



Mekong River Commission

Adaptation to climate change in the countries of the Lower Mekong Basin: regional synthesis report

MRC Technical Paper

No. 24

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Meeting the Needs, Keeping the Balance



Mekong River Commission

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Abbreviations and Acronyms

ADB	Asian Development Bank
AusAID	Australian Agency for International Development
CCCO	Cambodian Climate Change Office
CCFSC	Vietnamese Central Committee for Flood and Storm Control
CCAI	Mekong River Commission Climate Change and Adaptation Initiative
CDM	Clean Development Mechanism
CIDA	Canadian International Development Agency
Danida	Danish International Development Assistance
DFID	UK Department for International Development
DNA	Designated National Authority for CDM Projects
DOE	Department of Environment in Lao PDR's Water Resources and Environment Administration
FAO	Food and Agriculture Organisation of the United Nations
GCM	General Circulation Model
GEF	Global Environment Facility
GHG	Greenhouse Gas
GTZ	German Agency for Technical Cooperation or Deutsche Gesellschaft für Technische Zusammenarbeit
HCMC	Ho Chi Minh City
HPAI	Highly Pathogenic Avian Influenza
IPCC	Intergovernmental Panel on Climate Change
ISGE	Vietnam International Support Group on the Environment
IUCN	International Union for the Conservation of Nature
JBIC	Japan Bank for International Cooperation
LDC	Least Developed Country
LDCF	Least Developed Countries Fund
LMB	Lower Mekong Basin
MAF	Lao PDR Ministry of Agriculture and Forestry
MAFF	Cambodian Ministry of Agriculture, Forestry and Fisheries
MARD	Vietnamese Ministry of Agriculture and Rural Development
MIME	Cambodian Ministry of Industry, Mines and Energy
MOE	Cambodian Ministry for Environment
MOH	Cambodian Ministry of Health
MONRE	Vietnamese Ministry of Natural Resources and Environment
MOSTE	Ministry of Science, technology and Environment
MOWRAM	Cambodian Ministry of Water Resources and Meteorology
MPCC	Mekong Panel on Climate Change
MPI	Vietnamese Ministry of Planning and Investment
MPWT	Cambodian Ministry of Public Works and Transport
MRC	Mekong River Commission
MRD	Cambodian Ministry of Rural Development
NAPA	National Adaptation Programme of Action to Climate Change

NCCC	Cambodian National Climate Change Committee
NCDM	Cambodian National Committee for Disaster Management
NET	National Expert Team
NSCCC	Lao PDR National Steering Committee on Climate Change
NTP	Vietnam National Target Programme to Respond to Climate Change
ONEP	Thailand Office of Natural Resources, Environmental Planning and Policy
REDD	Reducing Emissions from Deforestation and Degradation
RETA	ADB Regional Technical Assistance
RSR	Regional Synthesis Report
SEI	Stockholm Environment Institute
Sida	Swedish International Development Cooperation Agency
SLR	Sea level rise
TA	Technical assistance
TCP	Technical Cooperation Programme of FAO
TFP	Trust Fund Programme of FAO
TGO	Thailand Greenhouse Management Organisation
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organisation
USAID	United States Agency for International Development
WB	World Bank
WREA	Lao PDR Water Resources and Environment Administration
WWF	World Wide Fund for Nature

Summary

Introduction

The Lower Mekong Basin (LMB) covers an area of approximately 606,000 km² within the countries of Cambodia, Lao PDR, Thailand, and Viet Nam. Based on the outcomes of recent national and regional studies, there is growing concern about the potential effects of climate change on the socio-economic characteristics and natural resources of the LMB region. There is an identified need for a more informed understanding of the potential impacts from climate change.

In response, the Mekong River Commission (MRC) has launched the regional Climate Change and Adaptation Initiative (CCAI). The CCAI is a collaborative regional initiative designed to address the shared climate change adaptation challenges of LMB countries. The Regional Synthesis Report (RSR) has been prepared as part of the initial phase of the CCAI to provide a snapshot of current knowledge and activities related to climate change in the LMB countries. The specific objectives of the RSR are:

- To inform a wide audience of the current state of knowledge of climate change issues in LMB countries and across the region;
- To provide up to date information on regional and national adaptation activities and policy and institutional responses in relation to climate change;
- To present the results of a climate change ‘gap analysis’ identifying information deficiencies and shortcomings in planned activities and policy and institutional responses;
- To present a series of recommendations for future climate change related actions in the LMB.

Existing knowledge of regional climate change situation

Climate change is expected to result in modifications to weather patterns in the LMB in terms of temperature, rainfall and wind, not only in terms of intensity but also in terms of duration and frequency of extreme events. Seasonal water shortages, droughts and floods may become more common and more severe, as may saltwater intrusion. Such changes are expected to affect natural ecosystems and agriculture and food production, and exacerbate the problems of supplying increased food demand to growing populations. The impacts of such changes are

likely to be particularly severe given the strong reliance of the LMB communities on natural resources for their livelihoods.

Several studies have attempted to accurately identify the potential future climate situation that could result in the region from global warming. However most of these studies were not able to fully quantify the uncertainty around future climate projections. A recent study undertaken for CSIRO (Eastham *et al.*, 2008) attempted to redress some of the limitations of earlier studies and based on the IPCC's Scenario A1B made the following predictions for the region by 2030:

- A basin wide temperature increase of 0.79°C, with greater increases for colder catchments in the north of the basin;
- An annual precipitation increase of 0.2 m, equivalent to 15.3%, predominantly from increased wet season precipitation;
- An increase in dry season precipitation in northern catchments and a decrease in dry season precipitation in southern catchments, including most of the LMB;
- An increase in total annual runoff of 21% which will maintain or improve annual water availability in all catchments, however with pockets of high levels of water stress remaining during the dry season in some areas such as northeastern Thailand and Tonle Sap;
- An increase in flooding in all parts of the basin, with the greatest impact in downstream catchments on the mainstream of the Mekong;
- Changes to the productivity of capture fisheries which require further investigation, although it is predicted that the storage volumes and levels of Tonle Sap, a major source of capture fisheries, will increase;
- A possible 3.6% increase in agricultural productivity but with overall increases in food scarcity as food production in excess of demand reduces with population growth; further investigations are required to take into account effects of flooding and crop damage on these predictions.

Existing knowledge of national climate change situations

Accurate information on the climate change situation at the national level in each of the LMB countries is very limited. Available information is often drawn from global or regional level models with varying degrees of relevance to the national level. Quantitative information is lacking and most of the data is presented in terms of broad potential trends in climatic conditions.

In Cambodia, it is predicted that there will be an increase in mean annual temperature of between 1.4 and 4.3°C by 2100. Mean annual rainfall is also predicted to increase, with the most significant increase experienced in the wet season. As with the other countries in the LMB, flooding and droughts are expected to increase in terms of frequency, severity and duration. The potential impacts of climate change include changes to rice productivity, with increases in wet season crops in some areas and decreases in others; acceleration of forest degradation including the loss of wet and dry forest ecosystems; inundation of the coastal zone and higher prevalence of infectious diseases.

In Lao PDR an increase in mean annual temperature is predicted together with an increase in the severity, duration and frequency of floods; most probable in floodplain areas adjacent to the Mekong. The impacts of climate change are predicted to include agricultural and infrastructure losses due to increased storm intensity and frequency; land degradation and soil erosion from increased precipitation and a higher prevalence of infectious diseases.

In Thailand, an increase in mean annual temperature is predicted together with an increase in the length of the hot season, with a higher number of days with a temperature greater than 33°C, and a corresponding decrease in the length of the cold season. Higher rainfall intensity is expected in the cold season. Some river basins are expected to face water shortages and an increase in flood and drought frequency is predicted. The impacts of climate change are expected to include changes in rice productivity, with increases in wet season crop in some areas and decreases in others; damage to wetland sites from reduction in water availability; and damage to the coastal zone from changes to coastal erosion and accretion patterns.

In Viet Nam, an increase in annual average temperature of 2.5°C by 2070 is predicted with more significant increases probable in highland regions. The average annual maximum and minimum temperatures are also expected to increase. An increased incidence in floods and droughts is predicted, together with changes to seasonal rainfall patterns and an increased incidence and severity of typhoons. A possible sea level rise of 1.0 m by 2100 has been identified. It is estimated that there would be direct effects on 10% of population from 1.0 m sea level rise and losses equivalent to 10% of GDP due to the inundation of 40,000 km² of coastal areas. Salinity intrusion in the Mekong Delta region is expected to increase, resulting in changes to cropping patterns and productivity and negative effects on aquatic and terrestrial ecosystems. A higher prevalence of infectious diseases is also forecasted.

National responses to climate change

National responses to climate change include policy, institutional and adaptation responses. All LMB countries have ratified the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. Each country has a primary policy document which outlines its strategy and responses to climate change. In Cambodia and Lao PDR, this takes the form of a National Adaptation Program of Action to Climate Change (NAPA). Thailand has prepared the 'Action Plan on National Climate Change as the Five Year Strategy on Climate

Change 2008 to 2012' and Viet Nam has prepared the 'National Target Plan to Respond to Climate Change'. In general, climate change issues are not well integrated into the broader policy frameworks of national governments.

Each of the LMB countries has nominated a national focal point for climate change issues. Within Cambodia the Ministry of Environment plays this role, within Lao PDR, the Water Resources and Environment Administration, and within Thailand and Viet Nam the respective Ministries of Natural Resources and Environment. All countries have established a high level governmental body with responsibility for the development of climate change policy and strategies. Cambodia has established the National Climate Change Committee, Lao PDR has established the National Steering Committee on Climate Change, Thailand has established the National Board on Climate Change Policy and Viet Nam has established the National Climate Change Committee.

All LMB countries have a history of implementation of adaptation activities; although most activities implemented to date have been focused on natural disasters response management rather than climate change. The NAPAs of Cambodia and Lao PDR contain information on proposed adaptation projects including 39 activities planned for Cambodia and 45 for Lao PDR. Thailand's 'Action Plan on National Climate Change as the Five Year Strategy on Climate Change 2008 to 2012' contains strategic directions for development of detailed action plans for future adaptation activities. The Viet Nameese 'National Target Plan (NTP) to Respond to Climate Change' establishes directions for the development of sectoral and geographic adaptation action plans; to date, an action plan has been completed for the agricultural and rural development sector.

A large number of international organizations are working on climate change issues in partnerships with national governments. Across the LMB, more than 300 projects are being implemented or are planned.

Regional climate change activities and stakeholders

A large number of stakeholders are working with national governments and regional organisations on climate change activities at the regional level including:

- The MRC has recently launched the CCAI and has been involved in other related climate change activities as part of its various sector programmes since 2000;
- The United Nations Development Program (UNDP) is mainstreaming climate change activities into development programmes through the poverty and environment initiative (PEI);
- The Asian Development Bank (ADB) has a range of climate change activities in the preparatory phase as part of its GMS Core Environment Program;

- The ‘Study on Climate Change Impact Adaptation and Mitigation in Asian Coastal Mega Cities’ is being carried out with support from the ADB, World Bank and JBIC and is investigating climate change issues in Bangkok and Ho Chi Minh City;
- A wide range of climate change activities are being carried out by other stakeholders include SEA-START, IUCN Asia, FAO, WWF, ICEM, Wetlands Alliance, Oxfam, SEI, CARE, Australian National University, ACIAR, IWMI/WorldFish Center, and the Global Water Partnership.

Gap analysis and recommendations

The gap analysis prepared by the national expert teams (NETs) and the regional synthesis report (RSR) study team identified a large degree of commonality in perceived shortcomings in climate change knowledge, activities and responses at both the national and regional level. A summary of the gap analysis is presented below; it has been categorised into (i) national issues for each of the LMB countries, and (ii) regional issues for the LMB region as a whole.

The gap analysis reflects the key concerns and priority aspects as expressed by the national and regional experts. When a gap is not highlighted it does not mean that the issue is resolved only that other aspects are considered more immediate to address.

Climate change issues in gap analysis (cells filled in blue identify gaps).

Issue	Cambodia	Lao PDR	Thailand	Viet Nam	Regional
Awareness of climate change in the general population					
Awareness of climate change at different institutional levels					
Low adaptation capacity to climate change in the general population					
Adaptation capacity					
Institutional strength and capacity					
Technical knowledge among government agencies & NGOs					
Concrete implementation of climate change policies					
Perception of climate change as sector and not mainstreaming necessity					
Prediction and assessment tools					
Climate change literature translated into local languages					
Tools for advising and instructing policy makers					
Analytical studies on climate change impacts					
Reliable climate change data					
Progress in implementation of NAPA/NTP					
Sectoral implications and adaptation					
Coordination to respond to climate change in developing policies & plans					
Financial support for climate change initiatives					

A large number of recommendations for future actions in climate change activities have been developed by the NETs and the RSR study team. These are presented below in terms of recommendations for each of the LMB countries followed by a series of regional level recommendations.

Country	Recommendation
Cambodia	C1–Support for implementation of NAPA priority activities
	C2–Development and implementation of climate change awareness raising campaigns
	C3–Mainstreaming of climate change adaptation into development programmes
	C4–Institutionalisation of an inter-organisational climate change coordination mechanism
	C5–Integration of climate change adaptation into the national budgetary process
	C6–Formulation of climate change adaptation and climate change proofing legislation/policies
	C7–Strengthening of climate change research
Lao PDR	L1–Development and implementation of capacity building programmes
	L2–Development and dissemination of modelling and assessment tools
	L3–Support to policy frameworks and improved regulatory and institutional frameworks
	L4–Pilot study of climate change impacts in selected provinces
	L5–Development and implementation of national monitoring and reporting system
	L6–Investigations into the appropriate use of forest resources as sink sources for carbon dioxide
	L7–Research to strengthen health systems and services to better anticipate and address potential health challenges
	L8–Development of a strategy for the multipurpose use of the water for national development activities

Country	Recommendation
Thailand	T1–Improved development and assessment of adaptation strategies
	T2–Development and implementation of capacity building programmes
	T3–Development and implementation of awareness raising programmes
	T4–Mainstreaming adaptation to climate change in national policy development processes
	T5–Mechanisms to increase funds for adaptation to climate change
	T6–Investigations into linkages between poverty and climate change
	T7–Development and dissemination of improved modelling tools
	T8–Increased scientific research
Viet Nam	V1–Identification of funding sources for NTP activities and adaptation measures
	V2–Further research on climate change impacts
	V3–Improved information sharing networks and mechanisms
	V4–Institutional coordination at a national level
	V5–Guidance on adaptation planning for national agencies
	V6–Communication of scientific results through translation of key findings
Regional level	R1–Development of regional institutional structure to address climate change issues
	R2–Climate change predictions and integrated basin wide assessment of climate change impacts
	R3–Provisions for sustainability of climate change policy planning
	R4–Development and implementation of stakeholder awareness raising campaigns
	R5–Riparian country cooperation to address trans-boundary issues related to adaptation activities
	R6–Development of regional information sharing networks and mechanisms

1. Introduction

1.1 Background to the regional synthesis report

The Lower Mekong Basin (LMB) covers an area of approximately 606,000 km² within the countries of Thailand, Lao PDR, Cambodia and Viet Nam (Figure 1.1). This densely populated region, which is home to more than 60 million people, is heavily reliant on natural resources and ecosystems for its social, economic and biophysical wellbeing.

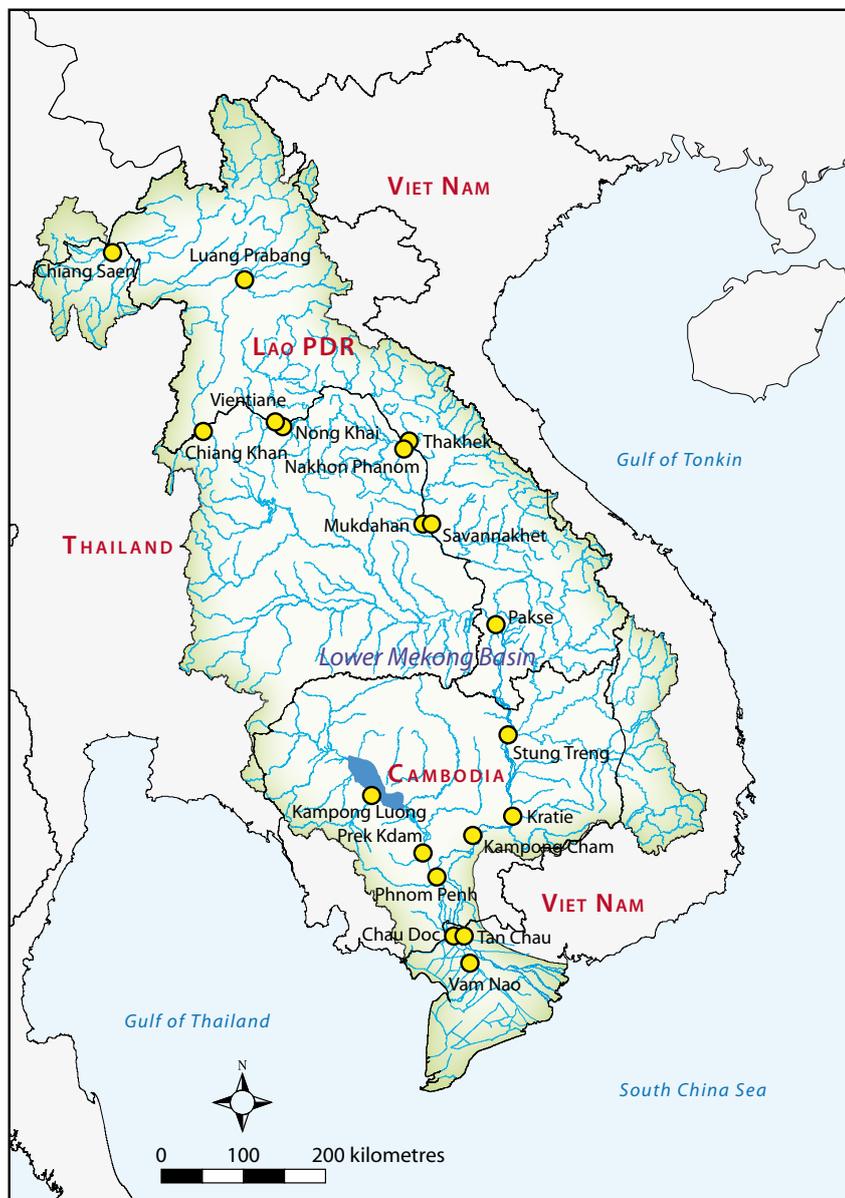


Figure 1.1 The Lower Mekong Basin.

There is increasing concern amongst the countries of the LMB as well as regional organisations, notably the Mekong River Commission (MRC), about the potential effects of climate change on the socio-economic characteristics and natural resources of the region. Studies (including (Eastham *et al.*, 2008; MRC, 2008b) undertaken to date suggest a range of potentially significant impacts are possible by 2030:

- Increase in the mean temperature of approximately 0.79°C;
- Increases in annual precipitation of more than 13.5% (equivalent to 0.2 m), predominantly from increased rainfall during the wet season;
- Decreases in dry season precipitation;
- Increased flooding, in terms of severity, duration and frequency;
- Impacts on productivity of agricultural activities and capture fisheries.

While a number of regional and national studies have been carried in recent years, there is a high demand for a more informed understanding of the potential consequences of climate change. In response to a directive from the LMB countries, the MRC has launched the regional Climate Change and Adaptation Initiative (CCAI). While still in the preparatory and consultative phase, the CCAI has supported National Expert Teams (NETs) in each of the LMB countries to prepare reports (referred to here as the National Reports) documenting the current state of knowledge of potential impacts of climate change, as well as existing national adaptation and policy responses. This Regional Synthesis Report (RSR) has been prepared to synthesise the information and findings from the National Reports as an input to shaping the CCAI coverage and approach.

1.2 Purpose and structure of the RSR

The RSR aims to provide a coherent and comprehensive snapshot of current knowledge and activities related to climate change in the LMB countries by responding to the following questions:

- i. What is the current level of knowledge of regional and national climate change predictions and effects in the LMB countries, as understood by regional organisations and the LMB countries;
- ii. What policy and institutional responses have been put in place at a regional and national level to respond to the predicted consequences of climate change, and;
- iii. What adaptation activities are in place, or are proposed, to respond to the predicted impacts of climate change?

The specific objectives of the RSR are:

- To inform a wide audience of the current state of knowledge of climate change issues in LMB countries and across the region;
- To provide up to date information on regional and national adaptation activities and policy and institutional responses in relation to climate change;
- To present the results of a climate change ‘gap analysis’ identifying deficiencies in information and shortcomings in planned activities and policy and institutional responses;
- To present a series of recommendations for future actions related to climate change in the LMB.

To achieve these objectives, the RSR is structured into five parts:

- Chapter 1 provides an introduction and background to the RSR;
- Chapters 2 and 3 provide an overview of the current state of knowledge of the situation regarding climate change in the region. They draw on the analyses carried out by LMB countries to provide an overview of current state of knowledge each has about climate change;
- Chapters 4, 5, 6, and 7 identify the national policy and institutional responses, and adaptation activities currently being implemented or planned for future implementation;
- Chapter 8 identifies the key activities being carried out at a regional level to address concerns about climate change;
- Chapters 9 and 10 document the results of a gap analysis and contains recommendations for future actions.

The RSR represents a synthesis of numerous source documents prepared by LMB countries and the MRC. Chapter 11 provides a full list of references used in the preparation of the national reports and the RSR.

2. Existing knowledge of regional climate change

Climate change is expected to result in modifications to weather patterns in the LMB in terms of temperature, rainfall and wind, not only in terms of intensity but also in terms of duration and frequency of extreme events. Seasonal water shortages, droughts and floods may become more common and more severe, as may saltwater intrusion into the Mekong delta (Hoanh *et al.*, 2003; Snidvongs *et al.*, 2003; Chinavanno, 2004b). Such changes are expected to affect natural ecosystems and agriculture and food production, and exacerbate the problems of supplying increased food demand to growing populations (Hoanh *et al.*, 2003; Snidvongs & Teng, 2006). The consequences of such changes are likely to be particularly severe given the strong reliance of the LMB communities on natural resources for their livelihoods.

Several studies have attempted to identify accurately the regional climatic conditions that could result from global warming (e.g. Hoanh *et al.*, 2003; Snidvongs & Teng, 2003; Chinavanno, 2004a; Snidvongs *et al.*, 2006; Kiem *et al.*, 2008). The results from these studies indicate broadly similar climatic changes. Temperatures are projected to increase across the basin to a varying degree. Wet season rainfall is projected to increase, and dry season rainfall to decrease in some areas during some months. Flooding is expected to increase in duration and frequency; increased flooding in the delta and other areas is expected to have the most significant consequences for the region.

Most of the studies used a single, or limited number, of global climate model simulations to represent the future climate and did not fully quantify the uncertainty around projections of the future climate. A recent study undertaken by the Eastham *et al.* (2008) for CSIRO, which has attempted to resolve some of the limitations of earlier studies has been used as the basis of information presented in this section. The study modelled predicted parameters of climate change for 2030 based on the IPCC's Scenario A1B. The study made the following predictions:

- A basin wide temperature increase of 0.79°C, with greater increases for colder catchments in the north of the basin;
- An annual precipitation increase of 0.2 m, equivalent to 15.3%, predominantly from increased wet season precipitation.
- An increase in dry season precipitation in northern catchments and a decrease in dry season precipitation in southern catchments, including most of the LMB.
- An increase in total annual runoff of 21%, which will maintain or improve annual water availability in all catchments. However, pockets of high levels of water stress will remain during the dry season in some areas, such as northeastern Thailand and Tonle Sap.

- An increase in flooding in all parts of the basin, with the greatest impact in downstream catchments on the mainstream of the Mekong.
- Changes to the productivity of capture fisheries that require further investigation, although it is predicted that the storage volumes and levels of Tonle Sap, a major source of capture fisheries, will increase.
- A possible 3.6% increase in agricultural productivity but with overall increases in food scarcity as food production in excess of demand reduces with population growth; further investigations are required to take into account effects of flooding and crop damage on these predictions.

Table 2.1, Table 2.2 and Figure 2.1 summarise the potential consequence of climate change for sub-regions in the LMB.

Table 2.1 *Regional effects of climate change on sub-regions of the LMB by 2030.*
(See Figure 2.1 for location.)

Moung Nouy: Northern Lao PDR
Agricultural productivity decreased; Existing food scarcity increased; Temperature and annual precipitation increased; Dry season precipitation increased; Annual runoff increased; Dry season runoff increased; Potential for increased flooding (not quantified).
Luang Prabang: N Thailand and Northern Lao PDR
Agricultural productivity decreased; Existing food scarcity increased; Temperature and annual precipitation increased; Dry season precipitation increased; Annual runoff increased; Dry season runoff increased; Potential for increased flooding (not quantified)
Vientiane: Northern Lao PDR and of NE Thailand
Agricultural productivity increased; Food availability in excess of demand decreased; Temperature and annual precipitation increased; Dry season precipitation increased; Annual runoff increased; Dry season runoff increased; Potential for increased flooding (not quantified)
Tha Ngon: Central Lao PDR
Agricultural productivity decreased; Existing food scarcity increased; Temperature and annual precipitation increased; Dry season precipitation decreased; Annual runoff increased; Dry season runoff increased; Potential for increased flooding (not quantified)
Nakhon Phanom: Central Lao PDR and NE Thailand
Agricultural productivity increased; Existing food scarcity increased through population growth; Temperature and annual precipitation increased; Dry season precipitation decreased; Annual runoff increased; Dry season runoff decreased; Potential for increased flooding (not quantified).
Mukdahan: Southern Lao PDR and NE Thailand
Agricultural productivity unaffected; Existing food scarcity increased through population growth; Temperature and annual precipitation increased; Dry season precipitation decreased; Annual runoff increased; Dry season runoff increased; Potential for increased flooding (not quantified).

Ban Keng Done: Central Lao PDR
Agricultural productivity increased; Food availability in excess of demand decreased; Temperature and annual precipitation increased; Dry season precipitation decreased; Annual runoff increased; Dry season runoff decreased; Potential for increased flooding (not quantified).
Yasothon: NE Thailand
Agricultural productivity increased; Food availability in excess of demand decreased; Temperature and annual precipitation increased; Dry season precipitation decreased; Annual runoff increased; Dry season runoff increased; Annual water stress (ratio withdrawals: availability) reduced to moderate; Dry season water stress decreased but remains high; Potential for increased flooding (not quantified).
Ubon Ratchathani: NE Thailand
Agricultural productivity increased; Food availability in excess of demand increased; Temperature and annual precipitation increased; Dry season precipitation decreased; Annual runoff increased; Dry season runoff increased; Annual water stress (ratio withdrawals: availability) reduced to medium-high; Dry season water stress decreased but remains high; Potential for increased flooding (not quantified).
Pakse: Southern Lao PDR and NE Thailand
Agricultural productivity increased; Food availability in excess of demand decreased; Temperature and annual precipitation increased; Dry season precipitation decreased Annual runoff increased; Dry season runoff increased; Potential for increased flooding (not quantified).
Se San: Southern Lao PDR, northeast Cambodia and Central Highlands of Viet Nam
Agricultural productivity increased; Food availability in excess of demand decreased; Temperature and annual precipitation increased; Dry season precipitation decreased; Annual runoff increased; Dry season runoff decreased; Potential for increased flooding (not quantified).
Kratie: Southern Lao PDR and central Cambodia
Agricultural productivity increased; Food availability in excess of demand decreased; Temperature and annual precipitation increased; Dry season precipitation decreased; Annual runoff increased; Dry season runoff decreased; Frequency of extreme floods increased from 5% to 76% annual probability; Peak flows, flood duration and flooded area increased; Dry season minimum flows increased.
Tonle Sap: central Cambodia
Agricultural productivity increased; Food availability in excess of demand decreased; Temperature and annual precipitation increased; Dry season precipitation decreased; Annual runoff increased; Dry season runoff decreased; Dry season water stress increased and remains high; High probability of increased flooding (not quantified); Seasonal fluctuation in Tonle Sap Lake area and levels increased; Minimum area of Tonle Sap Lake increased, areas of flooded forest permanently submerged and possibly destroyed reducing fish habitat; Net impact on capture fisheries uncertain; Maximum area of Tonle Sap lake increased with possible negative impacts on agricultural areas, housing and infrastructure.
Phnom Penh: Southeastern Cambodia
Food scarcity due to population increase; Temperature and annual precipitation increased; Dry season precipitation decreased; Annual runoff increased; Dry season runoff increased; High probability of increased flooding; Flooded area increased.
Border: Southern Cambodia and south Viet Nam
Agricultural productivity decreased; Food scarcity due to population increase; Temperature and annual precipitation increased; Dry season precipitation decreased; Annual runoff increased; Dry season runoff decreased; High probability of increased flooding; Flooded area increased.
Delta Catchment: South Viet Nam
Food scarcity due to population increase; Temperature and annual precipitation increased; Dry season precipitation decreased; Annual runoff increased; Dry season runoff decreased; High probability of increased flooding; Flooded area increased; Dry season minimum flows increased and possible reduction in saline intrusion.



Figure 2.1 Regional subdivision of the LMB used Eastman *et al.* (2008) for climate predictions.

Table 2.2 Summary of predicted regional consequences of climate change.

	Agricultural productivity	Existing food availability	Temperature	Annual precipitation	Dry season precipitation	Annual runoff	Dry season runoff	Annual water stress	Dry season water stress	Flooding potential	Peak flows	Flood duration	Flooded area	Dry season minimum flows	Saline intrusion
Moung Nouy: Northern Lao PDR	-	-	+	+	+	+	+			+					
Luang Prabang: N Thailand and Northern Lao PDR	-	-	+	+	+	+	+			+					
Vientiane: Northern Lao PDR and of NE Thailand	+	- 1	+	+	+	+	+			+					
Tha Ngon: Central Lao PDR	-	-	+	+	-	+	+			+					
Nakhon Phanom: Central Lao PDR and NE Thailand	+	- 2	+	+	-	+	-			+					
Mukdahan: Southern Lao PDR and NE Thailand	=	- 2	+	+	-	+	+			+					
Ban Keng Done: Central Lao PDR	+	- 1	+	+	-	+	-			+					
Yasothon: NE Thailand	+	- 1	+	+	-	+	+	- 3	- 5	+					
Ubon Ratchathani: NE Thailand	+		+	+	-	+	+	- 4	- 5	+					
Pakse: Southern Lao PDR and NE Thailand	+	+	+	+	-	+	+			+					
Se San: Southern Lao PDR, northeast Cambodia & Central Highlands of Viet Nam	+	- 1	+	+	-	+	-			+					
Kratie: Southern Lao PDR and Central Cambodia	+	- 1	+	+	-	+	-			+	+	+	+	+	
Tonle Sap: Central Cambodia	+	- 1	+	+	-	+	-		+	+		+	+		
Phnom Penh: Southeastern Cambodia		- 1	+	+	-	+	+			+			+		
Border: Southern Cambodia and south Viet Nam	-	- 2	+	+	-	+	-			+			+		
Delta: South Viet Nam		- 2	+	+	-	+	-			+			+	+	-

Note: 1 = due to decrease in surplus; 2 = due to population growth; 3 = moderate level; 4 = medium level; 5 = high level

+ = predicted increase; - = predicted decrease; = = status quo; blank cell = unstated.

3. Existing knowledge of national climate change

3.1 Cambodia

Cambodia's Initial National Communication to the UNFCCC (MOE, 2002) includes the first attempt to assess the country's future climate using two General Circulation Models (GCM); the CCSR and CSIRO models. The global warming scenarios used in the analysis were the SRESA2 and SRESB1 scenarios. The GCM models used in this analysis were developed for use in Japan and Australia, which are very different geographical regions. At the time of the assessment, there was an absence of more suitable models. Projections were made for changes in the average temperatures and rainfall. However, the deviation of the GCM models from the observed rainfall data was very significant (MOE, 2002). The GCM models predicted:

- Mean annual temperatures could increase between 0.3 and 0.6°C by 2025 and between 1.6 and 2.0°C by 2100 (Figure 3.1).

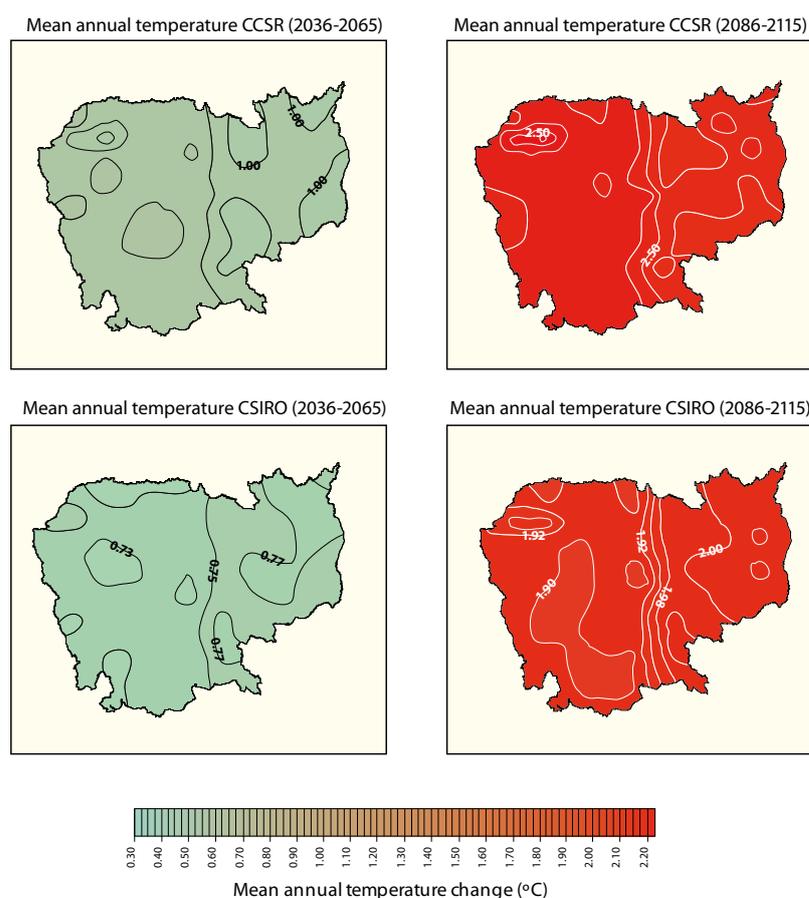


Figure 3.1 Mean annual temperature change (°C) using CCSR and CSIRO GCMs.
Source: MOE, 2002.

- Mean annual rainfall could increase by between 3% and 35% by 2100, with the magnitude of change varying with time and location; lowland areas are expected to experience higher increases in rainfall than highlands (Figure 3.2).

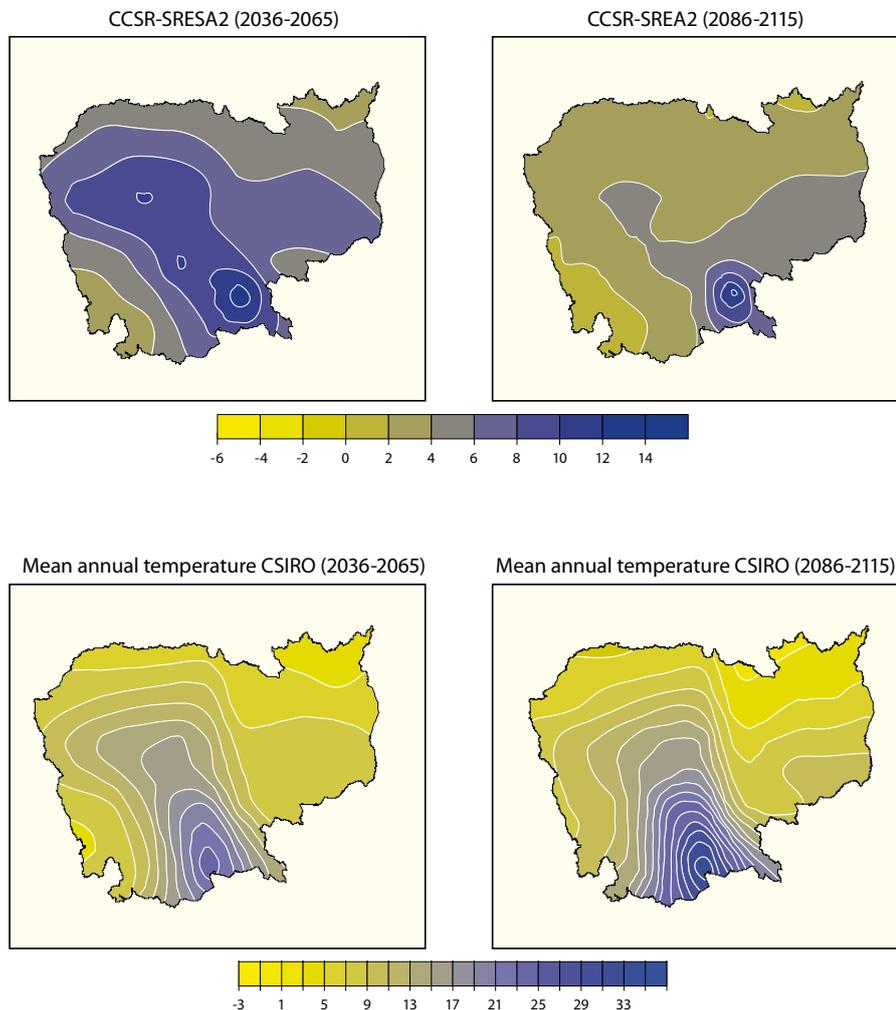


Figure 3.2 Mean annual rainfall change (%) using CCSR and CSIRO GCMs.

Source: MOE, 2002.

- Precipitation increases are projected predominantly in the central agricultural plains stretching from the southeast to the northwest, where rainfall has historically been below the national average; these areas are already vulnerable to floods and drought.

More refined simulations are under way as part of Cambodia's Second National Communication. The impact of increased precipitation on wet season floods and dry season droughts will be assessed as part of these more refined simulations.

A climate change country profile for Cambodia produced by the University of Oxford (McSweeney *et al.*, 2008) contained projected future climate conditions under three IPCC emission scenarios (A2, A1B, and B1).

The main findings of the profile are as follows:

- The mean annual temperature is projected to increase by 0.7 to 2.7°C by 2060, and 1.4 to 4.3°C by 2090; which represents a higher predicted temperature increase than revealed by the GCM modelling described above.
- All projections indicate substantial increases in the frequency of days and nights that are considered hot in the current climate.
- Projections of mean annual rainfall broadly indicate increases in annual average rainfall. This increase is mainly due to the projected increases in wet season rainfalls, and is partially offset by projected decreases in dry season rainfalls.

As part of its Initial National Communication, Cambodia also conducted a Vulnerability and Adaptation Assessment which examined the impacts of climate change on agriculture (rice production), forestry (forest types), human health (malaria) and coastal zone (sea level rise). In preparation for the NAPA (MOE, 2006) the Cambodian government conducted a survey in rural areas to get a picture of existing climate hazards and vulnerability and adaptation to climate change (MOE, 2005a). Floods and droughts are experienced every year, but preparedness and adaptive capacity are very low. People may be aware of coping and adaptation possibilities but lack financial resources to implement them (MOE, 2005a).

The assessment of the effects of climate change on agriculture was conducted for rice cultivation, as it forms the backbone of traditional livelihoods and constitutes Cambodia's staple food source. Flood and rainfall patterns play a determining role in paddy cultivation and the absence of widespread irrigation and water harvesting schemes in Cambodia make this sector particularly vulnerable to climate change, especially due to the effects of flooding and drought. Based on data from 1996 to 2001, rice production loss in Cambodia was mainly due to the occurrence of flooding (more than 70% loss) and followed by drought (about 20% loss) and others such as pest and diseases (10% loss). Figure 3.3 and Figure 3.4 show the communes most at risk of flood and drought in Cambodia (WFP, 2005).

Under elevated CO₂, yields of wet season rice might increase above that of dry season rice. However, there is a chance that under changing climate, rice yield in some provinces would be more variable than under current conditions due to the increase in flood frequency and intensity, in particular in rice growing areas surrounding the Tonle Sap lake and the Mekong (MOE, 2002).

Cambodia's forests are composed of dry forests (60%), wet forests (20%) and moist forests (20%). Under changing climate conditions, increased precipitation would increase soil erosion, which in turn would accelerate forest degradation. In addition, changes in soil water availability caused by the combined effects of changes in temperature and rainfall could have a significant impact on forest composition and biomass production. Under projected climate conditions, Cambodia's area of wet and dry forests would decrease while the area of moist forest would increase. Given the degraded nature of Cambodia's forests and the added pressure of

deforestation, some forest ecosystems and their unique biodiversity could disappear. This would have significant impacts on watershed protection, agricultural production and hydroelectricity output.

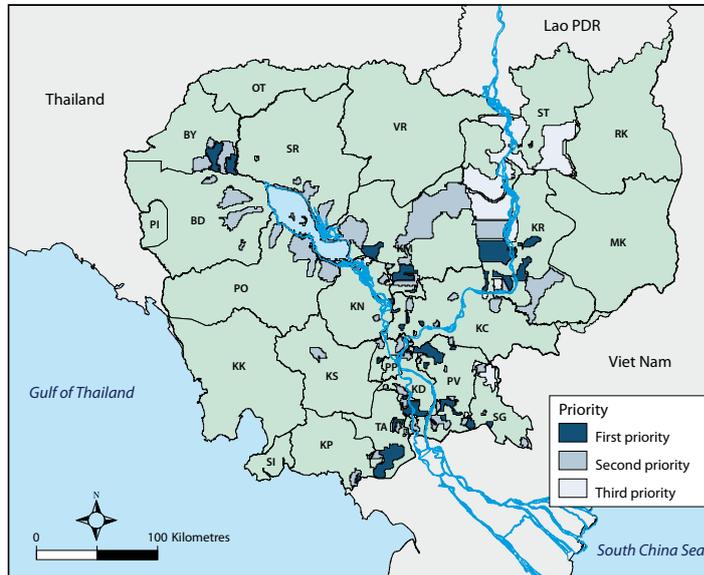


Figure 3.3 Level of vulnerability to flood by province in Cambodia.

Source: WFP, 2005.

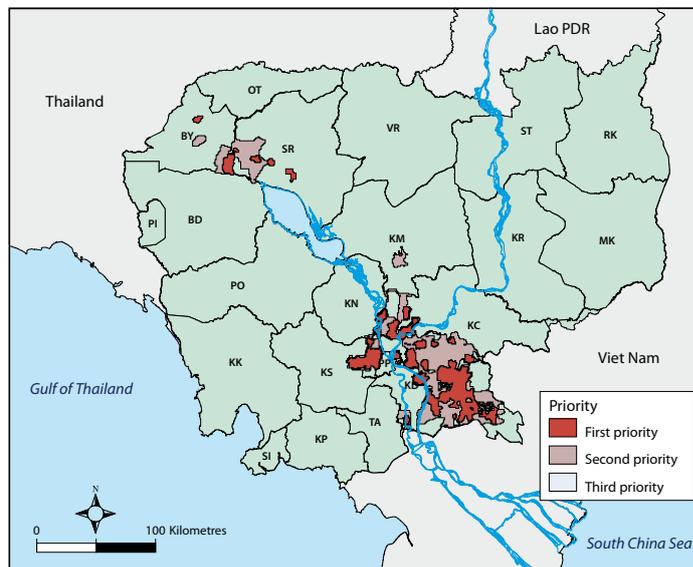


Figure 3.4 Level of vulnerability to drought by province in Cambodia.

Source: WFP, 2005.

3.2 Lao PDR

In Lao PDR little information is available to identify future climate change trends. However, there is clear evidence that extreme weather events are already occurring. For example, the high water level in the Mekong in August 2008, which resulted in flooding of large numbers of villages and areas of agricultural land and highlighted the vulnerability to extreme weather in the country. The areas of rain-fed rice fields destroyed by an increased frequency of flooding were 65,937 ha in 1995, 67,500 ha in 1996, 42,900 ha in 2000, 42,223 ha in 2001 and 57,300 ha in 2005 (MAF, 2005).

The National Adaptation Programme of Action to Climate Change (NAPA) Report for Lao PDR states that the impacts of climate change have already been experienced through an increase in floods and droughts (DOE, 2004). However, little scientific evidence is available to determine whether such climatic conditions are due to natural variability or the effects of climate change.

From 1996 to 2005, floods and droughts have caused significant economic losses. In the areas of Vientiane plain and the Nam Ngum valley, the losses from the 1995 flood amounted to more than US\$10 million (FAO, 1995). Significant damage to irrigation systems occurred accounting for nearly US\$9 million of losses between 2005 and 2007. The 2007 storms caused a loss of 34,751 ha of rain fed rice and destroyed US\$7 million of crops and US\$10.4 million worth of livestock. The same storm caused almost US\$1 million worth of damage to the power house of Namtha 3 hydro power project and Namlung hydropower project, in Luangnamtha province. Floods and droughts are also thought to have led to an increase in disease outbreaks such as smallpox, malaria, diarrhoea, dysentery, dengue fever and pneumonia.

Country specific information on the potential consequences of climate change is virtually non-existent; reported trends for the Mekong Basin as a whole are the most accurate predictions to date. These trends include a projected increase in temperature of 0.68°C to 0.81°C for 2030. An increase in the severity, duration and frequency of floods and droughts is the most probable risk posed by climate change in Lao PDR. The majority of the population, approximately 80%, still relies on agriculture (crop, livestock and fisheries) for their livelihoods, and an increase in the incidence of floods or droughts will have a significant impact on this sector and particularly on the livelihoods of vulnerable groups with low adaptive capacity. The parts of Lao PDR which are most prone to flooding are the plain areas along the Mekong in the central and southern parts of the country including the capital, Vientiane; whereas areas in the north and northwest parts of the country are more prone to drought or rice insufficiency.

Land degradation is another potential impact of climate change. Lao PDR has a potentially cultivable land area of 5.9 million ha, of which 800,000 ha is cultivated for rice or secondary crops under both lowland terrace and upland shifting cultivation systems. Increased precipitation resulting from climate change could cause increased erosion, especially on steep slopes. Erosion effects would potentially be most significant in areas where shifting cultivation has already led to soil degradation, particularly in those areas where population pressure has led to a significant decrease in the rotation period or where traditional lowland farmers encroach

on neighbouring uplands to make up for low and often declining yields on their lowland paddy fields. Increased land degradation leading to lower productivity may also increase deforestation as new lands are still threatened by slash and burn cultivation.

3.3 Thailand

Several research groups in Thailand at Universities, research organisations, and at the Thai Meteorology Department work on climate change predictions using a range of down-scaling methodologies based on GCM results Thai institutions are playing an important part in regional work. Recently completed studies on Krabi Province and Bangkok (WWF, 2008) have been innovative and provided important reflections on the national situation.

In 2003, SEA START RC initialised climate change scenarios using the Conformal Cubic Atmospheric Model (CCAM model) at the Southeast Asia regional level (SEAS START RC, 2006). This research investigated the impacts of climate change on hydrological conditions and rain-fed agriculture in the LMB and assessed vulnerability and adaptation of rain-fed crop production to climate change impacts. Future climate scenarios were developed using the CCAM climate model with given conditions of increasing atmospheric CO₂ concentration from the baseline of 360 ppm to 540 ppm and 720 ppm, in other words, 1.5 and 2 times the baseline CO₂.

The result from the simulation suggested that the average temperature in the region will tend to be slightly colder under climate conditions with a CO₂ concentration of 540 ppm, but will be slightly warmer under climate conditions with a CO₂ concentration of 720 ppm. The range of temperature change is predicted to be 1 to 2°C (Figure 3.5).

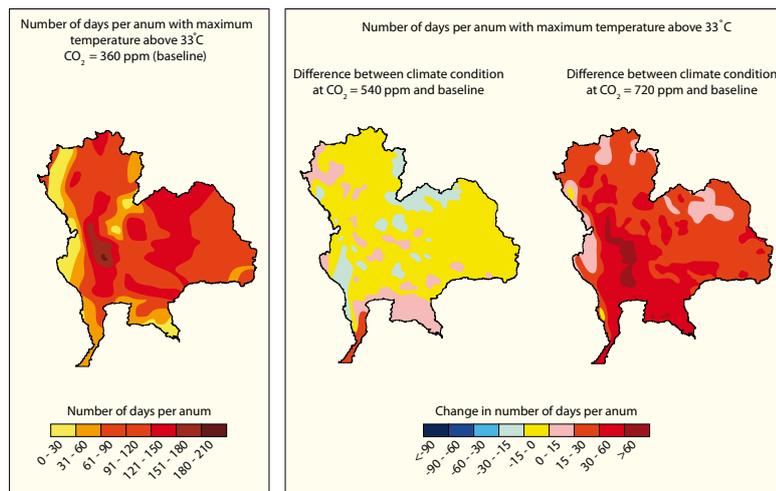


Figure 3.5 Number of days per annum with daily maximum temperature > 33°C.

Source: SEA START RC, 2006.

The hot period of the year will extend longer and the cold period will be significantly shorter while the length of rainy season would remain the same, but with higher rainfall intensity. This is to some extent already happening (Limsakul and Goes, 2008).

In 2008, SEA START RC commenced research into climate change and sustainable development on a regional scale in the Mekong River Basin using the PRECIS regional climate model. Different scenarios under two different CO₂ increase scenarios, SRES A2 and B2, are being used to generate a range of future climate change predictions. These climate scenarios are being used as foundation for climate change impact analysis. Some selected preliminary results from this work show the number of days that the temperature is predicted to be above 33°C (Figure 3.6), and 15°C (Figure 3.7).

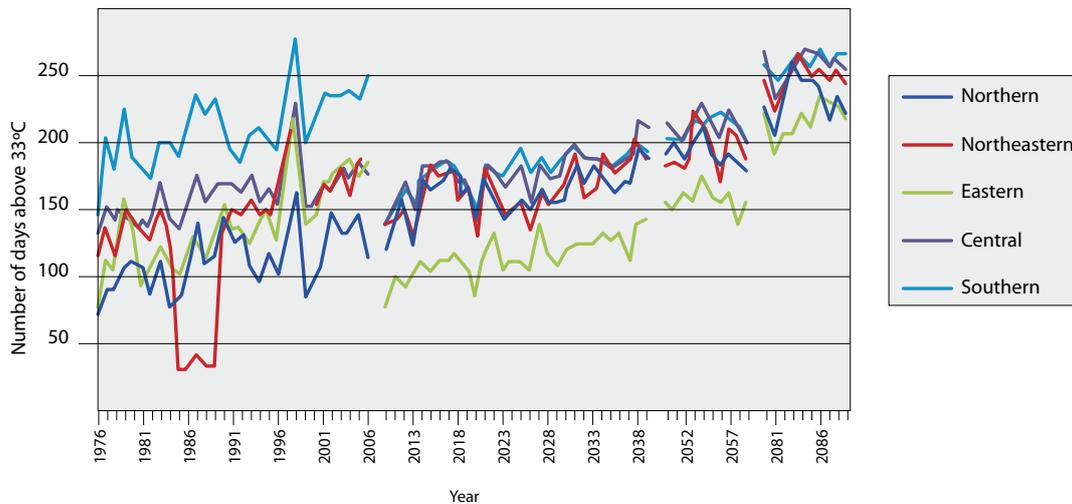


Figure 3.6 Trend of number of days with temperature above 33°C.

Source: Thai NET, 2009.

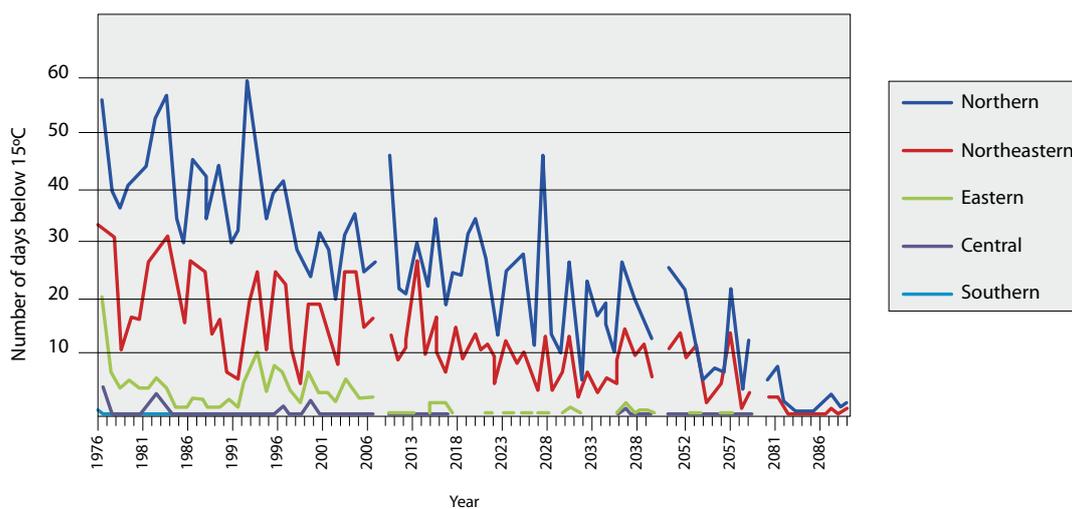


Figure 3.7 Trend of number of days with temperature below 15°C.

Source: Thai NET, 2009.

Information on the potential impacts of climate change has been drawn from the National Report and the Initial National Communication to the UNFCCC (MOSTE, 2000). A recent study by FERs (FERs, 2008a) provides a scientific perspective on these impacts.

While total forest area is predicted to remain the same, the composition of forests, by type, are expected to change markedly. In general, subtropical life zones are expected to decline, while tropical life zones, toward the southern region of Thailand, are predicted to increase due to expected intensification of precipitation. Subtropical dry forests, which currently occupy 1.2% of total forest area, might completely disappear and be replaced by tropical dry forests. A new type of forest, tropical very dry forest, may also emerge in the north and the northeast areas of the country (MOSTE, 2000; Chantragoon, 2007; Thangtham, 2007).

Rice grown under rain-fed conditions in Thailand was found to be highly vulnerable to climate change. The results, which were based on climate data from four GCMs, suggest similar declining trends in rice and maize yields over time. Their magnitudes, however, vary depending on climate conditions, soil types and crop practice. Maize yields, for example, could drop from 5% in Nakhon Sawan province to 44 percent in Nakhon Ratchasima province. The impacts on rice yields could be even more extensive and diverse. Rice yields could drop by 57% in Roi-et province, but increase by 25% in Surin. The four climate models also demonstrated that climate change could increase temperature in areas during the flowering period of crops by 1 to 7°C. This will reduce flowering and harvesting periods as well as crop yields in general. In general, the vulnerability of agriculture to climate change varies according to crops and location characteristics, in addition to the climate conditions (Kerdsuk *et al.*, 2004; Kerdsuk *et al.*, 2007; Bhaktikul, 2008; Jintrawet and Prammanee, 2005; Jintrawet, 2007).

Conflicts over the allocation of surface water in Thailand have now become a critical issue due to the expansion of demand and a shortage of supply. Variations in the frequency and intensity of rainfall in a monsoon region like Thailand also have imposed high risks of drought and flood in the dry and wet seasons respectively. Climate change alters precipitation patterns and potentially increases temperature. Changing rainfall patterns, in turn, affect the level and intensity of surface runoff, while increasing temperature increases the rate of evapotranspiration and hence reduces the water storage capability of the rivers and reservoirs. For example, a case study of the potential climate change impact on water storage capacity of the reservoir of the Sri Nakarin Dam, found that doubling CO₂ levels could result in possible shortages of water in the watershed area above the Sri Nakarin Dam in 10 to 15 years, unless water management is improved. While this dam is located outside the boundary of the LMB, similar conclusions can be drawn for water resources within the LMB (Kongjan, 2008). The most notable impacts of the climate change scenarios on water resources are variations in precipitation and their intensity in different regions. More extreme flooding and drought could emerge. The impacts on water resources could affect agricultural development substantially. Lower water levels in the dams require serious water resource management. Crop yields and cropping pattern could be severely affected. Hydropower development schemes are considered as possible solutions to these problems even though they may have transboundary effects (Thai Net, 2009; FERs, 2008b).

3.4 Viet Nam

Investigations to date indicate that Viet Nam is amongst the countries with the potential to be the most severely impacted by climate change (Dasgupta *et al.*, 2007); with the Mekong and Red River delta regions most at risk, predominantly as a result of increased inundation (Carew-Reid, 2007). Viet Nam's Initial Communication to the United Nations Framework Convention on Climate Change (MONRE, 2003) provides predictions regarding potential climate change impacts in Viet Nam. Further work has commenced to improve the scenarios and climate change predictions (Nguyen and Hoang, 2007).

The average temperature is estimated to increase by 2.5°C in 2070. Temperature increases are predicted to be more significant in the highlands region, while coastal temperatures are predicted to increase by 1.5°C. Annual average maximum and minimum temperatures are also expected to increase; similarly the number of days with a temperature higher than 25°C will increase. Possible effects of such increases will include a large area of the country suffering from drought, reduction in agricultural productivity, and an increase in the incidence of epidemic diseases.

In the northern and southern regions, seasonal rainfall is predicted to decrease in July and August and increase in September, October and November. In the central region, rainfall is predicted to increase by approximately 19% in the rainy season by 2070; while rainfall in the dry season will decrease and drought conditions are predicted to become more frequent.

Over the past 30 years, sea level in Viet Nam has increased 5 cm. Sea level is expected to rise by another 9 cm in 2010, 33 cm in 2050, 45 cm in 2070 and 1 m in 2100 (MONRE, 2003).

In the past, typhoons affected northern Viet Nam predominantly in August, in October in the central region, and in November in the south. Climate change could lead to more typhoons occurring in the northwest Pacific Ocean which could affect Viet Nam. An increase in sea surface temperature is also expected to cause higher wind velocities during typhoons and increase the duration of such events. The typhoon intensity will be stronger, especially during El Niño years.

Simulations of temperature, rainfall and sea level changes in various regions are shown in Table 3.1 below. According to this scenario, in the year 2070, the surface average temperature will increase in the range of 1.5°C to 2.5°C and variation in precipitation will be from -5% to 10%.

With a sea level rise (SLR) of 1.0 metre, which is predicted to occur by 2100, approximately 10% of the population could be directly affected and economic losses equivalent to 10% of the GDP experienced. The sea level rise in combination with increased rainfall in the rainy season could have serious impacts on low lying lands in the coastal zone. Approximately 40,000 km² of coastal delta area could be inundated, including 90% of the Mekong Delta. This region is the most densely populated in the country, with over 18 million inhabitants, or 22% of the national

population and this population is growing by about 300,000 people per year. A high proportion of poor households, which are more susceptible to the impacts of climate change, are located in this area. Twelve provinces with an area of 12,376 km² and a population of about 5 million people are predicted to be affected (Table 3.2, Figure 3.8, Figure 3.9). More than 1,100 km² (7.65% of overall inundated area) will be inundated in the economically important southeastern economic region (Carew-Reid, 2007).

Table 3.1 *Climate change predictions in Viet Nam.*

Factors	Region	Season	2010	2050	2070
Temperature increase (°C)	Northwest, northern regions	n/a	0.5	1.8	2.5
	Northern plains region	n/a	0.3	1.1	1.5
	Northern central region	n/a	0.3	1.1	1.5
	Central region	n/a	0.3	1.1	1.5
	Southern central region	n/a	0.3	1.1	1.5
	Highlands region	n/a	0.5	1.8	2.5
	Southern region	n/a	0.3	1.1	1.5
Change in precipitation (%)	Northwest, northern regions	Rainy	0	0-+5	0-+5
		Dry	0	-5-+5	-5-+5
	Northern plains region	Rainy	0	0-+5	0-+5
		Dry	0	-5-+5	-5-+5
	Northern central region	Rainy	0	0-+10	0-+10
		Dry	0	0-+5	0-+5
	Central region	Rainy	0	0-+10	0-+10
		Dry	0	0-+5	0-+5
	Northern part of southern central region	Rainy	0	0-+10	0-+10
		Dry	0	0-+5	0-+5
	Southern part of southern central region	Rainy	0	0-+5	0-+5
		Dry	0	-5-+5	-5-+5
	Central highlands region	Rainy	0	0-+5	0-+5
		Dry	0	-5-+5	-5-+5
	Southern region	Rainy	0	0-+5	0-+5
		Dry	0	-5-+5	-5-+5
Sea level rise (cm)	All regions	n/a	9	33	45

Source: MONRE, 2003.

The Central Highlands region may also be affected by climate change. The economy of the Central Highlands region of Viet Nam is based on forestry and agriculture. The main products of the area include coffee, rubber, pepper and other cash crops. Climate change is expected to increase severe weather events in this region and affect agricultural productivity. A decrease in the groundwater level is another potential important effect in the area.

Table 3.2 Area inundated by 1.0 metre SLR in Mekong Delta, Viet Nam.

Province	Inundated area (km ²)	% of province area	No. of people affected	% of province population
An Giang	192.3	5.45	197,085	8.3
Bac Lieu	961.9	38.87	383,764	44.8
Ben Tre	1,131.4	50.14	759,174	54.6
Ca Mau	1,182.8	22.75	182,956	15.2
Can Tho	757.7	24.75	426,511	20.8
Dong Thap	389.4	11.53	222,289	13.4
Kien Giang	1,756.8	28.22	295,989	18.6
Long An	2,168.9	49.42	581,456	39.1
Soc Trang	1,424.6	43.71	457,821	35.0
Tien Giang	783.2	32.68	497,075	28.8
Tra Vinh	1,021.3	45.72	418,066	37.9
Vinh Long	606.4	39.69	364,414	31.6
Total	12,376.7	31.0	4,786,600	26.7

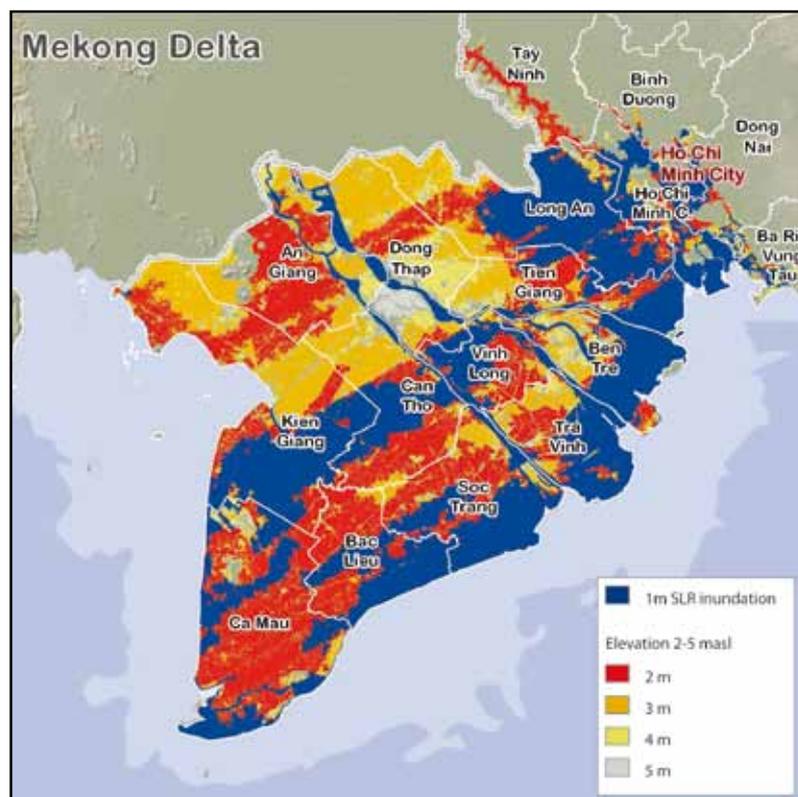


Figure 3.8 Predicted 1.0 m SLR inundation areas in the Mekong Delta region of Viet Nam in 2100.
Source: Carew-Ried, 2007.

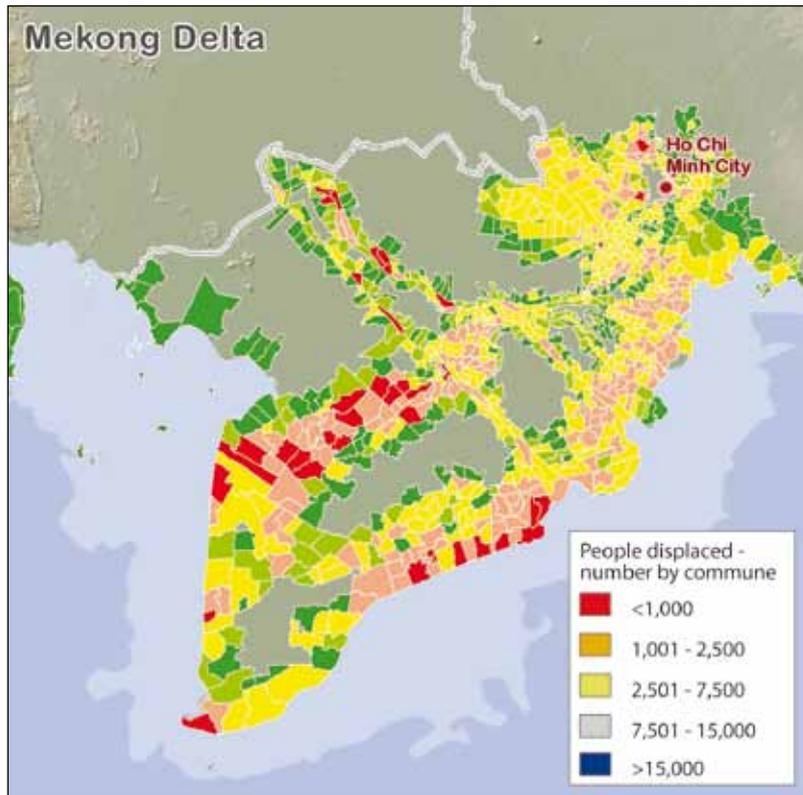


Figure 3.9 Predicted population displacement in Viet Nam from 1.0 m SLR in 2100.

Source: Carew-Ried, 2007.

A summary of the potential impacts of climate change in Viet Nam is presented below (Table 3.3).

Table 3.3 *Summary of potential impacts of climate change in Viet Nam.*

Climate change and natural disaster impacts	
Short-term	Increased number and severity of typhoons striking Viet Nam annually, which leads to large-scale damages in terms of life and agriculture, fisheries production in the coastal areas. Floods and inundation flooding occurring more frequently, with higher severity, which also leads to large-scale negative impacts on production in mountainous and delta areas.
Medium-term	Climate change and disasters can lead to outbreaks of old and new diseases, and also increase the expanding speed of these diseases. Increased temperature, desertification, sea-level rise will lead to more salinity intrusion, which adds to the problem of surface and ground water depletion, or being seriously contaminated.
Long-term	Sea-level rise will cause several areas to “disappear” under the sea. Large-scale desertification will lead to great losses of land for cultivation and aquaculture. Increased temperature will lead to changes in the ecosystems and difficulties for agriculture and fisheries production.

Given the sensitivity of the Mekong Delta region in Viet Nam to the effects of climate change, the potential impacts in this region are summarised below in terms of effects on water resources, crop production, forest and aquatic ecosystems, public health and infrastructure/energy/industry.

Water resources are particularly vulnerable to the effects of climate change. Water runoff from the Mekong River Delta of Viet Nam to the East Sea is 505 billion m³/year. The spatial and temporal distribution of runoff is very uneven; more than 80% of run-off is concentrated in summer (5–6 months), while the rest (20%) occurs during the 6–7 months of the dry season (Southern Institute for Water Resources Planning, 2008c).

Due to global warming, the planting boundaries of some crops could change as temperature and rainfall patterns are modified. Due to abnormal changes in rainfall intensity, flood inundation and drought could occur more frequently. Significant cultivation areas in Mekong delta could be under salt water due to sea level rise. SEA START RC (2006) found that rice production in the Mekong Delta in Viet Nam may be severely impacted by climate change, especially summer autumn crop production, where yield may be reduced by over 40%. Food scarcity could increase as supply fails to meet the demands of a growing population. The total area of agricultural activities could be reduced resulting in food scarcity and higher food prices that could affect not only this region, but the whole country given the importance of the Mekong Delta for national food production.

The area of mangrove forest in the region is expected to decrease due to SLR, increased incidence of droughts, and increased erosion and wave action (Phan and Le, 2008). Terrestrial forest ecosystems could also be affected with changes in temperature and drought incidence leading to increasing danger of forest fire development and spreading of plant pests and diseases. Salinity intrusion due to storm surge, extreme tidal flooding and SLR in the Mekong Delta is expected to lead to a reduction in the area and quality of habitat for freshwater organisms and affect the vertical distribution structure of ecosystems.

Infectious diseases that are common in the region include malaria, synoptic filariasis, dengue fever, and Japanese encephalitis. It is predicted that increased temperatures could facilitate the growth and development of various viruses and insects acting as disease carriers.

Infrastructure, energy and industry would potentially be affected in a number of ways. Storm surge, extreme tidal flooding and monsoon rains and sea level rise would inundate lowlands, leading to increasing energy consumption for pumping and drainage. The Delta region contains many important economic industrial zones and aquaculture areas located in low-lying coastal areas which could face increased challenges from floods and rising sea level. Climate change could cause difficulties in water and material supply for industries and construction such as exploitation and processing of agricultural products, forest product and aquaculture products, industrial and domestic construction, and communication. More frequent extreme storms, flooding and salinity would reduce life span of materials, equipment, machines, and buildings, and maintenance costs would be higher. Sea level rise could affect coastal beaches and thus tourism; it could also affect cultural and historical heritage and preservation areas (Southern Institute for Water Resources Planning 2008a,b, c).

4. National policy responses to climate change

The following sections provide information on policy responses in each of the LMB countries that specifically address climate change. It also describes other policies identified by the NETs which relate to climate change, and which are relevant for the mainstreaming of climate change issues.

4.1 Cambodia

Cambodia ratified the United Nations Framework Convention on Climate Change (UNFCCC) on December 18, 1995 and acceded to the Kyoto Protocol on July 2, 2002. The country's Initial National Communication (MOE, 2002) was submitted to the UNFCCC on October 8, 2002. The Second National Communication was initiated in January 2007 and is expected to be completed in December 2009.

The primary policy framework for climate change is the National Adaptation Programme of Action to Climate Change (NAPA) which was submitted in March 2007 to the UNFCCC (MOE, 2006). The aim has been to develop a realistically achievable country-driven programme of action and priority activities addressing the needs for adapting to the adverse impacts of climate change. The climate hazards addressed by Cambodia's NAPA are flood, drought, windstorm, high tide, salt water intrusion and malaria.

The proposed NAPA projects are already justified by current climate conditions and would contribute to national sustainable development regardless of the magnitude of future climate change impacts on Cambodia. Under changing climate conditions, including higher frequencies of climate hazards, the selected priority activities would be even more attractive. A total of 39 project profiles were developed, amounting to an estimated budget of US\$130 million.

Other Cambodian policies and programmes do not fully integrate global policies on climate change, but focus mainly on post-disaster emergency relief. Numerous Royal Decrees and national laws are relevant to environment and sustainable development and climate change response, but do not explicitly mention climate change. These include the Royal Decree on the Creation and Designation of Protected Areas (1993), the Law on Environmental Protection and Natural Resource Management (1996), the Forestry Law (2002), as well as actions related to disaster management (National Committee for Disaster Management, 2002).

The negative impacts of climate change are only discussed briefly in national Socio-Economic Development Plan, under goals and strategies for the environment, agriculture and disaster relief. Other important national policy documents identified, which are relevant to climate change, include the National Strategic Development Plan 2006 to 2010 and the National

Poverty Reduction Strategy 2002; neither of these policy documents contain reference to climate change issues (Royal Government of Cambodia, 2001; 2002; 2005).

4.2 Lao PDR

Lao PDR ratified the UNFCCC in 1995 and the Kyoto Protocol in 2003. Lao PDR prepared the First National Communication in 2000 (STEA, 2000). In 2003, preparation of the NAPA was commenced by DoE/WREA to assess the urgent and immediate needs to address vulnerability to climate change and propose adaptation mitigation for all development sectors. The main objective of the NAPA is to develop a country-driven programme of action for adaptation to address immediate and urgent needs related to current and projected adverse effects of climate change in key sectors such as agriculture, forestry, water resources, and human health. The NAPA is considered as a project that has cross-cutting issues and actions embedded in national development policies and strategies for all sectors, particularly the most recent policies and strategies such as the National Environment Strategy 2020 and Action Plan 2010 (STEA, 2000), the National Biodiversity Strategy to 2020 and Action Plan to 2010, (STEA, 2004), the National Growth Poverty Eradication Strategy (NGPES, 2004), and the National Forestry Strategy (MAF, 2003), as well as the Sixth National Socio-Economic Development Plan from 2006–2010 (Committee for Planning and Investment, 2006).

The Second National Communication on Climate Change was commenced in late 2008 with funding from the Global Environment Facility (GEF) and facilitation by the United Nations Development Programme (UNDP) and implementation by the NSCC Secretariat Office (DoE). The project will help strengthen the country's climate change office and associated Technical Working Groups, and therefore the technical and institutional capacities of both. It will also assist in the incorporation of climate change issues in the general planning and development strategy formulation processes in the country identified by the Government of the Lao PDR and presented in the National Socio-Economic Development Plan.

In 2003, the Government formulated the Disaster Management Strategic Plan, (NDMO, 2003), which has immediate relevance for climate change adaptation and responses and which has a number of objectives relating to the management of negative impacts of natural disasters on the lives and well-being of local people. The strategy includes activities related to climate change response such as the establishment of district level Disaster Management Committees and implementation of early warning systems.

The Ministry of Agriculture and Forestry (MAF) has developed an agriculture and forestry strategy which has been integrated into the Government's 6th five year socio-economic development plan for 2006 to 2010. While making no specific reference to climate change, this strategy contains elements common to the priority sectors identified in the NAPA.

Other policy documents identified by the NET as being relevant to climate change, while not specifically addressing climate change issues, include:

- Socio-Economic Development Plans;
- National Poverty Alleviation Action Plan and Strategy;
- Water and Water Resources Strategy and Action Plans;
- Policy on Water and Water Resources;
- Shifting Cultivation Stabilisation Plan;
- Integrated Watershed Management Plan.

4.3 Thailand

Thailand ratified the UNFCCC in December 1994. Subsequently, Thailand ratified the Kyoto Protocol in August 2002. From 1997 to 2000 Thailand developed the Initial National Communication to UNFCCC which was funded by Global Environment Facility (MOSTE, 2000). In 2006, the Second National Communication to UNFCCC commenced.

The National Action Plan on Climate Change of Thailand, which was completed in 2000, was the final output of the US Country Studies Program (Thailand Environment Institute, 2000). The development of the Action Plan enabled Thailand to establish a framework national climate change action plan, which consists of action plans for mitigating emissions of GHGs and adapting to the adverse impacts of climate change. National goals and objectives were established for the formulation of the action plan. Programme-based mitigation options were identified and discussed among groups of experts in each sector. A programme of consultation provided an opportunity for public input into action identification of the plan.

The adaptation plans were designed based on available information from systematic assessments of key sectors: forests; water resources; coastal resources; health and agriculture. The National Action Plan involved the establishment of the National Climate Change Office (NCCO) and the National Climate Change Fund (NCCF) to facilitate its implementation.

The Master Action Plan on National Climate Change as the Five-Year Strategy on Climate Change (2008–2012) was approved in January 2008 (ONEP, 2008). It outlines measures that need to be undertaken by various agencies, which include:

- Building capacity to adapt and reduce vulnerabilities to climate change impacts;
- Promoting greenhouse gas mitigation activities based on sustainable development;
- Supporting research and development to better understand climate change, its impacts and adaptation and mitigation options;

- Raising awareness and promoting public participation;
- Building capacity of relevant personnel and institutions and establishing a framework of coordination and integration;
- Supporting international cooperation to achieve the common goal of climate change mitigation and sustainable development.

Three main laws which facilitate the national implementation of measures to address climate change exist as follows:

- The Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (A.C., 1992) or so called NEQA. NEQA authorizes the National Environmental Board (NEB) to set environmental quality standards and to strengthen the rules of governing the monitoring and control pollution, including emission standards (ONEP, 1997).
- The Energy Conservation Promotion Act B.E. 2535 (A.C., 1992) or so called ECPA. ECPA acts on (i) identifies general measures that factory owners should reduce energy uses, (ii) mandates energy audits and monitoring of energy consumption by owners of large buildings, (iii) establishes energy conservation promotion funds for energy efficiency, renewable energy projects, etc.
- The National Energy Policy Council Act, B.E. 2535 (A.C., 1992) promotes a study and analysis of energy policies, management and development plans of the country (Thai Government, 1992).

Other policy documents identified by the NET as being relevant to climate change, while containing no specific reference to climate change include the National Water Policy, Thailand National Forestry Policy and the Land Development Department Policy.

4.4 Viet Nam

The Government of Viet Nam ratified the UNFCCC in 1994 and the Kyoto Protocol in 2002 and subsequently stipulated a number of policy documents to enable the implementation of national commitments to address climate change issues. The first communication to UNFCCC was submitted in 2003 (MONRE, 2003). The Vietnamese National Target Program to Respond to Climate Change (NTP) was approved by the Prime Minister in December 2008 under Decision 158/2008/QD-TTg (Government of Vietnam, 2005). Serving as an overall national strategy for addressing climate change issues, the NTP aims to communicate priority activities addressing the urgent and immediate needs and concerns of the country, relating to adaptation to the impacts of climate change. The NTP is proposed to be integrated into future national, sectoral and local socio-economic development strategies and international commitments. The strategic objectives of the NTP are to assess climate change impacts on sectors and regions,

to develop feasible sector action plans to effectively respond to climate change to ensure the sustainable development of Viet Nam, to take opportunities to develop towards a low-carbon economy, and to join the international community's efforts in mitigating climate change and protecting the climatic system. The specific objectives of the NTP are:

- To identify the extent of climate change in Viet Nam due to global climate change and assess climate change impacts on every sector, area and locality;
- To identify measures to respond to climate change;
- To promote scientific and technological activities to establish the scientific and practical basis for climate change response measures;
- To consolidate and enhance the organisational structure, institutional capacity and the development and implementation of policies to respond to climate change;
- To enhance public awareness, responsibility and participation; and develop human resources to respond to climate change;
- To promote international cooperation to obtain external support in response to climate change;
- To mainstream climate change issues into socioeconomic, sectoral and local development strategies, plans and planning;
- To develop and implement action plans of all ministries, sectors and localities to respond to climate change; to implement projects, and first of all pilot projects to respond to climate change.

The NTP is divided into three phases: (i) First Phase (2009–2010): Start up; (ii) Second Phase (2011–2015): Implementation; and (iii) Third Phase (after 2015): Development. The key tasks that need to be implemented over the period of 2008–2010 are to assess climate variability and impacts of climate change on different fields, sectors and regions, and develop climate change scenarios. There are series of the activities have been suggested for implementation under the NTP:

- Assessment of climate change extent and impacts in Viet Nam;
- Identification of measures to respond to climate change;
- Development of a science and technology programme on climate change;
- Strengthening the capacities of organization, institutions and policy on climate change;
- Awareness raising and human resources development;

- Enhancement of international cooperation;
- Mainstreaming climate change issues into socioeconomic, sectoral and local development strategies, plans and planning.
- Development of Action Plans of Ministries, sectors and localities to respond to climate change;
- Develop and implement projects of the programme.

Viet Nam's policy framework for disaster management is set out in the National Strategy for Disaster Prevention, Response, and Mitigation 2020 (MRAD, 2008a). This strategy prioritises increased awareness raising and participation, minimizing loss of life and assets, and stresses the importance of coexistence with floods. Other key initiatives of the Second National Strategy include: establishment of disaster forecast centres in the north, centre and south of the country; construction of flood corridors and flood retention areas in southern Viet Nam; the use of advanced information and communication technology; strengthening the role of schools and the media in awareness raising; maintaining and upgrading equipment for local Flood and Storm Control Committees; and a proposal for a national disaster fund for projects on disaster mitigation and preparedness, and setting up a disaster insurance company. The Second National Strategy is still, however, designed principally to address short-term climate extremes rather than to respond to future climate change.

5. National institutional responses to climate change

The following sections describe the institutional arrangements that have been established for the management of climate change activities within each of the LMB countries.

5.1 Cambodia

The Ministry of Environment (MOE) is the national focal point climate change within Cambodia (Figure 5.1). On 23 June 2003, the Cambodian Climate Change Office (CCCO) was established within the Department of Planning and Legal Affairs of the MOE (www.camclimate.org.kh; MOE, 2003). The CCCO has the broad mandate of carrying out all technical activities related to the implementation of the UNFCCC, and all other assigned climate change-related tasks (MOE, 2003). Specifically, the CCCO acts as the secretariat for the MOE in its role and climate change focal point and as the Designated National Authority (DNA) under the Kyoto Protocol for Clean Development Mechanism (CDM) activities. The CCCO's role is to facilitate and coordinate donor and private sector activities relevant to climate change. CCCO organises inter-ministerial technical working groups specialised in sectors (energy and forestry), and along climate change themes (GHG inventory, mitigation, vulnerability and adaptation, and UNFCCC implementation). The priority of the CCCO to date has been to raise awareness of climate change issues among other government agencies and to attract donor funding for adaptation and mitigation activities.

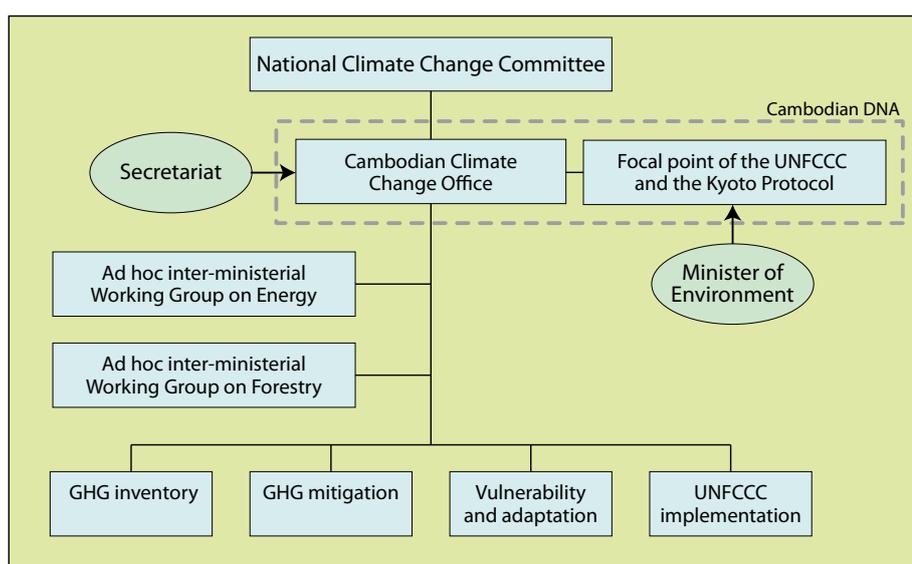


Figure 5.1 Cambodian institutional arrangements for climate change.

Source: Cambodia NET, 2009.

While the CCCO is a technical unit, the National Climate Change Committee (NCCC), established by Ministerial Sub-decree on 24 April 2006, is a senior policy-making body. The Committee is an inter-ministerial mechanism with the mandate to prepare, coordinate and monitor the implementation of policies, strategies, legal instruments, plans and programmes of the Royal Government of Cambodia to address climate change. The NCCC is cross-sectoral and is composed of Secretaries and Under-Secretaries of State from 19 Ministries and government agencies whose mandates are relevant to climate change adaptation or mitigation activities. The NCCC meets at least twice yearly and more often if needed (Cambodia NET, 2009).

5.2 Lao PDR

The Department of Environment (DOE) within the Water Resources and Environment Administration (WREA) has been appointed as the national focal point for climate change actions and initiatives (Figure 5.2). In 2008 the Prime Minister of Lao PDR issued Decree No. 83/PM that established the National Steering Committee on Climate Change (NSCCC), chaired by the Deputy Prime Minister and with the Director General of DOE as the secretary and with members from all concerned sectors.

One of the first assignments of the NSCCC has been to initiate the formation of seven Technical Working Groups with representatives from various line agencies as follows:

- Food and livelihoods security and agricultural productivity led by the Ministry of Agriculture and Forestry;
- Forest and land management to reduce emissions from deforestation and degraded landscapes led jointly by the Ministry of Agriculture and Forestry and the National Land Management Authority;
- Energy management including export of electricity to neighbouring countries led by the Ministry of Energy and Mines;
- Hydrology assessments to predict variability and vulnerability to water resources led by Water Resources and Environment Administration;
- City infrastructure resilience and efficient building design led by the Ministry of Public Works and Transport;
- Economic management to ascertain the implications of climate change impacts on growth targets poverty reduction goals and attaining the country's 2020 vision led by the Ministry of Planning and Investment;
- Financing instruments economic incentives and benefit sharing arrangements under the clean development mechanism or successor arrangements.

The main task of the Technical Working Groups is to study and assess the impacts of climate change on the issues under their respective responsibility for the period 2009 to 2020. The DOE, which acts as the secretariat to the NSCCC, facilitates and coordinates the work of the Technical Working Groups. Based on future climate change impact studies, the DOE in cooperation with the Technical Working Groups will be responsible for drafting the National Climate Change Strategy for 2020; the Interim Action Plan for 2009–2011; and the First National Action Plan for 2011–2016 in alignment with the 7th National Socio-Economic Development Plan. The DOE has also been appointed as the DNA in terms of the CDM.

In addition, the Ministry of Labour and Social Welfare has responsibility for natural disaster management, particularly for flooding. In 1999, the Government created the National Disaster Management Committee to take the lead role in disaster management; the National Disaster Management Office was set up to act as its secretariat to assist the committee in carrying out its duties.

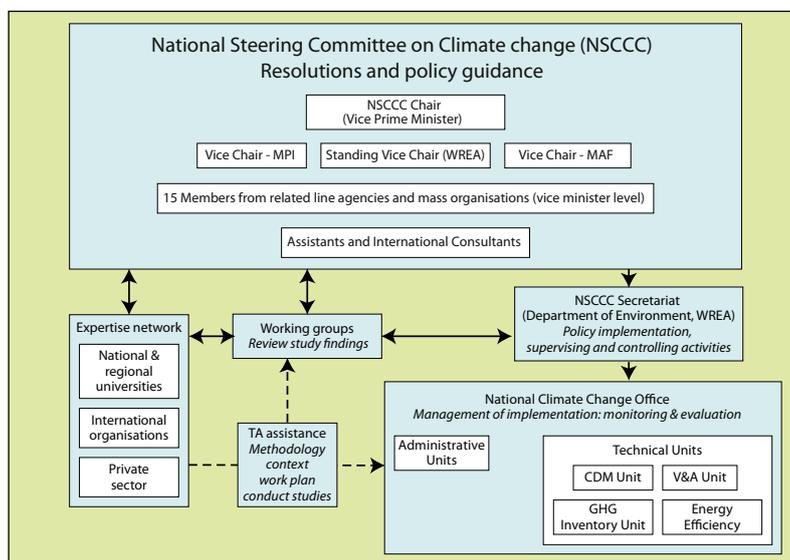


Figure 5.2 Lao PDR institutional arrangements for climate change.

Source: Lao PDR NET, 2009.

5.3 Thailand

In 2004, the Office of Natural Resources and Environmental Policy and Planning (ONEP), which forms part of the Ministry of Natural Resources and Environment was designated as the national climate change focal point. In 2007, Thailand established the National Board on Climate Change Policy, and the Climate Change Coordinating Unit under ONEP and established the Greenhouse Gas Management Organization (TGO) as a public organization under the Ministry as the Designated National Authority (DNA) for Clean Development Mechanism (CDM) projects.

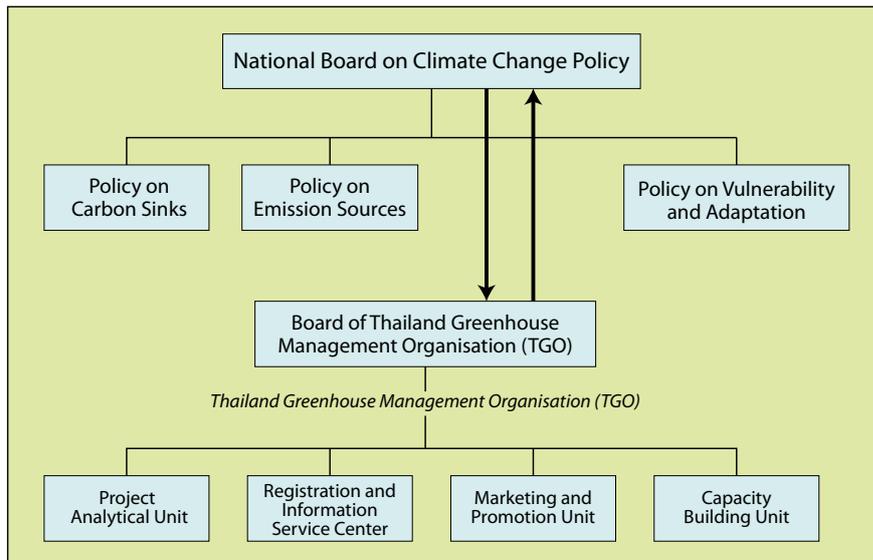


Figure 5.3 Thailand's institutional arrangements for climate change.

Source: Thailand NET, 2009.

The membership of the National Board on Climate Change Policy is wide and includes representatives of line ministries, research institutes and the economic interests. The Board is chaired by the Ministry of Natural Resources and Environment.

To respond to ongoing climate change challenges, the Ministry of Natural Resources and Environment has formulated Thailand's Strategic Plan on Climate Change (2008–2012), which aims to be country's first comprehensive response to climate change, to remove existing barriers to climate change implementation in Thailand, and to promote an integrated approach of problem-solving by relevant agencies in various sectors. The main objective of Thailand's Strategic Plan on Climate Change (2008–2012) is to provide a comprehensive guideline of national responses to climate change challenges. It is essential that national-level and local-level agencies with relevant mandates develop their own action plan that corresponds to the guidelines set forth in the Strategic Plan. Thailand's Strategic Plan on Climate Change (2008–2012) was approved by the Cabinet on 22 January 2008, and the Ministry of Natural Resources and Environment is now initiating the Action Plan Development Process among relevant agencies, expected to be completed this year. There are six strategies in Thailand's Strategic Plan on Climate Change (2008–2012).

- Build capacity to adapt and reduce vulnerabilities to climate change impacts;
- Promote greenhouse gas mitigation activities based on sustainable development;
- Support research and development to better understand climate change, its impacts and adaptation and mitigation options;
- Raise awareness and promote public participation;

- Build capacity of relevant personnel and institutions and establish a framework of coordination and integration;
- Support international cooperation to achieve the common goal of climate change mitigation and sustainable development.

5.4 Viet Nam

The Ministry of Natural Resources and Environment (MONRE) is the focal point for climate change related activities. Groups of technical experts from other sectors, including one for vulnerability and adaptation to climate change, have been established to assist in the implementation of climate change projects.

Under the National Target Program to Respond to Climate Change (NTP), which serves as a national climate change strategy framework, responsibility for climate change and adaptation activities in Viet Nam will be expanded to involve not only the MONRE specific structures but all ministries and sectors, provinces and local governments. In 2008, the Prime Minister established the Steering Committee and Executive Board for the NTP (Figure 5.5). The Steering Committee is a high level organisation comprising the Prime Minister and other Ministers of relevant line agencies and the Executive Board comprises ministers and vice-ministers of relevant line agencies. Both MONRE and the Ministry of Planning and Investment (MPI) have key roles to play in the implementation of the NTP.

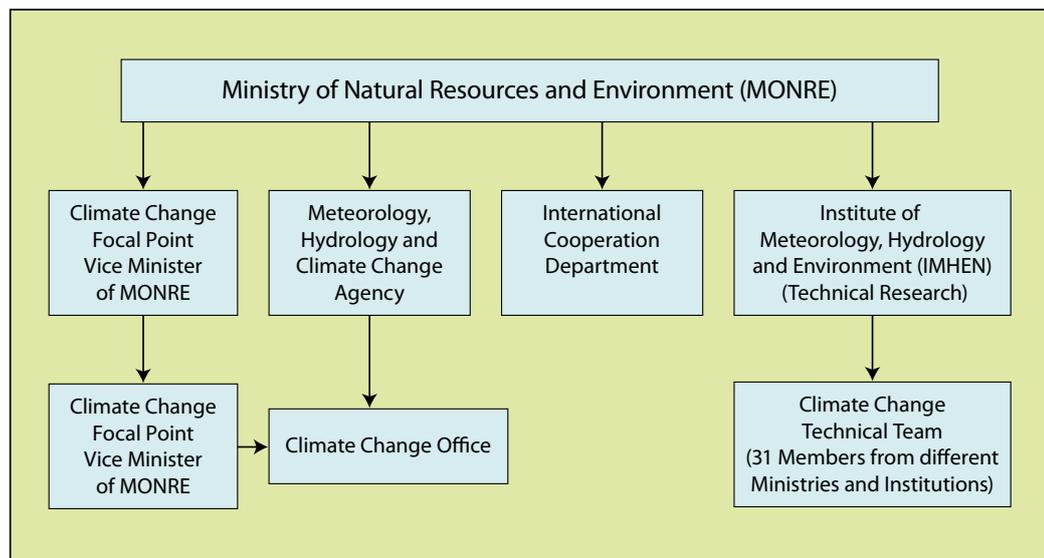


Figure 5.4 Vietnamese institutional arrangements for climate change at ministerial level

Source: Vietnam NET, 2009

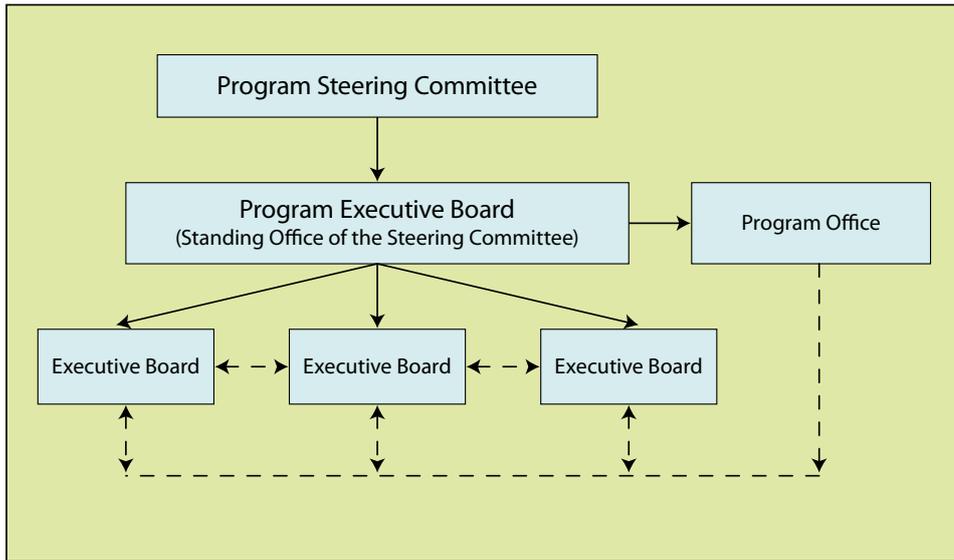


Figure 5.5 Organization chart for implementation of the Vietnamese NTP.

Source: Vietnam NET, 2009.

The MONRE-based International Support Group on Natural Resources and Environment (ISGE) has additionally established a climate change adaptation working group, which provides a forum for dialogue and coordination for climate change adaptation measures.

In addition to the climate change specific responsibilities discussed above, Viet Nam has a long-standing institutional response system for natural disasters. Disaster risk management activities are coordinated primarily by the Central Committee for Flood and Storm Control (CCFSC), chaired by the Ministry of Agriculture and Rural Development (MARD). Other members of the CCFSC include relevant line ministries, the Department of Floods and Storm Control and Dyke Management, the Disaster Management Centre, the National Hydro-meteorological Service, and the Vietnam Red Cross. A national network of local scale disaster management organizations already exists via the nested system of flood and storm control committees. These cross-sectoral committees are presently expected to produce annual disaster preparedness plans.

6. Country adaptation activities

The following sections provide an overview of the major adaptation activities being carried out by each of the LMB countries based on information contained in the NET reports. The information presented below is not exhaustive and focuses on those activities whose main theme or objective is climate change adaptation. It is recognised that numerous other activities in LMB countries are contributing to climate change adaptation through other objectives such as reforestation or poverty reduction. Such activities are not included in the following sections.

6.1 Cambodia

With support from various donors, Cambodia has implemented a number of projects to address climate hazards through natural disaster management response projects. During the period 1995 to 2003, Cambodia implemented 98 such projects to address institutional strengthening, infrastructure development, and human resource development with a total value of approximately US\$328 million.

However, surveys carried out during preparation of the Cambodian NAPA indicate that overall the preparedness to respond to extreme climate events is low, as is adaptation capacity to climate change (MOE, 2005a, b). There are cases where local communities are resourceful when dealing with climate hazards, but these are exceptions and usually coincide with settlements with higher socioeconomic standing and stronger local institutions.

The Cambodian NAPA outlines 39 adaptation activities proposed to be carried out (MOE, 2006). Table 6.1 provides a summary of the activities contained in the NAPA .

Table 6.1 *Summary of Adaptation Activities contained in Cambodian NAPA.*

Distribution by sector	Distribution by climate related hazard
Coastal areas: 8 projects	Coastal protection: 3 projects
Malaria: 6 projects	Drought: 9 projects
Water resources/agriculture: 20 projects	Flood: 5 projects
Cross sectoral: 5 projects	Malaria: 6 projects
	Multiple hazards: 16 projects
TOTAL: 39 projects	

Of the 39 projects contained in the NAPA, 20 have been identified as high priority.

Two years after the completion of the NAPA and its approval by the Royal Government of Cambodia, only one project in water resources management has been approved for funding by

the Least Developed Countries Fund (LDCF). The Government has been unable to attract donor interest in financing the implementation of other high priority adaptation activities.

The NAPA identified a number of barriers to the implementation of climate change adaptation projects in Cambodia. These include:

- Inadequate technical, financial and institutional capacity of government agencies and of local communities in dealing with climate hazards, and limited coordination among them;
- Limited integration of climate change issues into national policies and programmes;
- Limited awareness of climate change issues.

6.2 Lao PDR

The NAPA for Lao PDR was launched in 2009. It was prepared with support from UNDP (WREA, 2009). The NAPA identifies 45 priority projects across the four sectors of agriculture (3 projects), forestry (4 projects), water (10 projects) and health (8 projects).

The process of developing the NAPA in Lao PDR identified a number of projects as listed above but also stressed the way forward (WREA, 2009):

- Strengthen the capacity of the National Disaster Management Committee to deal with likely future adverse impacts;
- Strengthen the Climate Change Office;
- Install an early warning system;
- Initiate in-depth studies of the impacts of climate change, especially concerning droughts and floods;
- Formulate an adaptation strategy on climate change;
- Mobilize increased reforestation.

The Government is implementing a number of adaptation activities through the framework of water resources, forestry and infrastructure development policies. These projects include construction of a 30 km long embankment for flood protection in Vientiane Capital and in Pakse, Champasack province. A number of water gates have been built along the Mekong River and its major tributaries and the government has invested in the purchase of more than 7,000 sets of water pumps. Irrigation systems have been constructed with the capacity of supplying water to 310,000 ha during the rainy season and 215,000 ha during the dry season and public

irrigation systems have been constructed in six northern provinces to combat drought and provide permanent livelihoods for the local people. The government has also completed the construction of Hongxaeng water drainage channel approximately 9 km long, capable of preventing floods in some parts of Vientiane Capital.

6.3 Thailand

Thailand has a long history of implementation of adaptation and mitigation measures. Pressure on natural resources and energy demand does not present a new problem for Thailand. Past efforts have dealt with promoting better management and conservation of natural resources in various sectors and promoting energy security, with and without linking them directly to climate pressure and greenhouse gas emission reduction. These past efforts are summarized below based on ONEP (ONEP, 2008).

Water resource management and the agricultural sector

- The Royal Projects on the development of water resources for cultivation, for preserving water sources and streams and for water drainage from low-lying areas to extend land areas for cultivation.
- The Royal Projects on agriculture to conduct studies, research and experimentation of plant and animal species suitable for the nature of the local areas.
- The Royal Projects to plant vetiver grass for topsoil preservation.
- The projects by the Ministry of Agriculture to promote agricultural product and market improvements.
- The projects by the Ministry of Agriculture to build capacity for local agricultural communities.
- The projects by the Ministry of Agriculture to research drought-resistant plant and animal species.
- The projects by the Ministry of Agriculture to construct dams and irrigation systems.
- Integrated water resource planning for surface and ground water by the Ministry of Natural Resources and Environment.
- The projects by the Ministry of Natural Resources and Environment to promote participation by local administration agencies and local communities to manage water resources at the river region level.

- The projects by the Ministry of Natural Resources and Environment to build capacity to improve water resource efficiency in the agricultural sector and water resource conservation.

Natural disaster management

- The Royal Projects for relief of flooding.
- The Royal Projects relief of drought (Royal Artificial Rain Projects).
- The Royal Projects to construct dams and water reservoirs.
- The Royal Projects to plant vetiver grass to prevent soil erosion.
- The establishment of the National Committee on Water Policy for flood and drought crisis relief.
- The establishment of the Information Centre on Environmental Disasters under the Ministry of Natural Resources and Environment.
- The establishment of the National Disaster Relief Centre under the Ministry of Information, Communications and Technology.

Restoration and conservation of biological diversity and forest resources

- The Royal Projects to renew forested land in key areas such as upstream and reservoir areas.
- The Royal Projects to expand moist forests as buffer zone to prevent wildfires.
- Integrated management of biological diversity and forest resources for resource conservation and sustainable resource use.
- Integrated natural resource and environmental management plan by the Ministry of Natural Resources and Environment.

Management of carbon sources

The priority is greenhouse gas mitigation in the energy sector with active measures by the Ministry of Energy to promote supply and use of renewable and alternative energies in electricity generation and transport and to promote energy efficiency in the residential, commercial and industrial sectors, including:

- Establishment of market mechanisms to promote the use of alternative energies in electricity generation (electricity generation from biogas, biomass, solar energy, etc.);
- Establishment and improvement of the supply of and the infrastructure to support the use of renewable and alternative energies in the transport sector (use of biodiesel, gasohol);
- Implementation of Clean Development Mechanism (CDM) to promote greenhouse gas mitigation in various sectors (Ministry of Natural Resources and Environment);
- Activities to promote energy efficiency in the urban residential and commercial sectors by the Ministry of Natural Resources and Environment and as laid out in the Bangkok's Strategic Plan on Climate Change;
- Development of legal instruments to promote energy-efficient machinery in the industrial sector;
- Activities to reduce open burning in the agricultural and waste sectors;
- Waste management by shifting from open dumping to sanitary landfills and by promoting 5Rs principle (Reduce/Reuse/Recycle/Refill/Repair).

Promotion of carbon sinks

- Afforestation and reforestation projects by the Ministry of Natural Resources and Environment.
- Increase of urban green space as laid out in the Bangkok's Strategic Plan on Climate Change.

CDM Projects

- Biomass Power Projects.
- Biogas Projects.

In addition to national level responses, Thailand has a body of knowledge and experience at the local level on coping with climatic variability and extreme weather events such as floods, and drought. Within different sectors a range of approaches, particularly structural interventions, like large scale irrigation for agriculture, and flood protection, and warning systems have been researched and developed.

Traditionally, farmers have implemented a number of practices to adapt to climate variability, for example inter-cropping, mixed cropping, agro-forestry and animal husbandry. Moreover, over the years Thailand has adopted both surface water and groundwater irrigation and diversification in agriculture to deal with drought, and structural or non-structural measures to deal with flood and drought.

Several community based adaptation activities to climate change, variability and extreme events have been implemented or are being implemented in Thailand. Most of these adaptation activities are small-scale and concentrate on agriculture, water and natural disaster amelioration. Most of the community based adaptation projects have an emphasis on livelihood of the impacted community, diversification of agriculture, conservation of water and awareness raising to change practices.

6.4 Viet Nam

To date national adaptation strategies have been focused on the reduction of risk of disasters, and include a series of measures such the establishment of disaster forecast centres across the country and awareness raising activities. However, these strategies focus on emergency responses to short-term climate extremes and reconstruction after them, rather than long-term adaptation to future climate change. They are also not integrated into wider policies for sustainable rural development and poverty reduction.

As part of the NTP, it is proposed to develop a detailed programme of adaptation activities for various sectors and regions. To date, the Action Plan Framework for Adaptation to Climate Change in the Agriculture and Rural Development Sector Period 2008–2011 has been prepared and demonstrates clear efforts to link the disaster management activities (MARD, 2008), which were mainly under the mandate of MARD, with climate change adaptation activities. The objectives of the Action Plan are to enhance the Government's capabilities of adaptation and mitigation to climate change in order to minimize adverse impacts and to ensure sustainable development of the agriculture and rural development sector. The focus of the Plan is on ensuring the stability and safety of residents in cities and different zones and regions, especially the Mekong and Red River deltas and the central and mountainous areas; ensuring stable agriculture production and food security in an agricultural area of 3.8 million ha with two seasonal rice crops; and ensuring the maintenance of dyke and infrastructure systems to meet disaster prevention and mitigation requirements. The Action Plan does not identify specific adaptation measures but contains the following main tasks to allow development of such measures as part of its implementation.

- Development and implementation of communication and information programme.
- Development of human resources in agricultural and rural development sector in relation to climate change issues.
- Carrying out of investigations into suitable adaptation and mitigation measures and development of standards and procedures for infrastructure development that take into account climate change issues.
- Integration of climate change into sector development programmes.
- Promotion of international cooperation into climate change

National and local authorities in the Mekong Delta are beginning to integrate climate resilient policies into wider programmes of coastal zone management. In some areas of the delta dykes are being strengthened or heightened, mangroves are being planted to improve protection from storm surges, and some houses are being built on bamboo stilts.

Other adaptation activities that are being proposed or carried out through Viet Nam by local and national authorities include:

- Adaptation measures to protect water resources
 - Upgrading and raising the level of drainage system;
 - Actively limiting the population growth rate and redistributing residential areas to avoid the effects of sea level rise (especially in coastal area);
 - Cooperation in whole basin activities for efficient water use with special attention paid to increasing run-off during low-flow season, which is regulated by reservoirs upstream;
 - Conducting studies in long-term water resources prediction, seasonal, inter-annual predictions of water sources for planning rational and safe use of surface water sources;
 - Implementation of the strategy 'Living with Flood'.
- Adaptation measures for agriculture
 - Development of crop patterns suitable to climate change;
 - Effective use of irrigation water and enhancement of irrigation system for agriculture;
 - Development of new crop varieties that can resist severe environmental conditions;
 - Reserve and storage of local crop varieties, establishment of crop seed banks;

- Development of farming techniques appropriate to climate change.
- Adaptation measures for forestry
 - Enhancing afforestation, firstly in watershed, re-greening and protecting and developing mangrove forest;
 - Protecting natural forest and preventing forest fire;
 - Establishing seed banks of natural forest trees in order to protect some valuable varieties;
 - Selecting and developing plant varieties suitable to natural conditions taking into account climate change.
- Adaptation measures for aquaculture
 - Importing and developing valuable aquaculture varieties that could adapt to high temperature, for instance sugpo prawn, green clawed crayfish, lobster, white bass, black bass, etc and increasing the depth of fish lakes, and ponds to create suitable temperature and mitigate losses due to increased evaporation.
 - Changing farming structure in some wet areas from rice monoculture to fish-rice rotation system.
 - Taking into account sea level rise and increase of temperature when building infrastructures, quays, ports, warehouses, etc;
 - Building storm shelter port systems along the coast as well as close to islands;
 - Establishing natural ecological reserves, especially coral reefs and atolls.
- Adaptation measures for energy and transport
 - Upgrade and reconstruct transport infrastructure in areas often threatened by sea level rise and flood.
- Adaptation measures for health care
 - Accelerate the implementation of the programme ‘Eliminating hunger and reducing poverty’, improving socioeconomic standard of the people, especially of those in remote areas with many economic difficulties. Meanwhile, improve public knowledge on family sanitation and culture through national programme such as ‘Clean water and environmental sanitation’, ‘Garden–pond–breeding facilities’, ‘Biogas’, etc.

- Develop national plan and programme for medical control and monitoring in areas that have high danger of infections.
- Establish house-building criteria, considering climate change.
- Promote public awareness on climate change so that every person can take adaptation measures for himself.
- Implement strict quarantine at the borders, airports to prevent infection and disease transmission from outside.

Already, major investments have been committed to upgrading national and provincial dyke systems. For example, a US\$750 million dyke system for HCMC has been approved and a similar system is being planned for Hanoi. The Ministry of Agriculture and Rural Development (MARD) is carrying out a national plan worth US\$109 million to restore mangroves along the coastline of Viet Nam. Site specific plans are also being funded. The Government recently approved a plan for the port city of Haiphong to grow 2,800 ha of mangroves to mitigate the effects of rising sea levels.

Other adaptation activities are being implemented as part of the National Strategy for Disaster Prevention, Response and Mitigation 2020 (MARD, 2008a). The National Strategy stresses the notion of living with the floods. This includes various mandatory requirements for flood safety and security in residential areas. A programme to raise house foundations and make them more flood secure has been ongoing for some time. Low-level dyke systems already control saltwater intrusion and early flooding, and water management in the Mekong Delta, focusing on irrigation water supply and prevention of saline water intrusion.

7. International organisations involved in national activities

The following sections identify key international partners involved in national-level climate change activities within each of the LMB countries.

7.1 Cambodia

Table 7.1 summarises the international organisations involved in climate change activities in Cambodia.

Table 7.1 *International organisations involved in climate change activities in Cambodia.*

Sector	Estimated No. of projects	International partners
Cross-sectoral	10	Danida, EU, UNDP, GEF, Hamburg Institute, IGES, Riso, World Bank
Agriculture and water resources	6	GEF, UNDP, Helsinki University of Technology, START Regional Centre, Oxfam US, Oxfam GB, Kyoto University, GTZ, FAO, HEKS
Energy	1	GEF, World Bank

As noted, the Government has struggled to source international financing for activities identified in the NAPA. To date, only one activity in the NAPA has been financed and implemented.

7.2 Lao PDR

Table 7.2 summarises the international organisations involved in climate change activities in Lao PDR.

Table 7.2 *International organisations involved in climate change activities in Lao PDR.*

Sector	Estimated No. of projects	International partners
Environment	5	GEF, IUCN, MRC, UNDP, World Bank
Cross-sectoral	2	ADB, Government of UK, Japan Special Fund, UNDP
Mines and energy	1	UNDP-GEF

7.3 Thailand

Table 7.3 summarises the international organisations involved in climate change activities in Thailand.

Table 7.3 *International organisations involved in climate change activities in Thailand.*

Sector	Estimated No. of projects	International partners
Capacity building for climate change	9	ADB, GEF, IUCN, JBIC, Mangroves for the Future (MFF), UNDP, UNEP, World Bank
GHG mitigation	20	ADB, Canadian Cooperation Fund for CC, Danida, FAO, Finnish Technical Assistance Grant Fund, GEF, Netherlands Government, UNIDO, World Bank,
Research on adaptation and mitigation	26	ADB, British Council, GTZ, Hadley Centre UK, MRC, SEI, START, UNEP, UNITAR, World Bank, Worldfish Center,
Awareness raising and public participation	12	FAO, UNDP, UNEP, World Bank
Building institutional capacities and coordination	8	ADB, SEA START, UNDP, UNEP, World Bank,

7.4 Viet Nam

Table 7.4 summarises the international organisations involved in climate change activities in Viet Nam.

Table 7.4 *International organisations involved in climate change activities in Viet Nam.*

Sector	Estimated No. of Projects	International Partners
Assessment of climate change impacts	41	ADB, Danida, CARE, CIDA, DFID, GEF, Government of Netherlands, Government of Switzerland, JBIC, Macarthur Foundation, Oxfam, Rockefeller Foundation, SIDA, UK Economic, Social and Research Council, UNDP, UNEP, World Bank, WWF
Adaptation measures to respond to climate change	49	ADB, AusAID, BMZ, DEMF, Government of Denmark, Government of Finland, Government of Luxembourg, Government of Netherlands, Government of Sweden, Netherlands Red Cross, NORAD, PEF, Rabobank (Dutch Bank), SIDA, Tokyo University, UNEP/GEF, UNDP, USAID, World Bank, World Vision Vietnam, WWF
Develop scientific and technological programs	4	Government of Sweden, University of Colombia, UNDP World Bank
Capacity strengthening	26	CIDA, Danida, EC, Government of Sweden, Government of Luxembourg, Government of Finland, Government of Netherlands, Government of Switzerland, Netherlands Red Cross, SIDA, UNDP, UNEP/GEF, WWF

Sector	Estimated No. of Projects	International Partners
Awareness raising	8	Caritas Switzerland, Government of Finland, Government of Sweden, Government of UK, Green Cities Fund Inc, SIDA,
Enhancement of international cooperation	10	CIDA, Danida, Oxfam GB, SIDA, World Bank
Mainstreaming of climate change in strategies and plans	8	Danida, UNDP
Mitigation of climate change	59	ADB, AusAID, Government of Australia, Government of Netherlands, Government of Spain, GTZ, Honda Vietnam, IFAD, JBIC, JICA, SIDA, UNDP, UNEP/GEF, USAID, World Bank
Financial mechanisms	3	JBIC, Danida, UNDP/GEF
Monitoring and evaluation	2	Danida, World Bank

As well as direct support through project implementation, international partners are also involved in climate change activities through the MONRE-based ISGE that established a climate change adaptation working group, to provide a forum for dialogue and promotion and coordination of climate change adaptation measures. A similar forum has been established for NGOs working in the field.

8. Regional climate change activities

The following section provides an overview of the key activities and international stakeholders involved in climate change activities at a regional level. Understanding climate change and adaptation requirements at regional or transboundary level is in its early stages. A few studies have been conducted drawing down on the work of the IPCC and most international development and conservation organisations are only now defining their role in contributing to adaptation activities.

8.1 Mekong River Commission (MRC) Climate Change and Adaptation Initiative (CCAI)

The Mekong Climate Change and Adaptation Initiative (CCAI) is a response to a call from the Mekong River Commission member countries to mount a collaborative regional initiative in address their shared adaptation challenges (MRC, 2008b). Its goal is to have ‘an environmentally sound, economically prosperous and socially just Mekong River Basin, responsive and adapting to the challenges induced by climate change’. A CCAI framework document was designed by MRC with support from AusAID, which envisages a phased and multi-donor approach over 15 years. The process involved intensive consultation with the MRC member countries and international organisations and included the preparation of the national review reports by the NETs and this regional synthesis report.

The CCAI will work through the LMB government and implementing partners so that:

- Adaptation planning and implementation is piloted and demonstrated throughout the region drawing lessons learned from existing practices and demonstration with feed back to improve performance and influence strategies and plans;
- Improved capacity to manage and adapt to climate change at different levels in the Mekong including in the use of tools for different adaptation planning stages and methods;
- Strategies and plans for adaptation at various levels are in place and/or regularly updated and integrated with appropriate development plans, with implementation monitored and reported on a regular basis;
- Regional cooperation, exchange and learning implemented through partnerships in a fully gender responsive initiative for at least three five-year phases with a developed longer-term sustainability strategy.

The Initiative will build on existing MRC programme activities in climate change including:

- Down scaling of global climate change scenarios to the Mekong region (with SEA START);
- Modelling of hydrodynamics resulting from climate changes (with CSIRO and IWMI);
- Overview studies of basin vulnerability (with IWMI and the Thai Institute of Environmental Studies);
- Assessing threats, local vulnerabilities and adaptation capacities in two catchments in Lao PDR and Cambodia (with GTZ);
- Site specific studies (e.g. Songkhram River with support from Finland).

The first of regular Mekong Region Climate Change Forums was convened by MRC in February 2009 bringing together governments and technical organisations to discuss and help shape the CCAI (MRC, 2009).

8.2 Other MRC activities

MRC climate related work covers a range of issues briefly described below. It was started in 2001 where a team from MRC, IWMI and the Institute of Environmental Studies (IVM) highlighted that the Mekong River basin is vulnerable to climate changes, particularly in terms of changes in water resources and food production, which requires adaptation strategies (Hoanh *et al.*, 2003). This was confirmed in the recent Mekong Basin Focal Project, where MRC collaborated with a number of partners (CSIRO, IWMI etc.) under the Challenge Programme on Water and Food. The work provides an integrated basin-wide overview of water, food and poverty issues within the basin, and generated important knowledge on the relationship between agriculture production and water availability (Kirby and Mainuddin, 2006; Mainuddin *et al.*, 2008).

In 2005, MRC published the “Overview of the Hydrology of the Mekong Basin”, which addressed the need for climate change scenarios for the basin. An internal paper from 2006, concluded that there is insufficient evidence that climate change already has an impact on flows of the Mekong River, and this needs further studies (MRC, 2006).

The MRC, CSIRO, IWMI and SEA START RC recently undertook a study on climate change and food security for the LMB, supported by AusAID. The activities being carried out under the project (implemented from 2007 to 2009), include:

- Setting/selecting climate change scenarios, and interpreting to local Mekong spatial scale (down-scaling);

- Studying the adaptation strategies in water, land use and production systems with a focus on food security;
- Using the MRC Decision Support Framework (DSF) to analyse climate change impacts on basin-wide hydrology and impacts from adaptation strategies.

The MRC DSF has been developed further by MRCS and IWMI to cover the upper parts of the Mekong River and to simulate hydrological impacts of climate change based on downscaled regional climate scenarios, provided by SEA START RC. This information will be used to investigate the impacts on food productivity and availability (agriculture and fisheries) and to identify adaptation option.

In 2007 a study by MRC's WUP-FIN project looked at the climate change impacts on the hydrology of the Songkhram River a tributary to the Mekong in Thailand (Veijalainen *et al.*, 2007) and possible climate change impacts on the Tonle Sap lake were investigated and presented in 2008 (Penny, 2008).

The Basin Development Plan Programme (BDP) includes climate change effects in their scenario work. Combined climate and development scenarios are being modelled assessing the hydrological, environment and socioeconomic impacts of climate change in a development context. Through consultation processes with regional and local stakeholders, led by BDP, potential impacts and adaptations strategies on climate change will be discussed for policy uptake and implementation in the planning processes.

The GTZ implemented MRC Watershed Management Project (WSMP) has initiated activities aiming to elaborate a framework to mainstream climate change adaptation into watershed management, and to assess and prioritise interventions to reduce vulnerability in the face of climate change impacts in watersheds. Pilot watersheds are Nam Ton in Lao PDR and Stung Siem Reap in Cambodia.

The MRC Flood Management and Mitigation Programme provides technical and coordination services to the four countries in the Lower Mekong Basin on relation to floods. The MRC is not a disaster preparedness institution *per se*, but selected activities aim to reduce the vulnerability to disasters.

The MRC Fisheries Programme participated in a climate vulnerability assessment of national economies to climate change impacts on their capture fisheries (Allison *et.al*, 2009). This and future work will in the sector programmes will contribute to the vulnerability assessment under the CCAI, together with the Environment Programme's broader work on social impact monitoring and vulnerability assessment.

8.3 United Nations Development Programme (UNDP)

As part of the regional Poverty and Environment Initiative (PEI) of UNDP and UNEP, activities relating to the mainstreaming of climate change issues are proposed or being carried out. A regional workshop has been held on 'Economic development, poverty reduction and environment and climate change: Environmental economics for policy makers' and climate change adaptation aspects are considered a specific issue at the PEI meetings. Activities within both Cambodia and Lao PDR are in the preparatory phase.

Activities in Cambodia are likely to include: (i) integration of climate into national plans, sectoral strategies and the decentralization processes; (ii) linking climate change with disaster risk reduction; (iii) up-scaling pilots based on GEF-SGP; and (iv) linking up with donor coordination mechanisms. Activities in Lao PDR are likely to include: (i) building capacity of PEI champions and implementing partners including the Ministry of Planning and Investment, National Committee for Rural Development and Poverty Eradication and the UNDP-UNEP Joint Environment Unit; (ii) including environment into the 7th National Strategy for Economic Development and Planning; and (iii) activities in two pilot provinces.

8.4 Asian Development Bank (ADB)

The GMS Core Environment Program (CEP) supported through ADB's Regional Technical Assistance (RETA) 6289, was launched in 2006. Phase 1 of the CEP was from 2006 to 2008 and supplementary activities are being carried out from 2009 to 2011. The CEP has five programme components. Under the CEP's Biodiversity Conservation Corridors Initiative (BCI) seven climate change activities are proposed focusing particularly on infrastructure aspects of climate change and adaptation, but also including aspects on disaster preparedness capacity for communities in the BCIs:

- Research into adaptation of rice yield varieties in dry (upland) and wet rice (lowland) areas within BCI pilot sites;
- Carbon neutral transport corridors: greening and carbon sequestration;
- Reduction of emissions in transport sector (freight) along economic corridors through policy framework and incentives;
- Promotion of 'Reducing Emissions from Deforestation and Degradation' or REDD proposals through Carbon Funding Facilities and integration of BCI pilot sites into national benchmarking and capacity building for REDD;
- Assessment of selected infrastructure adaptation/relocation costs;

- Building the effects of climate change in infrastructure development planning (projects in pipeline):
- Disaster preparedness capacity development at community level in BCI sites.

These activities are in the preparatory phase.

8.5 Study on climate impact adaptation and mitigation in Asian coastal mega cities

The Asian Development Bank (ADB), the World Bank (WB) and the JBIC Institute are collaborating to carry out an assessment on the impacts of climate change on four major coastal cities in Asia including Bangkok (World Bank, 2005) and Ho Chi Minh City (ICEM, 2009). A separate study was conducted for each coastal city with a synthesis report to evaluate similarities and differences of results, and to identify common approaches to adaptation, which could be applied to other coastal cities

Each study addresses three major questions (i) what environmental, social and economic effects are expected due to climate change, and what is the projected magnitude of these impacts; (ii) what adaptation measures could each city employ to address the threats and related impacts; and (iii) what are the key policy priorities for decision-makers to deal with the threats. The HCMC study (ICEM, 2009) has developed a range of adaptation tools and options which will be replicated in a wider adaptation project in the Mekong Delta supported by AusAID and ADB.

8.6 Stockholm Environment Institute (SEI)

The Stockholm Environment Institute is undertaking and planning a range of climate change activities within the LMB, which have potential linkages to the MRC CCAI. These include:

- Developing tools to analyse data for decision making through the Water Evaluation and Planning System (WEAP) and the Climate Change Explorer (CCE);
- Examining the extent to which water-related issues influences levels of poverty through the Mekong Basin Focal Project;
- Facilitating the establishment of partnerships for adaptation through the Regional Climate Adaptation Knowledge Platform (with UNEP);
- Building capacity for research & communication through technical support to ACCCA and too much/too little water projects.

8.7 SEA START collaboration with CSIRO and MRC

Since 2008, MRC has been partnering with SEA START RC, to develop multiple climate scenarios for the region. SEA START RC has also accomplished works to develop vulnerability indicators for multiple systems and sectors, particularly in water related and rain-fed agriculture (Chinvanno *et.al.*, 2006; Chinvanno, 2004a; Chinvanno and Snidvongs, 2004). Further documentation is provided on the website — <http://research.start.or.th/climate/>. SEA START has been involved in a wide range of seminal studies relating to down-scaling IPCC scenarios to areas within the Mekong region—for example, with ICEM in HCMC (ICEM, 2009), with WWF in Krabi (WWF, 2008), and with MRC and CSIRO on the entire LMB.

8.8 International Union for the Conservation of Nature (IUCN) Asia

IUCN Asia is undertaking a range of climate change activities in the LMB in cooperation with international and national partners. The focal areas of IUCN's work are:

- Identify potential impacts of and vulnerability to climate change of socio-economic sectors and geographical regions in Indochina and South Asia;
- Develop climate change adaptation programmes and strategies;
- Mainstream climate changes issues in planning tools and management strategies;
- Raising awareness and building capacity in coping with and adapting to climate change.

A key activity has been the development of an ecosystem-based adaptation approach to climate change, which involves measures to build resilience and reduce risk for local communities and ecosystems. It includes a range of local and landscape scale strategies for managing ecosystems to increase resilience and maintain essential ecosystem services and reduce the vulnerability of people, their livelihoods and nature in the face of climate change.

Other climate change activities of the IUCN in the LMB include:

- National plans and strategies to adapt to and mitigate the effects of climate change;
- Science and technology strategies to adapt to climate impacts and mitigate GHG emissions;
- Climate change action plans for economic sectors and special economic zones;
- Main-streaming climate change issues in agricultural and aquaculture development;

- Technology transfers in mitigating GHG emissions;
- Facilitating international partnership and cooperation;
- Awareness raising and capacity building;
- Policy and institutional supports in climate change adaptation and mitigation;
- Consulting on scientific and technological development in climate change issues and use of natural resources;
- Developing action plans to cope with and adapt to climate change;
- Consulting in negotiation process and other climate-related issues for governments of Thailand, Lao PDR, Cambodia, and Viet Nam.

8.9 Food and Agriculture Organisation (FAO)

The Food and Agriculture Organisation (FAO) has carried out a number of climate related activities in the LMB and has a number of ongoing projects. Previous activities include:

- Cross-border animal disease control: avian influenza;
- Post-disaster agriculture recovery: floods, tsunami;
- Addressing water supply uncertainty: irrigation and water management;
- Rural livelihoods adaptation: crop variety, home garden, agriculture diversification;
- Sustainable fisheries in Mekong and coastal marine areas;
- Protection of mangroves.

Ongoing projects include:

- Cambodia: TFP on integrated irrigation improvement in Battambang, TCP on irrigation management;
- Lao PDR: TFP on small irrigation improvement, TFP emergency preparedness for HPAI
- Thailand: TCP on irrigation sector reform, TFP on livestock waste management;

- Viet Nam: TFP on livestock waste management, TFP emergency preparedness and management of animal disease.

Proposed activities of the FAO in the LMB are shown in Table 8.1.

Table 8.1 *Proposed FAO climate change activities in LMB.*

No.	Type of activity	Partners	Country	Title	Description	Duration	Estimated budget (US\$ million)
1	TA		GMS region	Strengthening poverty reduction through biofuel.	Assess, integrate, and develop national and regional biofuel policies and strategies with a view to strengthening poverty reduction.	2008–2009	0.5
2	TA		Thailand	Restructuring of livestock framing for climate change.	Under preparation.	2009–2011	0.7
3	TA		Thailand	Adaptive learning on tsunami early warning system for fishermen and marine occupations.	Under preparation.	2009–2011	0.175
4	ADPC, MRC and ADRC	TF	Cambodia, Lao PDR, Myanmar	Food security and vulnerability assessment and monitoring and agricultural crisis mitigation and preparedness.	Capacity building and piloting on agriculture disaster preparedness and mitigation and climate change adaptation.	2009–2012	2.4
5	UNEP, UNDP	TF	Indonesia PNG, Viet Nam	UN-REDD initiate.	Reducing emissions from deforestation and forest degradation.		

8.10 World Wide Fund for Nature (WWF)

WWF has completed pilot climate vulnerability assessments in Krabi (Thailand) and Ca Mau (Viet Nam) (refer: www.panda.org/greatermekong/climatechange). WWF is in the process of conducting a multi-sectoral vulnerability assessment for priority eco-regions in the Mekong Basin. The assessment will include an analysis of climate change impacts on biodiversity and riparian habitats, which will be used to assess the vulnerability of the fisheries sector and, by extension, livelihoods. The vulnerability assessment will also include analyses of impacts on the habitat mosaics in the Dry Forests eco-region, encompassing much of the Lower Mekong Basin. WWF will conduct a preliminary analysis of climate impacts on water availability in the Dry Forests given the likely sensitivity of isolated ponds and seasonal wetlands to climate change and the importance of these water sources for people and wildlife. Another component of the vulnerability assessment focuses on potential impacts of climate change on the unique forests in the Annamites, which provide important ecosystem services as well as habitat for myriad species, many of which are still being discovered. WWF raises awareness about climate change and the importance of adaptation through a variety of means including Earth Hour,

Climate Witness, engagement with the private sector (e.g., Coca Cola is a partner on two major projects in the Basin), and other environmental education initiatives.

8.11 International Centre for Environmental Management (ICEM)

ICEM—International Centre for Environmental Management has carried out studies into a number of climate change related topics in the LMB. These include a rapid assessment of the effects sea level rise in Viet Nam (Carew-Reid, 2007) and the Ho Chi Minh City Climate Change Impact and Adaptation Study (ICEM, 2009). ICEM is also in the final planning stages for implementing a project on Climate Change Impact and Adaptation in the Mekong Delta supported by AusAID and ADB, which will be identified as a one of the demonstration project within the CCAI Mekong local demonstration project network.

8.12 Wetlands Alliance

The Wetlands Alliance is an alliance of development partners committed to a process of regional collaboration to strengthen local level capacity for sustainable poverty-focused wetlands management. Based on their many years of experience working in the Mekong region, the Alliance partners believe that one of the most effective means of addressing poverty is through locally led management of wetlands and aquatic resources and building local capacity to manage wetlands for livelihood improvement. While the Wetlands Alliance does not have a separate initiative for climate change, it addresses climate change impacts as part of adaptation to environmental changes in general. At the local level change to the environment caused by large (water resources) infrastructure or climate change requires the same response; adaptation to the change, minimising negative impacts and risks, and take advantage of opportunities.

8.13 Australian Centre for International Agricultural Research (ACIAR)

The Australian Centre for International Agricultural Research (ACIAR) is focussing its support for climate change related research on adaptation of agricultural farming systems to climate change. ACIAR is currently undertaking a scoping-study in Cambodia and Lao PDR to develop a 4.5 year project aimed at underpinning long term food security and improving rural livelihoods by helping farmers increase their adaptive capacity to effectively manage impacts arising out of climate change.

8.14 International Water Management Institute (IWMI)/WorldFish

Over recent years IWMI South East Asia has expanded its research mandate from a relatively narrow focus on irrigation system management to the broader context of land and water management in the context of river basins, including climate change issues. IWMI has been involved in the ADAPT programme: Water, Climate, Food and Environment under Climate Change: An Assessment of Global and Regional Impacts and the formulation of Adaptation Strategies for River Basins. This global programme that had its regional focus on the countries of the Mekong Basin, assessed the impacts of climate variability and adaptation strategies in each of the LMB countries. IWMI continues to seek opportunities for involvement in other climate change activities in the LMB.

Together with its partner WorldFish, IWMI is also implementing a number of initiatives related to pro-poor alternatives for climate change adaptation in the LMB. Examples of climate change related activities undertaken by these organisations include:

- Estimating the impact of dams & irrigation infrastructure on fish migration and fisheries productivity;
- Assessing the feasibility of mitigation options for dams and fisheries;
- ‘Bright spots—identifying innovative practices and strategies to reverse natural resource degradation and to build resilience (Noble *et al.*, 2004);
- Improving water and soil productivity in rain-fed agriculture systems;
- Building capacity for community-based irrigation management;
- Integrating fisheries into local agro-ecosystem analysis for improved water allocation;
- Supporting community-based fish culture;
- Raising productivity of rice and fish through integrated agriculture-aquaculture farming systems;
- Optimising water harvesting for pond aquaculture operations in flood plains;
- Managing conflict associated with water quality in the Mekong Delta.

8.15 Australian National University (ANU)

A key strength of the Australian National University (ANU) is in climate change research and education. The ANU established the ANU Climate Change Initiative to draw upon the wealth of expertise in human, biophysical and integrated systems within the university. Skills within the Initiative range from fundamental climate science to economics, governance and law—providing quality and depth of expertise in these areas, as well as skills in integration.

The staff at the ANU Integrated Catchment Assessment and Management Centre (iCAM) is a team of researchers that specialise in integrated environmental modelling, integrated assessment theory and practice, and development of tools for policy and decision-makers. iCAM have conducted range of studies, including those focussed on climate change. Previous activities in the SE Asian region include the Integrated Water Resource Assessment and Management project in Thailand (ACIAR) and a capacity building training programme in risk assessment and management (MRC).

8.16 Oxfam

Oxfam has been implementing disaster risk management projects in Viet Nam and in a process of integrating disaster relief and climate adaptation activities in the livelihood programmes. Some of Oxfam's priority activities are reported below.

- Supporting community coping mechanisms and community managed disaster risk reduction and climate change adaptation: Oxfam is providing Training of Facilitator (ToF) courses for provincial, district and commune leaders and implementing a monitoring mechanism for supporting communities.

Commune leaders are now organizing training courses for women and men on disaster risk mitigation and preparedness. Communities develop and distribute information through home visits, group discussions and announcements over loudspeakers. Communes set up early warning mechanisms; collect information from different sources and announce early warning messages through loudspeakers. They identify evacuation centres and prepare rescue efforts. Oxfam has provided rescue equipment. Communities construct small-scale infrastructure like community roads to the evacuation centre. People maintain their own houses and toilets and relocate livestock and poultry and assets to safe areas before a disaster strikes. The poorest families also receive flexible funds to restore their livelihood according to their need.

- Integrating risk reduction and development: Community leaders in Oxfam's working areas conduct participatory assessments, identify risks and develop livelihood-related risk reduction plans. Action has been taken to raise awareness about seed preservation, the safety of livestock and poultry, fish farms, nets, boats, handicrafts, and tools. Based

on identified risks and vulnerabilities, Oxfam's Livelihood programme is working with related departments regarding crop diversification, irrigation, and evacuation centres, maintenance of livestock and poultry, and the safe storage of food items, preservation of seeds etc.

- Oxfam's emergency preparedness for emergency response: This includes producing guidelines and standards, regularly collecting information from the field, developing and practicing assessment and baseline data collection, organizing training on humanitarian needs assessment, and arranging contingency catastrophe funds to begin humanitarian responses. This process helps appraise existing development programmes in relation to humanitarian activities such as preparedness, mitigation and protection.
- Partners' Emergency Preparedness: Initiatives have been taken to improve partners' capacity for responding to emergencies. Oxfam is developing partners' capacity assessment tools to identify gaps in capacity and to design training manuals accordingly. Major training courses will be held on conducting humanitarian needs assessments, rescue and evacuation, monitoring and evaluation, SPHERE, gender and humanitarian response, designing humanitarian projects, and project management, etc. Partners will also be trained in establishing community-managed early warning mechanisms, developing contingency plans and organizing emergency drills.
- Oxfam's involvement in Inter-agency Coordination Groups DMWG and CCWG: Oxfam is promoting the partnership approach in disaster management, and is one of the core members of the Disaster Management Working Group (DMWG). This group facilitates inter-agency humanitarian needs assessment, improves coordination, and conducts research and advocacy.

8.17 CARE

In keeping with its core poverty-fighting mission, CARE's aim is to help the most vulnerable communities adapt to the unavoidable impacts of climate change. CARE focuses on community based adaptation using known climate predictions and participatory analysis of vulnerability, and by tapping local knowledge and experience in building adaptive capacity.

CARE has many years of experience in participatory methodology development, supporting community planning in the context of sustainable livelihoods development and disaster risk reduction. This experience contributes to and forms the foundation for the development of CARE's growing expertise in community based adaptation. CARE is building on its experience carrying out adaptation projects by developing regional 'learning programmes' which function as incubators and test-beds for ground-breaking ways to design, implement, monitor and evaluate the effectiveness of adaptation projects. They also demonstrate the complementary roles that national government, local authorities and civil society can play in helping highly vulnerable people adapt to the impacts of climate change.

CARE is creating new conceptual models and participatory methodologies to address the effects of climate change. For example, our Climate Vulnerability and Capacity Assessment tool helps stakeholders:

- Identify especially vulnerable regions and communities;
- Understand the consequences of climate change for different social groups within these communities;
- Design projects that provide immediate benefits and build adaptive capacity for further climate change.

Some of the key projects that CARE is working on in the LMB that relate to climate change are:

Cambodia

Food/livelihood security and emergency response	Is working in 5 provinces to address underlying causes of rural poverty and degradation of natural resources.
Integrated rural development: food and livelihood security and gender	Is working with rural women to play a central role in increasing climate change adaptive capacity of their family and community.
Community-led innovation in drought preparedness and mitigation	As part of a regional programme, communities in Baphnom district, Prey Veng province are provided with technical support to undertake preparedness planning.
Integrated rural development & disaster mitigation project (IRDM)	The project targets some of the poorest and most vulnerable communes in the provinces Prey Veng and Svay Rieng of Southeast Cambodia that are some of the most disaster-prone provinces. Village level efforts aimed at promoting Disaster Risk Management (DRM) are incorporated within longer term rural development initiatives targeted at poverty reduction.

Lao PDR

Poverty alleviation in remote upland areas	Is working with remote, poor, ethnic communities and local government partners to improve livelihoods and resilience and increase food security of poor households. Including exploration of potential of renewable energies in household poverty reduction.
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Viet Nam

Community watershed project	Is working with local communities in Ba Thuoc District, Thanh Hoa Province to adapt to chronic, long-term environmental changes (higher temperatures, sea-level rise, saline intrusions, subsiding water tables, +/- rainfall, less predictable seasons). The project has supported the communities to develop their own development vision and goals and identify a participatory watershed management. Good process of management of natural resources within 3 watersheds will help to reduce the incidence and severity of drought and flash floods.
Community based mangrove reforestation and management project	This project was successful in promotion of participatory planting and community based management of extensive mangrove areas of 350 ha in Hau Loc district, Thanh Hoa province to protect vulnerable communities from physical and economic impacts of disasters such as typhoons. The project provides multiple benefits – DRR, diversified livelihood options and carbon sequestration.
Community resilience to natural disasters in the Mekong Delta	Is working with local communities in Thanh Hoa and Binh Dinh Province to develop disaster risk reduction strategies and planning and to reduce vulnerability to increased risks of disaster posed by hazards like typhoons, droughts, sudden floods. The project has built the strengths of communities to identify hazards, assessed their vulnerability and realised their capacity to prepare for and mitigate against natural disasters such as floods, storms and droughts and helped to optimise their livelihood security during flooding and through out the year.
NGO coordination and national engagement	<p>Some of the activities are:</p> <ul style="list-style-type: none"> • Chair and coordinate the NGO Climate Change Working Group such as meetings, events, capacity building, information sharing, web maintenance. • Develop and pilot climate change mainstreaming guidelines. • Organized the national Mainstreaming workshop on CCA, DRR and livelihoods. • Developed and support implement proposal for capacity building for civil society through CCWG.

8.18 GWP-SEA Networks

The Global Water Partnership (GWP) is a network that promotes Integrated Water Resources Management (IWRM) through information sharing, implementation of practical approaches and through the development of IWRM policies and strategies throughout the world. GWP promotes IWRM through its Regional Water Partnerships (RWPs), Country Water Partnerships (CWPs), Area Water Partnerships (AWPs), the global office as well as other relevant regional thematic networks.

This GWP-SEA (Southeast Asian) network is playing a role in capacity building on climate change and adaptation. There are several meetings about climate change, proposed for the next Southeast Asia Water Forum and country members are developing proposals on climate change activities.

8.19 Association of Pacific Rim Universities

Formed in 1997, the Association of Pacific Rim Universities (APRU) is a consortium of 42 leading research universities in the Pacific Rim. The APRU World Institute (AWI) was established by APRU so that a larger international set of multi-disciplinary experts could focus on high priority research issues confronting countries within and in the Pacific Rim. As its first major research programme, the AWI has chosen to focus on the water systems of cities and associated regions under climate stress.

The participants in this Climate Mitigation and Adaptation Strategies (CMAS) programme are all leading research universities, including: the University of California, San Diego; Tsinghua University, China; The University of Melbourne and Australian National University, Australia; The National University of Singapore; The University of Malaya, Malaysia; Kyoto University, Japan, and Chulalongakorn University, Thailand. This project is also being developed with the support of the United Nations University and has been joined also by the Asian Institute of Technology, Thailand.

Key relevant projects of the rapidly developing CMAS programme are focussing on hydrological modelling and the prediction of flooding in the face of sparse data, methods for sharing data collected through diverse sources, the appropriate use of existing and emerging technologies and strategies to ensure water quality, and adaptation barriers and opportunities associated with approaches to governance and the role of local culture and knowledge. Work is being carried out in support of this in Viet Nam and the Mekong Basin, as well as in other case study countries (including Thailand, Malaysia and Singapore).

9. Gap analysis

The gap analysis presented below is drawn from the national reports and the outcomes of the Regional Climate Change Forum on the MRC CCAI held in Bangkok in February 2009. The discussion has been categorised into (i) national issues for each of the LMB countries, and (ii) regional issues for the LMB region as a whole.

9.1 Cambodia

Awareness of and low adaptation capacity to climate change in the general population:

Awareness of climate change and the need for climate change adaptation is limited in the general population, in particular in rural areas. Although people may have an intuitive understanding of climate extremes such as floods and droughts, the drivers and projected impacts of climate change on livelihoods are not understood by the general public. While 80% to 85% of the population lives in rural areas and a large proportion derive livelihoods from agriculture, there is a knowledge gap in climate change adaptation practises. The preparedness of villagers to extreme climate events is low, as is their capacity to adapt to climate change.

Technical knowledge of climate change among government agencies and non-governmental organisations: Technical knowledge of climate change in Cambodia is concentrated in the Ministry of Environment's Climate Change Office and a few environmental organisations. Other government agencies and stakeholders in development have a limited awareness of climate change issues. Line ministries and many development NGOs only have a basic understanding of climate change science. There is still much confusion about the physical basis of climate change, climate change impacts on Cambodia, as well as available adaptation and mitigation technologies.

Perception of climate change as a sector rather than a mainstreaming necessity: Cambodia's legislation and policies provide a complete coverage of environment and sustainable development, but do not explicitly mention climate change. With the exception of the NAPA, climate change issues are yet to be fully included into the national development agenda. Because of their lack of relevant technical knowledge, policy-makers remain ill-equipped to lead the mainstreaming of climate change issues into national development plans.

Climate change literature translated into Khmer language: Only a small number of climate change documents exist in Khmer language such as the NAPA, a general booklet on climate change and the Clean Development Mechanism, the Cambodia's Initial National

Communication, a CDM Country Guide for Cambodia and two other brochures for Clean Development Mechanism (CDM) projects. There is a need to translate essential technical climate change terms and international documents such as the UNFCCC, the Kyoto Protocol, as well as summaries of the IPCC Fourth Assessment Report.

Analytical studies on effects of climate change on Cambodia: There is a need to conduct analytical studies on predicted climate change outcomes for Cambodia and the potential impacts of climate change on the country. There is an absence of rigorous information relevant to specific sectors (agriculture, water resources, fisheries, rural development etc.) for use in the development of targeted policy responses and for hotspot areas. National meteorological observation and forecasting capacities need to be dramatically improved to feed into climate models and early warning systems.

Progress in implementation of NAPA: Two years after the completion of NAPA and its approval by the National Assembly, only one project in water resources management has been approved for funding by the Least Developed Countries Fund (LDCF). The Government has been unable to attract donor interest in financing the implementation of other high priority adaptation activities. This situation is not specific to Cambodia, as other LDCs have faced similar difficulties in getting disbursements through the GEF implementing agencies.

9.2 Lao PDR

Technical capacity and inadequate climate change data: There is not enough research available to convince decision makers or local populations how much the climate is changing. Lao PDR lacks suitably trained human resources to address climate change issues. There is a lack of appropriate tools/methodology and capacity to assess impacts and adaptation and projection on the climate change in the country and lack of sufficient practical assessment of the impact of climate change on the ground, particularly on a local scale. There is a lingering top down approach in the government which hampers implementation of climate change initiatives, and a weak understanding of both the technical and adaptation aspects of climate change, both within government and in the general public.

Concrete implementation of climate change policies: Most policy initiatives are still in the negotiation and development under the lead of the very new NSCCC; these include the following proposed future policies: (i) programme for setting the national climate change strategy for 2020; (ii) the Interim Action Plan for 2009–2011; (iii) the First National Action Plan for 2011–2016 in alignment with the 7th National Socio-Economic Development Plan; and (iv) policies on the Clean Development Mechanism.

Approaches to adaptation in the food and livelihood sector: The NAPA states that an adaptation measure to reduce impacts in the agricultural sector is to promote secondary professions in order to secure farmers' livelihoods; about 80% of the population in the country engages in shifting cultivation as a primary or secondary occupation. However, it is also a Government priority to reduce shifting cultivation and to eradicate this activity will weaken the livelihood security of numerous households. Clearly, there are livelihood and mitigation tradeoffs under these proposed priority adaptation programmes that require further deliberation, and must revisit earlier debates on shifting cultivation in Lao PDR.

Approaches to adaptation in the forestry sector: An integrated approach to natural resource management with support for shifting cultivators to implement better options in land use and better farming and cropping systems and practices is proposed. Agro-forestry is one of the priority initiatives of the Government's Strategic Vision for the Agricultural Sectors to achieve this goal, and is also seen as one of the main tools for achieving sustainable agriculture in the uplands and would have an important role in climate change adaptation. However, the bio-physical and socio-economic constraints and opportunities for agro-forestry development in different upland farming systems are currently not well understood and the skills and experiences to develop acceptable agro-forestry systems are still lacking among existing staff.

Approaches to adaptation in the health sector: This sector is often included in national discussions for adaptation (as a result of NAPA). Overall, poor health is a major factor contributing to poverty and vulnerability, and directly affects the capacity of individuals and families to adapt to climate change. The range of severe health impacts that may emerge from climate change will exacerbate these conditions. It is essential that research and development efforts increase investment and development of capacities to manage these new and dynamic health threats in order for any adaptation efforts to be effective.

Further investigations into linkages between hydropower and climate change are required: In keeping with development objectives of the Lao PDR to reduce poverty line by 2020, more than 50 large and medium hydropower projects are proposed to be constructed with a total capacity of approximately 20,000 MW. However, there have been limited investigations on the overall effects of climate change on hydropower in the region and vice versa, little research on the long term cumulative effects of hydropower on the region.

Information on the effects of climate change on urban infrastructure: Further investigation of this issue is required both to understand the potential impacts and to inform development of future building regulations and urban planning.

9.3 Thailand

Institutional strength, capability and availability of reliable data are key issues for generating reliable climate scenarios: In Thailand, governments, research institutes, universities are investing in climate change studies and trying to provide technical knowledge in this area. There has been progress from private research and academic institutions with appropriate expertise that carry out climate change studies and predict scenarios. Furthermore, international organizations are supporting governments and private institutions to carry out advanced climate change research and assess vulnerability and adaptation options. However, limitations exist in terms of the technical capacity of experts and sourcing of appropriate funding. The situation is changing with the emergence of the threat of climate change to the development, politics, and economies of the country.

Baseline data: There is still a lack of baseline information for understanding the complex interplay between and within natural and human systems and a considerable gap in information on likely changes in climate and human systems in different ecosystems and agro-climatic systems. National scale assessment based on models failed to incorporate human dimensions, particularly livelihood aspects and inter-sectoral relationships. Without such national assessments as a sound basis for designing and planning adaptation policies, strategies and programmes, decisions on adaptation will remain uncertain and will not lead to effective results from implementation. Baseline data between different organisations working on climate change must be shared.

Capacity in developing adaptation activities: Understanding the effects of climate change, and associated enhanced climate variability at the local and national levels is critical for adaptation, as is the capacity to select and apply appropriate methods and tools to prepare for adaptation. Furthermore, the development of technologies for adaptation; the use and integration of traditional knowledge for developing adaptation options; integration of local knowledge and scientific knowledge for technology transfer; and communication of vulnerability and adaptation both to vulnerable communities and policy makers are also essential. Documentation of successful pilot schemes on adaptation assessment with emphasis on processes; development of sharing mechanisms like the adaptation database of the UNFCCC (<http://maindb.unfccc.int/public/adaptation/>) and stronger public education and awareness programmes are all useful in disseminating information relating to adaptation activities to climate change and its benefits.

Awareness of climate change issues: There is a need to build awareness about the potential impacts of climate change amongst potentially affected people. There is a need to convince stakeholders that climate change is a reality and the effects are already being experienced. There is also a need to develop and disseminate good quality information. Systematic efforts are required to study the impact assessments of different climatic parameters. Studies about future projections of changing regional climate provide insights for methodological developments,

including models for integrated assessment and GIS-based computer algorithms for supporting policy assessments at regional levels.

9.4 Viet Nam

Knowledge on climate change and climate change impacts: The perception of communities and some governmental institutes on climate change is a limitation in taking up appropriate activities. Human resources, especially technical staff who can guide and manage the process, are limited.

Priority given to climate change policies: Climate change programmes including long term programmes by the government institutions and provincial, district and commune levels is not given sufficient priority in work plans.

Financial support for climate change initiatives: There is no government budget specifically for climate activities at the province or lower levels. The budgets that the national government and local authorities have at their disposal for adapting to climate change are inadequate.

Awareness of climate change issues: Those most at risk from climate change, the rural poor living in provinces most affected by climate change have limited information or financial and technical support to adapt to their changing world. The concept of climate change, its potential impacts and the need for adaptation are not yet well known in Viet Nam beyond a small community of experts and development workers, some concerned state management agencies, and some localities.

Ability to implement NTP: Even with the approval of the NTP to respond to climate change limitations exist in its implementation:

- Awareness on the part of decision makers, officials in sectors and localities in social mass organizations, and vulnerable communities. Therefore, raising awareness of all levels is obviously the first priority of the NTP activities.
- Coordination to respond to climate change in developing the policies, plans and programmes in sectors/regions, even in highly sensitive sectors/regions. There is still not adequate awareness of the necessity to integrate climate change information into policies/plans.
- Tools and methodologies to instruct and advise decision makers. This happens also with the experts in the sectors/local levels as well as in vulnerable communities. Therefore,

training and knowledge upgrading; collecting and utilizing the data on climate change; developing tools/methodologies for analysis and adaptation with the climate change, are important activities that should be done immediately.

- Relevant knowledge. Climate change is a long-term issue, the impact of the climate change are very complex including present impact and potential impact in the future. The knowledge of the world and Viet Nam on the trend of the climate change and its impacts to socio-economic activities is still limited.

9.5 Regional

Improved knowledge base of climate change predictions and impacts: The understanding of how climate change may threaten the natural environment (e.g. water resources, biodiversity, soils) and the populations that depend upon it in the Mekong River riparian countries is limited. Past initiatives on climate change impacts and adaptation strategies for the lower Mekong Basin (LMB) have mostly been based on low-resolution projections of future climate conditions. Some recent studies have attempted to use higher resolution regional climate scenario and analysed impacts of climate mean and variability on the water regime, agricultural crops, and some ecosystems (SEA START, 2004, Chinvanho & Choengbunluesak, 2006, Veijalainen, Kummur and Lauri, 2007). However, these studies have been limited to a few selected pilot sites and do not capture basin-specific characteristics in the process, such as landforms, land cover and aerosols. Further, because there have been only few such studies there is a lack of diversification of scenarios to address the uncertainties of future climate changes. There is also a lack of analysis of SRES scenarios and GCMs. There is a need to build on these studies and expand the area coverage to other parts of the LMB.

Facilitated collaboration amongst LMB countries: Considering the commonality of problems related to climate change, as well as many economic, social characteristics, and institutional capacity limitations, increased cooperation and information sharing amongst LMB countries in relation to existing experiences on assessment of impacts and vulnerability and adaptation would be highly useful. The sharing of experiences on disaster risk reduction and preparedness and integration of climate change into disaster risk reduction is also necessary.

Consolidated information on climate change activities: There is an ad-hoc approach to the collection and storage of information on climate change activities throughout the region. A consolidated information collection, storage and network system would better allow LMB countries and regional stakeholders to understand the status of climate change modelling, assessment and adaptation activities. Availability of some data is limited, such as the data needed for meaningful down-scaling of global models, calibration and validation. Close cooperation with national line agencies and regional and international academia shall provide a network for data acquisition.

Increased awareness about climate change issues and potential impacts: There is a need for raising awareness about climate change and its impacts on the part of national Governments, policy makers, NGOs and other development partners, and the general community.

Better understanding of links between climate change and livelihoods in LMB: Strategies for poverty alleviation through sustainable development must rely on a good understanding of the likely impacts from climate change on aquatic resources and people's livelihoods. The level of knowledge on water resources, land use and livelihoods in the LMB has improved rapidly over the past decade. However, knowledge about the relationships to the predicted changes occurring in the basin is still insufficient. Particularly scarce is the information related to people's vulnerability to ecosystem changes resulting from climate change, and strategies and ability to adapt to these changes.

Improved MRC Technical Capacity: As a regional stakeholder, MRC has a potentially important role to play in climate change activities. However, MRC needs to expand its technical capacity in this field to manage and implement major climate change activities.

Integration of climate change into policy at national level: There will be a need to ensure that national level policy formulation takes into account the results of regional climate change activities and investigations as appropriate.

9.6 Summary of gap analysis

Based on the above discussion, it is evident that many of the gaps identified at a national level are common across the LMB. Table 9.1 presents a summary of the gap analysis and indicates where such commonalities occur. The gap analysis reflects the key concerns and priority aspects as expressed by the national and regional experts. When a gap is not highlighted it does not mean that the issue is resolved only that other aspects are considered more immediate to address.

Table 9.1 *Summary of gap analysis (cells filled blue identify gaps).*

Issue	Cambodia	Lao PDR	Thailand	Viet Nam	Regional
Awareness of climate change in the general population					
Awareness of climate change at different institutional levels					
Low adaptation capacity to climate change in the general population					

Issue	Cambodia	Lao PDR	Thailand	Viet Nam	Regional
Adaptation capacity			■		
Institutional strength and capacity			■		
Technical knowledge among government agencies & NGOs	■	■	■	■	■
Concrete implementation of climate change policies		■		■	
Perception of climate change as sector and not mainstreaming necessity	■			■	
Prediction and assessment tools			■		
Climate change literature translated into local languages	■				
Tools for advising and instructing policy makers				■	
Analytical studies on climate change impacts	■	■	■	■	■
Inadequate, reliable climate change data	■	■	■	■	■
Progress in implementation of NAPA/NTP	■			■	
Sectoral implications and adaptation		■			■
Coordination to respond to climate change in developing policies & plans				■	■
Financial support for climate change initiatives	■			■	

10. Recommendations

The recommendations presented below are drawn from the national reports and the outcomes of the Regional Climate Change Forum on the MRC CCAI held in Bangkok in February 2009. The discussion has been categorised into (i) national issues for each of the LMB countries, and (ii) regional issues for the LMB region as a whole.

10.1 Cambodia

C1 – Implementation of NAPA priority activities: The NAPA has been built on existing coping strategies implemented by local communities and aims to enhance their adaptation capacity. The focus is on adaptation measures that have direct impacts on the lives of local people, in particular the poorest. If implemented, the NAPA would significantly contribute to Cambodia's achievement of sustainable development under changing climate conditions. The 16 priority projects in the non-health sectors consist of a range of activities from localised community based projects with estimated budget of US \$1 million to larger irrigation and flood control infrastructures covering multiple provinces with budgets around US \$30-45 million. These planned projects have already been approved by the National Assembly but cannot be implemented without donor involvement.

C2 – Climate change awareness raising campaigns: A series of climate change awareness campaigns needs to be conducted using Khmer media (television, radio, newspapers) and other appropriate communication channels (village discussions, household visits etc). It is necessary to develop original climate change content adapted to local populations and to translate into Khmer language existing leaflets, brochures, short films, documentaries and other available multi-media resources. The focus should be put on rural communities and on the need to adapt to changing climate conditions. Topics to be disseminated will include the impacts of climate change on Cambodia, household based adaptation measures applicable in the Cambodian context.

C3 – Mainstreaming of climate change adaptation into development: Climate change is mistakenly considered by many stakeholder in Cambodia as a stand-alone sector (usually perceived as an environmental mandate), rather than as a cross-cutting issue with wide-ranging sectoral implications for development. Technical training seminars geared towards staff of government agencies (agriculture, education, rural development, planning, public works and transport, water resources and meteorology) and development NGOs operating in sectors relevant for water related climate change adaptation are required.

C4–Institutionalisation of an inter-organisational climate change coordination mechanism:

With the gradual mainstreaming of climate change issues, there is a greater need for coordinating climate change programmes and projects between government agencies, NGOs, academic institutions, donors and other stakeholders. This recommendation proposes the institutionalisation of climate change round table meetings, workshops and forums aimed at promoting information and experience exchange, and creating a platform for greater cooperation among stakeholders. In turn, this coordination mechanism will allow for synergies and avoid the duplication of climate change adaptation efforts.

C5–Integration of climate change adaptation into the national budgetary process: National budget allocation is the responsibility of the Council of Ministers, upon proposals from line ministries, with the support of the Ministry of Economy and Finance and the National Assembly. Without national financial allocation, climate change adaptation cannot be realistically implemented. Because technical staff and policy makers with national budgetary mandates are not familiar with climate change issues, it is difficult for them to approve climate change adaptation funding into the national budget. Thus, it is necessary to incorporate from the early stages of national budget negotiations climate change adaptation concerns. This proposed activity would consist of capacity building and awareness raising of climate change adaptation for staff of government institutions involved in the national budgetary process, as well step by step integration of climate change concerns in the national budget (support to line ministries, needs assessment, costing, budgeting etc.).

C6–Formulation of climate change adaptation and climate change proofing legislation/policies: Cambodia lacks policies and legislation that would provide a legal framework and authority for the implementation of climate change adaptation measures on a broader scale. There are opportunities for the formulation of building codes and design standards promoting the construction of climate resilient infrastructures (roads, bridges, reservoirs, wells, dams, dikes, culverts etc.) and housing (design, materials, zoning etc.). There is also a need for developing legislation governing the operation of water control structures (irrigation, hydroelectricity, water supply and sanitation etc.) under changing climate conditions.

C7–Strengthening of climate change research: Academic institutions and governmental agencies in Cambodia have little research capacity and funding in climate change. There is a need for conducting analytical studies on the projected climate for Cambodia and the potential impacts of climate change on the country. This recommendation proposes funding sector specific studies on the impact on climate change in Cambodia (agriculture, water resources, fisheries, etc.), strengthen national climate change forecasting (downscaling of GCMs etc), build capacity in seasonal climate forecasting (including higher temporal and spatial resolution of rainfall and flood forecasting), and support researchers and academics for training and studies in countries with capacity in climate change adaptation.

10.2 Lao PDR

L1 – Capacity Building Programmes: Effective programmes for climate change adaptation require the strengthening of research capacity at various levels and among public sector agencies, research institutions and organizations. Lao PDR requires capacity need assessment and basic capacity building programme on climate change awareness and scientific knowledge at all levels of government, and also within national and local level. This activity is the first priority for the CCAI.

L2 – Modelling and Assessment Tools: The MRC should provide a package of tools for climate change modelling and assessment that can be utilised by all member countries.

L3 – Support to Policy Frameworks: Improving regulatory and institutional frameworks for government line ministries on climate change adaptation to ensure the effectiveness of management and implementation.

L4 – Pilot Study of Climate Change Impacts: Conduct pilot studies on the impact of climate change on flood and drought prone and high risk areas (for Bolikhamxay and Vientiane Provinces (flood) and Savannakhet, Pakse, Saravanh Provinces (drought)).

L5 – Monitoring and Reporting System: Establish monitoring and reporting system to inform/broadcast climate change status and information to public and all sectors in national and local languages.

L6 – Forestry Sector: Investigations into the appropriate use of forest resources as sink sources for carbon dioxide are required.

L7 – Health Sector Responses: Research is required to strengthen health systems and services to better anticipate and address potential health challenges, and also respond to the uncertainty of CC, such as unexpected and sudden changes in temperature and precipitation.

L8 – Water Resources Strategy Development: Develop a strategy for the multipurpose use of the water for national development activities (hydropower, irrigation, water supply and fishery). This activity would provide the basic facility and infrastructure to cope with extreme events (flood and drought) for all groups of people in both urban and rural areas and also mitigate the flood in the country.

10.3 Thailand

T1–Improved Development and Assessment of Adaptation Strategies: Adaptation should aim to strengthen traditional coping mechanisms: optimising current systems whilst building flexibility to cope with the uncertainties posed by climate change. Introducing new technology can be sustainable where it strengthens and builds on traditional approaches and reinforces local knowledge. An assessment of existing coping strategies and its effectiveness under the warmer climate is necessary to modify practices for readjusting with changing conditions that climate change will bring. Implementation of pilot projects should be carried out.

T2–Capacity Building: Enhancement of technical capacity is needed to assess, plan and integrate adaptation needs into sectoral development plans that deal with the adverse impacts of climate change.

T3–Awareness Raising: The development of educational and public awareness programmes on climate change, the provision of public access to information on climate change issues and public participation (including NGOs) are important components of both the implementation of the UNFCCC and the development of national action plans.

T4–Mainstreaming Adaptation to Climate Change in National Policy: There is a need to support mainstreaming of adaptation into sectoral policy, particularly water, agriculture, coastal zones and managing natural ecosystems.

T5–Funding Sources: More work is needed to promote mechanisms to increase funds for adaptation to climate change. Implementation of adaptation measures identified in National Communications and National Adaptation Programmes of Action should be supported effectively.

T6–Investigations into Poverty/Climate Change Linkages: In order to address adaptation to climate change, including variability and extreme events, it is vital to continue research into the circumstances of the poor and vulnerable. This requires stakeholder involvement, and will not be based exclusively on a top-down approach. This research must be communicated in a clear, targeted manner to relevant stakeholders including the communities themselves, NGOs active in the communities, and local and national authorities.

T7–Improved Modelling Tools: Modelling should be applied in inland and mountainous areas as well as coastal zones. Additional real time water allocation and drainage models in the time of

floods and droughts are essential needs. The results should be communicated to development planners. Research in modelling must result in direct linkages to community adaptation.

T8–Increased Scientific Research: Scientific research is required into social aspects of climate change, food security and crop production issues, land use changes, and soils and land cover.

10.4 Viet Nam

V1–Funding Sources: Developing countries do not have the resources to finance national adaptation—and should not be expected to cover the cost alone. International finance will be needed to enable a wide range of measures, from community-led initiatives and disaster risk reduction strategies to long-term national planning and social protection in the face of unavoidable impacts.

V2–Further Research on Climate Change Impacts: Comprehensive research on the possible impacts of climate change on the Vietnamese economy and key development goals, particularly poverty reduction is required. Little is known yet on the potential social and economic implications of for example sea level rise on settlements and agriculture, or changes in climate conditions that could result in significant numbers of ‘climate migrants’. Research is needed on the most effective long-term adaptation measures and strategies to ensure human well-being and continued economic growth and poverty reduction.

V3–Improved Information Sharing: A facility for information-sharing and for defining and sharing of lessons is needed so that others can benefit from agencies with experience in integrating climate change adaptation thinking into their socioeconomic planning.

V4–Institutional Coordination: Coordination between line ministries also needs to be urgently improved, and cooperation with international agencies and NGOs enhanced so that climate change can be addressed in an integrated way with long-term socio-economic and poverty reduction efforts. The idea of a high-level coordinating body should be explored with authority to set policy and provide cross-sectoral direction and coordination. The Government might consider establishing a high-level, cross-ministerial, national climate change coordination platform.

V5–Guidance on Adaptation Planning: In order to facilitate adaptation planning and piloting, guidelines are needed for line ministries such as MPI, MARD and MOC showing how to integrate climate change into their development planning processes. Key sectors and local government will need strong technical support in vulnerability analysis and adaptive planning.

V6–Communication of Scientific Results: Need for translation of the scientific studies results to the language of the end-users. One of the most difficult but important tasks is to translate the scientific results to the easy-to-understand language for the different target groups: the provincial leaders and policy makers, the sectoral managers and local authority; the local communities and poor people. The local people would not talk in the same language as the experts, and they don't like complicated scientific issues, so all the results should be simplified and correlated with local/regional customs and problems.

10.5 Regional

R1–Regional Institutional Structure: A regional organisation for climate change needs to be established to provide scientific advice for LMB countries to ensure the continuity of the response to CC. In addition, the role of the MRC in climate change activities needs to be strengthened. The MRC is well placed to develop tools and policy frameworks on assessing the impacts and adaptation strategies on climate change. It is a cross-cutting issue that affects many aspects of the basin including the hydrological regime, environment, ecology, fisheries, agriculture, hydropower generation and social well-being of people living in the basin. In this sense, almost all programmes within MRC are linked to climate change, and existing capacities and earlier experience within MRC, put the organization in a unique position to address climate change. As an inter-governmental river organization, MRC has the mandate and capacity to help the countries in LMB to share data and information to address regional and local impacts from climate change, and to develop mechanisms to mitigate these impacts. Furthermore, MRC can provide training and capacity building to line agencies on the use and integration of tools and policies into national planning and monitoring programmes. Being a neutral party with credibility MRC can provide independent and balanced advice and information and facilitate awareness building on climate change to its member countries.

R2–Climate Change Predictions and Integrated Basin Wide Assessment of Climate Change Impacts: Further research is required to generate consistent and consolidated information on climate change predictions across the region and to redress deficiencies of previous studies. Much of this work is currently underway through the MRC. There is also a need to assess climate change impact and adaptation based on basin-specific tools and information to project future climate impacts on the hydrological regime, ecosystems and people (including livelihoods–climate change linkages) in the Mekong River basin using integrated systems assessment approach. This activity is proposed to be carried out as part of the MRC CCAI.

R3–Provisions for Sustainability of Climate Change Policy Planning: There is a need to establish and strengthen institutional framework for climate change planning in the region and improve the knowledge and capacity of MRC, NMCs and line agencies in the member countries to assess and mitigate future climate change impacts on ecosystems and people for a sustainable

development of the Mekong River Basin and the riparian countries. This activity is proposed to be carried out as part of the MRC CCAI.

R4–Stakeholder Awareness Raising: A programme of awareness raising for national decision-makers, local planners, affected communities and researchers is required. This activity is proposed to be carried out as part of the MRC CCAI.

R5–Riparian country cooperation to address trans-boundary issues related to adaptation activities: The MRC provides a platform for closer riparian cooperation in the area of climate change adaptation. Successful experiences and practises may be shared across countries, and adaptation programmes may be implemented regionally. In the area of climate forecasting and modelling, there are opportunities for combining meteorological and hydrological records from parts of Cambodia, Lao PDR, Thailand and Viet Nam with similar topographical and climate features for joint research. It is also essential that research into the effects of trends and responses in upstream countries is undertaken, including countries outside the LMB, to identify and account for potential negative social and environmental impacts on downstream countries.

R6–Regional Information Sharing: A regional database of baseline data and information on climate change modelling results and adaptation activities needs to be created and maintained. There should be protocols for the sharing of data between LMB countries and regional organisations.

11. References

- Allison, E.H., Perry, A.L., Badjeck, M., Adger, W.N., Brown, K., Conway, D., Halls, A.S., Pilling, G.M., Reynolds, J.D., Andrew, N.L. and N.K. Dulvy, (2009) Vulnerability of National Economies to the Impact of Climate Change on Fisheries. *Fish and Fisheries*, **10**, 173–196.
- Bhaktikul, K. (2008) *Study on Climate Change Impacts on Evapotranspiration using Data Mining Model. The Study Report on Impacts of Climate Change on Natural Resources and Environment in Thailand*. Faculty of Environment and Resource Studies, Mahidol University, Nakhon Pathom.
- Cambodia National Expert Team (NET) (2009) *Cambodia Country Report MRC Climate Change and Adaptation Initiative*. NET, Phnom Penh.
- Carew-Reid, J. (2007) Rapid Assessment of the Extent and Impact of Sea Level Rise in Viet Nam, *Climate Change Discussion Paper 1*. ICEM–International Centre for Environmental Management. Brisbane.
- Changtragoon, S. (2007) *Policy and Methodological Approach on Forestry under REDD and Carbon Stock Assessment*. National Park, Wildlife and Plant Conservation Department, Bangkok.
- Chinvanno S., Souvannalath, S., Lersupavithnapa, B., Kerdsuk, V. and T.H.T. Nguyen (2006) Climate Risks and Rice Farming in the Lower Mekong River Countries. *AIACC Working Paper* No. 40. Washington DC, USA
- Chinvanno, S. (2004a) Building Capacity of Mekong River Countries to Assess Impacts from Climate Change–Case Study Approach on Assessment of Community, Vulnerability and Adaptation to Impact of Climate Change on Water Resources and Food Production, Asia-Pacific Network for Global Change Research.
- Chinvanno, S. (2004b) *Information for sustainable development in light of climate change in Mekong River Basin*. Southeast Asia START Regional Centre, Bangkok, Thailand.
- Chinvanno, S. and A. Snidvongs (2004) The Pilot Study of Future Climate Change Impact on Water Resource and Rain-fed Agriculture Production Case studies in Lao PDR and Thailand. In: *Proceedings of the APN CAPABLE CB-01 Synthesis Workshop* Vientiane, Lao PDR 29–30 July 2004
- Committee for Planning and Investment (CPI) (2006) *Sixth National Socio-Economic Development Plan (NSED) 2006–2010*. CPI, Vientiane.

- Dasgupta, S., Laplante, B., Meisner, C., Wheeler, D. and J. Yan (2007) The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis. *World Bank Policy Research Working Paper* No. 4136.
- Department of Environment (2004) *Lao PDR National Adaptation Program for Action on Climate Change (NAPA)*. DOE, Vientiane.
- FAO (1995) *Lao PDR, assessment of the impact of the floods on the agricultural sector and emergency measures to be taken*. Report prepared by L. Thomas, Special Relief Operations Service. Rome.
- Eastham, J., F. Mpelasoka, M. Mainuddin, C. Ticehurst, P. Dyce, G. Hodgson, R. Ali and M. Kirby, 2008. Mekong River Basin Water Resources Assessment: Impacts of Climate Change. CSIRO: Water for a Healthy Country National Research Flagship
- FERs (2008a) *The Study on Impacts of Climate Change on Natural Resources and Environment in Thailand*. Mahidol University, Nakhon Pathom.
- FERs (2008b) *Dam Construction Project; Upper Chi-basin in Chaiyapum, Office of the National Economics and Social Advisory Council*. Mahidol University, Nakhon Pathom.
- Government of Vietnam (2008) *National Target Plan to Respond to Climate Change*. Hanoi.
- Hoanh, C.T., Guttman, H., Droogers, P. and J. Aerts (2003) *Water, Climate, Food, and Environment in the Mekong Basin in South East Asia*. Institute for Environmental Studies, Free University of Amsterdam.
- ICEM (2009) *Ho Chi Minh City Adaptation to Climate Change Study Report*. ICEM, Ho Chi Minh.
- Jintrawet, A. and P. Prammanee (2005) Simulating the Impact of Climate Change Scenarios on Sugarcane Production Systems in Thailand. In: *Proceedings of the 25th International Society of Sugar Cane Technologists Congress*. Guatemala City, Guatemala, 30 January–4 February 2005.
- Jintrawet, A. (2007) Climate Change and Agricultural Production. In: *Proceedings of the Impacts of Climate Change on Agricultural Production* organised by Department of Agricultural Extension. Bangkok, 13 September 2007
- Kerdsuk, V., Kongton, S., and A. Jintrawet (2004) Impact of Climate Change on Rice Production in Tung Kula Field, Thailand. *Journal of Remote Sensing and GIS Association of Thailand (RESGAT)* 5(2).

- Kerdsuk, V., Sookchan, S., Kerdsuk, W., and P. Ruechuwaraluck (2007) The Impact of Climate Change on Jasmine Rice (KDML105) Production and Risk Analysis of Paddy Farming: Case Study in Khon Kaen, Mahasarakam and Roi Et Provinces. Khon Kean.
- Kiem, A.S., Ishidaira, H., Hapaurachchi, H.P., Zhou, M.C., Hirabayashi, Y. and K. Takeuchi (2008) Future hydroclimatology of the Mekong River Basin simulated using high-resolution Japan Meteorological Agency (JMA) ACM. *Hydrological processes*. **22**, 1382–1394.
- Kirby, M. and M. Mainuddin (2006) Water productivity assessment: Mekong River Basin approach. *Basin Focal Project Working Paper No. 4*.
- Kongjan, T. (2008) *Study on Climate Change Impacts on Hydrology. The Study Report on Impacts of Climate Change on Natural Resources and Environment in Thailand*. Faculty of Environment and Resource Studies, Mahidol University, Nakhon Pathom.
- Lao PDR National Expert Team (NET) (2009) *Lao PDR Country Report MRC Climate Change and Adaptation Initiative*. NET, Vientiane.
- Limsakul, A. and J.J. Goes (2008) Empirical Evidence for Interannual and Longer Period Variability in Thailand Surface Air Temperatures. *J. Atmospheric Research*, **87**, 89–102.
- McSweeney, C., M. New and G. Lizcano (2008) *Cambodia Climate Change Profile*. Oxford University, Oxford. (Available at <http://country-profiles.geog.ox.ac.uk/>).
- MAF (2003). *Forestry Strategy to the Year 2020*. MAF, Vientiane.
- MAF (2003) *Permanent Secretary Report on Areas affected by Drought, Lao PDR*. MAF, Vientiane.
- MAF (2008) *Department of Planning Paper on Flood and Drought, Lao PDR*, MAF, Vientiane.
- Mainuddin, M., Kirby, M. and Y. Chen (2008) Spatial and temporal pattern of land and water productivity in the lower Mekong River basin. *Basin Focal Project Working Paper No. 6*.
- MARD (2008a) *National Strategy for Natural Disaster Prevention, Response and Mitigation to 2020*. MARD, Hanoi.
- MARD (2008b). *Action Plan Framework for Adaptation to Climate Change in the Agriculture and Rural Development Sector Period 2008–2011*. MARD, Hanoi.
- MOE ONEP (2008) *Thailand Strategic Plan on Climate Change B.E. 2551–2555 (2008 to 2012)*. MOE, Bangkok.
- MOE (2002) *Cambodia's Initial National Communication to UNFCCC*. MOE, Phnom Penh.

- MOE (2003) *Declaration on Cambodia Climate Change Office Establishment (CCCCO) No 195*. MOE, Phnom Penh.
- MOE (2005a) *Vulnerability and Adaptation to Climate Hazards and to Climate Change: A Survey of Rural Cambodian Households*. MOE, Phnom Penh.
- MOE (2005b) *Analysis of Policies to Address Climate Change Impacts in Cambodia*. MOE, Phnom Penh.
- MOE (2006) *National Adaptation Programme of Action to Climate Change*. MOE, Phnom Penh.
- MOSTE (2000) *Thailand's Initial National Communication under the United Nations Framework Convention on Climate Change*. MOSTE, Bangkok.
- MONRE (2003) *Viet Nam Initial National Communication under the United Nations Framework Convention on Climate Change*. MORNE, Hanoi.
- MRC (2005) *Overview of the Hydrology of the Mekong Basin*. Mekong River Commission, Vientiane.
- MRC (2006) *Integrated Basin Flow Management Specialist Report IBFM 3: Possible improvement of 1-D model for zones 2 and 3*.
- MRC (2008a) *Annual Mekong Flood Report 2007*. Mekong River Commission. Vientiane.
- MRC (2008b) *Concept Note: AusAID Support to MRC Environment Programme Climate Change and Adaptation Initiative*. Mekong River Commission, Vientiane.
- MRC (2009) *Report on the Regional Forum on the MRC Climate Change and Adaptation Initiative*. Mekong River Commission, Vientiane.
- National Committee for Disaster Management (2002) *Disaster Management in Cambodia*. Phnom Penh.
- NDMO (2003) *Disaster Management Strategies*. NDMO, Vientiane.
- NGPES Secretary (Department of Planning, State Committee for Planning and Investment) (2004) *National Growth and Poverty Eradication Strategy*. NGPES, Vientiane.
- Nguyen Van Thang & Hoang Duc Cuong (2007) *Building Scenarios of Climate Change with the High, Medium and Low scenarios in the Period 2010–2100 for 7 climate regions of Vietnam*. Institute of Meteorological, Hydrological and Environmental Sciences, Hanoi.

- Noble, A.D., D.A. Bossio, F.W.T. Penning de Vries, J. Pretty and T.M. Thiyagarajan (2004) *Intensifying Agricultural sustainability: An Analysis of Impacts and Drivers of Development of 'Bright Spots'*. International Water Management Institute.
- Noimunwai, W., Bhaktikul, K., Pumijumnong, N., Nantasenamart, C., and S. Chinvano (2008) Estimation of Potential Evapotranspiration under Climate Change using Data Mining: Case study of Thailand. FERS Annual Conference, Mahidol University.
- ONEP (1997b) *Thailand Policy and Perspective Plan for Enhancement and Conservation of National Environmental Quality, 1997–2016*. MOSTE. Bangkok.
- Penny, D (2008). The Mekong at Climatic Crossroads: Lessons from the Geological Past. *Ambio* 37(3), pp. 164–169
- Phan Nguyen Hong and Le Xuan Tuan (2008) Mangrove Forest and Possibility of Responding to Sea Level Rise – Workshop on Climate Change and Response Solutions of Viet Nam. Hanoi.
- Royal Government of Cambodia (2001) *Second Five Year Socioeconomic Development Plan 2001–2005*. Phnom Penh.
- Royal Government of Cambodia (2002) *National Poverty Reduction Strategy 2003–2005*. Phnom Penh.
- Royal Government of Cambodia (2005) *The National Strategic Development Plan (2006–2010)*. Phnom Penh.
- STA (2000) *First National Communication on Climate Change*. Vientiane.
- STA (2004) *National Biodiversity Strategy to the year 2020 and Action Plan to the year 2010*. Vientiane.
- STA (2005) *Environment Performance Assessment Report 2005*. Vientiane.
- SEA START RC (2006) Southeast Asia Regional Vulnerability to Changing Water Resource and Extreme Hydrological Events due to Climate Change, Southeast Asia. *Technical Report No.15*. Bangkok.
- SEA START RC (2008) The Study of Climate Change Impacts on Vulnerability and Adaptations Sectors. On going research (start August 2008). Chulalongkorn University, Bangkok. (Unpublished)
- Snidvongs, A. and S-K. Teng (2006) Global International Waters Assessment, Mekong River. *GIWA Regional assessment No. 55*.

- Snidvongs, A., Choowaew, S. and S. Chinvanno (2003) Background paper: Impact of climate change on water and wetland resources in Mekong River Basin: directions for preparedness and action. *Regional Centre Report No 12*. Southeast Asia START, Bangkok, Thailand.
- Southern Institute for Water Resources Planning (2008a) Impact of Climate Change on Disasters and Adaptation Measures for Mekong River Delta. Workshop of MARD, Hanoi.
- Southern Institute for Water Resources Planning (2008b) Study on Climate Change Scenarios Assessment for Ca Mau Province: Final Technical Report. Ho Chi Minh City.
- Southern Institute for Water Resources Planning (2008c) The Assessment of Impacts of Sea Level Rise on the Flood and Salinity Intrusion in Mekong River Delta and Lower Basin of Dong Nai River. Ho Chi Minh City.
- STEA (2002) *National Environmental Strategy 2020 and Action Plan 2010*. Vientiane.
- Tangtham, N. (2007) Effect of Deforestation and Tropical Rainforest Ecosystem, Forest Research Centre, Faculty of Forestry, Kasetsart University. Presentation at The brainstorming seminar on research framework on Thailand Air Pollution: *The Effect from Climate Change*, 24th April 2007. The Miracle Grand Hotel. Bangkok.
- Thai Government (1992) The national energy policy act. Government Gazette **109(9)** 12th February 1992 B.E. 2535.
- Thai Government (1992) The energy conservation promotion act. Government Gazette **109(33)**, 2nd April 1992 B.E. 2535.
- Thailand Environment Institute (2000) National Action Plan on Climate Change of Thailand Volume I: Main Report. Office of Environmental Policy and Planning Ministry of Science, Technology and Environment, Bangkok.
- Thailand National Expert Team (NET) (2009) Thailand Country Report MRC Climate Change and Adaptation Initiative. Bangkok.
- TKK and SEA START RC (2008) Water and Climate Change in the Lower Mekong Basin: Diagnosis & Recommendations for Adaptation, Interim Report.
- UNEP (1998) *Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies*. UNEP.
- Veijalainen, N., Kummu, M., and H. Lauri (2007) Impact of Climate Change on Hydrology and Flooding in Songkhram River, Thailand. In: *Climate and Water Conference*, Helsinki, Finland. September 2007.

Vietnam National Expert Team (NET) (2009) *Vietnam Country Report MRC Climate Change and Adaptation Initiative*. NET, Hanoi.

WFP (2005) *Food security atlas of Cambodia*. World Food Programme, Cambodia.

World Bank (2009) *Climate change impact and adaptation, study for Bangkok*. World Bank, Bangkok.

WREA (2009) *National Adaptation Plan of Action to Climate Change*. Vientiane.

WWF-GMP (2008) *Climate Change Impacts in Krabi Province, Thailand. A study of environmental, social and economic challenges*. Prepared by WWF Greater Mekong Programmes and South East Asia START Regional Center.

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