CLIMATE CHANGE ADAPTATION AND IMPACT STUDY
SUMMARY:
Assessing Threats to Lower Mekong Livelihoods, Communities, and Ecosystems

Mekong Adaptation and Resilience to Climate Change (Mekong ARCC)

October 2012
About the Mekong Adaptation and Resilience to Climate Change project

Mekong ARCC is a five year project (2011-2016) funded by the USAID Regional Development Mission for Asia (RDMA) and implemented by DAI in partnership with the International Centre for Environmental Management (ICEM) and World Resources Institute (WRI). The project focuses on identifying the environmental, economic and social effects of climate change in the Lower Mekong Basin (LMB), and assisting highly exposed and vulnerable rural populations in ecologically sensitive areas to increase their ability to adapt to climate change impacts on water resources, agricultural systems, biodiversity, ecosystems, and livelihood options. Mekong ARCC is headquartered in Bangkok with project activities carried out in Thailand, Vietnam, Cambodia and Lao PDR.

The primary goal of Mekong ARCC is: Increase adaptation capacity and resilience of communities to the negative impacts of climate change.

Objectives of the project include:

• Increase human and institutional capacity to develop and implement climate change adaptation plans and strategies.

• Strengthen policies, tools, methodologies and practices for ecosystem services valuation and climate resiliency.

• Demonstrate and scale-up model actions for integrated approaches to climate change adaptation.

• Support and sustain regional learning networks to share and replicate best practices.

This publication is made possible by the support of the American People through the United States Agency for International Development (USAID). The contents of this document are the sole responsibility of DAI and do not necessarily reflect the views of USAID or the United States Government.
The U.S. Agency for International Development’s (USAID) Mekong Adaptation and Resilience to Climate Change project (Mekong ARCC) is conducting a Climate Change Adaptation and Impact Study that will assist in addressing key knowledge gaps of how climate change will affect livelihoods, communities, and ecosystems in the Lower Mekong Basin (LMB). The Study, which will be completed in early 2013, will translate downscaled modeling data into river basin and site specific maps showing areas and agricultural crops, fisheries, and natural systems most exposed and sensitive to climate impacts.

How the Study Will Be Used
Policy makers, investors, and community leaders often face difficult choices around the use of their natural resources to at once sustain economic growth and build healthy communities. The outcomes of decisions on how best to optimize land, water, and natural resource use can be complicated by unclear and sometimes conflicting information regarding the impacts of climate change.

The Mekong ARCC Study will provide accessible climate change assessments identifying key agricultural, fisheries, and ecological vulnerabilities and the connections between them. Clearly articulated sectoral vulnerabilities will assist government and community leaders make informed decisions that strengthen resilience to climate change. Also, the data driven understanding of climate impacts on sectors and areas across the entire Lower Mekong Basin will contribute new knowledge and insights for research and development.

Key Objectives and Results of the Study
The 10 month Study develops projections of the impacts of climate trends and threats on agricultural production, ecosystems, and livelihoods for a 2°C increase and for two future time slices: 2030 and 2050. Important results of the Study will include:

- A clear delineation of ecological zones (ecozones) most exposed and sensitive to the impacts of climate change - according to two future time slices - 2030 and 2050;
- A prioritized compendium of economic and community vulnerabilities across LMB ecozones, emphasizing climate-driven impacts on food security, rural health, livelihoods, and natural disaster risk;
- An enhanced ability for decision makers to factor vulnerabilities from a cross-section of ecological and socioeconomic variables into policy making and economic investments; and
- Identification of focal provinces and adaptation strategies where Mekong ARCC will undertake field-based efforts to address climate challenges faced by communities.

Who Will Benefit From the Study
To varying degrees, climate change threatens all stakeholders in the LMB. The Study results will provide useful information and analysis to many of these groups, key among them:

- Field practitioners actively engaged in planning and/or implementing development programs focused on improved livelihoods, natural resource management, or economic growth.
- National Government climate change focal points e.g. Ministry of Natural Resources and Environment (MONRE) in Viet Nam and Thailand, Ministry of Environment (MOE) in Cambodia and Water Resources & Environment Administration (WREA) in Lao PDR, which are responsible for facilitating and promoting implementation of the national climate change target plans throughout government and the community;
- The National Mekong Committees and sector agencies in the four LMB countries that are tasked with planning and implementing adaptation options in all their development policies and activities;
- Research institutions and scientists with a focus on the impacts of climate change either within the region or globally;
- Local government authorities and community representatives in agro-ecological zones identified in the Study as falling within areas with high vulnerability to climate change; and
- Private sector companies and trade organizations associated with key sectors – agriculture, forestry, fisheries, and hydropower – that can use results to inform future investments and management strategies.
Climate Trend and Threat Modelling – The Study Methodology

The Mekong ARCC Study team has developed a modelling approach to define and quantify the changes in hydro-meteorological variables over time, and to apply changes in the global climate system down to zones at a subnational scale across the LMB. These factored changes include incidence, magnitude and duration of events such as floods, storms, rainfall-runoff relationships, evapotranspiration, and temperatures. Figure 1 on page 3 is the decision tree the Mekong ARCC team employed to analyze the suite of available modeling options and ultimately define the Study methodology.

Four geographical scales will be considered: (i) global, (ii) Mekong Basin, (iii) Mekong ecozones sharing common bio-physical characteristics such as meteorology, hydrology, ecosystems, land use, and agriculture systems and (iv) provincial level.

(i) Global

The Mekong ARCC Study will apply six Global Circulation Models (GCMs) under the Intergovernmental Panel on Climate Change (IPCC) Emissions Scenarios. GCMs approximate general circulation of the planetary atmosphere and are widely applied for weather forecasting, understanding climate, and projecting climate change at a large scale. The six selected were chosen based on their ability to most accurately replicate daily historical temperature and rainfall data. GCM output is compared to observed information from a reference period of 1980-2005 to calculate period factors.

(ii) Lower Mekong Basin

Since GCMs operate at coarse resolution, they are not appropriate for spatial assessments at basin, national or subnational levels. A statistical technique -- which assumes local climate is conditioned by global climate but does not try to understand physical causality -- is applied by Mekong ARCC to downscale global information to a Mekong Basin scale. An Integrated Water Resource Management Hydrological model will then utilize data from 151 precipitation stations and 61 temperature stations on the Lower Mekong to understand how climate change will alter hydrologic processes and forecast future changes in the movement, distribution, and quality of lower Mekong River water resources. The hydrological models will project changes in rainfall, runoff, flows, infiltration, evapotranspiration, crop suitability, productivity and patterns.

TABLE 1: **Global Circulation Models chosen for the Climate Change Adaptation and Impact Study**

<table>
<thead>
<tr>
<th>Climate model</th>
<th>CO2 Scenario</th>
<th>Abbreviation</th>
<th>Data period</th>
<th>Model resolution (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCCMA_CGCM3.1</td>
<td>A1b, B1</td>
<td>ccA, ccB</td>
<td>1850-2300</td>
<td>3.75° × 3.75°</td>
</tr>
<tr>
<td>CNRM_CMS3</td>
<td>A1b, B1</td>
<td>cnA, cnB</td>
<td>1860-2299</td>
<td>2.8° × 2.8°</td>
</tr>
<tr>
<td>GISS_AOM</td>
<td>A1b, B1</td>
<td>gA, gB</td>
<td>1850-2100</td>
<td>3° × 4°</td>
</tr>
<tr>
<td>MIROC3.2Hires</td>
<td>A1b, B1</td>
<td>miA, miB</td>
<td>1900-2100</td>
<td>1.1° × 1.1°</td>
</tr>
<tr>
<td>MPI_ECHAM5</td>
<td>A1b, B1</td>
<td>mpA, mpB</td>
<td>1860-2200</td>
<td>1.9° × 1.9°</td>
</tr>
<tr>
<td>NCAR_CCSM3</td>
<td>A1b, B1</td>
<td>ncA, ncB</td>
<td>1870-2099</td>
<td>1.4° × 1.4°</td>
</tr>
</tbody>
</table>
The A1B IPCC emission scenario selected reflects a future with rapid economic and population growth and intermediate use of fossil fuels.

12 GCMs have been considered in past studies of the Mekong Basin. The six chosen most accurately replicate historical data for the period 1980-2005.

The study draws downscaled data from the six GCMs using statistical techniques.

The ICEM IWRM hydrological model has the capacity to extend computation to crop modeling.
(iii) **Mekong Ecozones**

Mekong ARCC’s approach to ecozoning identifies areas in the LMB with common bio-physical and socio-economic characteristics, and projects temperature, rainfall and other “shifts” in these areas expected to result from global climate change. Corresponding impacts on biodiversity and ecosystem services; agriculture, aquaculture, fisheries and livestock production; and food security and livelihoods will be determined and described for each zone.

Each climate change induced shift within these zones will be examined according to geography - including change in total area of crop suitability - elevation, and seasonal changes in yields and cropping patterns. The relative level of vulnerability of a zone will be determined taking into account the following factors:

1. **Exposure**
   - significant climate change relative to base conditions
   - exposure to new climate/hydrological conditions

2. **Sensitivity**
   - limited temperature and moisture tolerance range
   - degraded and/or under acute pressure
   - severely restricted geographic range
   - rare or threatened

3. **Adaptive capacity**
   - socioeconomic metrics
   - population dynamics

(iv) **Provincial Level**

The study will identify ecozones and areas within them highly vulnerable to climate change. Using this information, Mekong ARCC will develop a set of options for community-based *integrated adaptation interventions* that link agriculture, animal husbandry, and fisheries sectors with ecosystems at a provincial scale. These focal provinces will be targeted for the implementation of the Mekong ARCC Community and Ecosystem-based Adaptation Demonstration Sites, which will be initiated upon completion of the Study.
FIGURE II: Ecozones in the Lower Mekong Basin
How the Study Measures Climate Change Impacts on Key Sectors and Natural Systems

AGRICULTURE

Alteration of climate in the LMB will bring about changes in temperatures, rainfall, and hydrological conditions that will affect agricultural production. Through the Study, Mekong ARCC’s experts will focus on crops of significant importance for each country. Selection of crops to be examined is based on four criteria:

- Economic contribution to national economies
- Vulnerability to climate change
- Significance for subsistence
- Diversity and coverage over vulnerable areas

The Study begins with an analysis of a broad range of prospective crops as shown in Table 2 below. Their importance for both economic reasons and for subsistence is then reviewed along with their sensitivity to climate and whether they fall into climate vulnerable zones. This will narrow the number of crops analyzed from the initial list and lead to different crops being introduced into the study. Data sources to be used in the analysis will include literature review, GIS overlays of crop locations and consultation with national and international experts.

**TABLE 2: Candidate Crop Species for the Climate Change Impact and Adaptation Study**

<table>
<thead>
<tr>
<th>TOP COMMERCIAL CROPS</th>
<th>Vietnam</th>
<th>Lao PDR</th>
<th>Thailand</th>
<th>Cambodia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice, paddy</td>
<td>Rice, paddy</td>
<td>Rice, paddy</td>
<td>Rice, paddy</td>
<td>Rice, paddy</td>
</tr>
<tr>
<td>Coffee, green</td>
<td>Maize</td>
<td>Rubber</td>
<td>Cassava</td>
<td>Maize</td>
</tr>
<tr>
<td>Cashew nuts, with shell</td>
<td>Coffee, green</td>
<td>Cassava</td>
<td>Sugar cane</td>
<td>Bananas</td>
</tr>
<tr>
<td>Cassava</td>
<td>Tobacco</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fruit trees:** Bananas and mangoes

**Vegetables:** Sweet potatoes, tomatoes, beans, chilli

**Subsistence crops**
- Lowland and upland rice
- Cassava
- Maize
- Peanuts

**Traditional crop varieties**
- Rice (more than 13,000 identified in Lao PDR)
- Eggplant (more than 3,000 identified in Lao PDR)
- Papaya
- Banana (centre of origin)
- Mango (centre of origin)
- Pineapple
- Water melon
- Passion fruits

**Wild plants**
- Cardamom
- Rattan and bamboo
- Orchids
- Mushrooms

**Wild crop relatives**
- Glutinous rice (centre of origin)
- Eggplant (centre of origin)

**Centre of origin for:** coconut palm, sugarcane, clove, nutmeg, black pepper, onion, cucumber
**FISHERIES**

Freshwater capture fisheries contribute significantly to the income and nutrition of the poorest groups in the LMB. They are the primary source of animal protein for populations within the basin and in countries like Cambodia, contribute 65 to 75% of total protein in the diet (C. Ringler - 2006). Climate change may affect the composition and abundance of fish species through changes to fertility, recruitment, nutrition and growth patterns.

The Study will analyze baseline trends and undertake a climate change vulnerability assessment for Mekong fisheries and aquaculture systems. Adaptation options will be developed for fisheries within each of the climate vulnerable zones.

**LIVESTOCK**

The Study team will carry out a climate change impact and vulnerability assessment of livestock, identifying vulnerable areas, species and systems in the region. Livestock such as cattle, buffalo, poultry, and pigs are important sources of food and cash income in poor communities. Buffalo and cows in particular also provide a savings “safety net,” as key household assets in lean economic times. However, livestock are vulnerable to changes in temperature and extreme weather events, which can increase mortality and make survivors more susceptible to diseases.

**NATURAL SYSTEMS**

The role diverse and interlinked natural systems play in providing ‘natural’ resilience to climate change will become increasingly important as the effects of climate change intensify over time. The Study team will examine climate impacts on representative ecosystems, including highland and lowland forests and riparian areas, flooded forests and floodplain grasslands, peat swamps, mangroves, coastal and estuarine systems, and others. These habitats host many important species of global significance and provide services that contribute to linked agriculture, fisheries and livestock farming systems.
How the Study Incorporates Non-Climate and Development Drivers

Within the basin, non-climate drivers are expected to exacerbate the impacts of climate change and must be taken into consideration in tandem by development planners. The Study will develop projections of the impacts of economic development activities on the status of agricultural production, ecosystems and livelihoods in each of the zones. Poorly planned economic development weakens natural system resilience and adaptive capacity of local people, while climate change heightens the negative impacts of poor planning. Principal development activity drivers of change will be identified in each vulnerable climate zone. Mekong ARCC’s study will explicitly consider the following drivers, based on their importance to development within each zone and the availability of accurate data:

• **Hydropower development:** As of 2012 there are 16 large hydropower projects existing in the Mekong Basin, with an additional 30 projects currently under construction or firm planning to come online by 2015. These 46 projects will have the capacity to store 44,415 million cubic meters of Mekong River flow reducing wet season flows by 10% and increasing dry season flows by on average 20-50% (ICEM, 2010). In addition a further 40 projects are being considered for development before 2030 inducing further regulation of the Mekong River flood pulse (ICEM, 2010).

• **Irrigation:** The vast potential of LMB water resources has long made irrigation attractive. To date, 3.8 million hectares of land are under some form or irrigation in the basin, by 2030 this is expected to increase to 6.0 million hectares (MRC, 2009). This will amount to less than 5% of the total annual flow in the Mekong Basin, but will have important applications for the local hydrological regime on tributaries and some reaches of the Mekong River.

• **Forest exploitation and changes in land use:** Forests are an important resource of the Mekong Basin with large remnant areas of important terrestrial biodiversity. These areas face continued and increasing pressures from logging, and the expansion of economic concession and agricultural land. Changes in forest cover will influence the run-off volumes generated in some sub-catchments as well as the amount of sediment transported downstream. For example, extensive clearing in Yunnan province (1970-80s) and then subsequent soil conservation practices has resulted in observable changes to flow regimes and more significant changes in sediment loads, and deforestation in the LMB (Lower Mekong Basin) has also resulted in changes to tributary hydrology (ICEM, 2010).

• **Population growth and regional/national demographic changes:** The region is currently going through a huge economic growth period that influences population and migration patterns. The impacts of these on the natural and agricultural environments are expected to be significant.
Using the Mekong ARCC Climate Study as a Decision-Support Tool

A central objective of the Mekong ARCC project is to serve as a nexus between high-level science and community-led responses to the changing climate. The Study will offer the most comprehensive downscaled picture to date of climate impacts on natural systems and community livelihoods in the LMB. The Study will enable community decision makers to visualize how shifting climate patterns will impact hydrology in their local watersheds, affecting traditional cropping systems and fish stocks. The Study will offer communities specific science-based vulnerabilities that can be incorporated into local development planning. This will assist them over the long-term in addressing climate change effects on critical aspects of rural life, including water supply, sanitation, agriculture, food security, biodiversity, livelihoods and natural disaster preparedness.

Additionally the Study will help answer an array of questions relevant to government planners, businesses and national citizens in the LMB, including:

- How will staple crops key to food security be impacted?
- What geographic areas will experience the greatest changes to existing crop patterns and productivity, leading to potential population movements?
- Where is the maintenance of natural systems most critical to mitigate the cost of natural disasters?
- What agricultural and fisheries commodities integral to national economic and private sector growth strategies will experience the greatest effects from climate change, both positive and negative, and in what specific locations in the Basin?
- How will community assets – natural and built – be impacted by intense weather events and shifting hydrology?
- What types of investments and adaptive behaviors will enhance resilience at the community level?
- Which land use patterns will increase or decrease vulnerability to climate change?
- Where do community health investments need to be made in order to offset changes in nutrition levels or potential increase in the spread of disease?