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Climate Risks and Rice Farming in the Lower Mekong River Countries[1]

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

1. Introduction

Climate change threatens to magnify existing climate threats, as well as bring new threats to the countries of the lower Mekong River basin. The expected changes in climate would impact on many systems and sectors of these countries, which include Cambodia, the Lao People's Democratic Republic (Lao PDR), Thailand, and Vietnam. Impacts on rain-fed agriculture are a particular concern because farm livelihoods that are based on cultivation of rain-fed crops are highly vulnerable to climate stresses (Chinvanno et al., 2006) and rain-fed agriculture is the dominant economic activity of the region, engaging a high proportion of the population (Schiller et al., 2001; UN-ESCAP, 2006).

Climate risks are not new to farmers of the lower Mekong. Important climate risks that are common to farmers of the region include midseason dry spells that can damage young plants and late-season floods just before harvest that can cause severe crop loss. Farmers have developed and used various measures to cope with these and other climate risks. Rice farmers' experiences with measures to manage climate risks and their perspectives on the potential for applying the same measures to adapt to climate change, are investigated through interviews and focus group discussions conducted in selected farming villages in Lao PDR, Thailand, and Vietnam. Although the climate hazards are similar for rice farmers across the study areas, significant differences are found in the measures used to cope with climate risks in the different villages. These differences in risk management practice arise from local and national differences in social, cultural, economic, and environmental conditions and policies, and suggest that effective

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strategies for adapting to climate change need to be attuned to the specific context of a place and time.

2. Climate Change in the Lower Mekong

It is widely accepted that human-induced climate change is under way (IPCC, 2001a,b). The future climate of the lower Mekong, like much of the world, will be warmer. It is also likely to be wetter. Mathematical modeling simulations from the high resolution Conformal Cubic Atmospheric Model (CCAM) provide scenarios of how the climate of the region may change at an output resolution of 0.1 degree (about 10 km × 10 km). CCAM is the second-generation regional climate model developed specifically for the Australasian region (McGregor and Dix, 2001) and has been evaluated in several international model intercomparison exercises to be among the best climate models for the Asian region (McGregor et al., 1998)

The future climate scenarios were simulated on the basis of three levels of atmospheric concentrations of carbon dioxide (CO_2), which is the main greenhouse gas. The atmospheric CO_2 concentration of 360 ppm was used as the baseline climate scenario, which was the concentration during the 1980s. The future climate scenarios were simulated for atmospheric CO_2 concentrations of 540 ppm and 720 ppm (or at 1.5 and double the baseline level). These concentrations may be reached by the middle and toward the third quarter of this century (approximately in the 2040s and 2070s, respectively, under SRES emission scenario A1FI, IPCC, 2000).

The simulation results, which are adjusted using observed weather data, show increasing precipitation throughout the lower Mekong River basin region (see Fig. 1). Projected changes in annual precipitation in sub-catchments of the region range from no change to more than 500 mm per year (up to approximately 25%), with the greatest increases projected for Lao PDR. The temporal distribution of precipitation was also analyzed, and the results suggest that the region would have higher precipitation within a rainy season of approximately the same length as for the baseline scenario, implying

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U.S. Environmental Protection Agency and co-executed on behalf of the United Nations Environment Programme and by the Global Change SysTem for Analysis, Research and Training and The Academy of Sciences for the Developing World. Correspondence regarding this paper should be directed to Suppakorn Chinvanno, suppakorn.c@gmail.com.

potentially greater intensity of rainfall in the rainy season (see Appendix 1: Lower Mekong region rainy season characteristic under simulated climate change scenarios).

The lower Mekong River basin subregion currently experiences floods from the major tributary of the river, mainly toward 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). The higher-intensity precipitation that is projected for the rainy season in the future is likely to increase the magnitude of floods in the region and possibly also the frequency of flooding. 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.

3. Household Surveys and Focus Groups

Farmers of the lower Mekong River basin have been adapting to climate impacts throughout history, and strategies for managing climate risks have evolved through time. However, it is difficult to separate adaptations made in response to climate pressures from actions taken in response to other forces emanating from demographic, social, economic, technological, environmental, and other changes. In many cases, farm practices are a response to multiple risks from a variety of sources. Our study examines two types of actions: (1) actions that farmers consider to be mainly driven by climate risks and (2) actions that are likely driven by other considerations but nevertheless improve the resilience of the farmer society with respect to climate stresses.

The study is an exploratory assessment of vulnerability and adaptation to the impacts of climate extremes and climate change. Findings regarding the vulnerabilities of rice farmers of the lower Mekong to climate risks are presented in Chinvanno et al. (2006). Here, we focus on adaptive strategies to cope with and reduce climate risks. The assessment was conducted through household interviews and focus group meetings in the selected study sites, which are detailed in Kerdsuk et al. (2005) and Boulidam (2005). The collected data are mostly qualitative information and reflect the opinions and

perspectives of the respondents. The interviews and discussions focused on the following topics:

- Observed changes in current climate pattern compared to the past (25–30 years or even longer).
- The major climate threats and impacts to their farming activity.
- Change in climate threat over the period of time, in terms of the nature of threat, degree of impact, and the frequency of occurrence.
- Measures and strategies for coping with the climate risks in the past, which include actions at the household level, community level, and external actions from government.
- Potential measures and strategies for responding to possible future increases in the frequency or magnitude of extreme climatic events.

The field assessment activity was based on a series of meetings with community leaders and household interviews in the selected study sites in Lao PDR, Thailand, and Vietnam (see Fig. 2). These sites are major rice farming areas in the region, and the field interviews covered 290 households in Vientiane plain (May and June, 2005) and 160 households in Savannakhet province (September, 2004) in Lao PDR; 560 households in Ubonratchathani Province (June and July, 2004) and 625 households in Kula Field (April and May, 2005) in Thailand; 60 households and provincial officials in the Mekong River delta area (June and July, 2004) in Vietnam.

4. Farmers' Observations of Climate

Many farmers surveyed in Thailand and Lao PDR over the age of 40 years reported noticeable changes in the present climate pattern in comparison to the past 25 to 30 years. These noticeable changes include increasing variability in the dates of onset and end of the rainy season, changes in wind direction, changes in rainfall distribution pattern throughout the season, and an increase in thunderstorm activity. Thunderstorms, as far as the farmers' observations are concerned, have increased in frequency, and their occurrence has extended throughout the rainy season in many study sites. In the past, they only occurred during the beginning and toward the end of 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 moves southward again at the end of rainy season. The front now seems to stay within the region throughout the rainy season. Some farmers also noticed a change in wind direction pattern, which now varies throughout the season, unlike the old days, when farmers observed that clouds and rain always came from only a certain direction, which was more predictable.

5. Farmer's Concerns About Climate

The farm household interviews revealed that the climate risks of major concern to farmers of the lower Mekong basin vary from location to location, depending on the geographical characteristics of the farmland, and are influenced by the farming practices of the community. However, two climate phenomena were identified by farmers at most study sites as significant threats to farmer livelihoods. These are the midseason dry spell, particularly after sowing rice seeds or transplanting seedlings, and flood, particularly near the end of the crop cycle before harvesting.

With limited extent of irrigated area in the lower Mekong River region (Barker and Molle, 2004), most farmers rely mainly on natural rainfall for their farming activity. Farmers of rain-fed rice in most parts of Thailand and Lao PDR practice 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 implement 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 under the influence of two monsoon systems, the southwest monsoon and northeast monsoon, are able to grow two rice crops per year (N. T. H. Tuan, personal communication, 2004). However, the timing of farming practices may vary slightly depending on rainfall distribution in the year (Schiller et al., 2002).

The midseason dry spell normally occurs after seeding and/or transplanting, and a prolonged one would seriously damage young rice plants. Such events can 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 would reach maturity.

Flood that occurs late in the rainy season, October or November, which is quite common in the region, poses serious risks for rice cultivation and farmers' livelihoods. This period is close to harvesting time; therefore, there would be no time to replant rice for that year if the crop were destroyed or damaged by a late-season flood, except in small areas by the river or major tributaries and only using short-cycle rice varieties. 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.

The impacts from climate change can be considered as a chain of consequences (Rothman et al., 1998). The field interviews identified direct and indirect impacts of climate that are major concerns of rain-fed rice farmers in the lower Mekong. 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 (see Table 1).

6. Managing Climate Risks: Current Practice and Potential Adaptation

Surveyed farmers identified numerous practices currently in use in their communities in Lao PDR, Thailand, and Vietnam, which they believed lessened their vulnerability to present-day climate variability and hazards. Some of the measures are motivated primarily by climate risks, while others are motivated by other concerns, yet nonetheless reduce climate risks by increasing the resilience of farmers' livelihoods to multiple sources of stress. They include measures that are implemented at the individual farm level (see Table 2), the community level (see Table 3), and the national level (see Table 4). 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 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.

6.1 Managing climate risks in 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 annual consumption of the farm household. They produce a single rice crop each year, and their use of mechanized and advanced farm technology and institutional instruments 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. Their 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 upon seasonal climate forecasts made with indigenous knowledge. Also common are raising livestock and harvesting natural products for additional food and income, which is 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 upon observations and interpretations of natural phenomena, for example, the height of ant nests in trees, color of frogs' legs, color of lizards' tails, and various indicators of the dry season climate pattern, is used to make forecasts of the 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/or to sell the 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 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, whereas 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 potentially could be enhanced by implementation of an early warning system based on modern interannual 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 semipermanent 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, lack of required financial reserves, and other factors. 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 practiced to a limited or moderate degree and can be an effective adaptation to climate change. But its use is restricted to 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 with small-scale irrigation systems. Shared water would be applied to shared farmland for 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 by households in the village or a community fish pond, also act as buffers to climate hazards that sustain 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 socio-economic conditions. Forces that have reduced the role of community level 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.

6.2 Managing climate risks in 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 institutional instruments. 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 et al., 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 et al., 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 an urban areas where there is demand for labor.

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 and to alter their crop calendar. In contrast, semipermanent changes in seed variety to commercial varieties that are more resilient to climate stresses is common practice of farmers at the Thai study sites. This is made possible by the greater financial resources of commercial farming and by research and development programs 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 practiced 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 practice 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 were 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 that have helped to improve 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.

Community-level measures are not common 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. The role of community or local administration units for planning, as well as implementing future adaptation to climate change in cooperation with the national agency, could be promoted, as local institutions can better address local needs and be more flexible and timely in implementation.

6.3 Managing climate risks in Mekong River Delta, Vietnam

Rice farmers of the Mekong River delta in Vietnam are mainly commercial farmers. They are able to grow two rice crops each year because of a longer rainy season,

can sustain annual consumption, make moderate use of modern farm technology, and use institutional instruments 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 interview 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 toward 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 flood. But investment costs and limited financial capacity of farmers limit wider use of these measures. Using an alternative strategy, some farmers in the study sites have adapted to flood by accepting floods as part of the ecosystem of their farmland, adjusting their the 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. In addition, use of alternative crops and seed varieties are also common adaptation measures of the farmer in the Mekong River delta in Vietnam.

Changing the variety of rice grown, both seasonally in response to climate forecasts and semipermanently, is practiced by Vietnamese farmers, even though they are commercial farmers and grow rice to match market demand. Because the rainy season in the Mekong River delta is usually 7 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 farmers' preferences regarding risk. Consequently, seasonal changes of rice variety is more commonly observed among rice farmers in Vietnam than in Thailand.

Community-level measures at the study sites in Vietnam are very limited and have low effectiveness. Some measures that are implemented on a national level in Vietnam are considered by farmers to be moderately effective. National research and

development programs 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.

7. Commonalities and Differences: A Matter of Context

Many measures for managing climate risks are common to all of the study sites, at least in general characteristics. But, as shown above, there are substantial differences across the study sites in the degree to which the farmers rely on farm-level, community-level, and national-level actions; farm households' objectives; the status of enabling and limiting factors; and the prevalence and effectiveness of different measures. 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. The measures that are used and their effectiveness are place and time specific.

Still, some commonalities do emerge from the experiences of farmers across the study sites. We summarize some of the commonalities and differences below. In interpreting the findings, it should be borne in mind that the exploratory assessment surveyed farmers at only two sites in Lao PDR and Thailand and only one site in Vietnam. While for convenience of exposition, we write of 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 across 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 upon 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 in 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 are based on the perspectives reported by farmers and community leaders at the study sites and do not reflect a comprehensive evaluation of national policies and programs 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.

Still, national-level measures in Thailand, as perceived and reported by farmers in the Thai communities of Kula Field and Ubonratchathani Province, are greater than what is 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, 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 sites climate resilient.

Farmers' objectives, priorities, and capacities for using farm-level risk management measures vary across the study sites, and this influences their choice of measures. At the Lao PDR sites, most farmers practice subsistence agriculture and depend primarily on their own rice production for their food supply. Their choice of rice

variety to cultivate need only satisfy their own preferences and are 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 labor, 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 labor 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 labor, 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 labor markets and so are highly dependent upon the cash income from sale of their rice. They have some financial resources and benefit from a longer rainy season than occurs 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.

8. Conclusions and Recommendations

Farmers of the lower Mekong River basin are exposed to a variety of climate hazards that threaten their livelihoods, food security, and well-being. Those who cultivate rain-fed rice as a primary source of food or income are particularly vulnerable to climate variations, such as prolonged dry spells during the growing season and flooding at the end of the season prior to harvest, events that are common in the current climate. Human-induced climate change is expected to bring greater and possibly more intense rainfall to the region, which would increase flood risks to farmers.

Rice farmers are experienced in managing climate risks and employ a variety of highly place- and time-specific measures to reduce their vulnerability. The measures used differ according to 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. Results from surveys of farmers in selected communities of Lao PDR, Thailand, and Vietnam suggest a pattern that is shaped by the socio-economic condition of their surrounding community. Farmers in communities with less-developed socio-economic 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 socio-economic 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.

The measures that are in use in the surveyed communities address current climate risks. They are not deliberate attempts to adapt to climate change. But they provide a basis of experience, knowledge, and skills upon 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, these farmers, 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 to manage climate risks. An effective starting point for a national strategy of climate change adaptation would be to integrate into farm, rural development, and poverty reduction policies raising the capacities of farm households and rural communities to manage present climate risks. 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 to 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 neighboring 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 transboundary effects of their actions, options for reducing negative transboundary effects, and options for collective actions that may yield higher effectiveness of the adaptation measures and positive transboundary effects.

References

Adger, W. N., P.M. Kelly and N. H. Ninh. 2001. *Living with environmental change: Social vulnerability, adaptation and resilience in Vietnam*. Routledge: London

Barker, R., and Molle, F., 2004. Evolution of irrigation in South and Southeast Asia. *Comprehensive Assessment Research Report 5*, Colombo, Sri Lanka: Comprehensive Assessment Secretariat.

Boulidam, S. 2005. *Vulnerability and Adaptation of Rain-fed Rice Farmers to Impact of Climate Variability in Lahakhok, Sebangnuane Tai, Dong Khamphou and Khudhi Villages of Songkhone District*, *Savannakhet, Lao PDR*, Mahidol University, Thailand

Bryant, C. R., Smit, B., Brklacich, M., Johnston, T. R., Smithers, J., Chiotti, Q., and Singh, B. 2001. *Adaptation in Canadian agriculture to climatic variability and change. Societal adaptation to climate variability and change*. Kluwer Academic Publishers: Dordrecht, The Netherlands.

Chinvanno, S., S. Boulidam, T. Inthavong, S. Souvannalath, B. Lersupavithnapa, V. Kerdsuk, and N. Thuan. 2006. Climate change risk and vulnerability of rain-fed rice farmers in the lower Mekong River. AIACC Working Paper, draft.

Department of Livestock Development, Ministry of Agriculture and Cooperatives, Thailand [Online]. 2004. Available at: http://www.dld.go.th/pvlo_ccs/p21.htm. Accessed on 09 October 2006.

Grenier, L. 1998. *Working with indigenous knowledge: A guide for researchers.* Canada: International Development Research Centre .

IPCC. 2000. *Emissions scenarios*, edited by N. Nakicenovic, and R. Swart. Cambridge, UK: Cambridge University Press.

IPCC. 2001*a*. *Climate change 2001: The scientific basis. contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*, edited by J. T. Houghton, Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, X. Dai, K. Maskell, and C. A. Johnson. Cambridge, UK: Cambridge University Press.

IPCC. 2001*b*. *Climate change 2001: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*. edited by J. J. McCarthy, O. F. Canziani, N. A. Leary, D. J. Dokken, and K. S. White. Cambridge, UK: Cambridge University Press.

Kates, R. W. 2001. *Cautionary tales: Adaptation and the global poor. Societal adaptation to climate variability and change*. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Kerdsuk, V., Kerdsuk, V., and Sukchan, S. 2005. *Impact assessment and adaptation to climate change: The study of vulnerability and adaptation options of rain-fed farms in Tung Kula Ronghai*, Khon Kaen University, Thailand.

McGregor, J. L., and M. R. Dix. 2001. The CSIRO conformal-cubic atmospheric GCM. In *IUTAM Symposium on Advances in Mathematical Modelling of Atmosphere and Ocean Dynamics*, edited by P. F. Hodnett, Dordrecht, The Netherlands: Kluwer Academic Publishers, pp. 197–202.

McGregor, J. L., Katzfey, J. J. and Nguyen, K. C. 1998: Fine-resolution simulations of climate change for Southeast Asia. Final report for a research project commissioned by Southeast Asian Regional Committee for START (SARCS). Aspendale, Victoria, Australia: CSIRO Atmospheric Research, 35 pp.

Mekong River Commission. 2005. *Overview of the Hydrology of the Mekong Basin*. Vientiane, Lao PDR: Mekong River Commission, November 2005.

Reilly, J., and Schimmelpfennig, D. 2001. *Irreversibility, uncertainty and learning: Portrait of adaptation to long-term climate change. Societal adaptation to climate variability and change*. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Rothman, D. S., D. Demeritt, Q. Chiotti, and I. Burton. 1998. Costing climate change: The economics of adaptations and residual impacts for Canada, vol. VIII. In: *The Canada Country Study: Climate Impacts and Adaptation*, edited by N. Mayer, Montreal, Canada, Environment Canada.

Schiller, J. M., S. A. Rao, Hatsadong, and P. Inthapanya. 2001. *Glutinous rice varieties of Laos: their improvement, cultivation, processing, and consumption*. Rome, Italy: Food and Agriculture Organization.

Schiller, J. M., B. Linquist, K. Douangsila, P. Inthapanya, B. Douangboupha, S. Inthavong, and P. Sengxua. 2002. *Constraints to Rice Production Systems in the Lao PDR*. Vientiane, Lao PDR.

United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP). 2006. Annual indicators for millennium development goals [Online]. Accessed on 09 October 2006. http://unescap.org/stat/data/goalIndicatorArea.aspx.

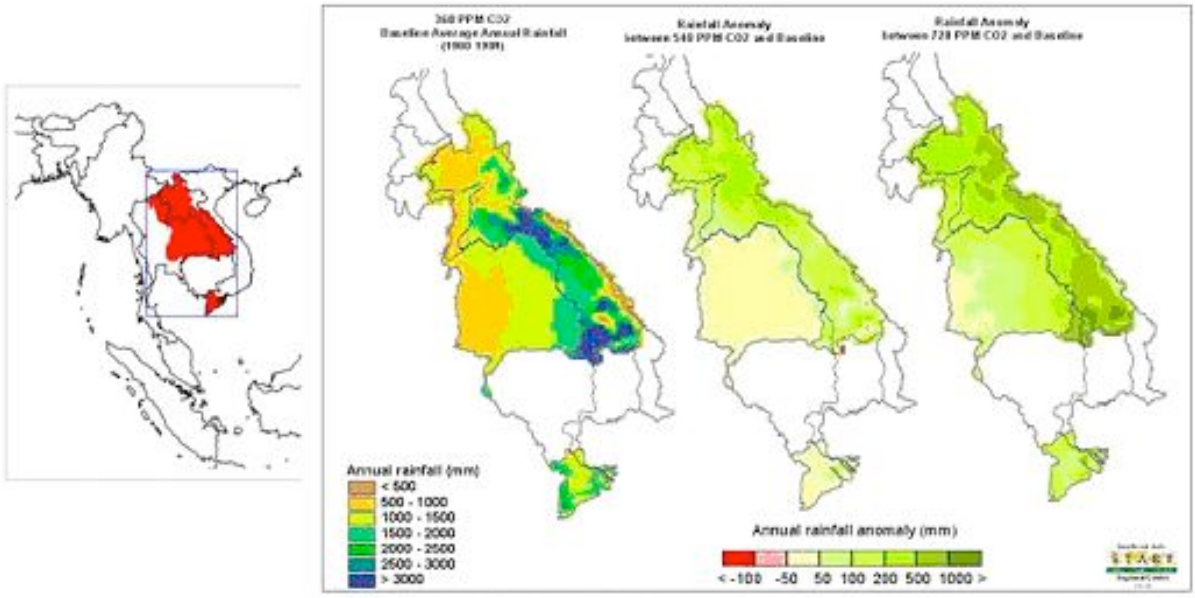


Figure 1. Averaged annual rainfall in the lower Mekong River region, which shows simulation of baseline condition and future changes.

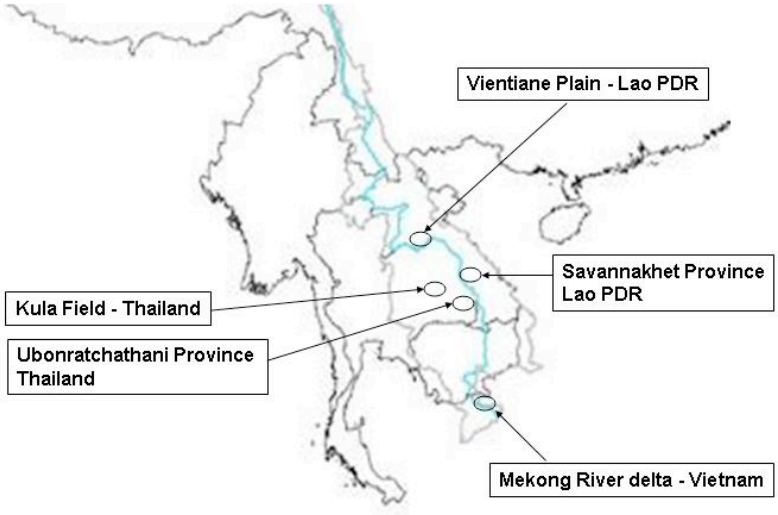


Figure 2. Study sites in Lao PDR, Thailand, and Vietnam.

Table1. *Multiple Orders of Climate Impacts on Rain-Fed Farms in the Lower Mekong Region*

Order of Impact	**Description**	**Impact(s)**
First-order impacts	Biophysical consequences of meteorological events	• Drying of soil due to midseason dry spell, particularly after the seeding or transplanting • Flooding due to unusual 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 and permanent) • Migration of entire household and exit from farming • Change in social status (e.g. change from independent farmer to contracted farmer or hired labor) • Conflict among villages
Fifth order impacts	Consequences of the fourth-order impacts	• Reduced labor force in farming communities • Greater costs for hired labor, machinery to replace labor

Table 2. *Farm-Level Measures for Managing Climate Risks*

Measure	**Objective**	**Current Implementation**	**Effectiveness**	**Enabling and Limiting Factors**
		On-farm measures		
Change seed variety—seasonal	Food security—to maintain an acceptable level of productivity under the seasonal climate pattern.	*Lao PDR:* Common practice—local seed varieties acceptable for local consumption. Indigenous knowledge still used for seasonal forecasting. *Thailand:* Limited—farming practice driven by market conditions; local seed varieties not widely accepted. *Vietnam:* Moderate—short-cycle seed variety also accepted by the market, but at a lower price.	Moderate—only able to cope with certain level of climate variability, e.g., moderate dry spell or moderate flood.	• Precision of seasonal climate forecast • Market acceptance • Consumption preference
Change seed variety—permanent	To meet market requirements and increase resilience of farming to severe climatic condition.	*Lao PDR:* Limited—not influenced by market conditions due to the market structure. Also limited implementation in breeding research. *Thailand:* Common practice—in commercial farming. Possible to research ways to breed new varieties.	Moderate—further research required in breeding new rice varieties	• New breed availability • Market acceptance • Consumption preference

		Vietnam: Common practice—commercial farming.		
Multiple farmland locations	To balance risks from climatic impacts	*Lao PDR:* Limited—depends upon geographical characteristics of the village *Thailand:* Limited—depends upon land availability and geographical characteristics of the village *Vietnam:* Limited—depends upon the geographical characteristics of the village	High—can balance risk, but low future potential	• Land availability • Population growth in the community • Geographical characteristics of the area
Adjusting planting technique and crop calendar to match climate pattern	To maintain an acceptable level of productivity under the seasonal climate pattern.	*Lao PDR:* Common practice—use of indigenous knowledge and flexibilty in seed variety selection. *Thailand:* Moderate—change in seedling technique; inflexible crop calendar for some seed varieties dictated by the market *Vietnam:* Moderate—long rainy season allows more flexibility in crop calendar and seed variety selection.	Low	• Precision of seasonal climate forecast • Flexibility of seed variety
Maintain appropriate farming conditions—	To maintain an acceptable level	*Lao PDR:* Limited—lack of resources.	Low in Lao PDR due to lack of	• Geographical conditions

e.g., small-scale irrigation system/embankments in the farmland	of productivity under seasonal climatic stress.	*Thailand:* Moderate—limited investment capacity *Vietnam:* Moderate—limited investment capacity	resources. Moderate to high in Thailand and Vietnam.	• Initial investment • Operating cost
Planting alternate crops in between rice crop seasons	Additional food supply/additional income	*Lao PDR:* Limited to moderate—depends on water availability and market conditions. *Thailand:* Limited to moderate—depends on water availability and market conditions. *Vietnam:* Limited to Moderate—2 crop seasons for rice is the normal practice.	Moderate.	• Market • Farm land—size and condition • Water supply
Changing to more climate-resistant crops	Household income security under climate stress.	*Lao PDR:* Limited—lack of know-how;based upon market conditions and dependence on rice cultivation for food security. *Thailand:* Limited to moderate—depends on resources available. *Vietnam:* Limited—dependence upon rice cultivation for national food security.	High—only applicable to certain farms but has potential.	• Soil condition. • Size of farmland • Know-how • Market conditions • Financial reserve • Local culture
Livestock	Secure	*Lao PDR:* Common practice—at a	High	• Capital

	household income under climate stress.	small scale (household level). *Thailand:* Common practice—at a small scale (household level). *Vietnam:* N.A.		• Farmland size and condition
Off-farm measures				
Harvest natural products	Additional food supply/additional income	*Lao PDR:* Common practice. *Thailand:* Limited—due to high population and ecosystem degradation. *Vietnam:* N.A.	High in Lao PDR. Moderate to low in Thailand and Vietnam.	• Productivity, diversity, and condition of the natural ecosystem
Nonfarm products, e.g., handicraft	Additional income	*Lao PDR:* Limited—due to the existing market structure. *Thailand:* Moderate—depends upon market conditions. *Vietnam:* N.A.	Low to moderate in Lao PDR and Vietnam. Moderate in Thailand.	• Know-how • Market
Seasonal migrating	Additional income	*Lao PDR:* Limited—due to existing urban economic conditions. *Thailand:* Common practice. *Vietnam:* N.A.	Low in Lao PDR and Vietnam. High in Thailand	• Capacity of other economic sectors / urban areas • Networks for job search
Permanent migration by family member	Income security under conditions	*Lao PDR:* Limited—because of existing urban economic conditions.	Low in Lao PDR and Vietnam. High	Capacity of other economic

	of climatic stress	*Thailand:* Common practice. *Vietnam:* Limited.	in Thailand	sectors/urban area

N.A., not available.

Table 3. *Community Level Measures for Managing Climate Risks*

Measure	**Objective**	**Current Implementation**	**Effectiveness**	**Enabling and Limiting Factors**
Shared resources—rice reserve/fish pond	Buffered food supply/additional income for community	*Lao PDR:* Common practice—partly due to culture and practice from war era. *Thailand:* Limited—competitive living conditions and repetitive crop failure. *Vietnam:* N.A.	High in Lao PDR. Low in Thailand and Vietnam.	• Guaranteed replenishment (community rice reserve) Guaranteed replenishment (community rice reserve)
Village fund	Funding to assist reinvestment in farming/sustaining livelihoods	*Lao PDR:* Limited—has begun to expand and come under community management. *Thailand:* Common practice—under government management. *Vietnam:* N.A.	Moderate in Lao PDR and Thailand.	• Guaranteed repayment by borrower
Cooperative network among villages—off-village farming practice	To obtain partial rice production to sustain livelihoods	*Lao PDR:* Moderate—depends on relationship between community leaders. *Thailand:* Limited—competitive living conditions. *Vietnam:* N.A.	Low to moderate in Lao PDR. Low in Thailand and Vietnam.	• Relationship between village leaders
Processing farming and/or natural products		*Lao PDR:* Limited. *Thailand:* Limited. *Vietnam:* N.A.	Moderate	• Know-how • Capital • Market

Table 4: *National-Level Measures for Managing Climate Risks*

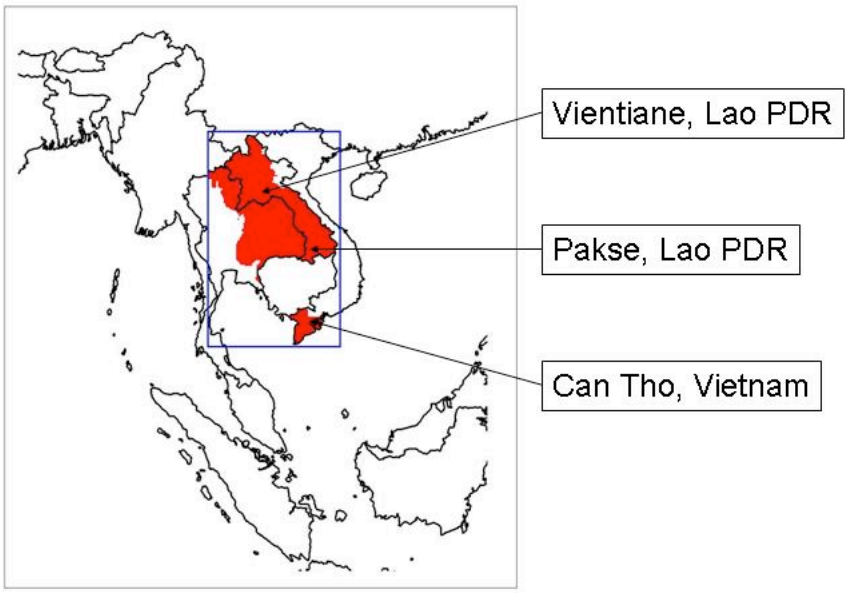
Measure	**Objective**	**Current Implementation**	**Effectiveness**	**Enabling and Limiting Factors**
Financial support infrastructure	Funding to assist reinvestment in farming/sustaining livelihood	*Lao PDR:* Limited—limited institutional arrangement and local cultural influence. *Thailand:* Common practice. *Vietnam:* Moderate.	Low in Lao PDR. Moderate in Vietnam. High in Thailand.	• Sufficient funding • Mechanism to reach and allocate available funds to the farmers in need • Terms and conditions of loan
Support in transition to a more diversified farming system	Sustained farming practice	*Lao PDR:* Limited—due to limited know-how and resources. Livelihoods also sustained by reliance on ecosystem products. *Thailand:* Limited—Expanding farming sector driven towards monocropping by the market. Vietnam: N.A.	Low in Lao PDR. Moderate in Thailand and Vietnam.	• Budget • Know-how transfer
Support in transition to other plants	Sustained farming practice	*Lao PDR:* Limited—need for focus on rice farming to provide food security. *Thailand:* Moderate—but limited to small farmland owners. *Vietnam:* Limited—need for focus on rice farming for food security.	Low in Lao PDR and Vietnam. Moderate in Thailand.	• Budget • Know-how transfer • Soil property
Support in marketing village products	Income diversification	*Lao PDR:* Limited—market structure. *Thailand:* Moderate *Vietnam:* N.A.	Low in Lao PDR and Vietnam. Moderate in Thailand.	• Appropriate marketing mix • Mechanism to develop a sustained market
R&D—new seed varieties	Sustain farming	*Lao PDR:* Moderate—need to develop know-how.	Low in Lao PDR. Moderate in Thailand and Vietnam.	• Budget • Time • Technology

		Thailand: Common practice. *Vietnam:* Common practice.		
Infrastructure development—dams, other water diversion infrastructure, underground wells, irrigation network	Sustain farming	*Lao PDR:* Limited—limited investment capacity. *Thailand:* Moderate—also limited technical feasibility. *Vietnam:* N.A.	Moderate	• Budget • Geographical conditions
Information for farming planning—e.g., seasonal or interannual climate prediction	Proper planning of farming activities	*Lao PDR:* Nonexistent. *Thailand:* Limited. *Vietnam:* Limited.	Moderate	• Technology • Communication channel and format

Appendix 1

Lower Mekong Region Rainy Season Characteristic Under Simulated Climate Change Scenarios

These charts show the results of analysis of the climate scenarios, which were simulated by CCAM climate model under this study. They show changes in rainy season patterns in three locations in the lower Mekong River region in order to illustrate trends in future changes in rainy season characteristics under the influence of climate change of this region.



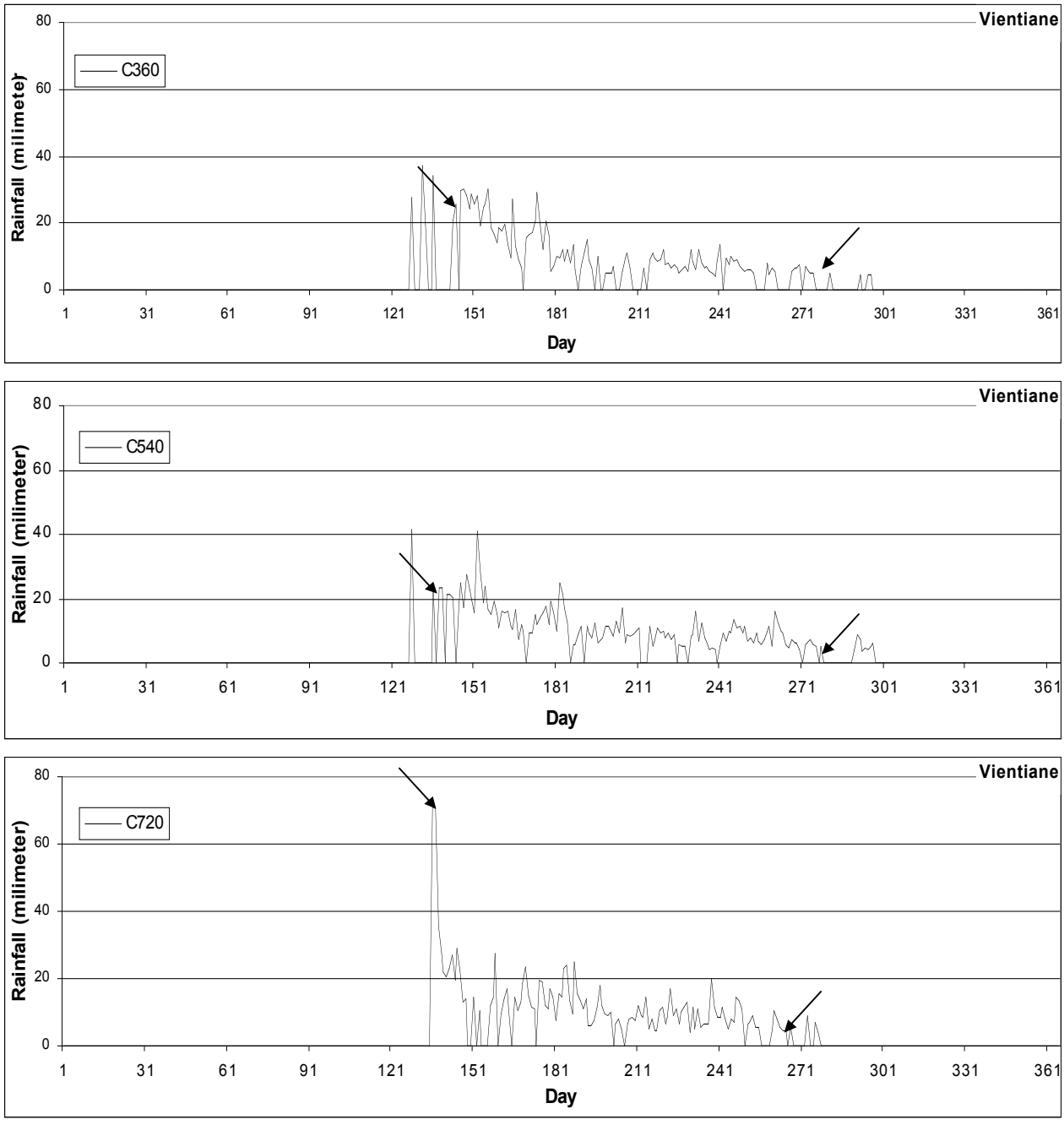


Figure A2. Rainy season characteristics under climate change influence at Vientiane, Lao PDR.

Table A1.

CO_2 Scenario	Onset Date	End Date	Length of Rainy Season (days)	Annual Rainfall (mm)
Baseline	146	275	130	1229
540 ppm	136	278	143	1511
720 ppm	136	267	132	1502

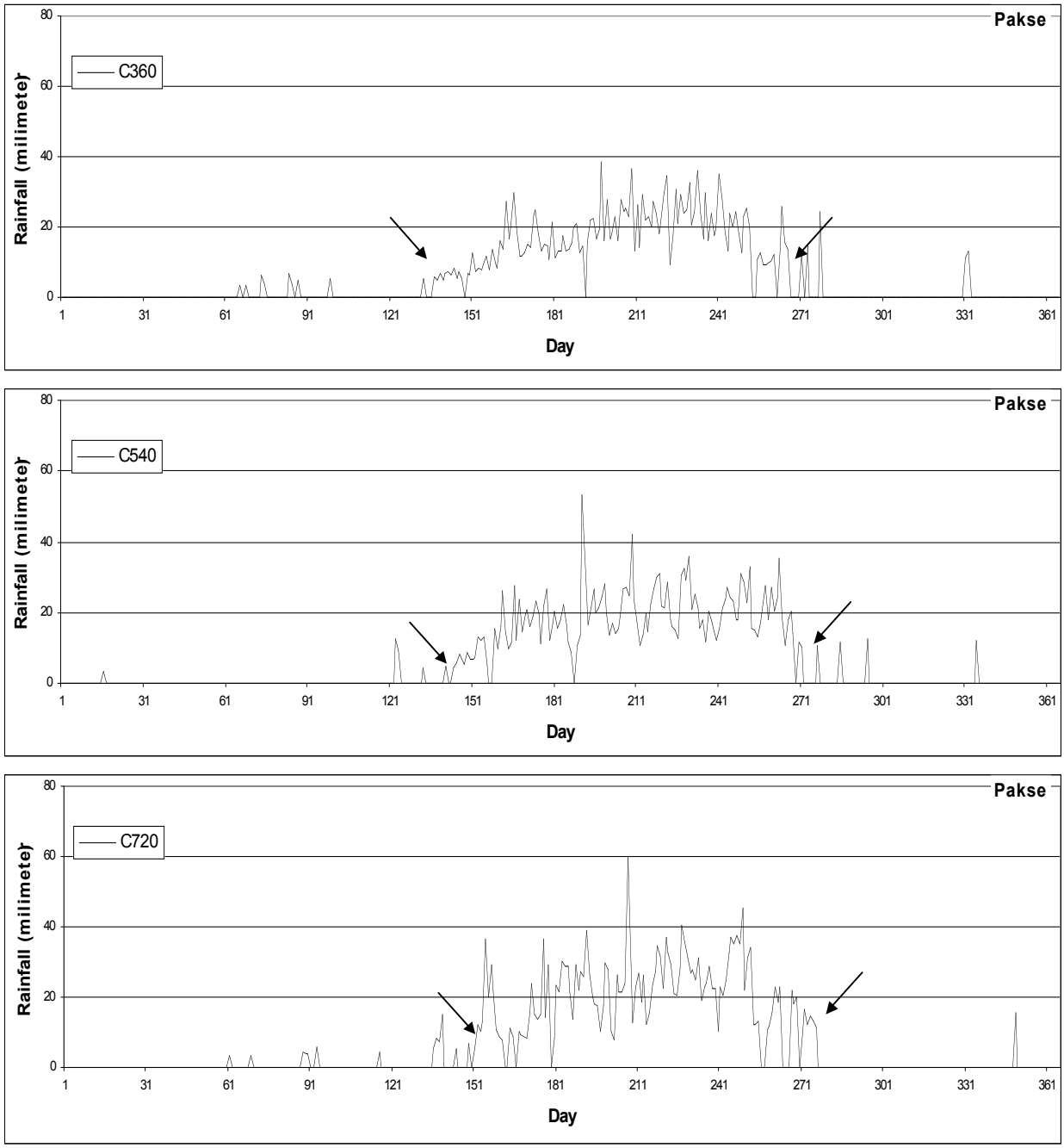


Figure A3. Rainy season characteristics under climate change influence at Pakse, Lao PDR.

Table A2.

CO_2 Scenario	Onset Date	End Date	Length of Rainy Season (days)	Annual Rainfall (mm)
Baseline	137	267	130	2213
540 ppm	145	271	128	2370
720 ppm	152	277	126	2551

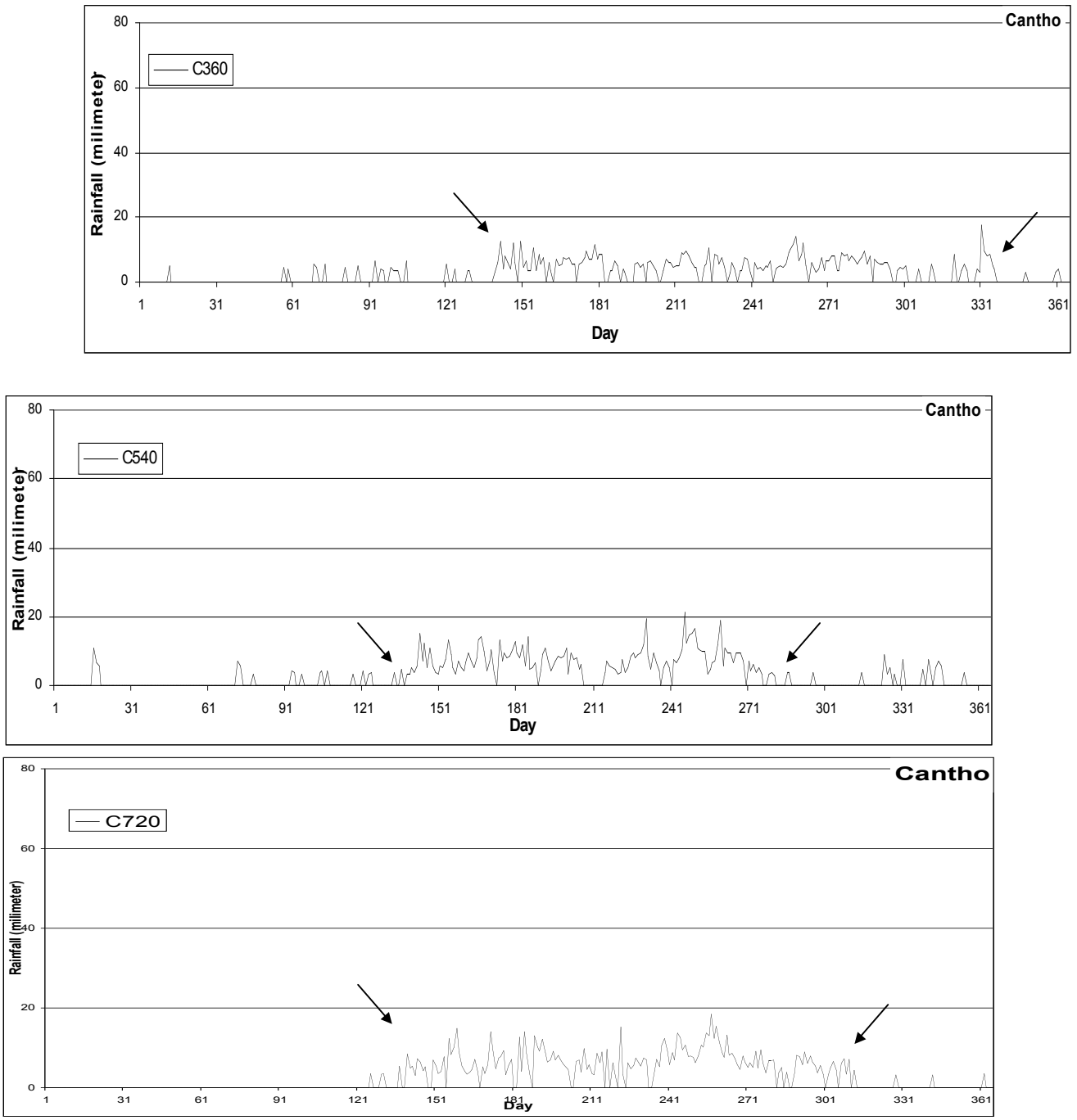


Figure A4. Rainy season characteristic under climate change influence at Can Tho, Vietnam.

Table A3.

CO_2 Scenario	Onset Date	End date	Length of Rainy Season (days)	Annual Rainfall (mm)
Baseline	140	336	197	959
540 ppm	133	287	155	1027
720 ppm	137	312	176	1105