR and Vietnam; high in Thailand	Labour demand in urban areas; access to labour market; networks for job search
Permanent migration by family member	Increase and diversify income	Lao PDR: Limited use Thailand: Common practice Vietnam: Limited use	Low in Lao PDR and Vietnam; high in Thailand	Labour demand in urban areas; access to labour market; reduced farm labour for family

actions include population growth and expansion in the use of credit as an alternative to village rice reserves for coping with crop losses.

To date, national-level measures to manage climate risks are reported by surveyed farmers to be limited in scope and scale in Lao PDR. National action on climate risks has been constrained by local culture, lack of institutional arrangements to address climate risks, and limited know-how, resources and investment. Looking to the future, climate change is magnifying climate risks and increasing the amount of resources, technology and know-how that will be needed to manage the risks. Farmers have very limited capacity to adapt to the changes, and the diminishing role of communities is widening the gap between needs and capacities for managing risks. Consideration should be given to measures at the national level that would enhance capacity and enable actions for managing and adapting to climate risks at the farm level and at the community level.

Kula Field and Ubonratchathani Province, Thailand

Rice farmers in Thailand, particularly in the study areas in the northeast, are mostly commercial farmers who live in a monetary-oriented society and grow rice primarily for national and international markets. They have farms of moderate size on which they produce a single rice crop each year using mechanized and modern technologies, and formal organizations to support farm operations. The sale of rice is their main source of income, which is used primarily to purchase household basic needs, including rice for consumption, which could be cheaper in price and of different quality and texture than the rice the farm household grows. Only a small portion of farmers with larger farms are able to divide their farmland to grow both commercial rice variety for sale and a local rice variety for their own consumption or sale in the local market. The farming communities are closely linked to urban society. The surrounding land area is populated and used for settlements or is deteriorated natural forest that can provide only limited natural products as a supplement or alternative source of food and income (Kerdsuk and Sukchan, 2005).

According to the field assessment, farmers at the study sites in Thailand tend to rely on household and national-level measures for reducing climate risks, whereas the role of community-level measures has declined or been neglected. The household-level measures focus on income diversification, primarily from off-farm sources, which are not as sensitive to climate variations as income from rice (Kerdsuk and Sukchan, 2005). The main practice is seasonal migration to work in the cities, which can lead to the permanent migration of some members of the family in order to secure fixed income for the household. Wage income from city employment is less sensitive to climate and helps to insulate the farm household from climate-driven variations in farm income. Seasonal and permanent migration to diversify and supplement household incomes are more common in the Thai study sites than in Lao PDR and Vietnam and are made possible by close links between the rural villages and urban areas where there is demand for labour.

Table 13.4 *Community-level measures for managing climate risks*

Measure	Objective	Current Implementation	Effectiveness	Enabling and Limiting Factors
Shared resources – rice reserve/fish pond	Spread risks by creating food reserve; increase income for community	Lao PDR: Common practice Thailand: Limited use Vietnam: Not available	High in Lao PDR; low in Thailand and Vietnam	Cultural practices; strength of community institutions; guaranteed replenishment of rice reserve
Village fund	Finance investments to improve farms, livelihoods	Lao PDR: Limited use; use expanding under community management Thailand: Common practice; managed by government Vietnam: Not available	Moderate in Lao PDR and Thailand	Guaranteed repayment by borrower
Cooperative network among villages	Spread risks by sharing rice production, food supplies and labour with other villages	Lao PDR: Moderate use Thailand: Limited use Vietnam: Not available	Low to moderate in Lao PDR; low in Thailand and Vietnam	Relationship between village leaders; cultural practices
Cooperative processing and marketing of farm and natural products	Increase and diversify income	Lao PDR: Limited use Thailand: Limited use Vietnam: Not available	Moderate	Know-how; financial reserves; market access; market conditions

Unlike the studied communities in Lao PDR, where seasonal changes in rice variety and the crop calendar made in response to seasonal climate forecasts is common practice, these measures are little used by rice farmers in Kula Field and Ubonratchathani Province. Because they grow rice for national and international markets, they are limited in their ability to use local seed varieties, which fetch lower prices than commercial rice varieties, or to alter their crop calendar. In contrast, semi-permanent changes in seed variety to commercial varieties that are more resilient to climate stresses is common practice for farmers at the Thai study sites. This is made possible by the greater financial resources of commercial farming and by research and development programmes that provide new rice varieties that are both accepted in the market and more resistant to stress. This option could be moderately effective for adapting to climate change. Limitations on wider use are financial, technological and environmental.

Other on-farm measures for reducing climate risk practised by rice farmers in Thailand include changing seedling technique, using hired machinery, growing alternative crops between rice seasons and raising livestock. Some farmers make investments to increase and sustain the productivity of their farms in ways that make them more resilient with respect to climate variations and changes. For example, they construct small-scale irrigation systems to provide an alternative source of water for midseason dry spells or for growing a crop during the dry season. They may also build embankments to protect their fields from flood damage. Such measures are more common than in Lao PDR. But greater use is limited by financial requirements for investment and maintenance. A small number of farmers with large landholdings implement mixed-farming practices or switch part of their farmland from rice to a crop that is more resistant to climate stresses. Harvesting of natural products from forests, a common practice in Lao PDR, is limited at the study sites in Thailand because of high population densities and the degraded nature of forests that are adjacent to farm lands.

National-level policies and measures that serve to reduce vulnerability to climate hazards are more prevalent in Thailand than in Lao PDR and Vietnam. These policies and measures are not motivated by concerns about climate stress, especially climate change, but mainly by poverty reduction goals. Yet national measures in Thailand have supported financial needs, infrastructure development, transitions to more diversified farming systems, marketing of local farm products and farm planning, which have helped to improve the livelihoods of farmers and increase their resilience to climatic stresses. For example, an initiative of the Ministry of Agriculture and Cooperatives in 2004 (Department of Livestock Development, 2004) diversifies farming activity by promoting and providing support to farmers to raise livestock. Another initiative promotes transition from rice cultivation to other plantation crops that are more resistant to climate stresses, such as rubber trees. Research and development by government research facilities have provided new varieties of rice that are more resilient to climate variations, while maintaining the quality that is required by the market.

Table 13.5 *National-level measures for managing climate risks*

Measure	Objective	Current Implementation	Effectiveness	Enabling and Limiting Factors
Financial support to farmers	Assist investments to improve farms, livelihoods	Lao PDR: Limited use Thailand: Common practice Vietnam: Moderate use	Low in Lao PDR; moderate in Vietnam; high in Thailand	National financial condition; mechanism to allocate funds to the farmers; terms and conditions of loan
Support transition to other crops and more diversified farming systems	Diversify and improve farm livelihoods; increase resilience and sustainability of rural economy	Lao PDR: Limited use; rice farming central to food security Thailand: Limited to moderate use; market driven trend toward mono-cropping Vietnam: Limited use; rice farming central to food security	Low in Lao PDR and Vietnam; moderate in Thailand	National financial condition; know-how; mechanism to transfer know-how to farmers; markets; food security; soil properties
Support marketing of village products	Increase and diversify incomes	Lao PDR: Limited use Thailand: Moderate use Vietnam: Not available	Low in Lao PDR and Vietnam; moderate in Thailand	Markets; national financial conditions; know-how; mechanism to develop sustained market
Research and development of new seed varieties	Increase farm productivity and incomes; decrease variability of farm productivity and incomes; increase sustainability of farming	Lao PDR: Moderate use Thailand: Common practice Vietnam: Common practice	Low in Lao PDR; moderate in Thailand and Vietnam	National financial condition; time lag between research and availability of new seeds to farmers; technology; transfer knowledge to farmers
Develop rural infrastructure	Reliable water supply for irrigation; flood control	Lao PDR: Limited use Thailand: Moderate use Vietnam: Not available	Moderate	National financial condition; geographical conditions; technical feasibility
Provide information for farm management, including seasonal climate forecasts	Enable improved farm management	Lao PDR: Nonexistent Thailand: Limited use Vietnam: Limited use	Moderate	Communication channel; know-how to apply information; technology; forecast accuracy

Community-level measures are diminishing in Kula Field and Ubonratchathani Province, with the exception of village funds for local investments to support farm livelihoods, which are managed by the government. But community or local administration units could play an expanded role to assist in planning as well as implementing future adaptation to climate change. The advantages of involving local institutions are that they are more aware of local risks, priorities and resources than national authorities and can be more flexible and timely in implementation.

The Mekong river delta, Vietnam

Rice farmers of the Mekong river delta in Vietnam are mainly commercial farmers. Unlike farmers at the study sites in Lao PDR and Thailand, they are able to grow two rice crops each year because of a longer rainy season. Farmers of the delta can grow sufficient rice to both supply the annual consumption of the household and sell rice to the market. They make moderate use of modern farm technology and formal institutional organizations in farming practice. The household relies heavily on income from rice production. The farm communities are surrounded by populated areas and are not tightly tied to the urban economic system (field interviews in Long An, Can Tho, Dong Thap and An Giang Provinces, Vietnam, 2004).

The farmer of rain-fed rice in Vietnam tends to rely on measures implemented at the household level and aimed mainly towards on-farm actions to protect against climate hazards. Community- and national-level measures play a very limited role in reducing their climate risks. The farm-level solutions include efforts and investments to increase and sustain the productivity of their farms, such as construction and maintenance of small-scale irrigation systems or embankments to protect their farmland from flooding. But investment costs and the limited financial capacity of farmers limit wider use of these measures. Using an alternative strategy, some farmers in the study sites have adapted to floods by accepting them as part of the ecosystem of their farmland, adjusting their crop calendar accordingly and allowing their lands to be flooded, thereby gaining advantages from nutrients being deposited that enhance soil fertility and pollutants being washed from their farmland. The use of alternative crops and seed varieties are also common adaptation measures used by farmers in the Mekong river delta.

Changing the variety of rice grown, both seasonally in response to climate forecasts and semi-permanently in response to markets and technological changes, is practised by Vietnamese farmers, even though they are commercial farmers and grow rice to match market demand. Because the rainy season in the delta region is usually seven months long, two crop cycles of rain-fed rice can be grown in one year. A two-crop cycle is also facilitated by the availability of short-cycle rice varieties that are suitable for growing in Vietnam and that are accepted by the market. This gives additional flexibility to farmers in Vietnam to select varieties of rice so as to balance the risk of losses from climate events against expected market returns according to their preferences regarding risk. Consequently, seasonal changes of rice variety are more commonly observed among rice farmers in Vietnam than in Thailand.

Community-level measures at the study sites in Vietnam are limited and have low effectiveness. Some measures that are implemented at a national level in Vietnam are considered by farmers to be moderately effective. National research and development programmes have facilitated changes in rice varieties by farmers that lessen vulnerability to climate extremes. Also being implemented, but on a limited scale, are national support for transition to alternative crops and provision of climate forecast information to farmers to assist with farm planning efforts.

Commonalities and Differences: A Matter of Context

Rice farmers are shown by the surveys to be experienced at managing climate risks, employing a variety of highly place- and time-specific measures to reduce their vulnerability. Many measures for managing climate risks are common to all of the study sites, at least in general characteristics. But there are also significant differences in the specific measures chosen and in the degree to which farmers rely on farm-level, community-level and national-level actions. These differences are apparent despite our focus on farmers who all make their livelihood primarily from growing rain-fed rice in a common river basin of Southeast Asia and who are exposed to similar climate hazards. The differences demonstrate the strong influence exerted by the local context on climate risk management. They arise from local differences in the specific climate hazards faced, physical and environmental constraints, available technologies, social and economic condition of the farm household and community, vitality of community institutions, degree of engagement in the market economy, market conditions, and the priorities and objectives of the farm households.

Even so, some commonalities do emerge from the experiences of farmers across the study sites. Some of the commonalities and differences are summarized in the following sections. In interpreting the findings, it should be borne in mind that the exploratory assessment surveyed farmers at only two sites each in Lao PDR and Thailand and only one site in Vietnam. While for convenience of exposition, we write about farmers in Lao PDR, Thailand or Vietnam, it would be misleading to extrapolate from farmers at the selected sites to characterize the condition and practices of farmers nationwide in any of the three countries. Differences in local context within a country can yield different risk management approaches and performance between communities of the country, just as they do in our comparisons of study sites from different countries.

At all of the study sites farmers rely primarily on their own capacity for implementing farm-level measures. But the context for farm-level action is shaped by what is done at community and national levels. Community-level measures are most prevalent in the farm communities of Vientiane Plain and Savannakhet Province in Lao PDR, where they play an important role in providing food security buffers and strengthening livelihoods. Farmers from the study sites in Thailand and Vietnam report that community-level measures are used only to a limited degree and are much diminished relative to the past. This too is the trend at the Lao PDR sites. The diminishing role of collective

action at the community level may be an important deficit in the capacity of these communities to adapt to future climate change.

Our evaluation of national-level measures is based on the perspectives reported by farmers and community leaders at the study sites and does not reflect a comprehensive evaluation of national policies and programmes that are related to climate risks. But this is an important perspective, as it gives a sense of what is happening on the ground, at least in the communities surveyed. In none of the three countries can the national-level measures of which farmers are aware be described as constituting a national strategy for managing climate risks. The actions are not coordinated and typically are not designed specifically to combat climate risks.

National-level measures in Thailand, as perceived and reported by farmers in the Thai communities of Kula Field and Ubonratchathani Province, are greater than those reported by farmers surveyed in the other two countries and are an important complement to farm-level measures there. National-level actions in Thailand provide financial and other support for investments in farming infrastructure and expansion of farming technologies, including climate-resilient varieties of rice and other crops, sustainable farming practices, and diversified farm incomes. These efforts help to strengthen farm livelihoods and make them more resilient to climate and other shocks. In Vietnam, the national government supports research and development of seed varieties and provides financial support for investment in farm sector infrastructure, but other measures by the national government are reported by farmers to be limited. National-level measures are the least prevalent in Lao PDR and do not presently play a strong role in making farm households in the study areas climate resilient.

Farmers' objectives, priorities and capacities for using farm-level risk management measures vary between the study sites, and this influences their choice of measures. At the Lao PDR sites, most farmers practise subsistence agriculture and depend primarily on their own rice production for their food supply. Their choice of which rice variety to cultivate only needs to satisfy their own preferences and is not constrained by market requirements. They have access to healthy forests, from which they can harvest products to supplement their food supply. There are opportunities to earn monetary income, but these are little used. Consequently, their choices emphasize providing and protecting basic household needs, most particularly household food security, and employ strategies that have little financial cost and rely on household labour, indigenous knowledge and use of natural products.

Rice farmers in Kula Field and Ubonratchathani Province in Thailand are very much oriented to the market economy. They grow rice for cash income and have opportunities to participate in nearby urban labour markets. Their participation in commercial activities provides them with important financial resources and capacity, but their income can be volatile due to climate and market events, and market requirements for commercial rice can limit options for changes in rice cultivation. Consequently, their choices emphasize diversifying household income, particularly from off-farm labour, adoption of rice varieties that are more climate resilient and thus less variable in the income

they provide, and investments such as small-scale irrigation and flood control that improve the productivity and resilience of their farmland.

In the Mekong River delta of Vietnam, farmers grow rice commercially but have little opportunity to participate in urban labour markets and so are highly dependent on the cash income from the sale of their rice. They have some financial resources and benefit from a longer rainy season than that at the Thai and Lao PDR sites, which allows them to grow two rice crops each year. The availability of short-cycle rice varieties that are suitable for growing on their farms and are accepted by the market also gives them greater flexibility to vary their rice cultivar and crop calendar if the season is expected to be unusually short or dry. Choices of the surveyed Vietnamese farmers emphasize varying cultivation practices to reduce the risk of damage or loss to the rice crop, and investments to improve the productivity and resilience of their farms.

Taken as a whole, the survey results suggest a pattern of climate risk management choices by farm households that is shaped by the socioeconomic condition of their surrounding communities. Farmers in communities with less developed socioeconomic conditions tend to pursue simple strategies targeted at increasing coping capacity and sustaining basic needs that can be implemented at the household or community level with limited financial and other resources. Farmers in communities with more developed socioeconomic conditions tend to pursue strategies targeted at reducing the variability of income and at improving the productivity and resilience of their farms. The measures that they adopt tend to depend more on market and other institutions, improved technologies and financial resources than is the case for farmers in less developed communities.

Climate Change in the Lower Mekong

Rain-fed agriculture is the dominant economic activity of countries in the lower Mekong basin and engages a high proportion of the population (Schiller et al, 2001; UN-ESCAP, 2006). Despite the efforts made to manage climate risks, farmers of rain-fed crops remain highly vulnerable to climate variations and extremes. Today, human-caused climate change threatens to magnify climate risks in the region and expose farmers to conditions that are outside of the range of current experience.

Many farmers over the age of 40 surveyed in Thailand and Lao PDR report noticeable changes in climate patterns over the past 25 to 30 years. These include increasing variability in the dates of onset and end of the rainy season, changes in wind direction, changes in the rainfall distribution pattern throughout the season, and an increase in thunderstorm activity. Thunderstorms, according to farmers at many of the study sites, have increased in frequency, and their occurrence has extended throughout the rainy season. In the past, they only occurred during the beginning and towards the end of the rainy season. This observed phenomenon may be an indicator of changes in the regional high–low pressure front during the rainy season, which no longer moves to a higher latitude after the beginning of the rainy season and south-

ward again at the end of the rainy season. The front now seems to stay within the region throughout the rainy season. Some farmers also noticed a change in the wind direction pattern, which now varies throughout the season, unlike in the old days, when farmers observed that clouds and rain always came from a certain direction, which was thus more predictable.

The future climate of the lower Mekong, like much of the world, will be warmer. It is also likely to be wetter. Climate model simulations project trends toward greater precipitation and higher intensity precipitation in the region during the rainy season, which would increase the magnitude and possibly the frequency of floods in the Mekong basin. The greater precipitation during the rainy season suggests the potential for reduced frequency of prolonged dry spells in the middle of the growing season, but this will depend on how daily variability in rainfall changes.

Mathematical modelling simulations performed with the high resolution Conformal Cubic Atmospheric Model (CCAM) from McGregor and Dix (2001) are used to construct scenarios of future climate change for our assessment of impacts and vulnerability (Chinvanno et al, 2008). The scenarios correspond to increases in the atmospheric concentration of carbon dioxide from 360ppm to 540 and 720ppm, which are projected to be reached roughly by the 2040s and 2070s respectively in the IPCC's A1FI scenario (Nakicenovic and Swart, 2000). Projected changes in annual precipitation in subcatchments of the region range from no change to increases of more than 500mm per year (an increase of up to approximately 25 per cent), with the greatest increases projected for Lao PDR. Higher precipitation within a rainy season of approximately the same length as for the baseline scenario is projected by CCAM, implying potentially greater intensity of rainfall in the rainy season. Because of the potential for increased flood risk, as well as other changes in climate that would impact agriculture, there is a need to evaluate current practice for managing climate risks to the farm sector and strategies for adapting to future climate change.

Enabling Adaptation to Climate Change

The measures that are in use in the surveyed communities of Lao PDR, Thailand and Vietnam address current climate risks. They are not deliberate attempts to adapt to climate change. But they provide a basis of experience, knowledge and skills on which to build a climate change adaptation strategy. They also demonstrate a history of farmers in the region acting effectively, within their constraints, in their self-interest to reduce their vulnerability to climate hazards. Despite these efforts, however, farmers in the study area, particularly those who rely on rain-fed crops, are still strongly impacted by prolonged dry spells, floods and other climate events. They are highly vulnerable to climate hazards now and so can be expected to be highly vulnerable to climate change in the future.

Their vulnerability is partly due to lack of capacity of farm households, lack of capacity of rural communities, and lack of coordinated national strategies to support farmers and their communities in managing climate risks. An

effective starting point for a national strategy of climate change adaptation would be to integrate policies to raise the capacities of farm households and rural communities for managing present climate risks into farm policy, rural development and poverty reduction efforts. Some national policies in the region already do this to a limited extent, though not explicitly.

Farm households need help with financial resources, opportunities for off-farm income, marketing of farm products, access to water and healthy ecosystems, information about current and changing climate hazards, know-how to diversify their farming practices and apply new farming methods and technologies, and access to improved varieties of rice and other crops. They also need buffers to protect their food security, health and livelihoods when they suffer severe crop or financial loss. Delivering this assistance to bolster the capacity of farm households requires community-level institutions with vitality and high capacity. Community institutions can also play a role in coordinating collective actions that require pooled resources to implement. Sadly, community-level institutions in the surveyed communities are in decline, and some community-level measures are becoming obsolete. A reversal of this trend will be important for maintaining existing capacity and raising capacity to the levels that will be needed to address the challenges of climate change.

An important concern for adaptation measures in the basin is that measures taken in one locality may have significant 'spillover' effects on neighbouring or downstream communities. A holistic approach to national policy and strategic planning for managing climate risks is needed in order to address concerns about potential spillovers. In addition, coordinated regional action by the countries of the lower Mekong river basin should also be considered as the countries share a common resource, the Mekong river, and some adaptation measures may only be feasible with regional collaboration.

Climate change will alter water availability, water quality, flood risks, and the performance and sustainability of river-dependent livelihood systems throughout the basin. The actions taken within any of the countries to adapt to these changes are also likely to have spillover effects that cross national borders. In this context, the countries of the lower Mekong river region should explore the potential for trans-boundary effects of their actions, options for reducing negative trans-boundary effects, and options for collective actions that may yield higher effectiveness of the adaptation measures and positive trans-boundary effects.

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