Country Paper: Kingdome of Cambodia
Climate Change Impacts and Adaptation in Cambodia

1. INTRODUCTION

The Kingdom of Cambodia is located in Southeast Asia between latitudes 10° and 15° N and longitudes 102° and 108° E, borders with Viet Nam, Lao People's Democratic Republic, Thailand and South China Sea (approximately 435 km coastal line). Cambodia covers an area of 181,035 km^2 with a total population projected at about 13.4 million people in 2008 (NIS 2008) and approximately 80 % of this population lives in rural areas.

Cambodia is a least developed country, with a GDP per capita increased from US$ 250 in 1993 to US$ 651 in 2008. As a least developed agrarian country, Cambodia is highly vulnerable to climate change, the more so as it has low adaptive capacity to changing climate conditions. In recent years, we have witnessed more frequent and severe floods, droughts and storms, which have resulted in a significant number of fatalities and considerable economic losses.

Cambodia's agriculture receives the least inputs in terms fertilizers, machinery, irrigation, and agricultural extension. Cambodia's agriculture is largely a means for four million poor Cambodians to make end needs. They generally practice traditional agriculture, collect common property resources and sell their labor outside the cultivation seasons. The agriculture sector has accounted for approximately 60.4% of employment, industry sector for 14% and services sector for 25.6% in 2007(NIS, 2003, 2008). Agricultural production is dependent on the annual flooding and recession of the Tonle Sap Lake and the Mekong River, which brings fertile alluviums to the central plains.

Climate change is another challenge to agriculture sector in Cambodia since agriculture is closely linked to the climate in many ways such as crop yields will be affected by global warming, climate change will exert pressure on water resources, often associated with irrigation, as rainfall will become more variable and exhibit a changing spatial distribution, droughts and floods will stress agricultural system, and some coastal food producing areas will be inundated by sea level rise.

2. HISTORICAL INFORMATION ON CLIMATE CHANGE, CLIMATE VARIABILITY AND CLIMATE EXTREMES

2.1. Climate variability and climate extreme

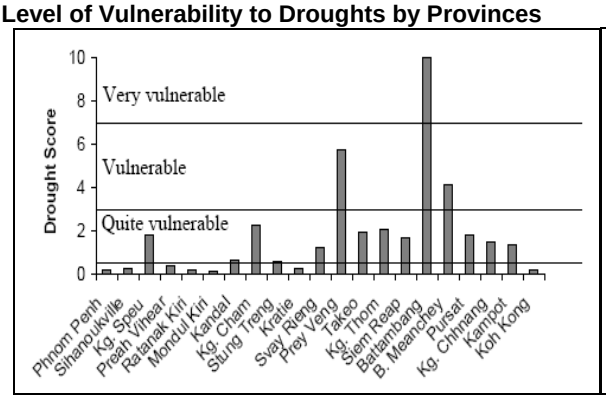
Cambodia's climate is dominated by the tropical monsoon with distinct rainy/wet and dry seasons. During the rainy season (May to October), winds blow from the Indian Ocean southwest landward bringing heavy rains. During the dry season (November to May) winds

blow from the northeast. Hot air dominates from April to May and cooler air from November to March.
The average maximum temperature was around 33.7^{o}C and the average minimum temperature around 22.4^{o}C (2003-2006). April is the warmest month, and January is the coldest. Maximum temperatures exceeding 38^{o}C are recorded every year during the dry season just before starting raining season (March-April). Although Cambodia has an extensive a long coastline, but the country is not bordered by the Pacific Ocean. Thus, the direct impacts of typhoons are buffered by mountainous regions and highlands to the east. Flood and drought are the most common natural disasters and results in loss of lives, crop failures, and destruction of property and infrastructure (MoE 2006).

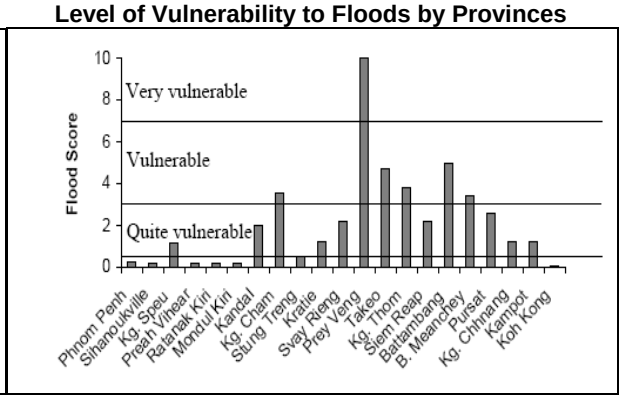
2. 2. Floods, droughts and storms

The Mekong, Bassac, Tonle Sap Rivers, and Tonle Sap Lake constitute a unique hydrological system and play an important role in Cambodia's agriculture and traditional livelihoods. The Mekong River and the Tonle Sap Lake are connected by the Tonle Sap River which reverses its flow annually. In the raining season, water surface of the Tonle Sap Lake increases its size three times from 2,600 km^2 in dry season to 10,500 km^2. With an estimated storage capacity of 72 km^3, Tonle Sap Lake is one of the largest freshwater bodies in Asia during the wet season. As the floods of the Mekong subside in November and water levels decrease, the Tonle Sap River reverses its flow. The seasonal floods of the Mekong River and its tributaries and Tonle Sap Lake provide nutrients essential to agricultural soils, and breeding and nursing grounds for fish. Tonle Sap Lake is one of the most productive freshwater fisheries in the world (World fish 2008). Cambodia's rural communities have traditionally lived by regular patterns of flooding by the Mekong River, its tributaries and Tonle Sap Lake. Rural livelihoods have adapted to floods, which are considered beneficial as long as they are predictable in terms of frequency, timing, duration and intensity. However, the frequency of severe floods has increased since the 1990s (MoE 2006).
Floods affected 1.6 million Cambodian people in 1996, 3.4 million in 2000 and 1.7 million in 2001 (CRED, NCDM & WFP, 2005). Intense and prolonged flood periods are characterized by mass displacement of populations, and water and food shortages. The results are increased poverty and chronic food insecurity. The year 2000 floods were the worst to hit Cambodia in seventy years, and were followed by similarly severe floods in 2001 and 2002 resulted the death toll at 347 fatalities (80% of whom were children), 317,975 houses damaged or destroyed. Total direct physical damages to infrastructures, properties and crops were estimated at US$150 million. The 1990-2000 records suggest that floods have resulted in average annual losses of 100 lives and financial losses from US$100 to 170 million.
The typhoon Ketsana hit 14 provinces of Cambodia between 29 September and 5 October 2009, resulted 43 people dead and effected livelihood of about 180,000 people. According to post disaster damage, loss and needs assessment estimated the total damage and loss approximately US$132 million (damage: US$58m and loss: US$74m). In term of agriculture impact, this typhoon affected 10 provinces that destroyed 40,136 ha and damaged 67,335 ha of rice crop just before harvesting. The total damage and loss for agriculture, livestock and fisheries sector was about US$ 56.5 million (Cambodia PDNA 2010).
The frequency and intensity of floods may increase with changing climate conditions, and cause severe damage to rice harvests. Successions and combinations of droughts and floods have resulted in a significant number of fatalities and considerable economic losses. Losses arising from floods have been further exacerbated by deforestation. Floods have accounted for 70% of rice production losses between 1998 and 2002, while drought accounted for 20% of losses. This year 2010 Cambodia has met very severe drought that is impacting seriously to the agriculture production and human being.

Level of Vulnerability to Droughts by Provinces



Level of Vulnerability to Floods by Provinces



Source: MoE 2006

Water shortages are common all-year around for 81% of households, which significantly limits local capacity to cope with drought. Since only a third of rural Cambodians have access to safe drinking water, and less than 34% of cultivated land is irrigated, Cambodia ability to cope with drought is severely limited (CIPS 2004, WFP 2005)

3. SENSITIVITY AND VULNERABILITY OF AGRICULTURE AND WATER SECTORS TO CLIMATE CHANGE

As part of its Initial National Communication, Cambodia conducted a Vulnerability and Adaptation Assessment (V&A) which examined the impacts of climate change on agriculture (rice production), forestry (forest types), human health (malaria) and coastal zone (sea level rise) (MoE 2002).

For rice cultivation, as it forms the backbone of traditional livelihoods and constitutes Cambodia's main staple food. Flood, drought and rainfall patterns play a determining role in paddy cultivation. The absence of widespread irrigation and water harvesting schemes in Cambodia makes this sector particularly vulnerable to climate change. Yield anomalies for wet season rice yield is correlated with May rainfall, when farmers start planting seedlings. Water shortages during this month have critical negative impacts on the early stages of plant growth. Under projected climate conditions, the variability in yields and crop output would increase. With the potential increase in the frequency and intensity of floods in the central agricultural plains, farmers would be exposed to higher risks of crop failure. The V&A identified the following adaptation options: genetic improvement of high yielding varieties, improvement of cultural practices, development of early warning system for climate extremes, development of irrigation, expansion of planting to other areas, and diversification of foods.
The V&A in the second national communication uses historical climate and rice production statistics to estimate that every additional 10mm of wet season total rainfall adds 6,500t (or about 0.1%) to rice production. This is used to calibrate the Decision Support System for Agro-technology Transfer (DSSAT) model so that the impact of changes in rainfall can be simulated. The analysis was undertaken in 9 rice growing areas, where the required soil information was available. With total rainfall increasing by between 1 and 2 mm/yr in the south and east, production in this area may increase by 1% over 50 years as a result of the increasing rainfall pattern. In the north, rainfall may decrease by a similar amount, resulting in an equivalent reduction. The net effect of total rainfall on rice production is therefore likely to be small.
The impact of changes in flood and drought frequency may be more important than changes in total rainfall, in view of the opportunities for public expenditure to support the development

of new varieties and increased water storage to deal with this increased variability. The analysis of flood and drought days suggests that, over 50 years, drought days may decrease by about 25% in the south of the country, with the opposite trends in the north. Losses from drought and flood vary greatly, but have been about 5.5% of total production over the last decade, equivalent to about 400,000t per year, with a gross margin value of about $80m. If losses were proportional to the number of drought and flood days, then this could increase by 25%, or $20m over the next 25 years.

The PRECIS analysis for the seasonality of rainfall suggests that there will be changes in the start and duration of the wet season. Because temperatures are sufficiently high at the end of the wet season to allow most crops to mature, there would be limited impact on crop production if the wet season started and finished later, especially if light insensitive varieties are used. Therefore, the main effects of seasonality are the loss of production that would occur if the wet season became shorter. The V&A analysis suggests that wet seasons could shorten by at least a month in many regions, although this effect could be reversed after 2050 in the low emissions scenario. In most crop growing regions, the wet season will still be sufficiently long to allow for one rice crop to be grown, especially if short maturing varieties are used. Thus, the main loss of production would come from the inability to double crop. In 2007, late wet season rice was grown on over 500,000 ha, or about 25% of total rice area with crop margins worth $200m. Much of this would be under threat from a shortened growing season. In addition, a large part of the vegetable crop is grown as a second wet season crop and this would also be greatly affected by a reduced wet season. There are therefore strong benefits to be gained by breeding and extension for shorter growing varieties and for investment in water storage that will allow crops to mature beyond the end of the rainy season (WB 2010).

4. INSTITUTIONAL FRAMEWORK FOR ADDRESSING CLIMATE CHANGE IN 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 (INC) was submitted to the UNFCCC on October 8, 2002. The INC was prepared by the Ministry of Environment (MOE), which is the National Climate Change Focal Point. The Second Nation Communication (SNC) was initiated in January 2007 and is expected to be completed in the mid of 2010.

In June 2003, the Cambodian Climate Change Office (CCCO) was established within the Ministry of Environment and promoted as Department of Climate Change (CCD) in 2009. The broad mandate is to carry out all technical activities related to the implementation of the UNFCCC and other climate change-related tasks as assigned including acts as the secretariat of the UNFCCC, National Focal Point and a Designated National Authority under the Kyoto Protocol for Clean Development Mechanism (CDM) activities. While CCD is a technical unit, the National Climate Change Committee (NCCC) was established in April 2006, is a senior policy-making body. The NCCC is an inter-ministerial mechanism with the mandate to prepare, coordinate and monitor the implementation of policies, strategies, legal instruments, plans and program of the Royal Government of Cambodia to address climate change. The member of NCCC is a high policy level such as Secretary and Under-Secretary of State from 19 Ministries and government agencies whose mandates are relevant to climate change adaptation or mitigation activities.

5. NATIONAL ADAPTATION PROGRAM OF ACTION TO CLIMATE CHANGE (NAPA)

As a least developed agrarian country, Cambodia is highly vulnerable to climate change, the more so as it has low adaptive capacity to changing climate conditions. In recent years, there were more frequent and severe floods and droughts, which have resulted in a significant number of fatalities and considerable economic losses. The goal of development of the Cambodian NAPA is to provide a framework to guide the coordination and implementation of adaptation initiatives through a participatory approach, and to build synergies with other relevant environment and development program. Cambodia's NAPA presents priority projects to address the urgent and immediate needs and concerns of people at the grassroots level for adaptation to the adverse effects of climate change in key sectors such as agriculture, water resources, coastal zone and human health.

The formulation of Cambodia's NAPA has relied on consultations from the grassroots level to policy-makers. Countrywide surveys of local authorities, non-governmental organizations, and households were conducted in 17 provinces to identify existing coping mechanisms to climate hazards and climate change adaptation needs. Adaptation projects were ranked according to criteria for improvement of livelihoods, food security, water availability, use of appropriate technology, responsiveness to immediate community needs, and sustainability.

The proposed projects are "no regrets" in nature, that is, they are already justified by current climate conditions and would contribute to national sustainable development regardless of the magnitude of 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 including 20 projects for agriculture and water sector. The proposed activities in agriculture and water resources as in the table below:

Agriculture and Water Resources	1	Development and Improvement of Community Irrigation Systems
	2	Water Gates and Water Culverts Construction
	3	Establishment and Improvement of Farmer Water User Communities
	4	Safer Water Supply for Rural Communities
	5	Groundwater Extraction for Crop Cultivation
	6	Development and Improvement of Small-Scale Aquaculture Ponds
	7	Development and Rehabilitation of Flood Protection Dikes
	8	Development of Community and Household Flood Safe Areas
	9	Traditional Wooden Boat Distribution
	10	Cement Water Tanks Construction
	11	Promotion of Food Supplements in Household Cattle Raising
	12	Development of Community Rice Banks
	13	Improving Farmers' Adaptive Capacity to Climate Change
	14	Community Agro-Forestry in Deforested Watersheds
	15	Introduction of Short-Period Rice Varieties in Areas Affected by Seawater Intrusion and Drought
	16	Rehabilitation of a Multiple-Use Reservoir in Takeo Province
	17	Rehabilitation of Provincial Waterways
	18	Training of Village Veterinary Workers
	19	Promotion of Household Integrated Farming
	20	Rehabilitation of Multiple-Use Dams in Takeo and Kampong Speu Provinces

The NAPA has also identified a number of barriers to the implementation of climate change adaptation projects in Cambodia. These include: (i) inadequate technical, financial and institutional capacity of Government agencies and of local communities in dealing with climate hazards Government agencies, and limited coordination among them; (ii) limited integration of

climate change issues into national policies and program; and (iii) limited awareness of climate change issues.

6. ADAPTATION OPTIONS FOR AGRICULTURE SECTOR UNDER SNC

The Royal Government of Cambodia has planned a number of programs and activities to increase rice production to make Cambodia one of the major rice export countries in the near future. For addressing climate change problem, Cambodia should be done by increasing adaptive capacity to the changing climate condition and develop more climate resilience programmes to the future climate and at the same time also contributing to the reduction of GHG emission.

In the context of adaptation, the short term and long term efforts should be done by involving stakeholders. For the short term efforts should be directed to increase coping capacity to current climate risks through the improvement of climate risk management and community livelihood such as (i) increasing capacity in using climate information such as the use of climate forecast information in setting up better cropping strategies and agribusiness activity, (ii) implementing adaptation measures which also contribute to emission reduction such as introduction of technology that increase water use efficiency via System Rice Intensification (SRI), (iii) creating more source of incomes for communities from mitigation activities such as generating carbon credit from the use of manure and biomass waste (e.g. biogas for cooking and biomass energy in rice mills, composting etc). For the long term efforts should be directed to increase the resilience of the agriculture system to future climate risks through the revitalization of long term policies and planning by taking into account climate change such as (i) institutionalizing the use of climate information in agriculture management and development , (ii) prioritizing structural intervention programs (where and when a particular intervention should be in place to minimize the impact of increasing climate risk such as constructing dam, irrigation facilities), (iii) expanding agriculture areas to regions with lower climate risk, (iv) creating climate insurance for vulnerable communities, (v) generating more varieties resistant to drought, flood and high salinity, and (vi) developing and implementing long term research on climate modeling, mitigation and adaptation technologies.

7. CONCLUSION

The Mekong, Bassac, Tonle Sap Rivers, and Tonle Tap Lake constitute a unique hydrological system and play a central role in Cambodia’s agriculture and traditional livelihoods. The seasonal floods of the Mekong and its tributaries and Tonle Sap Lake provide nutrients essential to agricultural soils, and breeding and nursing grounds for fish.

Increases in mean annual temperatures and the frequency of floods, drought and wind storms have already been existed in Cambodia. Climate projections forecast substantial increases in the frequency of days and nights that are considered hot in current climate conditions. The potential increase in the frequency and intensity of floods, droughts and wind storms in the central agricultural plains would expose farmers to higher risks of crop failure. Floods, droughts and storms are already the most common natural disasters and resulted yearly loss of lives, crop failures, and destruction of property and infrastructure.

To cope with changing climatic conditions, Cambodia has a National Adaptation Program of Action to Climate Change, which was developed and approved by the Royal Government of Cambodia in 2006. The implementation of the NAPA would contribute significantly to the Cambodian Millennium Development Goals (MDGs) and national sustainable development

objectives. However, after the completion of NAPA years ago, Cambodia has struggled to attract donor interest in financing the implementation of high priority adaptation activities.

With regards to adaptation to climate change in the water sector, Cambodia could suffer from the negative impacts of adaptation measures undertaken by its upstream neighbor's countries on the main rivers. Any development in hydropower, agriculture and industry that may have negative impacts on the hydrology of these main rivers would constraint Cambodia's ability to adapt to climate change itself. The most significant threat would be on inland fisheries and floodplain agriculture, particularly those relying on the flood regime surrounding Tonle Sap Lake.

In order to address the urgent climate change adaptation needs in Cambodia, Ministry of Environment have prioritized the following activities for funding: (1) Implementation of NAPA priority activities, (2) Climate change awareness raising campaigns (3) Mainstreaming of climate change adaptation into development, (4) Institutionalization of an inter-organizational climate change coordination mechanism, (5) Integration of climate change adaptation into the national budgetary process, (6) Formulation of climate change adaptation and climate change proofing legislation/policies, (7) Strengthening of climate change research, (8) Riparian country cooperation to address trans-boundary issues related to adaptation activities.

Under the preparation of Cambodian National Communication to the UNFCCC, Cambodia has conducted an assessment for vulnerability and adaptation options in agriculture sector, indicated that trends in rainfall will be complex, with a general decrease in the dry season and mixed patterns in the wet season. In most places, the growing season will shorten, at least over the next 50 years, and there is some evidence that drought will increase and floods decrease in the northern part of the country, whilst the opposite will happen in the south. In the context of adaptation, the short term efforts should be directed to increase coping capacity to current climate risks through the improvement of climate risk management and community livelihood, and for the long term efforts should be directed to increase the resilience of the agriculture system to future climate risks through the revitalization of long term policies and planning by taking into account climate change.

The Climate Change Department has led some detailed technical work on climate change modeling and the impact of climate change on agriculture. This suggests that, because of Cambodia's location at the edge of the monsoon system, predictions of future climate change are difficult. The dry season is likely to become drier in all areas, but the wet season is likely to become wetter in the south and east. Evidence of increased variability of rainfall is mixed and this does not seem to have a large total impact, although individual events may still have devastating consequences for vulnerable households. Of much greater significance is the likelihood that most areas of the country will be subject to shorter rainy seasons. The implications of climate change for public expenditure suggest that the importance of research and extension will be greatly increased, in view of the need to develop new varieties with shorter growing periods and more drought and flood resilience. The importance of irrigation will also be much higher, to ensure that crops have water through to maturity, if wet seasons are shortened.

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