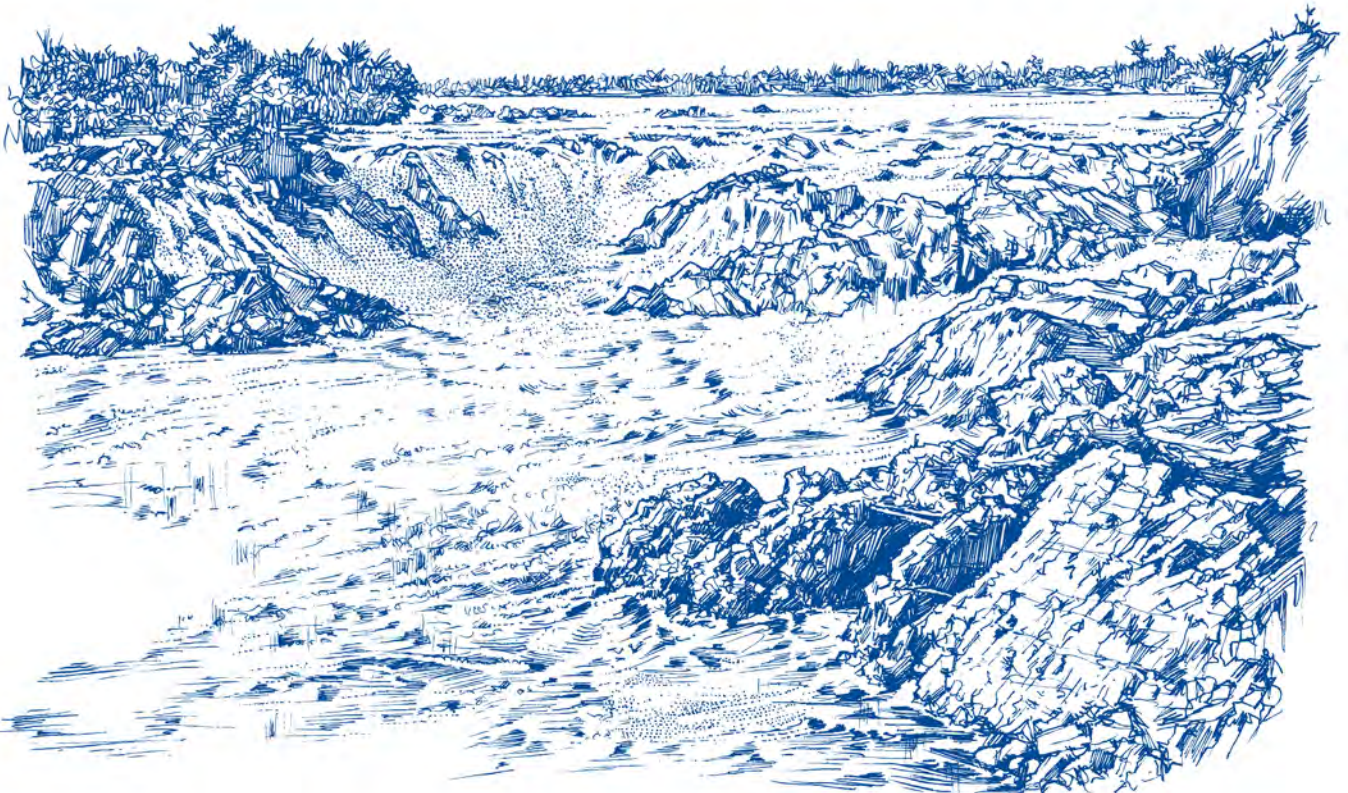




LAO PDR CLIMATE CHANGE VULNERABILITY PROFILE

BASED ON THE USAID MEKONG ARCC CLIMATE CHANGE IMPACT AND ADAPTATION STUDY

The Lower Mekong Basin (LMB) encompasses the major part of Lao PDR and its diverse physiographic regions including the northern highlands, which are the uplands extending through northern Lao PDR, northern Thailand, and Myanmar; and the Annamites, a high mountain range which forms much of the border between Lao PDR and Vietnam. The LMB portion of Lao PDR also incorporates significant stretches of alluvial plains along the Mekong mainstream, as well as the ecologically unique areas known as Siphandone (literally “four thousand islands”) and the Khone Phapeng Falls that are situated just upstream of the border between Lao PDR and Cambodia.

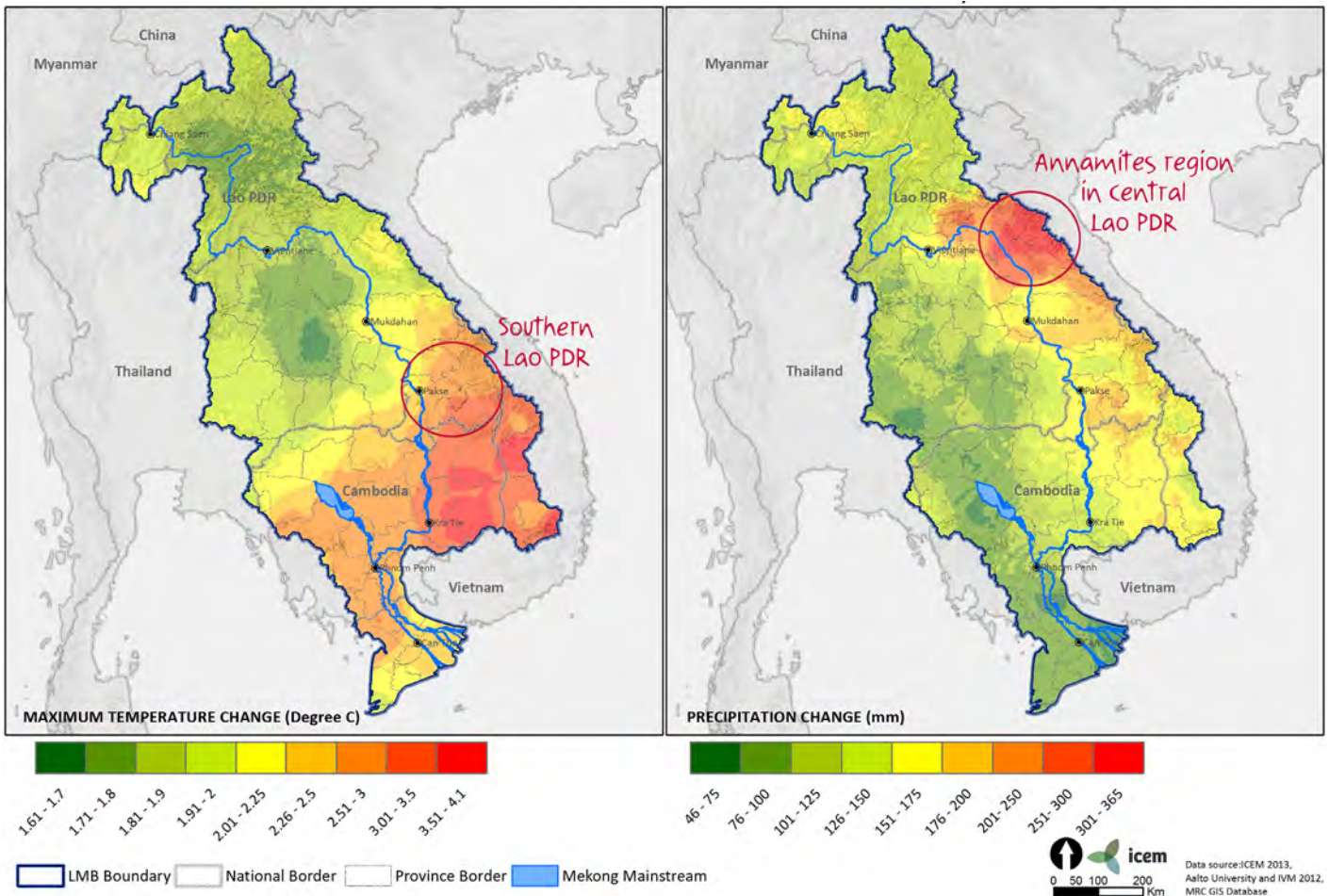


The results of the USAID Mekong ARCC Climate Change Impact and Adaptation Study indicate that Lao PDR will experience pronounced changes in rainfall and temperature patterns by 2050 with significant ramifications for ecosystems, and communities and the livelihoods that support them.

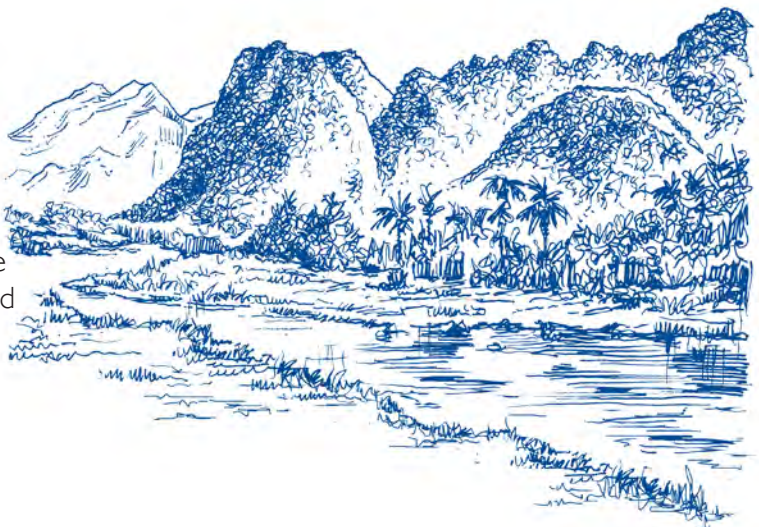
Key findings include the following:

- *The central and northern Annamites region of Lao PDR will experience some of the largest relative increases in precipitation that are projected for the LMB (Figure 1); more precipitation during the traditional growing season will impact crops through increased flooding, waterlogging of soils, and higher incidence of fungal disease and pests.*

Figure 1: Projected annual average maximum daily temperature and annual precipitation changes in the Lower Mekong Basin between 2005 and 2050.



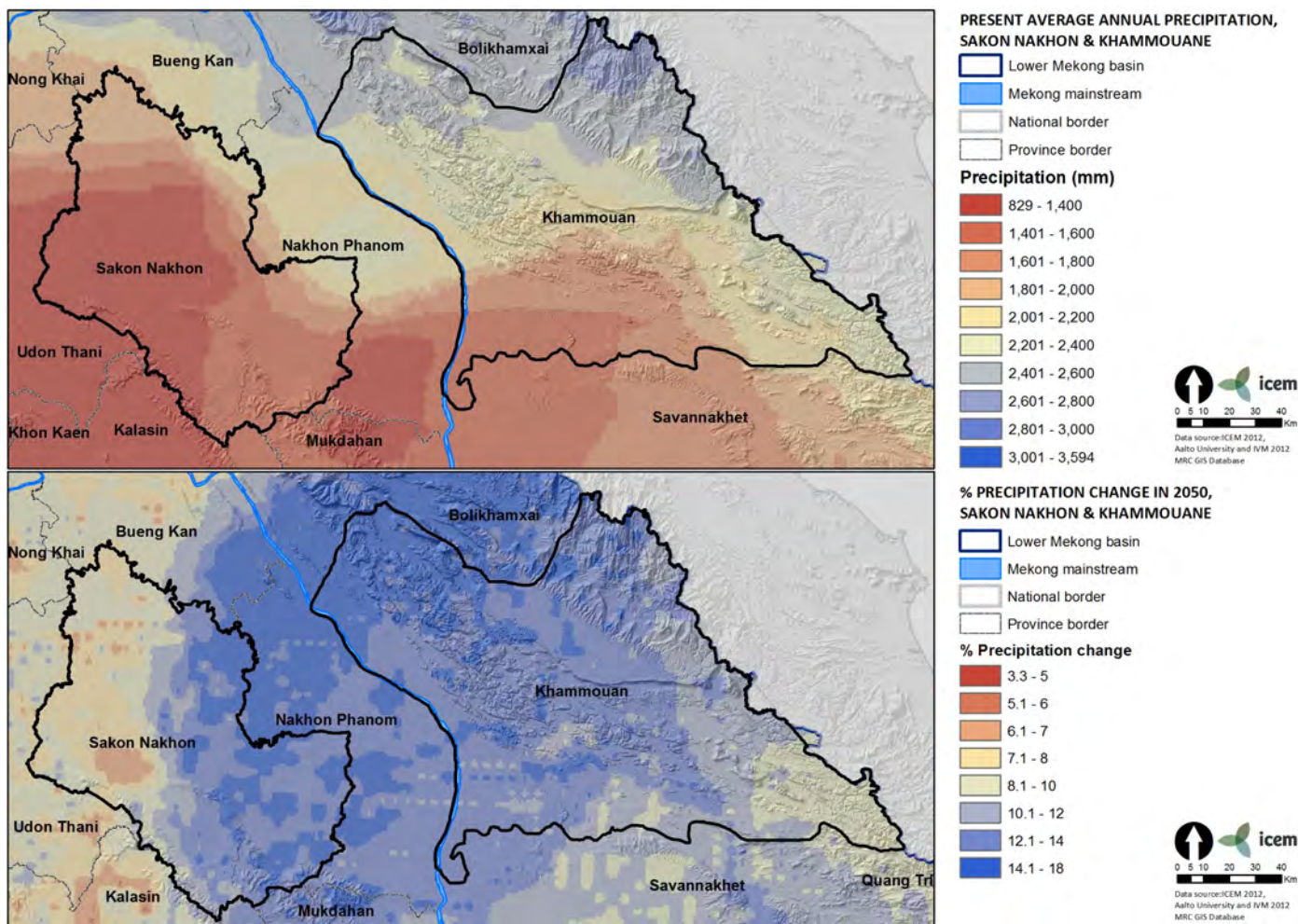
- *Large rainfall events (i.e., greater than 100 mm/day) will occur more frequently. In Khammouan Province, for example, such events will increase in frequency from once every 2.5 years to once every 2 years. This increase in large-event frequency will intensify costs and damages related to associated calamities such as flooding and landslides.*
- *Daily maximum temperatures will rise by roughly 2°C to 3°C in Lao PDR with higher increases to the south (Figure 1); in Champasak Province, for example, the average daily maximum temperature will rise from 33°C to 36°C. During the more extreme years, temperatures are expected to exceed 44°C. This increase in both average and extreme temperatures will have potentially devastating impacts on crops, livestock, and human health.*



ANNAMITE MOUNTAIN RANGE/CENTRAL LAO PDR

Khammouan Province in Central Lao PDR is projected to experience some of the largest relative increases in precipitation within the LMB with annual precipitation increasing by 8 – 18% (Figure 2).

Figure 2: Khammouan Province projected change in annual average precipitation.



Monthly precipitation is projected to increase for all months in Khammouan except during January and February. Relative increases in rainfall will be highest during the months of April, May, and September with a >20% increase in monthly precipitation. In terms of absolute values, this equates to an additional 28 mm, 73 mm, and 74 mm for April, May, and September, respectively (Figure 3). Annual rainfall in Khammouan is projected to increase by 335 mm (2,610 to 2,945 mm/yr).

The projected changes in the timing and extent of rainfall in Central Lao PDR will present challenges to livelihood productivity such as changing seasonality and an earlier start to the growing season; increased exposure to risks such as flooding, landslides, and waterlogged soils; and the potential for heightened spread of disease.

In Khammouan, there will be a positive shift of 2°C in average daily maximum temperatures throughout the year (Figure 4). The increase will be more pronounced, however, during the growing season. For example, during July and August daily maximum temperatures for a typical year are projected to hover around 30°C under climate change compared to around 27°C under baseline conditions. During extreme years under climate change, temperatures will occasionally exceed 40°C during this same period in the growing season.

Figure 3: Monthly precipitation for a typical year in Khammouan, Lao PDR.

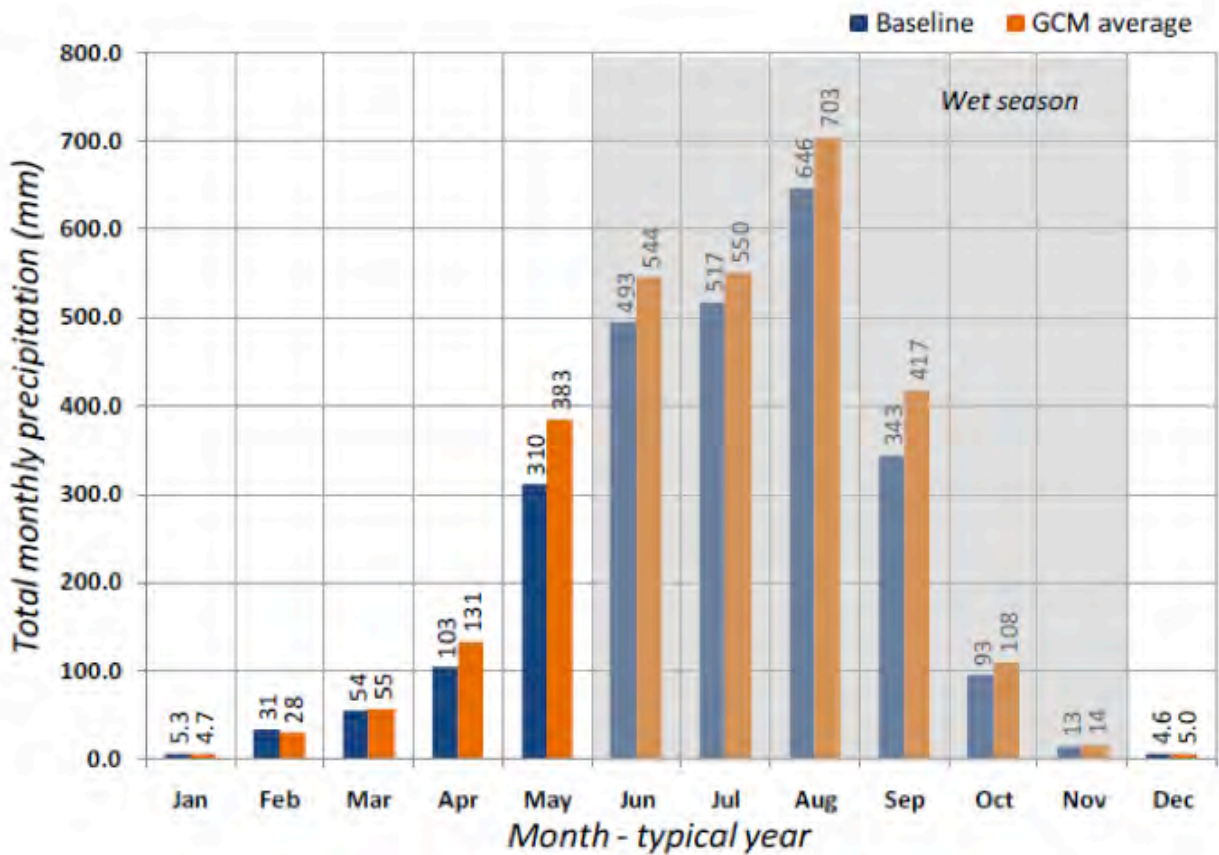
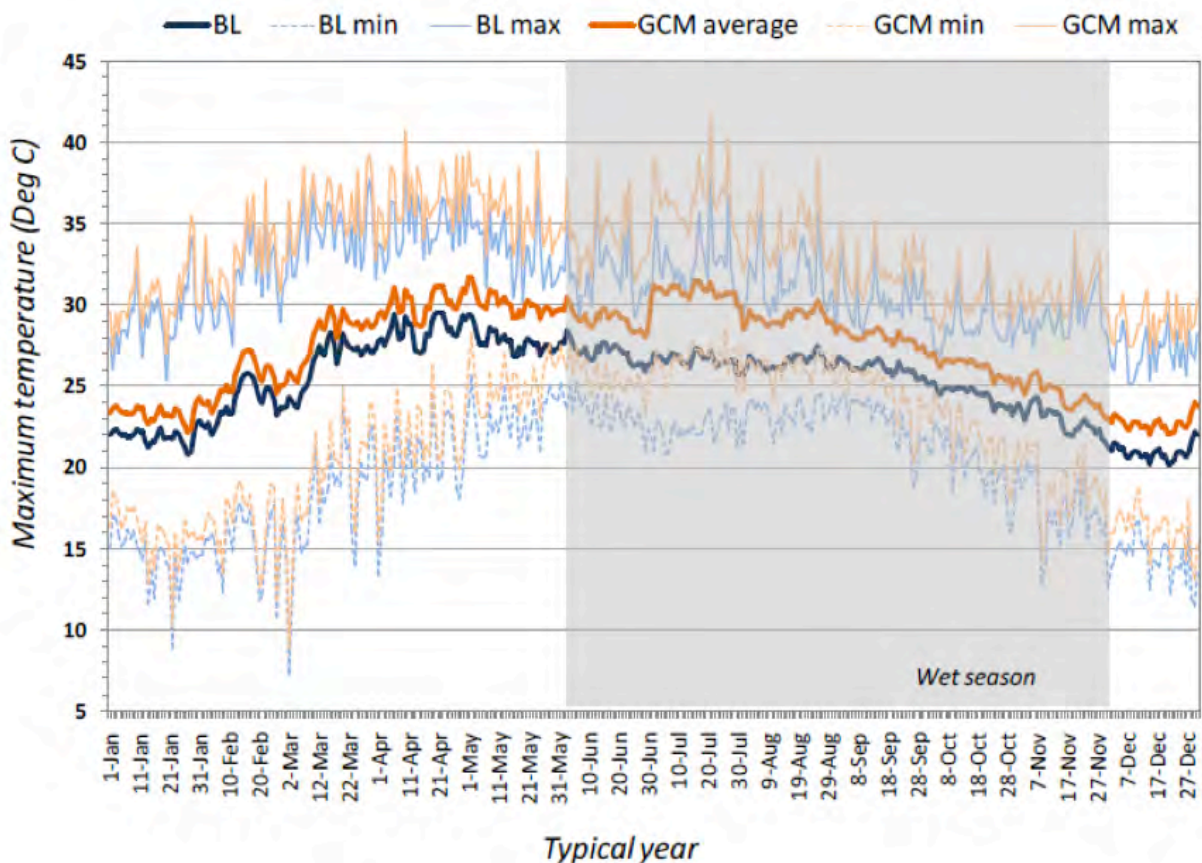


Figure 4: Maximum temperature typical year time series for a forested uplands area in Khammouan Province. Solid lines represent average daily maximum temperatures over a 25 year period for baseline (blue) conditions and projected climate change (orange) conditions.



Climate Change Threats and Sectoral Vulnerabilities in Central Lao PDR

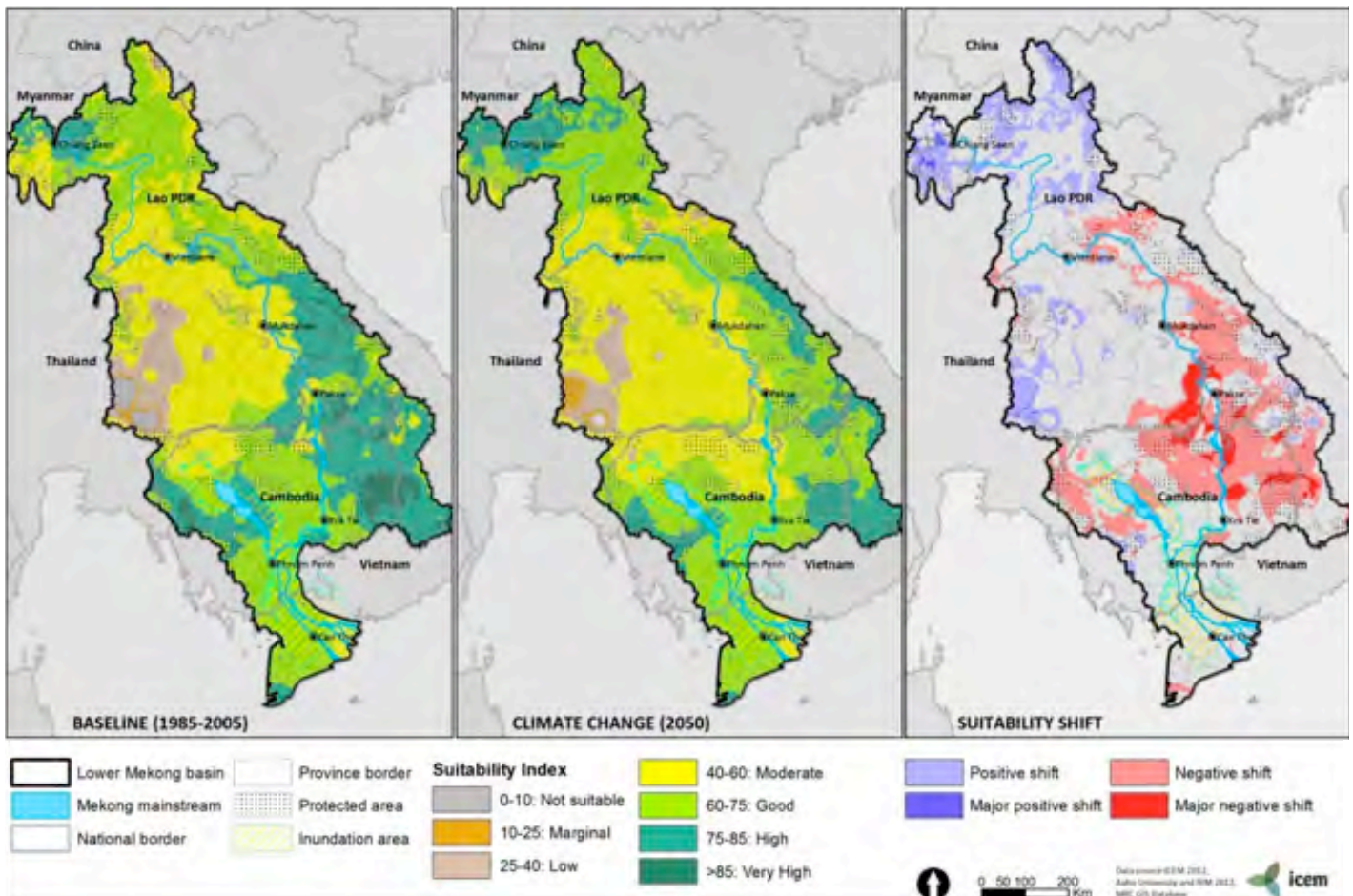
The vulnerabilities of the main crops cultivated in Central Lao PDR are related to effects from extreme rainfall events and increased precipitation, as well as increased temperature (Table 1). In Khammouan Province, for example, the farming system in upland areas will be strongly affected by the increase in rainfall and extreme events, lowering yield and increasing rates of erosion. Lowland areas will face higher incidences of floods and associated damages. The recent development of cassava culture will likely stop as the province will be less suitable for its cultivation and a shift of crop cultivation will probably be required.

Table 1: Main threats and vulnerability for crops in Khammouan Province, Lao PDR

| Vulnerable Crop | Threat | Impact Summary | Vulnerability |
|---|--------------------------------------|---|---------------|
| Lowland rainfed rice | Increased temperature | Increased temperature may impact productivity and lower yield. | High |
| Lowland rainfed rice, Cassava, Maize, Sugarcane | Flooding, flash flooding, and storms | Increasing frequency of rainfall events of >100 mm/day with a maximum of 200 mm/day expected; high storm frequency will increase the threat from rain events. | High |
| Cassava, Maize | Increased precipitation | Increased monthly precipitation of 5% to 27% between April and November; Monthly precipitation above 500 mm in June, July, and August (in August, monthly precipitation will reach 700 mm). Threat will be accentuated on heavy soil prone to waterlogging. | High |

- Due to the topography of the region, with both mountainous areas and floodplains, **extreme climatic events that involve storms and heavy rainfall above 100 mm per day will increase the threat for lowland rainfed rice, maize, cassava, and sugarcane.** Climate suitability was found to be lower for these crops by 2050 as a result of projected increases in precipitation.
- **Maize yields are expected to decline by 5.3%** compared to the 2010 baseline. However, maize production remains a limited percentage of the agriculture sector in Central Lao PDR and this change in yield will not drastically affect the sector.
- Cassava and sugarcane will be threatened by increases in precipitation and higher incidences of extreme climatic events; although sugarcane will be less affected by waterlogging compared to cassava. **Rubber will benefit from higher rainfall due to a shortened drought period, although some decline in suitability is expected within this region** (Figure 5).
- **Fisheries in Central Lao PDR will be affected by increased temperatures and changes in rainfall patterns.** Migratory white fish may be impacted by the loss of suitable refuge pools due to higher temperatures and decreased precipitation during a portion of the dry season. **Higher temperatures will affect the water quality of aquaculture ponds while increased flash flood events will decrease stocks and impact pond infrastructure.**
- **Livestock impacts include reduced reproduction and immunity** due to heat stress, and secondary impacts related to decreased fodder availability. **Increasing flood events will accelerate the spread of disease and herd loss.** In Central Lao PDR, smallholder cattle/buffalo systems are most vulnerable to temperature. The effects of an incremental increase in temperature will be limited as stock will gradually become accustomed to high temperatures. But extreme temperatures ('snaps') may have direct impacts on animal value, productivity, and resilience to disease.

Figure 5: Baseline and 2050 land suitability for rubber in the Lower Mekong Basin.



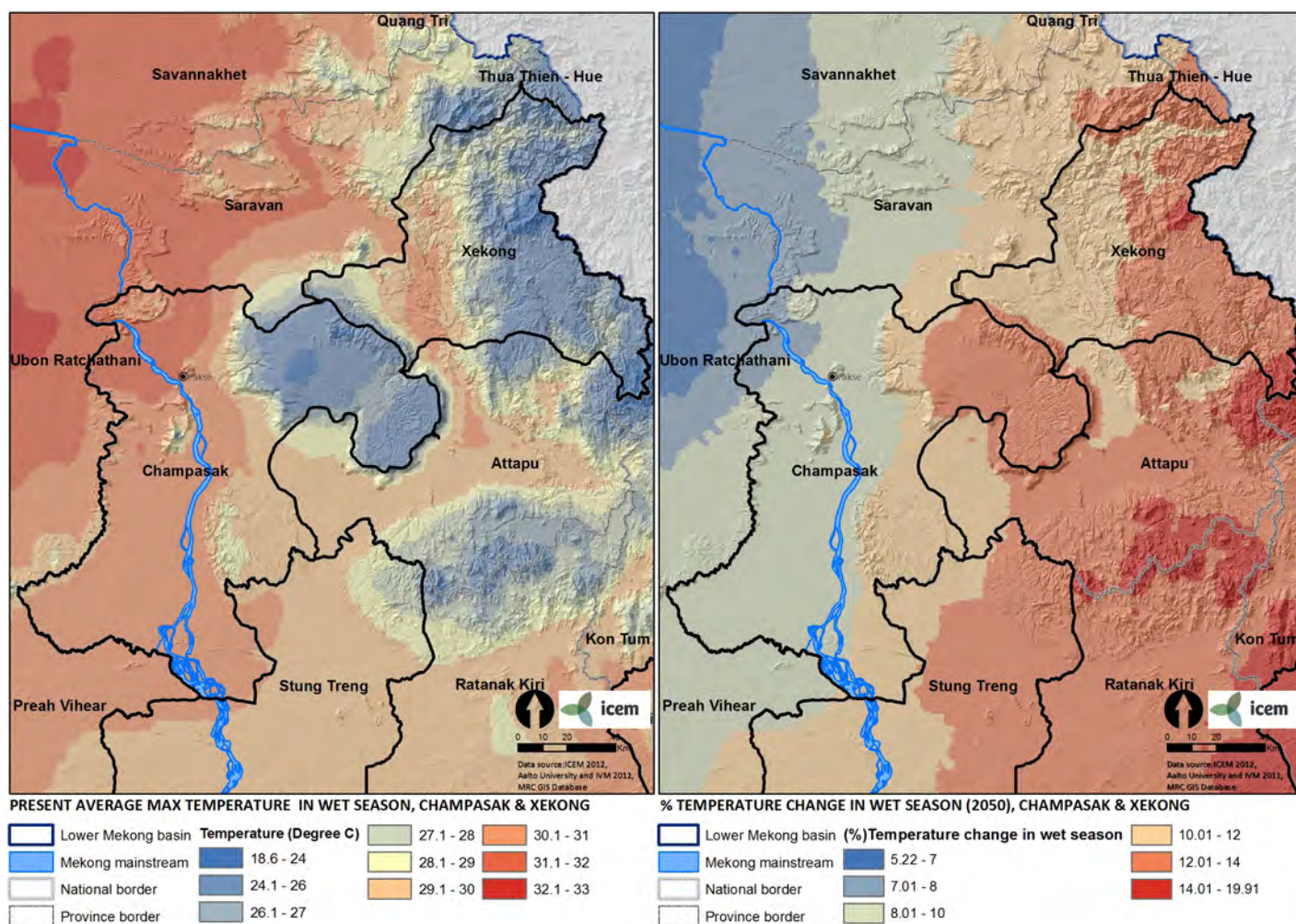
CHAMPASAK AND SOUTHERN LAO PDR

Champasak Province in southwestern Lao PDR is characterized by a specific agro-system, including the Bolaven Plateau (in the northeast corner of the province) that supports smallholder, rainfed Robusta coffee culture; and the Mekong corridor where there is development of commercial agriculture. The rubber concession covers a large area of the province and cassava culture has expanded in recent years. **Crops in Champasak Province will face threats from increased precipitation (+175 mm/yr) and temperature (+2.5°C mean annual temperature)** that will affect several crops' yields. Farming systems in the province for both smallholder and commercial plantations will face radical changes in terms of climate suitability in their production systems.

Under baseline conditions, average maximum temperatures along the Mekong corridor in southern Lao PDR range from roughly 30°C to 32°C during the growing season (Figure 6). Under climate change, we can expect an increase in wet season temperature of about 3°C. Growing season temperatures will therefore approach 35°C on a more routine basis, **which will result in significant stress on agricultural crops and other livelihood systems.**



Figure 6: Wet season average maximum temperatures in Champasak (map on left) and projected percent change by 2050 (map on right).



Climate Change Threats and Sectoral Vulnerabilities in Southern Lao PDR

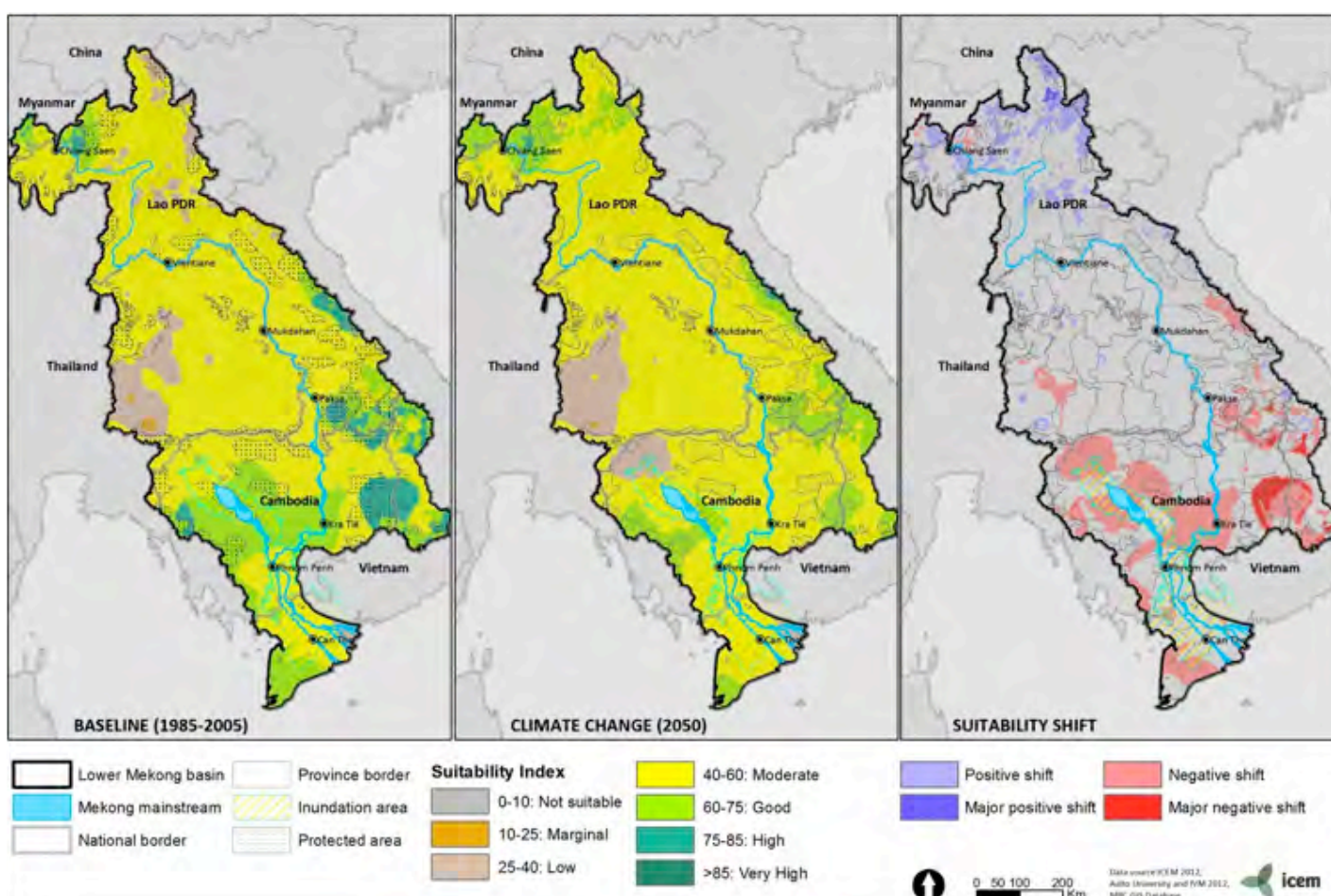
Table 2 outlines the main threats and vulnerabilities for crops in Champasak Province, Lao PDR.

Table 2: Main threats and vulnerability for crops in Champasak Province, Lao PDR

| Vulnerable Crop | Threat | Impact Summary | Vulnerability |
|--|-------------------------|---|-------------------|
| Lowland rainfed rice, Irrigated rice, Robusta coffee | Increased temperature | Critical period in March, April, and May with more than 50% of daily temperatures above 35°C; this will affect irrigated crops grown during dry season. Daily maximum temperature above rice optimal zone during the wet season. Extreme maximum temperatures above 36°C throughout the year. | High to Very High |
| Cassava, Robusta coffee, Lowland rice | Storms (flashflood) | Extreme events will increase in frequency and cause increased flooding. | High |
| Cassava, Maize, Robusta coffee | Increased precipitation | Total precipitation during the growth cycle will be below the upper limit (2,300 mm/yr) for cassava but above optimal zone. Precipitation above suitable range (close to or greater than 400 mm) in July and August for maize. | High |

- Irrigated rice is cultivated by 20% of the farmers in this region and this crop will face a critical period at the end of the dry season, with a significant increase in temperature. **Lowland rainfed rice** will also face increased temperatures; especially early wet season rice. Crop yield modeling estimated a decrease in yield of about 5.6% for Champasak, corresponding to **a drop of more than 11,000 tonnes of the annual provincial production.**
- **Robusta coffee, traditionally cultivated on the Bolaven Plateau, will face serious threats** with extreme temperatures above 36°C occurring throughout the year. Coffee will also face the threat of more frequent storms with heavy rainfall that may lead to flashfloods. The combined effect of increased precipitation and temperature may lead to an increase in pest occurrence and crop disease. A general decrease in suitability is predicted for Robusta coffee in southern Lao PDR (Figure 7).

Figure 7: Baseline and 2050 land suitability for Robusta coffee in the Lower Mekong Basin.



- Cassava culture will face waterlogging if planted on soil that does not drain well and maize crops will have reduced yields due to heavy rainfall at the end of the crop season. **The crop yield model estimated a drop in yield in Champasak of about 5.5% compared to the baseline resulting in a decrease of 2,000 tonnes of maize at the provincial level.**
- Livestock may see **reduced reproduction rates and immunity due to heat stress, and increased spread of disease and herd loss due to increased flood events.**

POTENTIAL ADAPTATION OPTIONS

Agriculture

Adapting the agriculture sector to climate change in Lao PDR will involve a mix of strategies, possibly including:

- Strengthening the resilience of both rainfed and irrigated rice-based systems through adoption of improved varieties and better management practices and reducing vulnerability to extreme climate events. This could include the use of specific varieties to mitigate the impact of flooding and extreme heat, as well as the shifting of cropping calendars to avoid harvest during periods of high rainfall.
- Improving soil fertility and soil management of both cash and subsistence systems such as improved erosion control techniques and intercropping.
- Promoting agricultural diversification and mixed farming systems to mitigate current trends of reliance on monocultures.

Livestock

The improvement of livestock development and resilience to climate change falls into five broad strategies:

- **Nutrition:** The quality and quantity of feed production, storage, and the nutritional balance of diets needs to be increased to reduce undernourishment.
- **Disease resistance:** Internal resistance needs to increase to reduce the threat of disease through improvement of nutritional status, body condition, and vaccination levels. It also requires improved biosecurity to prevent the movement of diseases onto and off farms and to reduce the risk of pathogens entering the herd or flock.
- **Housing:** Location and design should maximize natural ventilation and minimize exposure to extreme events.
- **Production planning and offtake:** Reducing inbreeding, earlier weaning, and strategic offtake plans can increase resilience of livestock systems.
- **Access to markets:** Improved access to input and output markets and producer organizations would reduce input costs, increase prices received, and reduce price volatility.

Fisheries

Due to its diversity of systems, scales of production, inherent manageability, and control of environments, aquaculture potentially offers more scope for adaptation to climate change than capture fisheries. Strategies for the fisheries sector include:

- Pond aeration to mitigate the effects of increased temperature;
- On-site water storage to reduce the risks of reduced water availability during the dry season;
- Strengthening of embankments to protect against flooding will be necessary for ponds in many areas; and
- Diversion canals may also have to be dug to channel water away from vulnerable pond areas.

Regardless of the livelihood sector, successful adaptation will require flexibility and a diversity of approaches to adapt to shifting conditions.

USAID Mekong Adaptation and Resilience to Climate Change (USAID Mekong ARCC)

11th Floor, Mahatun Plaza Building, 888/118 Phloenchit Road, Lumpini, Pathumwan, Bangkok, 10330, Thailand
Tel: +66.2.650.9919 to 21 Fax: +66.2.650.9922 E-mail: info@mekongarcc.net

Web: <http://www.mekongarcc.net>

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