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The NGO Forum on Cambodia
ធ្វើការរួមគ្នាដើម្បីការផ្លាស់ប្តូរវិជ្ជមាន
Working Together for Positive Change

Impacts of Climate Change on Rice Production in Cambodia

Phnom Penh, Cambodia
August 2012

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Printed date: August 2012

Published by: The NGO Forum on Cambodia, Environment Programme's Agricultural Policies Monitoring Project

Layout designed by: Mr. PHOURN Yu, Information and Publication Officer

The purpose of this report is to provide knowledge to the NGO Forum on Cambodia to support its advocacy work. This report analyzes the impacts of climate change (floods and droughts) on rice production in the three selected provinces (Takeo, Kampong Speu and Prey Veng) and reports on the strategies rice farming households are using to adapt and to the impacts of climate change and to mitigate their greenhouse gas emissions. It next discusses the ability of farmers to prepare for, respond to, and to recover from floods and drought. The report also gives recommendations to ministries and departments working on agriculture so that they can immediately improve their service provision to rice farmers. Finally, the report calls for the establishment of long-term strategic development plans to help rice farmers better adapt to the impacts of climate change at both the provincial and national levels.

ACKNOWLEDGEMENTS

This report was prepared after a desk review and field research study was conducted. Research is an integral part of NGO Forum on Cambodia advocacy activities. This report is one of the many research projects conducted by the Agriculture Policies Monitoring Project of the NGO Forum's Environment Program. The research and report were done by a group of consultants, led by Mr. Kong Sim in collaboration with Mr. Socheath Sou, Mr. Chanthy Sam, Mr. Chou Phanith and Mrs. Malyne Neang.

The authors of this report would like to thank Mr. Chhith Sam Ath, Executive Director of the NGO Forum on Cambodia and Mr. Tek Vannara, Deputy Executive Director who make final reviewed and comments on the report and all those who provided useful information and constructive feedback during the research and report writing process. They include the Provincial Department of Agriculture, Provincial Department of Environment, Provincial Department of Water Resources and Meteorology, Provincial Committee for Disaster Management, District Governors, Deputy Governors, Commune Councils, and community-based representatives in the selected target areas. In particular, we would like to thank Mr. Thorn Phally, former project officer of CARE, Mr. Ses Vong Sambath, CCK program manager, and Ms. Aing Chamroeun, Director of National Prosperity Association, who provided significant coordination support to our research

team. The acknowledgement should also be extended to Mr. Phourn Yu from the Research and Information Center of the NGO Forum for servicing excellent layout and design of the report.

The authors also would like to express our appreciation to relevant NGO staff members who helped us set-up interviews and conduct other aspects of the research. We greatly appreciate the contribution of Mrs. Im Phallay, the Environment Program Manager of the NGO Forum, and Miss Sophan Kanhchna, the Agriculture Policies Monitoring Project Coordinator of the NGO Forum, for their useful recommendations on how to improve the report and for helping facilitate the research activities.

Finally, the authors would like to give a special thanks to Mr. Rick Dubbeldam for his useful and general comments on report contents and editing English which improved the quality of the report.

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LIST OF ACRONYMS

ADB	:	Asian Development Bank
CCD	:	Climate Change Department
CCDMs	:	Commune Committees for Disaster Management
CCK	:	Chamroeun Cheat Khmer
CDM	:	Clean Development Mechanism
CDRI	:	Cambodia Development Resources Institute
CEDAC	:	Centre d'Etudeset du Développement Agricole Cambodgien
CH_4	:	Methane
CO_2	:	Carbon Dioxide
CRC	:	Cambodian Red Cross
DAFF	:	Department of Agriculture, Forests, and Fisheries
DNA-CDM	:	Designated National Authority for the Clean Development Mechanism
DNDC	:	Denitrification and Decomposition
DRR	:	Disasters Risk Reduction
GHG	:	Green House Gas
HEKS	:	Hilfswerk der Evangelischen Kirchen Schweiz (English: Swiss Inter-Church Aid)
IFRC	:	International Federation of Red Cross
INGOs	:	International Non-Governmental Organization
IPCC	:	Inter-Governmental Panel on Climate Change
LDCEG	:	Least Developed Countries Expert Group
MAFF	:	Ministry of Agriculture, Forests, and Fisheries
MoC	:	Ministry of Commerce
MoE	:	Ministry of Environment

MoH	:	Ministry of Health
MoP	:	Ministry of Planning
MoRD	:	Ministry of Rural Development
MoWRAM	:	Ministry of Water Resources and Meteorology
MoEYS	:	Ministry of Youths, Education and Sports
N_2	:	Nitrogen (molecule)
N_2O	:	Nitrous Oxide
NAPA	:	National Adaptation Programme of Action for climate change
NCCC	:	National Climate Change Committee
NCDD	:	National Committee for Decentralization and De-concentration
NCDM	:	National Committee for Disaster Management
NGOs	:	Non-Government Organization
NGOF	:	NGO Forum on Cambodia
NPRS	:	National Poverty Reduction Strategy
NSDP	:	National Strategic Development Plan
SNAP-DRR	:	Strategic National Action Plan for Disaster Risk Reduction
PCDM	:	Provincial Committee for Disaster Management
PDA	:	Provincial Department of Agriculture
PDAO	:	Peace and Development Aid Organization
PDoWRAM	:	Provincial Department of Water Resource and Meteorology
RGC	:	The Royal Government of Cambodia
SRI	:	Systems of Rice Intensification
ToR	:	Terms of Reference
UNEP	:	United Nations Environment Programme
UNFCCC	:	United Nations Framework Convention on Climate Change
WB	:	World Bank

EXECUTIVE SUMMARY

Cambodia's climate is hugely dependent on the arrival of seasonal monsoon rains which occur from May onwards, often extending until November. Cambodia's most important crop is rice which occupies 84% of the country's total cultivated land. Rice is grown in a variety of systems, depending largely on the area's rainfall and flooding patterns. The most common system is planting rice shortly after rains commence in rain-fed or partial irrigated systems. Another system is planting rice after floods recede later in the year, especially in the low lying areas around the Tonle Sap Lake and Mekong River. Both areas are subject to annual flooding which vary depending on local rainfall as well as rainfall in the wider Mekong catchment. In areas with access to annual water flows, irrigated rice is also grown from February to May.

In 2008, 32.5% of Cambodia's economy was dependent on agriculture (ADB 2010) and nearly 60% of the country's population earned their income from agriculture. The World Bank (2011) estimates that 35% of the nation's population was living under poverty lines in 2004 with rural poverty at much higher rates. Cambodia's Ministry of Environment (2002) concluded that rice output in Cambodia is directly correlated with climate variations. The total production of rice is highly affected by the occurrence of floods or droughts. Based on data collection, it has been concluded that floods more often lead to production losses (in 70% of the cases) than droughts (20%) and nationwide both can occur at the same time. Production losses due to pests and diseases were insignificant. Cambodia's National Poverty Reduction Strategy (NPRS) explicitly identifies natural disasters, particularly floods and droughts, as critical factors that have and continue to increase socio-economic vulnerabilities of the rural poor, including placing a disproportionate burden upon women.

In response to the issues above, the Agriculture Policies Monitoring Project of NGOF's Environment Program initiated this study. The objectives of the study are:

1. To understand the climate change mitigation and adaptation process in the context and experience of affected rice-farming communities

2. To identify strategies how to prepare for and recover from natural events and disasters (especially droughts and floods) with the aim to decrease the long-term effects on agricultural systems and the environment especially considering the fact that agricultural production will be greatly affected by the impacts of climate change;
3. To highlight mitigation and adaptation measures which can be used as effective responses to the effects of climate change. Civil society organizations can then advocate for the government to support or incorporate these measures.

Previous studies, such as the country's NAPA report, have identified Kampong Speu, Prey Veng and Takeo Provinces as the most vulnerable areas to climate change, especially drought and floods. Due to limited resources and a timeframe for the research, the field research was conducted in fifteen villages in six communes of five districts. 27 key informants within the three study provinces were interviewed. They were commune chiefs, district governors, NGO staff members working on flood and drought risk reduction, representatives from the Provincial Departments (Agriculture, Environment, Water Resource and Meteorology), and provincial representatives of the National Committee for Disaster Management. The number of respondents within each study village was not the same. Overall, our field surveys interviewed 90 respondents in the six study communes. This report also includes three case studies.

Results of the field survey show that the impacts of climate change, such as increased floods and droughts, rising temperatures, and uncertain rainfall period, have been occurring in the selected study area. In the past decades, extreme events such as flood and drought have negatively affected the livelihood of farmers, especially their rice production. People's lives, rice crops, cattle, houses, home gardens, farming ecosystem, and other socioeconomic opportunities have been lost due to droughts and floods in the study areas.

To improve their livelihood, farmers have autonomously changed their rice production practices and techniques adapting to those climate change events. Rice-cropping calendars in all study areas have been changed while many farmers have chosen more and more seasonal rice varieties in

order to increase their rice productivity. These two approaches enable many farmers to successfully meet their household sufficiency levels and to sell their rice surpluses. However, to improve the yields of their rice crops, many farmers have been using more chemical fertilizers and pesticides. At the same time, farmers are increasingly using machines rather than animals. While adopting new practices, some farmers have been autonomously reducing their emission of greenhouse gases, for example, by applying SRI, recycling cow dung, using natural compost, and rotating their crops.

Under the National Committee for Disaster Management framework, government agencies, particularly the line provincial departments such as the Departments of Agriculture, and Water Resource and Meteorology, and its counterparts has undertaken activities with support from international NGOs, such as CRC, CARE and Oxfam, and national NGOs to improve disaster preparedness, response, and recovery in the study areas.

Recently, drought intensity and severity were observed to be high. Droughts have been occurring more gradually than floods. Droughts are connected to climate change, especially due to the temperature rise and changes in rainfall patterns. Droughts have seriously affected farmers' rice crop and other farming activities. Unlike floods, droughts arise unpredictably and in different areas. The Ministry of Water Resource and Meteorology has a limited capacity to provide drought forecasts to alert farmers. Farmers therefore have become more vulnerable to droughts than to floods. In response, the government has constructed a number of water-related infrastructures, such as dams, canals and pumping stations, in study areas. Concurrently, local communities and NGOs have built and restored dikes, wells, ponds, and reservoirs NGOs. These constructions are a key component of drought preparation and response strategies.

To improve the capacity of farmers to mitigate and adapt to climate change events in a long run, the report's authors recommend a number of key strategies. Based on the findings from both the field research and literature review, they are:

- Raise climate change awareness among schoolchildren, farmers, and local government officials;

- Develop a Cambodian rice-based farming systems to respond to climate change;
- Research and develop new varieties of rice crops which are more resistant to floods and droughts;
- Improve soil, water and nutrient management (for example, crop rotation);
- Innovate and promote appropriate usage of mechanized farming and agriculture inputs;
- Promote rice banks and community rice insurance schemes;
- Develop and improve irrigation system;
- Build more reservoirs, canals, and community ponds around houses and rice fields to harvest and store rainwater and runoff;
- Build climate-proof infrastructure (such as constructing road which are resistant to floods and droughts);
- Promote livestock raising and agri-food processing and create market linkage for farmers; and
- Widely and quickly disseminate accurate weather forecasts and disaster warnings to farmers.

To successfully implement the aforementioned strategies, there needs to be a strong commitment from key stakeholders, namely MAFF, MoE, MoWRAM, MoRD, MoEYS, MoP, MoC, NCDM, NGOs, INGOs, donor agencies, microfinance institutes, concerned private companies, local authorities, and other relevant institutions. These agencies should prioritize these recommendations and implement them immediately. The required level of coordination from these key actors is high. To reach this level, concerted assistance by other key players, particularly development agencies and NGOs, is needed too.

1. INTRODUCTION

1.1. An overview

In 2007, the Inter-Governmental Panel on Climate Change (IPCC) stated that climate change is undeniably occurring as temperatures have increasingly risen during the past 25 years. It predicts that global average temperatures could rise by as much as 3°C by 2100. Other impacts of global warming are expected to be sea level rise and an increase in climate-related extreme events such as floods, droughts, and storms. The above changes will affect crop production systems because increased heat and changes in precipitation amounts will negatively affect rice yields. Research suggests that an increase in global temperatures and a decrease in relative humidity will cause more water to evaporate from rice paddies. This increase in evaporation would impact run-off, soil moisture, water in reservoirs and groundwater table, and would lead to either a reduction in irrigated rice yields or an increase in water demand to meet previous levels.

IPCC (2007) states, "The effects of these changing conditions on agriculture are obvious, but considerable gaps exist in our knowledge of how agricultural systems can be affected by both short- and long-term changes in climate and what implications these changes will have for rural livelihoods, particularly among the most vulnerable. For some regions and crops, opportunities for increased production exist, but, for most, there is simply not enough information available regarding impacts at scales that are relevant to decision making and research prioritization, and this has an adverse effect on the global net agricultural production."

The majority (90%) of rice production and consumption occurs in Asia, with China being the biggest rice producer and consumer globally. A recent important study by Lobell *et al.* (2011) highlighted how recent research on yield levels in the last three decades indicates that rice production levels have increased in higher latitudes while some losses have arose in warmer areas, with temperature playing a bigger role than rainfall. They further noted that more subtle effects of climate change, such as more intense precipitation events and exceptionally hot days, are often not included in scientific analyses, resulting in an underestimation of

climate change effects. The Economist (2011) adds that climate change effects could accelerate, while growth in yields of major grains seems to have slowed. This implies that annual growths in yield that have been larger than the losses attributed to climate change are a phenomena of the past while it is expected that losses due to climate change would increase. Especially China's ability to grow rice in the drier areas of the country would be hampered, thereby negatively affecting global production.

While focusing on climate change and rice production, Wassman *et al* (2010) describe how higher temperatures would affect rice production through gradual changes, such as changes in water availability, and could cause crop sterility if temperatures extend beyond a certain threshold. Asia's dry-season rice production would especially be threatened by increasing temperatures.

1.2. Cambodia, climate change and rice production

Located in Southeast Asia, Cambodia's climate is highly dependent upon the arrival of seasonal monsoon rains which occur from May onwards, often extending until November. Beyond these rains, however, precipitation is scarce. Total annual rainfall varies from 1,100 to 2,200 mm depending on the location. Average temperatures are often in the high twenties or in the lower thirties, with the hottest period occurring shortly before the onset of the rains.

Cambodia's most important crop is rice which is also the country's most valuable export crop. Agri-Consulting International (2006) estimated that rice is grown on 84% of all cultivated land in Cambodia rice. Rice is grown in a variety of systems, dependent on differing rainfall and flooding patterns. The most common system which farmers use is to plant shortly after rains commence in rain-fed or partial irrigated systems. Another system is planting after floods recede later in the year, especially in the low lying areas around the Tonle Sap Lake and Mekong River. Both areas are prone to annual flooding which vary depending on local rainfall as well as rainfall in the wider Mekong catchment. In areas with access to annual water flows, irrigated rice is also grown from February to May.

Other crops farmers extensively grow in Cambodia are cassava, maize, soya, cashew and rubber. Maize and soya are mostly grown during the dry

season. Cassava competes with maize and soya with the exception being that it is growing season lasts for 18 months, while rubber and cashew are grown on non-irrigated land.

In 2008, 32.5% of Cambodia's economy was dependent on agriculture (ADB 2010). Nearly 60% of the country's population gained its income from agriculture. The World Bank (2011) estimates that 35% of the nation's population was living under poverty lines in 2004 with rural poverty occurring at much higher rates.

Cambodia's Ministry of Environment (2002) concluded that rice output in Cambodia is directly correlated with climate variations. The total production of rice is highly affected by the occurrence of floods or droughts. Based on data collection it was concluded that floods more often lead to production losses (in 70% of the cases) than droughts (20%) and nationwide both can occur at the same time. Production losses due to pests and diseases were insignificant.

Magnan *et al.* (2011) predicted that world market prices for rice will rise by 50% in 2050. Additionally, there are overall economic growth expectations which influence the demand side and hence future prices. This combined with what Magnan *et al.* (2011) believes are the future ranges of prices, they conclude that the production of rice in Cambodia would at best stay stable, but the overall area in Mainland Southeast Asia on which rice is produced would decrease by 20%.

1.3. Existing mitigation and adaptation measures in rice production in Cambodia

According to the United Nations Framework Convention on Climate Change (2002), "Adaptation is processes through which societies make themselves better able to cope with an uncertain future. Adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes".

The ability to adapt is directly related to vulnerability, the less vulnerable people are, the better they are able to adapt to changing circumstances. Considering the high dependence of Cambodia's rural population on rice growing, devising adaptation strategies and solutions is of utmost urgency.

Specifically for rice, adaptation can occur through improving rice varieties. As Wassman *et al.* (2008) contend, these strategies would be to make current varieties more resistant to droughts and floods, as well as increasing their tolerance to heat and salinity.

During the past few years, growth in the agricultural sector has continued strongly, buoyed by higher prices for products as well as increased ease of access to markets. In Cambodia promoting high yield varieties which result in higher economic returns can contribute to decreasing overall vulnerability levels of Cambodian rural communities. Other rice-specific measures suggested by Mitin (2009) are instituting alternating wetting and drying of rice fields as is commonly used in Systems of Rice Intensification (SRI). This would decrease the demand for water. Mitin (2009) also mentions site-specific management adjustments, such as shifting planting dates and improving water management. Other researchers have mentioned other adaptive measures made by Cambodia's rural communities. For example, Solar (2010) listed a number of micro-projects, such as construction of bridges, culverts, and dams.

Many mitigation options for GHG emissions through field management have been suggested, which can be classified into four categories: (1) changes in water management; (2) organic matter applications; (3) soil amendments, (4) and others (Yagi, 2002). Changing water management appears to be the most promising option and is particularly suited to reducing emissions in irrigated rice production, such as in rice ecosystems which have high emission potential. Mid-season drainage or intermittent irrigation, which prevents the development of soil reductive conditions, is considered to be an effective option for mitigating methane emissions from rice fields (Yagi*et al,.* 1997). A statistical analysis of a large dataset from Asian rice fields indicated that, compared with continuous flooding, a single mid-season aeration can reduce average seasonal methane emissions by 40%, and multiple aerations reduce them by 48% (Yan *et al.* 2005). Li et al. (2006) estimated that despite the large-scale adoption of mid-season drainage, large potential still exists for additional methane reductions of 20–60% from Chinese rice fields over 2000-2020 using the process- oriented denitrification and decomposition (DNDC) model.

According to a recent study on climate change perceptions and adaptation in Sam Rong Tong and Chbar Morng districts of Kampong Speu province

by Mlup Baitong, a Cambodian NGO, two notable changes in rice production practice were found as adaptation strategies in target areas. First, many farmers shifted from using a long-term rice variety to a medium-term rice variety to cope with the uncertainty of rainfall. Second, farmers whose rice fields are accessible to water sources started increasing rice production by growing short-term rice varieties before the beginning of the rainy season. Modern weather forecast information is not yet understood widely and used by farmers to improve their decision-making processes for their farming activities. However, traditional or indigenous experiences in rainfall forecasting are used very often in the studied areas.

A study on drought management considerations for climate change adaptation, conducted in 2008 by Oxfam GB and Graduate School of Global Environmental Studies of Kyoto University, Japan, showed that meteorological data was fairly scant for Svay Rieng province, existing only on a provincial scale. It does not appear to demonstrate marked changes in temperature or rainfall.

Two kinds of adaptation strategies were identified in the researchers study locations: autonomous adaptation options and planned adaptation options. The former included storing seed and fodder for the next season, selecting different crops, and diversifying livelihoods. The latter, planned by government and NGOs, include digging wells and providing pump sets and better crop seeds. In practice, however, the boundaries between the two types of strategy are blurred.

Unfortunately, no significant investments in drought-mitigation programs were found in the study areas. Despite the regular occurrence of drought in Svay Rieng, drought preparedness and response on the part of government and agencies appears to be underdeveloped. Some of the most important deficiencies have been the absence of a dependable drought-forecasting measure, of a clear definition of drought, and of a consistent response mechanism. Drought response so far has often resulted in short-lived solutions. This is in contrast to flood response measures, largely because floods are more obvious phenomena and response mechanisms are better developed. The lack of sufficient livelihood-diversification options in the rural areas has forced populations to migrate to urban areas – a trend which leads to various kinds of social stress. Further, irrigation systems in particular and water-harvesting systems in

general need a big boost. There is a need to map the existing capacities of communities and to undertake a long-term capacity-building program consistent with market development strategies in order to improve income generation and general well-being.

The NAPA survey report states that the more understanding of climatic hazards villagers have, the stronger adaptive capacity they have to cope with extreme climate events. Further, according to the report, authorities' efforts so far have focused on post-disaster management, rather than on disaster prevention and adaptation to extreme climate events. The report also notes several failed cases of adaptation, including shifting the cropping calendar, which was unsuccessful due to a lack of forecasting of local weather patterns; switching to flood resistant rice varieties, which could not survive long periods of drought; construction of wells to pump groundwater to irrigate agricultural fields, which yielded water for one season only and overall lowered the water table.

Key changes in farm management practices to improve adaptive capacity include:

- Land use changes to maximize yields under new conditions;
- The application of new technologies and changes in input use including organic and low external-input agriculture;
- The application of new land-management techniques and changes in crop and livestock varieties; Changes in planting dates; and
- The introduction of water-use efficiency techniques (Adger *et al.*, 2007).

Changes to agricultural water-management practices will be discussed in succeeding paragraphs. Adaptive agricultural management practices include effective use of pest, disease, and weed management systems through wider application of integrated pest and pathogen management techniques and development and use of crop varieties resistant to pests and diseases, as well as efficient quarantine capabilities and monitoring programs. Changes in location or timing of cropping activities are very simple, but also very effective techniques.

A World Bank-financed study (WB, 2006) identified several common coping strategies used by local communities in Cambodia during and after disasters. The research also considered the outcomes of these strategies.

For example, taking refuge in safe areas during flooding helped to save lives and assets, although such areas were often overcrowded and lacked clean water and proper sanitation. Reducing food consumption was viable only for short periods as it posed serious health risks. Receiving disaster assistance was widespread, however insufficient and unevenly distributed. Harvesting common property resources such as fish and water plants provided poor households with food and earnings, although overexploitation led to their depletion. Selling assets enabled households to buy food and rice seeds and to pay medical expenses, but sales of productive assets such as livestock and land served to drive poor households deeper into poverty. Borrowing money likewise provided short-term relief, while high interest rates precipitated indebtedness and ensuing landlessness. Migrating temporarily to work in other areas emerged as an important source of income for disaster affected households, with remittances providing a safety net for members left at home. A Cambodia Development Resources Institute (CDRI) report presented to the National Assembly and private sector during the devastating flood of 2000 listed the likely outcomes affecting rural households struggling to cope with the impact of the flood. These included erosion of savings, declining health, deterioration of capital assets, increased indebtedness and entrapment in the debt cycle, increased reliance on natural resources, increased land sales and landlessness, deepening poverty, and increased rural-urban migration. The CDRI report then suggested that coping strategies of flood victims might differ among various classes.

The World Bank Poverty Assessment 2006 notes that covariant shocks such as extreme floods and droughts affect many households concurrently and are likely to overwhelm social coping strategies based upon support within families and communities. The report maintains that vulnerability to these shocks is exacerbated by: 1) the limited asset base and savings of poor households; 2) the underdevelopment of financial markets for savings, borrowing or insurance; 3) the lack of diversification in many rural households and communities; 4) heavy reliance on common property resources when access to or productivity of these resources is in decline; and 5) a lack of rule of law and guaranteed access to justice in conflicts between the poor and more powerful actors. Floods and droughts in several years coupled with lack of good soil and irrigation were primarily

responsible for the lower rice yields and consequent drop in productivity. At the same time, poor households earning substantial income from fishing, forestry and other common property assets were adversely affected by widespread natural resources depletion, and were unable to produce enough rice to compensate for this decline. Poor households offset the loss of income from rice production and natural resources by increasing their reliance on wage work by hiring out their labor locally or migrating cross border to Thailand or to other destinations for jobs. Whether the increased dependence of the poor on local and migrant labor constituted a temporary adjustment or signaled an irreversible shift in livelihood strategies remains to be seen.

Flood and drought preparedness strategies were included in the National Poverty Reduction Strategy (NPRS) by the Royal Government of Cambodia. A series of collaboration and coordination mechanisms have been enacted to facilitate a better understand the impacts of climate change and to respond to these appropriately across all sectors of society. Primary institutional actor involved in this process is the National Committee for Disaster Management (NCDM). Numerous other government actors are involved in addressing climate change and work closely with the NCDM (see Annex A).

1.4. Study objectives

In response to the above issues identified by the literature review in sections 1.1 to 1.3, this study on the impacts of climate change, in particular the impacts of increased and more intense droughts and flooding, on rice production in the three provinces of Cambodia was initiated by the Agriculture Policies Monitoring Project of the NGO Forum's Environment Program. The study's objectives were: 1) to understand the climate change mitigation and adaptation process in the context and experience of affected communities; 2) to identify strategies how to prepare for and recover from natural events and disasters (especially droughts and floods) taking into account the long-term negative effects on agriculture and the environment, especially the fact that agricultural production will be severely affected by the severity and pace of climate change; and 3) to highlight mitigation and adaptation measures which can be used as effective responses to the effects of climate change.

Civil society organizations can then advocate for the government to incorporate and support these mechanisms.

The findings discussed in chapters 3 and 5 are related to the first objective. The sections of the chapter 4 address the second objective while chapter 7 addresses the third objective.

1.5. Scope and limitations of the study

The field survey was conducted in three selected target provinces (Kampong Speu, Takeo, and Prey Veng) where droughts and floods have been occurring frequently. A minimum of 30 respondents and 5 key informants, were selected respectively for the in-depth and key informant interviews. The theme of the study covered only the impact of climate change (mainly drought and flood) on rice production in Cambodia, the adaptive measures of farmers, and mitigation / adaptation strategies and policies implemented by government agencies and relevant stakeholders. This study did not go into the details of how climate change overall impacts Cambodians' livelihood.

The study did not cover other areas of the country which were affected by flood and drought events. Since the selected samples of the study were relatively small, the research findings may not be generalized within each target province or for the whole country.

2. METHODOLOGY AND RESPONDENT'S PROFILE

2.1. Research framework

The research framework presents a step-by-step process with key relevant activities required for the effective research progress and conduction, aligned by the designed methodology. The framework consist of five stages: desk review, selection of target areas and tools design, field work and data collection, data analysis and draft report, and final report with practical recommendations. Please see Figure 1 below.

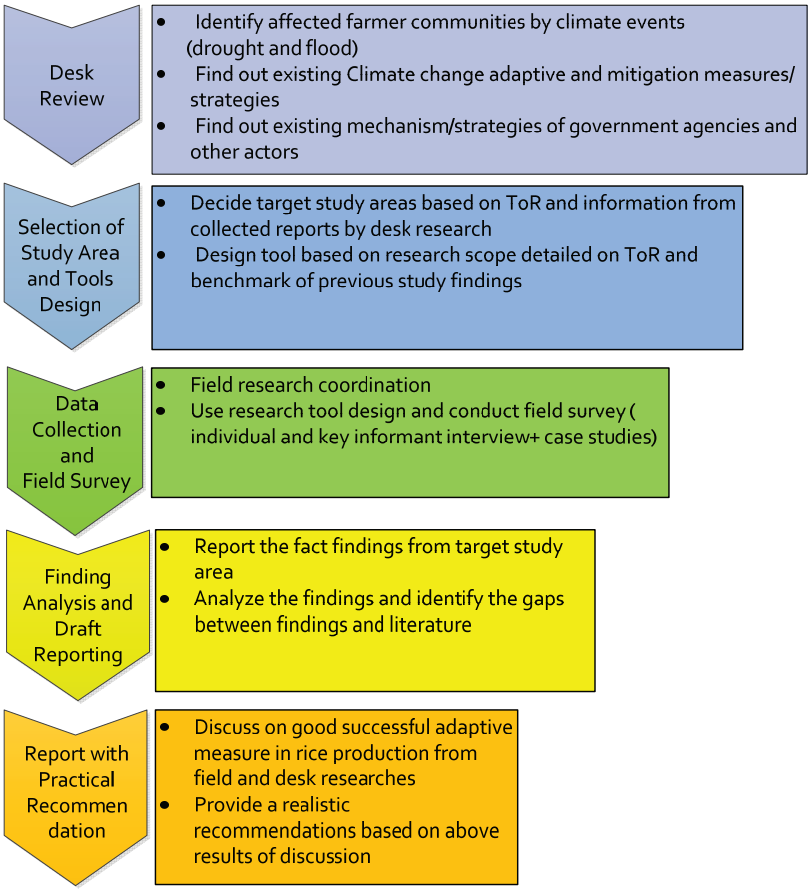

Figure 1 Summary of each step of the research process conducted by the research team

(i) **Desk review** was conducted at an early stage of the research process to identify the affected farmer communities by climate change (flood and drought) and to find out the existing climate change adaptation and mitigation measures undertaken by famers, local agencies, and other key actors.

(ii) **Selection of target areas** was done upon the completion of the desk review and key ideas are understood. The result of discussion with the NGOF and the literature review gave the authors a good idea of which areas should be selected as target areas. The selected study areas were based on which province's rice production was most vulnerable to the impacts of climate change vulnerability (drought and flood). Kampong Speu, Prey Veng and Takeo provinces were identified by previous studies - please see Figure 2. For example, the NAPA report had identified that the three provinces are the most vulnerable to climate change, especially drought and floods.

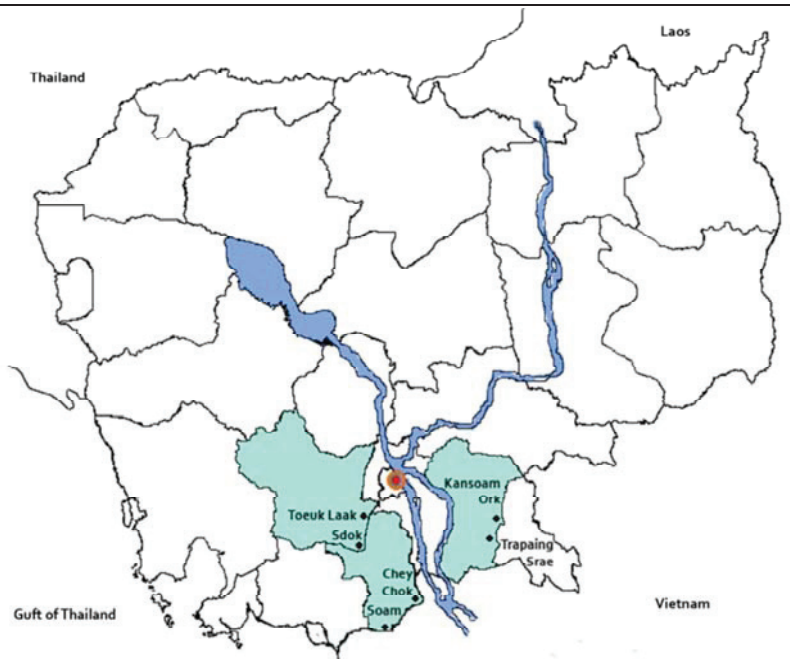

Figure 2 Map of locations of the selected study areas in Cambodia.

The black dots represent the appropriate locations of communes and where questionnaire- based field surveys were conducted during the research period.

Due to limited resources and a timeframe for the research, the field research was conducted in fifteen villages in six communes of five districts - please see Table 1 for more information. The main criteria in selecting the target villages, communes and districts within the three studied target provinces included the area's degree of vulnerability, its rice production potential, and geographical conditions.

Tools were designed to collect data and information which could fill the gaps found in the literature review, to cross-check finding with existing studies, to discover new information about climate change and rice production in the target areas as well as the challenges of adaptation and mitigation, and to learn existing local strategies to prepare, respond, and recover from droughts and floods. Details of the tools used are discussed in Section 2.2, Methodology and Tools.

(iii) **Data collection and field survey** were conducted in the selected communes and villages, based on the proposed methodology and tools. Three types of field surveys were conducted, including a questionnaire-based survey for farming households, key informant interviews with those whole play important roles in adaptation and mitigation measure at community or sub-national levels, and case studies. Field observations were also included in the data collection process.

Table 1 Target areas of the study.

Province	District	Commune	Village
Kampong Speu	Korng Pisey	Sdok	Sdok
			Trapaing Korkoh
			Beng
			Trapaing Prolet
		ToeukLaak	Trav
			Snoul Chrum
			Ang Daun Peis
Takeo	Borei Chulsa	Chey Chork	Darakum
			Banteay Sloeuk

	Kirivong	Soam	Tonloap
Prey Veng	Kampong Trabek	Kansom Ork	Krouch
			Kansom Ork
			Trapaing Run
	Me Sang	Trapaing Srae	Mrenh
			Trapaing Srae

(iv) Once field surveys and data collection were completed, **data analysis** started accordingly. All data was entered into a database for further analysis and study. Records of the data collection were used to analyze and to determine the gaps of the field findings and literature and then were incorporate as findings in the report. The report draft was presented to the NGOF and key stakeholders, especially the NGOF Network's members, who then provided feedback.

(v) The **final report** incorporates the field findings, recommendations, and proposed strategies and mechanisms. The report discusses the successful adaptive measures in rice production from the field and desk reviews and provides sensible recommendations based on the findings. The authors have used a participatory approach in their recommendations and proposed strategies and measures so that the NGOF, network members, key stakeholders, and government agencies can work together to implement them.

2.2. Methodology and Tools

Qualitative data were mainly used in this study; however, quantitative data were also supportive and useful for this research. The data were collected from both primary and secondary data by employing the following methods and techniques:

Secondary Data Sources: In order to meet the research purpose's guidelines provided by the NGOF, secondary data was collected from various sources for desk review. They include government policies,

guidelines, research paper and articles of governmental agencies, NGOs, and research institutions. They include previous studies related to climate change issues. Secondary data was very important for researchers to identify research target areas and to design appropriate tools. The desk review for qualitative analysis was conducted before the field work.

Primary Data Sources: A mixture of primary data was collected during the study.

- ***Household survey*** were conducted to collect data on: (i) general information of the respondents and their livelihood practice, (ii) climate events and its impacts, (iii) existing local adaptation strategies to climate change in rice farming sector, (iv) and farmers' preparedness, response and recovery to extreme climate events (floods and drought). A standardized questionnaire was developed and a pre-tested survey was also employed before the commencement of the data collection at the household level - please see **Annex B**. The number of respondents within each study village was not the same. Ninety respondents within the six target communes, under the guideline's stated in the ToR and mostly under the coverage areas of NGOF Network's Members, were randomly on-site interviewed.
- ***Key informants interview*** was conducted with the relevant organizations, agencies, and institutions. The interview aimed to expand knowledge regarding existing policies, the legal framework, and development projects available to support climate change adaptation, mitigation measures and natural disaster risk management of the local line agencies in different geographical locations. They included commune chiefs, district governors, and NGO staff members working on flood and drought responses, representatives from Provincial Departments (Agriculture, Environment, Water Resources and Meteorology) and provincial representatives of National Committee for Disaster Management. Please see **Annex D** for the list of interviewed key informants. The discussions mainly focused on: (i) capability and level of involvement of each agency to prepare for, respond to, and recover from climate

and related agricultural risks and disasters, (ii) effectiveness of the existing plans and the strategy to cope with climate risk disasters, especially the impacts of flood and drought on rice farming, and (iii) key challenges. The results of the discussions were used to design recommendations, strategies, and mechanisms to improve climate change adaptation and mitigation effort and to improve rice production.

- ***Case studies*** were conducted in selected target communes, or villages. Mostly, good practices were discussed and presented in the report findings. Three case studies within the study areas were selected and reported to support the research. These case studies are accordingly enclosed in the following sections.
- ***Field observations*** were carried out during the data collection period to better understand the overall living situation of target communes and villages. Researchers observed social and economic aspects of the villages, the climate, and geographical hazards and threats.
- ***A consultative presentation*** was made after the first draft report was completed. It was done in order to share the collected data and draft analysis output and to receive comments from key NGOs involved in the project, especially those who are the NGOF's network members. The authors received the comments and ideas from the consultative presentation and revised the report accordingly. Appropriate comments were incorporated into the report; the remaining ones were retained further discussion or study.

2.3. Respondents' background

Among the 90 selected farmer respondents, 51 respondents were men (57 %) and 39 respondents (43 %) were women. Their ages ranged from 20 to 80 years old. However, most of them (about 90 %) were aged between 31 and 70 year-olds, see Chart 1. The respondents chosen were believed to be able to provide the most comprehensive answers to and able to best describe how natural extreme events affect rice production and the measures they have taken to mitigate these risks. Only a few respondents were less than 30 years old or older than 70 years old.

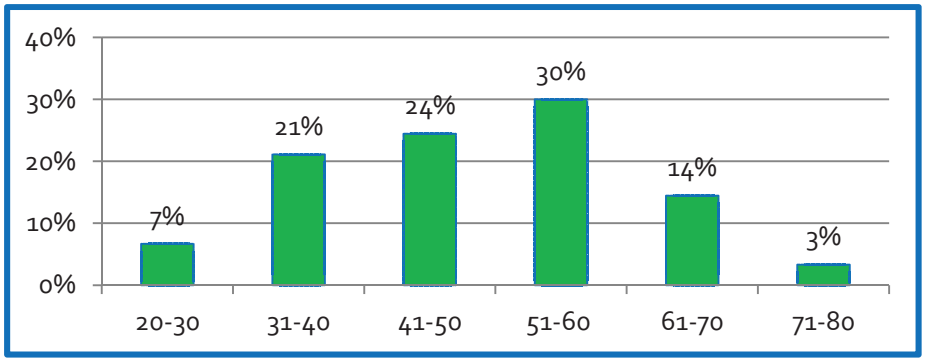

Chart 1 Age distribution of farmer respondents

The majority of respondents (84%) in the study area can read and write, as most had completed primary and secondary school education. Only a few respondents had completed high school, while about 8% received non-formal education in the villages. The rate of illiteracy of farmer respondents is slightly higher: about 14% of them are illiterate. Please see Chart 2.

Eight respondents are leaders of farmer groups/associations; three respondents are leaders of saving groups and two respondents are village representatives. The rest are normal farmers who earn their living based on agriculture, particularly rice farming. They are considered to be the most vulnerable group to climate change impacts, especially floods and droughts.

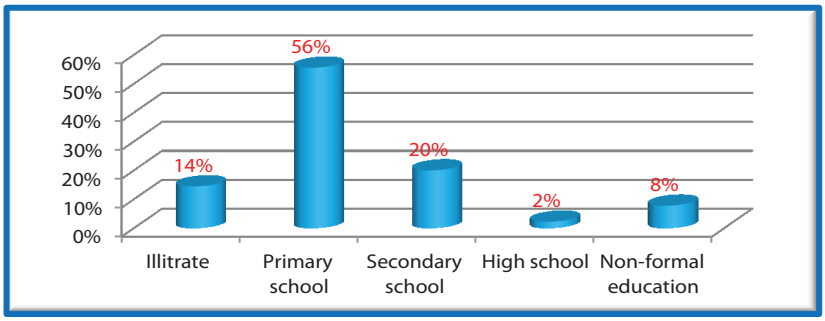

Chart 2 Farmer respondents' education profile

Besides rice production, which is the main source of income of the respondents, 52 % generated additional income from animal husbandry and 50 %of the respondents earned extra income from off-farm activities.

58 % of respondents grow rice once a year; 30 % grow it twice a year and 12% grow it thrice a year. In Takeo, the average yield of wet season rice

is 4.81 t/ha and the yield of dry season rice is 3.00 t/ha, while rice crop yield is only 1.20 t/ha in Kampong Speu. In Prey Veng, the yields are 3.12 t/ha and 1.35 t/ha for dry season rice and wet season rice respectively.

In the three selected provinces, farmers still mostly depend upon rainwater for their wet season rice production. Dry rice farming in Takeo depends mostly on irrigation systems, including man-made canals and reservoirs, while farmers in Prey Veng use water from drilled wells.

3. FLOOD AND DROUGHT IN THE SELECTED PROVINCES

3.1. Observed climate events

According to the literature, the most frequent climate change related extreme weather events in Cambodia are droughts and floods. Floods are often associated with typhoons and heavy rain in the Mekong basin and drought typically coincides with El Niño events. Moreover, the Mekong River basin is subject to significant spatial and temporal variability in rainfall distribution associated with the monsoon regime.

A practical definition of drought helps in identifying the phenomenon and in initiating timely and effective responses. Such a definition needs to be established at various geographical levels, including village, commune, district and national levels. Our interactions with local-level government agencies suggested that no common definition of drought has been identified by the government. The only definition of drought that government officers could provide was "lack of sufficient water" or "lack of sufficient rainfall" for paddy cultivation. Hence, it is imperative that a comprehensive and agreed-upon definition of drought is established in Cambodia and would improve drought preparedness and response mechanisms.

Cambodia naturally experiences an annual "dry season" between November and April, which does not constitute drought; and the annual "wet season" (from May to October) typically causes the inundation of large tracts of land in the floodplain areas — an important process that assists in maintaining biodiversity, fish stocks, and soil fertility. Even the floods caused by extreme weather events can provide positive impacts. For example, it has been reported that flooding in the year 2000, which is widely reported as the "worst" flood of the last 70 years, were accompanied by natural fish spawning, an increase of biodiversity and soil nutrients, new land accrual, and natural flushing.

Cambodia's NAPA classified Prey Veng as the most vulnerable area to flood and as the second ranked vulnerable area to drought. Takeo was identified as the third most vulnerable to flooding and sixth-most in

vulnerable to droughts. Kampong Speu province was ranked as 13th the most vulnerable area in Cambodia.

3.2. Drought event

⏩ Kampong Speu

A period of abnormally long dry weather is regarded as a drought. Normally, the rainy season runs from May to October including the heavy rains from mid-August to October. Specific characteristics of drought in Kampong Speu province are unpredictable delays in rainfall arrival in the early wet season, erratic variations in wet season rainfall arrival, amount, or duration, early ending of rainfall during the wet season, and mini-droughts of three weeks or more during the wet season. During droughts, the farmed rice crop was often destroyed due to lack of irrigation. Drought largely influenced rice production in Kampong Speu province in wide areas in 2001, 2002, and 2003. It caused stress on water supply for agricultural crop production. Among the 420 affected communes of the year 2002 drought, Kampong Speu province was affected severely (NCDM, 2008).

Drought is the most common disaster in Korng Pisey district. People in this area acknowledge that drought has been a natural disaster which degrades their rice yield almost every year. All farmers responded that the droughts of 1997 and mid-2000s resulted in total loss of rice crop. Around 30% of the interviewed households ended up with no rice grain harvested in these years. The droughts lasted a long period and damaged the majority of cultivated land in the district. From 1991 to 2000, about 7,000 hectares of rice cultivated in the Kampong Speu province was damaged by drought annually. Moreover, farmers' homegrown vegetables and fruit trees around their house were destroyed and their livestock raising was hindered by diseases and feedstock and water shortages. Drought has occurred very frequent in the last 20 years and almost twice per year; between June and July and between October and November. These twice-a-year droughts have posed many obstacles to rice growing. Farmers consider it to be difficult to ensure that their young rice seedlings survive after being transplanted and that their crop will mature at the grain-filling stage.

In 2010, there was a brown leaf hopper outbreak destroying their rice crop. Most of farmer respondents said that the pests seemed resistant to

pesticides that they had been using. The rice deficit in this particular district was high due to a rice harvest failure.

In Kampong Speu, farmers perceived that droughts have produced a significant negative impact on farmers' livelihood, particularly food security. Due to the low productivity of rice, almost half of the interviewed households in the study areas faced food shortages of three to five months. Farmers have difficulties finding other livelihood options due to the fact that the surrounding environment is not well-endowed with natural resources. Every household interviewed reported to have sent children to work in garment factories, most of them located in Phnom Penh.

The summary (Table 2) provides the intensity and severity of drought in Kampong Speu as perceived by farmer respondents in Korng Pisey district.

Table 2 Drought and its impacts in Korng Pisey, Kampong Speu province

Main climate event	**1990s**	**2000s**	**2010s**
Drought			
Intensity (period and coverage)	• Long period • Cover large area	• Short period • Cover large area	• Short period • Cover large area
Damages			
Home garden			
Rice			
Cattle (cow, buffalo)			
Chicken, Duck, Pig			
Soil quality			
Pests			
Diseases			
Level of seriousness: 	1 - Not serious 2 - Mildly serious 3 - Moderately serious 4- Serious 5-Very serious =High = Medium = Low		

According to the table 2 above, the interviewed farmers in Korng Pisey district observed that the intensity of drought in Korng Pisey seemed lower during the 2000s and 2010' than in 1990's. However, the impacts of drought on their rice production were still medium. They also mentioned that drought affects other agricultural activities besides rice cultivation, particularly animal husbandry and home gardening.

⏩ Takeo

A prolonged drought due to unusual dry weather during the rainy season frequently occurs in Takeo province. Usually the drought occurs in the middle of rainy season which is from July to September. Delays or early ending of the monsoon rains and erratic rainfall (volume and period) have contributed to agricultural droughts. As a result of the drought, farmers have not been able to plant wet season rice or transplanted seedlings were damaged. It has been reported that the droughts occur in three districts: Bati, Prey Kabas, and Som Roang. In 2009, the drought caused complete damage to 440 ha of rice fields. Around 8,000 ha were seriously affected in 2010. Table 3 provides an overview of the farmer perception's of drought intensity and its impact in Takeo province.

Table 3 Drought impacts in Kirivong, Takeo province.

Damages/Period	**1990s**	**2000s**	**2010s**
Drought (intensity)	●●	●●●●	●●●
Home garden	■	■	■
Rice	■	■	■
Cattle	■	■	■
Chicken, Duck, Pig	■	■	■
Soil quality	■	■	■
Pests/insects on rice farming	■	■	■
Diseases	■	■	■
Level of seriousness: ●●●●●	1 - Not serious 2 - Mildly serious 3 - Moderately serious 4 - Serious 5 – Very serious ■ = High ■ = Medium ■ = Low		

80% of interviewed farmers in Kirivong district perceived that intensity of drought was constantly high during 2000's, notably in 2009. They stated that drought did not reduce its intensity or negative impacts on their rice production during the last two decades. Apart from negative impacts on rice cultivation, drought was reported to have the same degree of impact to most other agricultural activities, such as animal husbandry and home gardening. Insect outbreaks (brown leaf hopper) and animal diseased notably occurred during period of droughts. Most insects were observed to have migrated from Vietnam.

⏩ Prey Veng

Local authorities and NGOs do not consider drought to be as serious risk to Prey Veng Province, even though it has been occurring annually since 1990. Sometimes the drought has occurred twice a year. According to all of the respondents (farmers and key informant), the most serious drought events were in 2002 and 2004, when it lasted for an extended period. It began in the middle of the rainy season (July-August) until the end of October. During those years, the drought occurred after heavy flooding in many places of Kampong Trabek district in the early rainy season (May-June).

According to 56% of interviewed farmers, the drought is a greater risk than flooding because it destroys their rice crops and has a greater affect upon their livelihoods. This is due to the fact that farmers are better prepared for floods than drought. When droughts arise, they could not find effective and immediate solutions to obtain water to save their rice crop and other farming activities. Their rice productivity became so low that 45% of respondents faced a food shortage). Moreover, the home gardens and grazing areas for cattle of many were seriously damaged. 86% of interviewed farmers remarked that they must deal with pests such as rats and brown leaf hoppers (it is locally called Mo Meach Tnot) during these droughts. The farmers' perception of drought intensity and impacts are highlighted in Table 4.

Table 4 Drought and its impact in Kampong Trabek and Me Sang, Prey Veng province

Damages/Period	1990s	2000s	2010s
Drought			
Home garden			
Rice			
Cattle			
Chicken, Duck, Pig			
Soil quality			
Pests/insects on rice farming			
Diseases			
Level of seriousness: 	1 - Not serious 2 - Mildly serious 3 - Moderately serious 4 - Serious 5 – Very serious ■ = High ■ = Medium ■ = Low		

As show in the table 4 above, interviewed farmers in Kampong Trabek and Mesang districts perceived that the intensity of drought was highest during 2000's, particularly in 2004-05. They responded that the drought did not reduce its intensity or the degree of negative impacts on their rice production during the last two decades. Farmers' animal husbandry reportedly affected by the drought, especially diseases breaking out during the drought period. The interviewed farmers also observed that the population of brown leaf hoppers swelled during the drought period.

3.3. Flooding events

⏩ Takeo

The Mekong river floods affect the provinces of Kandal, Kampong Cham, Kratie, Prey Veng, Stung Treng, Svay Rieng and Takeo. Takeo is one of the most severely affected provinces due to its flat and low land. Four districts of Takeo are exceptionally flood prone: Koh Andeth, Kirivong, Borei

Chulsa ,and Angkor Borei). Flood levels in this province are very high and "living with floods" can almost be considered a way of life. Flood levels are too high for wet rice cultivation in most areas, while flooded rice accounts for about 30,000 ha, particularly in Borei Chulsa and Kirivong districts. These two districts have the highest rate of population dependent on agriculture, 97.3% and 98.6% respectively (NCDD, 2009). It has been pointed out that more than 3,000 ha of rice fields are annually under water and 147 ha of rice fields are completely damaged (PDA, 2010). This figure was higher in 2009, during which 760 ha of rice fields were completely destroyed.

Table 5 illustrates the farmers' perception of flood intensity and its impact in Takeo province.

Damages/Period	1990s	2000s	2010s
Flood intensity			
Home garden			
Rice			
Cattle			
Chicken, Duck, Pig			
Home			
Soil quality			
Pests/insects on rice farming			
Diseases			
Level of seriousness:	1 - Not serious 2 - Mildly serious 3 - Moderately serious 4 - Serious 5 – Very serious =High = Medium = Low		

75% of the interviewed farmers in Cheychok Commune revealed that the flooding was most intense during the early 2000s, particularly in 2000 and 2001. They declared that floods had caused serious impacts to their livelihood, particularly rice farming activities. They also asserted that floods occur regularly in this area because the land is the lowest area in the province. The floods usually covered the entire area of their villages and people sometimes had to evacuate to safer places, such as neighboring villages. Animal husbandry is affected by floods and diseases (foot and mouth disease) break out during flooding. Since 2007, floods have had less of impact on rice production since farmers have shifted the rice planting period to the dry season.

Photo 1 Mr. Kak Khon, a local farmer returning from trapping rats nearby the village. His house is in Banteay Sloek village of Chey Chok commune, Borei Chulsa District, Takeo Province.

THE TRUTH: LIVING WITH FLOOD

Banteay Sloek, a village in Chey Chok territory, lies in the lowland area in southern Takeo province. In this commune, floods are not a problem for farmers living in this area anymore. Rather, people cannot live without deep flooding.

Without floods, farmers cannot cultivate rice because there will have a serious pest outbreaks, particularly rats. Rats can completely destroy rice plants within just few days. Deep floods chase rats away.

"After harvesting rice, I also have other income generation activities. From catching rats I can earn about $5 to $7.5 each day and there are many people doing this job," said Mr. Kak Khon. Rat outbreak usually occurs in between April and May. During this period, farmers have almost completely harvested their rice. Only during this time is rice cultivation suitable in this area due to the invasion of rats.

"*I can also fish during the flooding period. I catch fishes for household consumption and also for selling them daily,"* he insisted.

Flooding is important to rice farming, the highest generator of income, in this area and also boosts other daily income-generating activities.

⏩ Prey Veng

92% of respondents discussed floods occurring from 2000 to 2002. Floods during these years were regarded as having severe impacts on farmers' livelihood. The intensity of these floods was very high and lasted for a long period. Consequently, they caused numerous negative impacts on rice production, home gardening, farmers' properties, and local infrastructure. They also claimed many human lives and killed a large amount of cattle and other livestock. The Provincial Committee for Disaster Management (PCDM) reported that 68 people died due to the floods and more than 100,000 ha of cultivated area was seriously damaged in 2000. Floods came again in 2001, this time killing 35 persons and damaging roughly the same area as they did in 2000. In 2002, 12 people were killed and more than 15,000 ha were devastated. The level of flood intensity decreased drastically after 2002 and since then, floods have not had many negative impacts on farmers. Please see Table 6 below.

Table 6 Flood and its impacts in Kampong Trabek, Prey Veng Province

Damages/Period	**1990s**	**2000s**	**2010s**
Flood intensity			
Home garden	■	■	■
Rice	■	■	■
Cattle	■	■	■
Chicken, Duck, Pig	■	■	■
Houses	■	■	■
Soil quality	■	■	■
Pests/insects on rice farming	■	■	■
Diseases	■	■	■
Level of seriousness: 	1 - Not serious 2 - Mildly serious 3- Moderately serious 4-Serious 5– Veryserious ■=High ■=Medium ■= Low		

According to the table above, interviewed farmers in Kampong Trabek district perceived that the intensity of flood was highest during the 2000s, particularly in 2001-2002. Besides rice, farmers' home gardens and animal husbandry were destroyed by the floods and diseases broke out often during the flooding periods. Interviewed farmers perceived that the intensity and impacts of flood has reduced since 2002.

3.4. Flood and drought calendars in the study areas

In Kampong Trabek district, flooding occurs normally every September and October and local resident consider it normal for their land to be flooded during those months. However, if rainfall becomes more intense than normal during May and June, the cultivated areas for rice can be quickly inundated by floodwater. In Borei Chulsa district of Takeo province, floods usually occur from August to November, while the most dangerous floods arise in September and October. An exception is Trapaing Srae commune in Me Sang district which has not been affected by serious flooding during the last decade. Residents in this commune think that today's floods are less intense and destructive than those of last decade and last a shorter period. According to Deputy Governor of Kampong Trabek district, the impacts of flooding are now lesser because the government has built dams and canals built along the Kampong Trabek. Table 7 shows the flood calendar in the selected study areas.

Table 7 Flood calendar in Kampong Trabek, Prey Veng and Borei Chulsa, Takeo province.

Flood Calendar												
Place/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kg. Trabek												
Borei Chulsa												

Note: Flood by rain water Flood by river water regime

Periods of drought are more difficult to identify. Predicted droughts usually occur in July and August and this period is called by local communities the "small dry season". Some years droughts have occurred once during the rice-growing period (which starts in May or June, includes the tillage stage in July and August, and ends at the maturation stage,

around October). Sometimes droughts occur twice a year. Most respondents, including local authorities, expressed deep concerns over drought disasters due to its unpredictable nature. The drought calendar, Table 8, was produced based on the respondents' experiences with the drought in the past.

Table 8 Drought calendar in Kampong Trabek& Me Sang(Prey Veng), Kirivong (Takeo), Korng Pisey (Kampong Speu).

Drought Calendar												
District/ month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kampong Trabek												
Me Sang												
Kirivong												
Korng Pisey												

According to respondents, drought rarely occurs in Borei Chulsa district. This is because the district is located in a low-lying area with a good irrigation system, particularly canals filled with water obtained during annual floods.

Apart from floods and droughts, farmers in the study areas have noticed that other climate-related events such as increased temperature, uncertain precipitation patterns, and pest outbreaks are also affecting negatively their rice productivity. The field survey revealed that some farmers lack an understanding of the anthropogenic causes of the droughts and floods because they regarded these as natural phenomena as opposed to being an outcome of climate change. Only a few farmers, who had obtained knowledge from radio and TV programs, said that the floods and droughts were the consequences of deforestation, of upstream hydropower dams, and of the human action of emitting greenhouse gases.

3.5. Impact of flood and drought on women

Gender differences intersect with climate risk and vulnerabilities. Women in developing countries are highly vulnerable to climate changes. For example, widows and women-headed households with many children face numerous problems if their crop failed due to droughts and floods.

Photo 2 Young women seek jobs in cities while old women do off-farm jobs to provide extra income to their families

Women are found to be more vulnerable than mare are to the impacts of climate change due to their different social roles and statuses. In general, women are given more tasks, both physically and mentally, are the ones primarily responsible for ensuring a family survival. Women are found to often work overtime in the fields in order to ensure that their families have enough. In some case, middle-age women leave their home to find jobs as housemaids and young women leave their home to work at factories or entertainment venues in cities. Also, many girls are quit school to help their parents.

Often because there is a food shortage due to floods or droughts, many women-headed household have requested loan from microcredit institutions near their village to start a new business. For instance, they use loans to buy a motorcycle for transporting vegetable and meats in order to sell them in other villages. However, if floods destroy their crops, there have a lower chance of repaying their loans and would then fall into debt. As a result, farmlands, houses or other assets would be seized due to their failure to repay their debt.

Further, famines and health problems arise when infectious diseases break out. These diseases are often caused by floods, droughts and rapid changes to the weather. If famines and these health problems are not

addressed immediately case, women face the risk of acquiring non-recoverable health problems.

The study reveals that women farmers currently are confronted with multiple stresses, including floods, droughts, indebtedness and chronic food security. It also shows that their livelihoods are no longer based solely on agriculture and migration, as wage labor is an increasingly important strategy they use. However, Cambodians also believe that women are in a good position to tackle the issues of climate change as consumers, educators, and change agents in homes as well as in community. They can do so by inspiring lifestyles with smaller carbon footprints and by promoting green values to youths.

The exclusion of women from climate change decision-making processes silences the voices of half the world's population, denies women their rights, fails to uphold human rights principles, and deprives society of many skills, experiences, and capacities unique to women. Women's environmental resources, knowledge, and practices can allow them to be a key stakeholder in climate change decision-making processes. Women can be powerful agents for development and, therefore, can and should be active participants and decision makers in helping society mitigate and adapt to climate change. Women and men should have equal access to information, training, financial instruments or mechanisms, and to the benefits of commercial approaches to address climate change. If resources are not allocated to reduce gender gaps, measures implemented to mitigate or adapt to climate change will reproduce and exacerbate existing social inequalities, not eliminate them. This study however was not extended to compare the impacts of extreme climate events on men and women. Future strategies for adaptation and mitigation to long-term climate change should incorporate a gender-sensitive approach.

4. COMMON EXPERIENCES WITH FLOOD AND DROUGHT

4.1 Flood

The results of the field survey in the flood prone areas, Takeo and Prey Veng, show that farmers are well -prepared for unexpected and serious flooding. Table 12 summarizes the measure farmers in Takeo and Prey Veng provinces have taken to prepare for, respond to, and recover from floods.

Table 9: Farmers' measures to prepare for, respond to, and recover from floods in Takeo and Prey Veng study areas.

DESCRIPTIONS	SUCCESS	FAILURE	CHALLENGES
PREPAREDNESS			
Reservation of high-quality seeds (short cycle seeds) for dry season rice	✓		Many farmers have limited budget for seeds
Obtain flood warning information	✓		• Some farmers do not have access to TVs and radios • Farmers still have limited knowledge on how to obtain weather information from news media and technology, such as mobile phones
Reservation of fertilizers		✓	• Fertilizer price is high and not easily affordable for farmers.

Allocate some budget for urgent need		✓	• Most farmers have limited savings this due to low income. • Many farmers have limited knowledge of financial planning.
Store farming equipment before floods (water pumping motors and mechanized agriculture equipment)	✓		• Limited safety hills available in their village and nearby ones.
Obtains loans from local bank and other microfinance organizations	✓		• Interest rate is too high for some • Obtaining loans is time-consuming
RESPONSE			
Assistance from Commune Council, PCDM, Line Departments and NGOs		✓	• Late response • Short-time assistance • Limited support budget • Political discrimination • Time consuming • Uncoordinated response
Water pumping and water dislocation		✓	• Not enough machines and limited period to use them • Cost of gasoline is high • Limited nearby water resources

RECOVERY			
Methods for immediate recovery			
Find off-farm employment.	✓		• Limited capacity for new jobs • Lack of technical expertise • Not enough jobs available • Outmigration • Less income earned • Not enough labor for farming activities
Sell properties.		✓	• Few valuable properties • Low prices given to sellers
Ask for help from Provincial Red Cross, PCDM, Line Departments, and others.	✓		• Late response • Time-consuming • Political discrimination • Received only short-term income boost
Employment gained from "food for work" project	✓		• Short term income
Request loans from others or microfinance institutions		✓	• High interest rate • Accrue debt • No income-generating jobs available
Methods for long term recovery			

Replanting rice	✓		• Limited seeds for replanting (most seeds were used for food during flooding period) • Limited water availability • Investment cost due to water purchasing, fertilizers, and pesticides. • Price of rice fluctuates
Animal husbandry	✓		• Disease outbreaks • Insufficient capital to spend on animal feeds
Home gardening	✓		• Traditional gardening technique which reduces yields • Limited time due to other labor • Limited irrigated water available during the dry season

At the beginning of each rice growing season, farmers normally conserve an appropriate amount of rice seeds and budget for restoring or restarting their rice production in the future. In the case that flood destroys the first crop they have sufficient seed for a second one. In addition, farmers often store their farm equipment in areas dry from flooding and they save money to ensure that they have enough in case they need to buy additional seeds and fertilizer.

These three strategies were commonly used in the study areas. However, less well-off farmers did not have sufficient savings. In some villages which are often flooded, many safety hills were built for villagers to save people's

life, cattle and assets. During one flood in Prey Vang province, the NGO Care provided a boat to the village authority for rescuing their residents in case of emergency. In 2003, a 23.4 km dam was constructed by the Ministry of Water Resource and Meteorology and financed by the World Bank in Takeo province. This dam was built with the aim to protect villages from serious floods in Koh Andeth district. Numerous safe havens were built in Borei Chulsa district as well as in other flood-affected areas.

CASE STUDY: A HISTORY OF THE COMMUNITY OF FLOOD PREPAREDNESS AND RECOVER

Living in Kroch village, Kansom Ork commune, Kampong Trabek district of Prey Veng province, Mr. Prak Leak, Mr. Soa Hun, Mr. Chin Ra, Mr. Long Koun, Mr. Pout Choeung and other villagers have encountered significant challenges due to serious flooding. Floods have damaged their rice crop, home gardens, vegetables, other agriculture crops, and livelihood systems. After a big flood in 2000, they organized many meetings to think about how to reduce the adverse impacts and adapt their agriculture activities to flooding. During the flood in 2000, about 200 cattle were kept on a few safety hills which had been built by CARE. At that time, the cattle were infected with foot and mouth disease and many of them died. Afterwards, villagers of Krouch village decided during village meetings to construct more safety hills from CARE's and their own community's funds. They prepare well for future flooding and in the next two years, 2001 and 2002, they placed only 20 cattle per hill during flood 2001 and 2002. They also quarantined any cattle with foot and mouth disease and this time successfully avoided an outbreak.

To obtain soil for the additional safety hills in their village, villagers dug small canals and ponds around their residential area. These canals and ponds also play an important role by storing flood water and conserving water during drought periods. Villagers can then use this water individually, such as by giving it to animals to drinks or to irrigate home gardens.

By having a good source of water, villagers were able to construct hedges around their house. They mostly planted fruit trees and used firewood to build traditional bamboo hedges. The available water from

their ponds and canals was enough to keep their home garden watered.

After a series of serious flood in 2000, 2001 and 2002 and before 2008, many villagers only use traditional strategies to adapt to wet-season rice growing to the flooding. The amount of rice they harvested was not even enough to fulfill their own consumption due to longer dry seasons and uneven rainfall. Since 2008, some villagers, particularly the active farmers named above, started increasing the rice production cycle by using short-term varieties and water from wells. The first rice cropping calendar was from April to June. During this time, farmers used water from wells (through a pumping system) and waited for the rain to fall in May or June before harvesting. After harvesting this rice for their own consumption, they started a second cropping cycle (receding rice production) after the flooding receded from their rice fields at the end of October. They harvested the rice at the end of January or at beginning of February and sold it.

By sharing their successful rice production knowledge and experiences to other villagers during several meetings, these farmers have been able to help most of the other farmers in Krouch village to adapt the same practices. As a result, they too have successfully improved their recovery from flooding as well as their overall livelihood.

After successfully initiating the aforementioned agriculture activities in their village, this group of farmers has established its own village association, named **"Agricultural development of our village."** The association has three key objectives: 1) to improve access to agricultural finance, such as saving group, rice banks and credit instruments; 2) to conceptualize cooperatives through the sale of their agricultural products; 3) To improve agriculture techniques and practices by exchanging experiences and agriculture innovations.

Even though the "Agricultural development of our village" association was not established or supported by any NGOs, this association has made many important contributions to their village and district.

According to officials working in Provincial Department of Agriculture of Prey Veng and Kampong Speu, the government always has one hundred

tons of rice seed in each province available in case of rice crops being damaged by flood and drought.

The field survey shows that farmers gained some knowledge on how to prepare for floods from their ancestors as well as from trainings and workshop disseminations organized by a number of active NGOs in their area, including CARE, CCK, CEDAC, World Vision, Oxfam Australia, PDAO, HEKS and PADEK.

The survey also reveals information about flooding alerts. Some farmers said they were informed of flooding alerts by the media, such as from the radio and television, whereas others said they were not informed by their local authorities but by NGOs working there. This contrasts with information obtained from key informants (district governors, officials of the Provincial Department of Agriculture, of Water Resource and Meteorology, and of Environment, and NGO's). They mentioned that alerts and information about flood are timely provided to farmers to enable them to prepare in advance. The information was shared within concerned provincial departments, governor office and local authorities, they insisted.

The period of response to flood was often very short. Despite efforts made by all concerned stakeholders during the emergency response period, the impacts of serious flooding have created a huge burden on farmers. To recover their losses due to flooding, farmers have to spend a significant amount of time, energy and resources. For those who have sufficient savings, they can recover in a short period. Poor farmers, however, struggled to recover from the flood. For a short period, Cambodian Red Cross, government agencies, and NGOs are able to provide flood victims with food, some basic needs, and other resources.

After the flooding, the poorer victims are required to work more intensively to increase their food security, rebuild their houses, replant their home gardens, and to restore their rice fields. Most of the poorer flood victims become trapped in poverty because they had borrowed money with high interest rate from money lenders and micro-finance organizations. Some farmers have no choice but to find off-farm jobs to sustain their livelihoods. Many other farmers send household members to work in the cities and factories. The field interviews showed that NGOs and other agencies working on emergency relief could assist victims only

in the short term and were not able to provide sufficient long-term support to enable farmers to stabilize their livelihood.

Overall, all of the farmer respondents and key informants sated that emergency preparedness is a very important step. This thinking is in line with the Khmer proverb "to prevent is better than to cure".

4.2 Drought

Based on their respective capacities and resources, farmers have adopted differing strategies to respond to droughts. Rice-growing farmers have shifted planting dates and have used different seeds and techniques. However, they have mostly been unsuccessful because of lack of reliable forecasts of local weather, the sensitive rainfall variation, and lack of surface water sources. In some areas, farmers have constructed wells to pump ground water for domestic consumption, but not to irrigate field as done in other parts of Cambodia. If it rain does not much at the beginning of the rice season, farmers have to postpone their farming calendar accordingly. Table 10 summarizes the measures farmers in Takeo and Kampong Speu provinces have taken to prepare for, respond to, and recover from floods.

Table 10: Measures farmers in Takeo and Kampong Speu provinces have taken to prepare for, respond to, and recover from floods.

DESCRIPTIONS	SUCCESS	FAILURE	CHALLENGES
PREPAREDNESS			
Rehabilitate irrigation system including canals	✓		• Water demand is still high and the capacity to supply water is limited • Drainage system is not yet improved • Water is available for the wet season only

Obtain agro forecast and broadcast information regarding drought		✓	• No alert system is available for specific areas and currently forecasts only give general conditions • Many farmers still use indigenous knowledge to forecast rainfall and drought.
Prepare rice seed for re-planting after drought	✓		• Many farmers still cannot easily access irrigated water and do not have enough water for growing rice seedlings. • Several farmers do not plan properly and depend solely on government agencies for free distribution of rice seeds
Allocate some budget for urgent need		✓	• Limited savings due to low income • Many farmers have limited knowledge of financial planning
Reservation of fertilizers		✓	• Fertilizer price is high and not affordable to farmers
Obtain loans from local banks and other microfinance organizations	✓		• Too high interest rate • Time consuming
RESPONSE			
Assistance from Commune		✓	• Late response • Short-term assistance

Council, PCDM, Line Departments and NGOs			• Limited support budget • Political discrimination • Time consuming • Uncoordinated response
Water pumping to rescue planted rice		✓	• Not enough machines and limited period • Cost of gasoline is high • Limited nearby water resources
RECOVERY			
Methods For Short- Term Recovery			
Find off-farm employment.	✓		• Limited capacity for new jobs • Lack of technical expertise • Not enough jobs available • Outmigration • Less income earned • Not enough labor for farming activities
Sell properties.		✓	• Few valuable properties • Low prices given to sellers
Ask for help from Provincial Red Cross, PCDM, Line Departments, and others.	✓		• Late response • Time-consuming • Political discrimination • Received only short-term income boost
Employment gained from "food for work" project	✓		• Short term income

Request loans from others or microfinance institutions		✓	• High interest rate • Accrue debt • No income-generating jobs available
Methods For Long- Term Recovery			
Replanting rice	✓		• Limited seeds for replanting (most seeds were used for food during flooding period) • Limited water availability • Investment cost due to water purchasing, fertilizers, and pesticides. • Price of rice fluctuates
Animal husbandry	✓		• Disease outbreaks • Insufficient capital to spend on animal feeds
Home gardening	✓		• Traditional gardening technique which reduces yields • Limited time due to other labor • Limited irrigated water available during the dry season

The results of the field research showed that farmers were less prepared for droughts than for floods. Preparing for droughts is more difficult due to their uncertainty. Droughts gradually create negative impacts on rice production and the livelihoods of farmers. For instance, unlike, information on possible droughts cannot be provided, unlike for the case

of flooding. The Department of Meteorology has a limited capacity to provide accurate weather forecast within a specific area or district.

Apart from reserving 100 tons of rice seeds for droughts and floods, each provincial government has constructed a number of water reservoirs, canals, and irrigation system. For example, in Takeo between 1998 and 2006, 22 reservoirs were constructed with a total length of 72 kilometers and 99 canals with a length of 206 kilometers. The irrigation schemes have a capacity to provide water for 33,798 hectares of dry rice cropping and 26,227 hectares of wet rice cropping. "About 80% of commune investment funds were allocated to small scale irrigation schemes in recent years," said an officer from PDoWRAM in Takeo. In this province, PDoWRAM has installed a number of pumping generators and other equipment for rescuing rice when droughts arise. A number of pumping stations were constructed and used during drought events. There are 11 pumping stations were installed in Takeo during 1998-2006 (PDoWRAM, 2006). NGOs, local authorities, and farmer associations in the study areas have raised some funds to rehabilitate damaged canals and water gates and to construct community ponds. These measures were done to mitigate the risk of droughts.

Increasing water availability plays a key role in mitigating the impacts of climate change on agriculture, particularly rice production, and in improving livelihood conditions of rural farmer. Plenty of water is normally available near rice farms, yet farmers often cannot enjoy using the water. This is sometimes due to water privatization schemes in which the water distributors have considerable power and dominate water management and dispatching. Individual contractors often provide payment-based services to farmers who need to use water even though the farm land is close to the main canals. It means that there is water available but farmer cannot use the water directly from the canals. In recent years, participatory farmer water user groups have been established in several areas and have helped to reduce the risks in water management and distribution in rural areas. Strengthening them can help solve water conflicts and improve the equitable usage of water among the poor.

CASE STUDY

A GOOD PRACTICE IN WATER PRIVATIZATION

Banteay Sloek village, which consists of 38 family households, is one of the smallest villages in the country. The village is located in the middle of a flood plain isolated from the mainland, but is close to Vietnam (only about 3 kilometers). Farmer households in this village depend mostly on flooded rice cultivation since almost every year their rice fields are inundated by deep flood water. Until 2007, villagers faced numerous problems because floods damaged their rice production and they had to temporarily relocate to safer places annually. Due to repeated difficulties, many families decided to emigrate from the village.

A large irrigation canal was built near the village in 2007. However, the canal could not reach the all rice fields in the village. Afterwards, a Royal Government of Cambodia water policy water privatization scheme was implemented in the village. Under this scheme, a contractor has the privilege to build a sub-canal to irrigate farmlands in distant area, yet farmers who use the water, have to pay $170 per hectare per planting cycle to the water supplier. This cost is equivalent to 20% of a farmer's income.

However, in this case, farmers and the water supplier developed a mutual agreement to lower costs. "*The water supplier received a smaller of payment or sometimes the supplier did not charge farmers who cannot pay for the service fee*," said the village chief of Banteay Sloek, Mr. Nuon Krel who is 40 years old. He continued, "*Before the construction of the sub-canal, the supplier gathered farmers and asked them whether they were happy with the project. I believe that although sometime the supplier obtains money from farmers, he also makes them happy with his service and farmers have agreed to pay the fees at an acceptable rate*."

This case significantly shows that in water privatization schemes, what is important is the full participation of smallholders or farm water users, a clear understanding of water management policy, and benefits are given to poor farming households. Having a consistent source of water and a good irrigation canal can help solve the stress of heavy water demand and benefit people. Also needed for sustainable water usage are a good water management policy and widespread participation from local farmers.

Different actors play different roles in responding to the drought and flood in study provinces. Ranging from the provincial to commune level, people respond depending on their social, financial, and human capital. Several provincial departments, particularly PDA and PDoWRAM, have worked to ensure that the appropriate seedlings and water are available to farmers. These departments' activities include distributing of seeds before the farming period, helping with pumping machines, distributing petrol for water pumping, introducing new and cost-saving/farming techniques, such as SRI. The provincial governor office (or PCDM) reports damages and makes requests to the central government for further assistance. They also raise fund and establish partnerships with NGOs, both local and international, in order to help reduce the severity of the impacts of the droughts and floods. Table 11 summarizes the actions and challenges of each provincial development and local line authorities. If key challenges are overcome, people will be able to better reduce the damage risk of drought flood and other disasters in Kampong Speu.

Although preparing to droughts is often well-planned, the implementation is not always successful. The best response to droughts is to pump water into canals for long-distance water dispatching and then farmers have to pump the water into their own rice field. For rice fields located farther away from the main canals, the owners have to pump the water into their own fields or to pave a small path to enable the water to reach the fields.

Table 11: Key stakeholders' strategies to respond to floods and droughts

Preparedness	Response	Recovery	Challenges
Provincial Department of Agriculture, Forestry and Fishery			
• Prepares seedlings for distribution • SRI orientation • Prepares agricultural extension	• Cooperates with the Department of Water Resource and Meteorology to improve water intervention • Distribute seedlings to those whose fields have been damaged	• Assesses the damage • Sends a damage report to Provincial Governor office (PCDM) and MAFF • Possibly redistributes the seedlings	• Limited number of seedlings • Limited capacity of staff • Limited financial resources
Provincial Department of Water Resources and Meteorology			
• Predicts rainfall and weather conditions for rice farming • Prepares pumping machines for urgent intervention • Rehabilitates canals and ponds	• Pumps water for rice fields where there are possible water sources • Assists farmers with pumping machines (i.e. providing machines and people offer • gasoline)	• Continues rehabilitating canals and pond • Proposes new irrigation systems if needed	• Limited forecasting equipment • Limited financial resources • Limited capacity of staff • Limited data availability

Provincial Disaster Risk Management Committee			
• Works with relevant departments to prepare for disasters	• Cooperates with other departments to respond to disaster • Provides food aid	• Provides food aid • Assesses the damage and request for more supports from Government • Rehabilitates the destroyed or broken infrastructures	• Limited financial resources • No concrete action plan (depends on relevant departmen ts)
Local commune council			
• Works with other provincial departments to rehabilitate canals and ponds • Prepares seedlings for distributions	• Works with other provincial departments to pump water where there is possible sources • Distributes seedlings	• Assesses the damage • Sends report to provincial governor • Redistributes seedlings	• Limited capacity to cope with drought • Limited financial resources

In the past, many farmers in the study area said that they had received some assistance from local authorities, relevant provincial departments), the Cambodian Red Cross and NGOs, (such as CARE). Although emergency relief was delivered, most farmers in the study areas raised main issues related to the assistance they received. These were:

- Relief was delivered slowly.
- Due to a limited financial resources or poor coordination, not all of the response activities were implemented.
- There was a political and personal discrimination by some of the government officials in charge of relief.
- Access to water was still limited in many places

5. COMMUNITY CLIMATE CHANGE ADAPTATION AND MITIGATION

5.1. Process and experience of climate change adaptation

The table below compares rice production practices used in the past and presently in the study area.

Table 12 Comparison of cropping calendar, rice seed varieties, and rice production practice employed by farmers in study areas.

KAMPONG SPEU PROVINCE		
Farming Practices	**Now**	**Before**
Type of seed varieties	Short and medium term rice (3-4 months)	Long-term rice (6 months)
Cropping calendar	June-September	April-December/January
Rice production techniques/ practices:		
1- Land preparation	Cattle and some mechanization	Cattle
2- Sowing and Transplanting	Manually	Manually
3- Coping with pests and weeds	Pesticides/herbicide	Manually pull-out (no pesticide usage)
4- Water source	Rainwater	Rainwater
5- Harvesting/threshing paddy	Manually	Manually
6- Drying paddy	Sunlight	Sunlight
7- Transportation of paddy	Ox cart	Ox cart or carrying
8- Paddy storage	Small barn	Big barn
9- Fertilizer usage	Cow dung +Natural	Cow dung

	compost	+chemical fertilizers
10- Dealing with rice stubble	Keep it at the field or burn it out	Keep it at the field or burn it
TAKEO PROVINCE		
Farming Practices	**Now**	**Before**
Type of seed varieties	Short and medium term rice (3-4 months)	Long term rice (6 months)
Cropping calendar	January – April (Chey Chok) December – February (Soam) June – August (Soam)	May-December/January
Rice production techniques/ practices:		
1- Land preparation	Some cattle +mechanization	Cattle
2- Sowing and Transplanting	Manually	Manually
3- Coping with pests and weeds	Pesticides, stubble burning	Natural compost/pesticides
4- Water source	Rainwater+ irrigated water	Rainwater
5- Harvesting/threshing paddy	Machine	Manually
6- Drying paddy	Sunlight	Sunlight
7- Transportation of paddy	Mechanized carts/ Motor carts	Ox cart
8- Paddy storage	• Store paddy in grange at home for own consumption • Sell paddy at rice field or soon after harvested	Store paddy in grange at home for own consumption
9- Fertilizer usage	Cow dung + natural compost+ chemical	Cow dung + natural compost

	fertilizers	
10- Dealing with rice stubble	Keep it at the field	Keep it at the field
PREY VENG PROVINCE		
Farming Practices	**Now**	**Before**
Type of seed varieties	Short and medium term rice(3-4 months)	Long-term rice (six months)
Cropping calendar	Jul-Sep &Dec-Jan(Kg Trabek) Apr-Sep, Sep-Nov & Nov-Jan(Me Sang)	June-December/January
Rice production techniques/ practices:		
1- Land preparation	Mechanization	Cattle
2- Sowing and Transplanting	Manually	Manually
3- Coping with pests and weeds	Pesticides	Natural compost/pesticides
4- Water source	Manually + machines	Manually
5- Harvesting/threshing paddy	Rainwater+ pumped water from drilled wells	Rainwater
6- Drying paddy	Sunlight+ drying machines	Sunlight
7- Transportation of paddy	Mechanized carts/ Motor carts	Ox cart
8- Paddy storage	• Store paddy in grange at home for own consumption • Sell paddy at rice field or soon after harvested	Store paddy in grange at home for own consumption
9- Fertilizer usage	Cow dung + natural compost+ Chemical fertilizers	Cow dung + natural compost
10- Dealing with rice stubble	Keep it at the field	Keep it at the field

One of the most significant rice production practices farmers have changed is their cropping calendar, as shown in the table above. In the study areas of Kampong Speu province, the majority of farmers have changed their seasonal calendar from April-December to June-September. This means that whereas before they started growing rice at the end of April or early May, they now start growing rice at end of June or the start to July. Their rice harvest time is now in December or January for long-season rice and in August or September for short-season rice. Similarly, 70% of interviewed farmers in Prey Veng have also changed their cropping season from June-December to April–June, June-August, or November-January. The current cropping calendar of farmers in Takeo has been shifted from May- December to January- April, June-August, or December-February.

The changes of cropping calendar vary from one to another place and it depends on their adaptation to rainfall patterns, and the intensity and the frequency of flood or drought they experience in their areas. For example, more than half of interviewed farmers who depend significantly on rainfall, particularly those in Korng Pisey district, have adapted their own rice seasonal calendar to rainfall patterns in order to improve their rice yields. The changes of the cropping calendar occurred at the same time as changes to rice seed varieties used, i.e. from long cycle varieties to short cycle varieties. Table 13 presents the current short season rice cropping calendar used by farmers in the three provinces.

In Kampong Speu, 50-60% of interviewed farmers were able to grow long-term rice varieties because rainfall in October and November was good enough for rice during the grain-filling stage. After experiencing serious droughts over the past decades, they have now chosen to plant short-term rice varieties that could better resist droughts.

In Kampong Trabek district and Borei Chulsa district, farmers changed their rice growing calendar because they have observed that floods are more regular and in moderate intensity. 46% of interviewed farmers in Kampong Trabek and Me Sang have been growing rice two to three times per year: the first cycle crop is planted between April and June, the second cycle between July and September, and the third cycle between November and January. However, the second cycle of crops in Kampong Trabek and

Me Sang faces the high risk of flooding due to a large number of rice fields being located in flood-susceptible areas. 60% of interviewed farmers whose rice field are located on high land area are now able to grow a second cycle because they can harvest rice before the floods arrive.

Table 13: Current rice seasonal calendar for short term rice within the study areas

Current rice cropping calendar by target study area													
Province	**District**	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kg. Speu	**Korng Pisey**												
Prey Veng	**Kg. Trabek**												
	Me Sang												
Takeo	**Borei Chulsa**												
	Kirivong												
Notes:	: Drought period				: Flood period					:Cropping calendar			

Not only climate factors but also economic factors influenced the choice of rice variety. Farmers seek to secure household consumption and to have a rice surplus to save money throughout the year. The aforementioned changes to the rice cropping calendar and rice varieties were observed to be successful because these farmers now have better access to water. However, many farmers who depend only on rainfall or stream levels are very vulnerable to lower rice yields. For example, 30-40% of interviewed farmers in Korng Pisey, where rice is mostly rain-fed have not been able, to improve their production by changing the time of or increasing the number of the rice cropping cycles.

To enrich rice productivity, farmers in Prey Veng and Takeo study areas have increased their rice production seasonal calendars and have been applying more chemical fertilizers and pesticides than compared to the past. In Korng Pisey district, a few farmers started using these methods but in a lesser degree than in Takeo and Prey Veng provinces. According to

the field survey, farmers apply an average 250-300 kg/ha of chemical fertilizers in Takeo. However, the amount of chemical fertilizer used depends largely on the financial situation of farming households. Due to the increased use of chemical fertilizer, the degradation of soil quality has been observed. Farmers noted that the outer soil of their rice fields has become more hardened, less fertile and eroded more easily. Using chemical fertilizers instead of natural manures helps improve yields, though some farmers are aware of the side effects. Some farmers in the study area started using cow manures, natural pesticides, and compost along with chemical fertilizers in order to keep their soil from eroding quickly.

CASE STUDY

RICE CROPPING CALENDAR ADAPTED TO FLOOD

Mr. Prak Leak, a farmer in Krouch village of Kamsom Ork commune, said that during and before the heavy floods of 2000-2001, most farmers in his village and other nearby villages harvested a low yield of rice or failed to harvest any rice due to the floods and droughts occurring in the areas. In order to have enough food for their families, other farmers and he were forced to seek off-farm jobs in cities and towns. After earning a modest amount from working in a small car workshop, in 2008 Mr. Prak Leak invested his savings in wells and generator to pump water to boost his rice production. At the beginning, he only pumped water when rainwater was not enough during the grain filling period. Later on, he discovered that underground water was plenty and a good source, and he pumped more water for a short-term rice production.

Some farmers have adapted their rice production to the flooding calendar which regularly occurs from September to October. It means that farmers cropped their rice after the floods and planted and harvested another cycle before the flooding. After being bothered by pests such as insects and rats, Mr. Prak Leak and other farmers started to use new seed varieties, chemical fertilizers, and pesticides. As a result of these changes, other farmers and he not only obtained enough rice for their own consumption, but also harvested a huge surplus of paddy which they could then sell at the market. The number of farmers migrating to work in cities has sharply decreased because their income generated

from rice production is higher than that from working in cities. This is due mainly to the fact that rice prices have been increasing since 2007.

Using new rice seed varieties, pumped water, fertilizers, pesticide, and mechanization, Mr. PRAK Leak and other farmers are able to harvest rice paddy at approximately 4-5 tons per hectare.

Photo 3: Farmers adopting SRI practices in rice transplantation, introduced to them by PDAO in Takeo Province (Photo Courtesy of PDAO)

Photo 4: Traditional rice farming activities: humans and animals working together (Photo Courtesy of PDAO)

SRI (System of Rice Intensification) has been successfully applied by many farmers whose rice fields are small and not accessible to secure water resources. Several NGOs and the Provincial Department of Agriculture have taught this method to farmers. SRI has numerous benefits to farmers since it requires less rice seed and less water consumption but still achieves higher yields. This method has not been widely applied by farmers, however, because they are resistant to switching from using traditional practices. Transplanting rice seedlings is an essential component of SRI but is less applicable in the intensive rice growing practices which most of the farmers in Prey Veng and Takeo use. A lack of available labor in villages to transplant rice and a lack of sufficient cash reserves for paying off the labor are the main reasons farmers are not

readily switching to SRI. The study commonly found that farmers have been manually broadcasting rice or sowing rice seed.

Another remarkable change in rice growing in Cambodia is the increased use of agricultural machineries, including tractors, hand-tractors, a combined harvester machine for reaping and threshing, or threshing machines. Farmers in the study target areas of Takeo and Prey Veng provinces have been using more and more water pumping machines, mechanized carts, and other agricultural machinery instead of cattle or human labor, commonly known as the traditional way of growing rice. For example, many equipment and machines have not been adjusted so that they are more practical and convenient for farmers' needs.

Photo 5: Hand tractors are widely used in rural areas, particularly in Prey Veng and Takeo

Photo 6: A small irrigation system created by famers to transport water from the main canal.

Additional water management is necessary for growing dry rice during the season rice or short-term rice growing. In Takeo, rice fields were generally observed as being planted in small plots, surrounded by man-made dikes. Small plots of rice field with good dikes can help farmers to flatten the soil and to control water levels. Water control is important as it is one of the techniques that farmers can use to drive away pests, to clear weeds and, to chase insects away. Another way of pest control includes encircling rice fields with pieces of plastic, and it is quite popular in Borei Chulsa district - see Photo 7.

Photo 7: Pieces of plastic surround rice field to protect them from the invasion of rats.

At least one of the above mentioned practices has been applied by farmers in the study areas of the three provinces. Obviously the level of success in applying these measures varies. The majority of farmers in Prey Veng and Takeo have been able to produce enough rice to meet their own consumption and have some surplus rice for market supply, whereas for farmers in Kampong Speu, the level of success was such that they had sufficient rice for their own consumption.

Success depends largely on land size availability and the farmers' efforts to adapt their rice production techniques to climate change. To meet their food security requirements, almost every farmer in Korng Pisey has extended their farming activities beyond rice cropping by growing vegetable, raising cattle and animal husbandry (pigs, ducks and chickens) and other various cash crops, such as water melon and blue pumpkin.

However, only few farmers were observed to be growing cash crops because only they had sufficient access to water from ponds or wells nearby their farm land in dry season. Diversifying their livelihoods is another option many farmers use to generate extra household income to sustain their needs. Most of this diversification comes from off-farm opportunities such as selling groceries at home, and setting up small in-house or off-house businesses. Other solutions applied concern sending household members off to work in cities, particularly in Phnom Penh, or overseas, including in Thailand, Malaysia and South **Korea, as factory workers or house m**aids.

This technique is widely used in Chey Chork Commune, Borei Chulsa district, Takeo Province.

5.2. Process and experience of climate change mitigation in affected farmers

Table 14 Current practices and future trends for mitigation options in rice farming.

Mitigation options	Current Practice	Future Trend	Notes
Rice field water management	↗	→	• Difficult to monitor • Difficult during erratic rainfall
Organic matter application	→	→	• Limited manure (small amount of cattle raised) • Slow fertility
Soil amendment	↗	↗	• More income • Diversification of cropping • Soil improvement
Appropriate use/recycle of rice stubble	→	→	• Release GHGs • Cattle food shortage
Appropriate use of chemical fertilizer	↗	↗	• Higher yields (in short term) • Degrades soil quality • Costly (greater debt for famers)

Table 14 above presents the mitigation measures farmers are using and will plan to use in rice farming. There are many alternatives to reduce GHGs in rice farming field. The finding from the study indicates that there have been some autonomous mitigation measures to climate change taken by local farmers.

Improvements in water management practices contribute to less methane emissions from rice paddy production. By changing water management practices, emissions can be reduced in irrigated rice production. These changes include midseason drainage of the rice paddies, as well as intermittent irrigation. The study, however, did not find that any of interviewed farmers using these practices.

Other water management practices which can reduce emissions during rice production include: (1) shallow flooding, which has the added benefit of reducing the amount of water needed for rice growth; (2) SRI practice which is adopting by a only a few farmers in the selected target areas; (3) and reduced usage of chemical fertilizers, a common practice to reduce GHG mitigation. Most of the interviewed farmers responded that they did not plan to reduce the use of chemical fertilizer and they were uninformed about the benefits of doing so.

Traditionally farmers have collected and stored rice straw in their residential areas because they use it for cattle feedstock. Farmers who do not throw away the straw are able to lower GHGs emissions. Many farmers in the study target area in Prey Veng have been combining cow dung, rice straw, stubble, and husks to be used as feedstock. Burning rice straw after harvest or before tillage releases GHGs into the atmosphere and it is considered a bad practice by many farmers. However, there is no specific study on the amount of GHGs emitted from these activities. On the other hand, soil amendment is also done by many farmers. They crop different varieties of plants besides rice, including watermelon, corn, mung bean, sweet potato, and soya bean.

Due to the soil quality degradation, maintaining a high level of productivity is critical and thus farmers turn to using more chemical fertilizers to improving yield. Farmers reported that they have increasingly used more chemical fertilizer during the past five to ten years and think that these levels will not drop. Although many farmers have increased their usage of chemical fertilizers, others have decided to use dried cow dung or slurry from their biogas oven to increase fertility.

Another source of GHGs emission from the rice field found by this study was the usage of generators to pump water, mechanized carts, tractors and other agricultural machineries. However there is not yet any accurate calculation of the amount of GHGs emitted due to these activities.

A mitigation measures farmers can adopt is planting trees. Trees can be considered as a good natural carbon sink. Farmers in Prey Veng have planted many fruit trees around their houses so that they can eat and sell the fruit and have shade near their house. They did know that trees can absorb large amounts of CO_2.

6. CONCLUSION AND RECOMMENDATION

The impacts of climate change, such as increased floods and droughts, temperature rise, and uncertainty of rainfall patterns, have been occurring in the selected study area. In the past decades, extreme events such as flood and drought significantly affected livelihood of farmers, especially rice production. Human lives, rice crop, cattle, houses, home gardens, farming ecosystem and other socio-economic opportunities were reportedly lost due to droughts and floods. Although heavy droughts and floods have not occurred recently, its past and current negative impacts on poor farmer victims, for instance food insecurity, continue to hurt farmers.

To improve their livelihoods, farmers have autonomously changed their rice production practices and techniques. These changes have enabled them to better adapt to climate change. Rice-cropping calendars in all study areas were changed while many farmers have chosen more seasonal rice varieties in order to increase their rice productivity. By using these strategies, farmers have successfully been able to improve their household sufficiency levels and to sell their rice surplus. Other strategies farmers have adopted include applying more chemical fertilizers and pesticides on their rice field and increasing the usage of agriculture machines to replace cattle labor in their rice production cycle.

By adopting new practices, a small number of farmers have also been autonomously reducing their emissions of greenhouse gases by applying SRI, recycling cow dung, using natural compost, and rotating their crops.

During the time of the study, the intensity and severity of floods were observed to be low and moderate. Most floods in the study area are connected to the Mekong river water regime which has been gradually changing due to climate change and the construction of upstream hydroelectric dams on the Mekong River. Farmers who are living in the flood-affected areas seem to be resilient to floods and can autonomously adapt or adjust their rice production cycle and techniques. Many of them, who used to suffer heavily from floods, have improved their resilience by gained more knowledge and experience on how to best prepare, respond to, and recover from floods. Under the National Committee for Disaster Management framework, the government has also helped farmers to

prepare, respond to, and recover from floods in the study areas. The government has worked together with emergency relief agencies such as CRC, CARE and Oxfam, national NGOs, line provincial departments such as Agriculture, and Water Resource and Meteorology, and with local authorities.

Recently, the intensity and severity of droughts was observed by respondents to be high. Droughts, which occur more gradually than floods, are connected climate change, especially temperature rise and the change in rainfall patterns. Droughts have significantly damaged farmers' rice crop and other farming activities. Different from floods, droughts have occurred unpredictably and do not recur in specific area. The Ministry of Water Resource and Meteorology has a limited capacity to provide drought forecasts and to alert farmers. Farmers, therefore, are therefore more vulnerable to droughts than to floods, even though the government has constructed a number of irrigation infrastructures, such as dams, canals and pumping stations, in the study areas to mitigate the risk of droughts. Most farmers in the study areas still depend entirely on rain water as their source of water for their crops, because they do not have sufficient access to water from irrigation systems or other sources.

In response to the findings, this study would like to make a number of recommendations to policymakers, practitioners, and farmers so that they can better mitigate and adapt to climate change in Cambodia:

- The national government especially the National Committee on Disaster Risk Management should work together with other organizations to establish and enhance community-based disaster management in order to prepare the community to be able to better prepare and respond to disasters, including drought.
- The government, including relevant provincial departments, and development partners should prepare responsive strategies and be ready to provide appropriate materials, such as pumping machines and rice seeds, to help farmers respond to disasters. Doing so would minimize the risk of a crisis.
- New practical farming technologies or temperature-stress resistant seed varieties need to be introduced to and shared among farmers to reduce their risks. The Government continues to develop new yielding rice varieties and these should be readily available to

farmers. There is also a need to improve crop management practices.

- Continue to raise the awareness of climate change effects and knowledge of how to mitigate and adapt to changes in a local context. This can be jointly done by line departments and NGOs.
- There should be a development of a better early warning system for extreme climate events.
- A Weather information sharing system, especially on rainfall, temperature and extreme events, should be nationally and provincially established to immediately inform farmers of upcoming weather-related risks so that they are well prepared for them.
- The government should continue to help farmers diversifying their livelihood options by teaching how to maximize production in limited areas, to increase the planting index in suitable areas, to develop or rehabilitate existing and new irrigation facilities. The government should also explore new opportunities for off-farm investments from private sector which would generate new employment.
- There is a need for the development of advanced modeling techniques, a map of the climate change effects on rice-growing regions in Cambodia, and crop insurance in order to manage risks and reduce vulnerability.
- Research on rice cultivation has identified that emissions mainly occur during the few months of the year when the ground is fully waterlogged. It is suggested that a more integrated approach to rice paddy irrigation and fertilizer application are needed to be practiced in order to reduce emissions.
- A gender perspective should be integrated into all disaster risk management policies, plans and decision-making processes, including those related to risk assessment, early warning, information management, and education.
- It is important to ensure equal access to appropriate training and educational opportunities for women and vulnerable constituencies and to promote gender and cultural sensitivity as integral components of education and training courses on disaster risk reduction.

- The national and local government should develop strategies to (1) improve natural resources management and to ensure that women have access to and have control of them; (2) to create educational and training opportunities in areas related to climate change; (3) to encourage the development of technologies taking women into account; and (4) to foster the transfer of technology to women.

To prepare for and recover from natural events and disasters, especially droughts and floods, in the context of the long-term impacts of climate change negatively affecting the agricultural sector, especially rice production, the authors suggest some adaption and mitigation strategies which are drawn from the research findings. These strategies are detailed in the next chapter

7. PROPOSED STRATEGY AND MECHANISM

Based on the research findings discussed in chapter IV and V and the knowledge of the researchers, adaptation and mitigation strategies as well as suggested mechanisms to implement them are summarized in the table below. While these strategies and its mechanism would not solve all of the issues related to the impact of climate change on rice production, they are useful reference for strategic planners, particularly key actors involved in climate change and agriculture. Although the key responsible agencies are identified in the table, these recommendations are not restricted to them. Rather, responsibilities can be shared among relevant actors operating at the national, sub-national and local levels. They can adopt them jointly or separately.

Table 15 Proposed Mitigation and Adaptation Strategy and Mechanism (flood and drought).

Sector/ Theme	Response Strategy	Mitigation	Adaptation	Mechanism
Education	Raise climate change awareness among school pupils, farmers and local government staff.	✓	✓	• MoE includes the strategy in its strategic plan, National Strategic Development Plan (NSDP). • MoE cooperates with MoYES to integrate climate change into school curriculums. • MoE cooperates with MAFF to integrate awareness activities into the MAFF farmer extension program. • MoE cooperates with NGOs/INGOs to conduct capacity building activities on climate change for

				government staff.
	Share best practices on climate change adaptation and mitigation	✓	✓	• NGO network representative such as the NGO Forum on Cambodia could play an important role by facilitating provincial and national workshops in collaboration with relevant government agencies.
Rice	Develop Cambodian rice based- farming systems to respond to climate change.	✓	✓	• MAFF includes the strategy in its strategic plan, NSDP, and SNAP-DRR. • MAFF cooperates with IRRI, water management and agriculture research institutes, and private companies to conduct research on new rice seeds and best rice farming techniques. • MAFF cooperates with private companies, NGOs, INGOs and ODA/WB/ADB development projects to promote rice export markets and micro-insurance schemes which would to strengthen food security in the country.
	Research and develop new varieties rice crop that are more resistant to flood and drought.	✓	✓	
	Improve better soil, water and nutrient management (for example, crop rotation)	✓	✓	
	Innovate and promote appropriate usage of mechanized farming and agriculture inputs.	✓		
	Promote rice bank and		✓	

	community rice crop insurance.			
Water management and irrigation system	Develop and improve irrigation system		✓	• MoWRAM includes the strategy in its strategic plan, NSDP, SNAP-DRR. MoWRAM cooperates with MAFF, MoRD, private companies, NGOs, INGOs and ODA/WB/ADB development projects to rehabilitate and construct both public and private irrigation system. • MoWRAM should improve its monitoring and evaluation system to ensure the effectiveness use of built irrigation systems in order to provide benefits to a large number of small and poor farmers.
	Build more reservoirs, canals around house and rice field, community ponds to harvest and store rainwater and run off		✓	
	Build climate-proof infrastructures (construction of flood-proof roads and infrastructure)		✓	
Agro forecast and broadcast	Effectively disseminate reliable and quality of weather forecast information and disaster warnings to farmers and the public		✓	• MoWRAM prioritizes the strategy in its strategic plan, NSDP, and SNAP-DRR. • MoWRAM cooperates with NGOs/INGOs, ODA/WB/ADB development projects to strengthen its to forecast weather and to effectively dissemination this information. • MoWRAM cooperates with MAFF to produce agro forecast information for farmers. MoWRAM cooperates with

				NCDM to improve warning systems and public disaster warnings.
Livelihood options	Promote livestock raising	✓	✓	• MAFF provides new techniques with high productivity and low costs farmers in specific areas. • MAFF cooperates with MoC to promote agribusiness and provide more incentives or policies to agri-food processing enterprises. • MAFF cooperates with MoC to improve market linkages for small producers and processors.
	Promote agri-food processing and create market linkage for farmers		✓	

The recommended strategies and mechanism in these five sectors listed in the table above are now described in depth as follows.

Education

Why, who and how should be aware of climate change?

Climate change is a global issue and requires the involvement of everyone to solve it. Understanding climate change's causes and impacts are very important for all people including farmer communities affected by climate change events (droughts and floods) to know. To help small farmers better adapt and mitigate their agriculture activities to climate change, key stakeholders such as NGOs and government agencies have to raise the public's awareness on climate change causes, impacts and issues. The Ministry of Environment should play a key role to make people's understanding and to get their involvement. The Ministry will have to collaborate with various key actors including the MoYES, NGOs and the MAFF. All relevant government agencies and NGOs should integrate this activity into their development plan.

The findings of this study showed that small farmers are very vulnerable to droughts and floods. These farmers are living with and learning how to

mitigate the risks of these events. They therefore have different capacities to adapt their rice production to the floods and droughts. The more they understood about droughts and floods, the more they are able to better adapt their agriculture activities to those events. In some areas, some farmers have their own good adaptive measures and practice which are applicable to other areas. NGO network therefore should play the role of a facilitator to help farmers share good practices and experiences. The quote, "knowledge is power" is especially true in the case.

What is needed is to simplify what scientists have found about climate change and deliver the key messages to relevant groups through awareness raising activities in schools or public announcements. Some basic knowledge on climate, the causes of changes to the climate, its impacts in Cambodia, and adaptation and mitigation methods need to be understood in plain language. This would enhance the existing capacity and inspire new practices of small-scale farmers. To be able to learn, farmers must be willing to open up to new ideas and avenues of thinking. Every manner of education which is promulgated, from textbooks to the field schools, can be fully utilized by farmers, and can help them realize the importance of education, particularly in regards to climate change. The simple desire to know more and wanting to be able to do more is where it all starts.

Rice

What are appropriate technique/practices, inputs, and innovations in rice cultivation for Cambodian farmers to adapt to the floods and droughts? How can farmers successfully apply them?

Under this theme, five recommended strategies are described below:

1- Develop Cambodian rice based- farming systems to respond to climate change

System of Rice Intensification (SRI) is a rice farming systems which can help farmers better adapt to and mitigate climate change. However, this system is still not widely used by Cambodian farmers.

The reduction of methane emissions from rice fields can be promoted by midseason drainage of the rice paddy or intermittent irrigation. NGOs

and government agencies, especially MoE and MAFF, need to play an important role encouraging farmers in within irrigated areas to practice SRI and use these methane reduction methods. There is the potential for Clean Development Mechanism (CDM) projects if substantial amount of methane can be reduced from the rice field by farmers' new practices.

2- Research and develop new varieties rice crop that are more resistant to flood and drought

IRRI, CARDI, concerned government agencies, in particular MAFF , and rice seed private companies should conduct research and develop new rice varieties that are more resistant to flood and drought. This study illustrates widespread concern over drought and calls for new rice varieties which require less water and are more resistant to heat stress, weeds and insects. More importantly, the new rice varieties should be more productive and meet market needs, especially the export market.

3- Improve soil condition by cultivating nitrogen fixation crops

A Rice mono crop culture is found in this country. A small number of farmers know how to improve their soil condition by cultivating nitrogen fixation crops such as mung bean and water melon. When soil conditions are improved, farmers will use less fertilizer on their rice field, which would reduce greenhouse gas emissions. However, those crops should still be marketable and profitable for farmers. Cost benefit analysis of each recommended cash crop should be therefore provided to potential group of farmers in order for them to make better decisions.

4- Innovate and promote appropriate usage of mechanized farming and agriculture inputs

Using appropriate agriculture mechanics and inputs is one factor which can increase productivity of the rice cultivation of farmers. MAFF's skilled engineering staff should be able to conduct research and develop recommendation of appropriate agriculture equipments and machineries. They should educate a large number of farmers how to use those machineries and equipments in a cost effective way. For example, sowing

mechanics should be created and widely used among farmers. This tool would enable farmers to reduce their costs of rice seed, water, labors and other agriculture inputs.

Agriculture inputs such as fertilizer and pesticide have been imported and used widely by farmers throughout the country. To mitigate climate change, the MAFF should have an effective mechanism to promote appropriate use of chemical substances, especially chemical fertilizers, which emit large amounts of greenhouse gases into the atmosphere.

5- Promote rice bank and community rice crop insurance.

Rice banks and rice crop insurance schemes should be promoted to farmer communities often affected by droughts and floods. NGOs focusing on agriculture development within the flood and drought vulnerable areas can successfully implement these activities. However, what is required a wide pool of farmers in order to have a better risk sharing scheme, and a lower premium each member must contribute. There is a need for private sector participation especially from insurance firms, private banks, and microfinance institutions to help provide loans. Moreover, farmers are an important stakeholder in this scheme and therefore their participation is needed. A comparative study of such experience needs to be undertaken from the region to contextualize what the best practices are for Cambodia to insure crop failure and to help farmers survive financially during a crisis. Thailand has started such insurance scheme but is struggling to find a way to maximize the benefits to the poor. On the other hand, if insurance companies decline to join the scheme and not all farmers participate resulting in higher premiums; the government may establish a fund to take up the slack. These policies require careful planning and strategy.

Water management and irrigation system

What and how should be developed to improve water access to farmers for rice cultivation?

1- Develop and improve irrigation system

Irrigation systems identified in the study areas have been very helpful for farmers to ensure the survival of their rice crop when long drought occurs.

Developing more irrigation systems in areas vulnerable to drought is one of the most important drought preparedness or adaptation strategies. However, the effectiveness of the irrigation system should be considered. Irrigated water should be equitably supplied to many plots of rice field. NGOs, government agencies, and private companies should cooperate to provide all farmers with irrigated water in an effective, equitable, and sustainable way. Good practices of public-private partnerships (PPP) should be promoted within water and agriculture.

2- Build more reservoirs, canals around house and rice field, community ponds to harvest and store rainwater and runoff.

Many rice cultivated areas, such as those in Korng Pisey district of Kampong Speu province, do not have access to water from rivers or main irrigated canals. Therefore, building reservoirs, small canals around houses and rice fields, and community ponds, and finding ways to retain runoff are good solutions to address the short-term needs of water during drought periods. These adaptive measures are applicable for wet season rice farming only since farmers can survive their rice crop within a short period of drought. Farmers also have experienced warmer temperatures and decreasing rainfall. They should be introduced to new drip irrigation techniques to make the best use of diminishing water supplies. They need to start to store water in reservoirs and can also use a geo-membrane plastic sheet to store water. These measures would reduce wasting water and washing nutrients from the land when it rains.

3- Build climate proof infrastructures (construction of road, prevent from flood and drought)

The Royal Government of Cambodia has built and renovated the country's main roads including national highways to improve access to rural communities. At the commune level, many small roads within villages and communes have been built by commune investment funds. All road construction projects should be made climate-proof since many areas are often flooded during the raining season. Climate proofing should be incorporated into any road construction and canal projects. Dual benefits from well-constructed roads and canals will occur if the climate proofing concept were integrated into the project plans. The project designers, particularly the MoWRAM and MoRD, should include this strategy in their plans and projects.

Agro forecasts and broadcast

What information and warnings should be given to farmers? How they can be delivered?

With traditional farming calendars becoming unreliable, there is a need to ensure communities can access the information they need to stay informed of the weather. They need radios to access information and training on how to interpret short- and long-term forecasts and climate change reports.Weather information which is usually broadcasted by mass media is normally regarding the general temperature and rainfall within cities and province. Farmers are not informed about drought forecasts or agro forecasts from the mass media. It is therefore difficult for farmers to prepare themselves to climate events, particularly droughts. Since rice farming system is rain-fed, rainfall forecasts within specific areas are crucial for farmers to know so that they can best decide on their agriculture activities, for instance, crop selection. The Ministry of Water Resource and Meteorology and the Ministry of Agriculture, Forestry and Fisheries should upgrade their capacity so that they provide accurate, timely, and recurring agro forecast information to farmers. The Department of Meteorology and the Department of Rice Crop should cooperate together to produce agro forecasted data for specific rice production areas and to broadcast them to farmers. NGOs, provincial department of agriculture, and local authority should educate the farmers how to effectively use the information for their agriculture activities, especially rice cultivation.

In addition to agro forecasting and broadcasting, the MoWRAM must be able to build its capacity so that I can establish a strong disaster warning system which could disseminate reliable forecasted information to farmers and the public.

Livelihood options

What other livelihood options than rice cultivation should be promoted among farmers to strengthen their adaptive capacity to climate change? How they are able to get those options?

1- Promote livestock raising

Off-farm job requires that farmers often leave their home town. However, farmers may not generate better or sustainable income from these jobs as they do not have many skills and job experience. Instead, diversifying and integrating farming jobs will provide them with better benefits as they do not have to leave their hometown and their rice field. Besides rice cultivation, livestock raising and vegetable planting are potential options for farmers to gain income or at least have more food for their own consumption. Also undertaking these activities would reduce their dependency on rice for their livelihood. Providing farmers with appropriate raising techniques, better access to markets, and investment capital would enable them to have better livelihoods, than if they relied only on rice production.

2- Promote agri-food processing and create market linkage for farmers

To improve soil conditions, farmers should plant some cash crops on their rice field. Selling the harvested cash crops, farmers may not gain as much benefits as they expect. However, by processing agri-products they produced, farmers will improve market access and gain additional value. The majority of their processed products may be marketable in the farmer communities. If potential food processing opportunities do exist in the target areas, concerned actors such as NGOs, government institutions, and local authorities should support the initiatives.

All of the proposed strategies need to be implemented. Key stakeholders including government agencies (MAFF, MoWRAM, MoE, MoRD, MoYES, and MoC), NGOs, and local authorities need to incorporate these strategies in their action plans. Policymakers and strategic planners should also take them into their account when they create any policies and strategic plans.

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ANNEX A

INSTITUTIONAL ARRANGEMENT FOR CLIMATE CHANGE AND DISASTER RISK REDUCTION

Cambodia's National Poverty Reduction Strategy (NPRS) explicitly identifies natural disasters, particularly floods and droughts, as critical factors that have and continue to increase socio-economic vulnerabilities of the rural poor, including placing a disproportionate burden of coping on women. Taken in perspective, climate change is not just an environmental, but also a development issue. In this context, a series of collaboration and coordination mechanisms have been enacted to facilitate a grouping of efforts to better understand the impacts of climate change and to respond to these appropriately across all sectors of society. Primary institutional actors involved in this process are the National Committee for Disaster Management (NCDM), the Climate Change Department (CCD), Designated National Authority for the Clean Development Mechanism (DNA-CDM), and the National Climate Change Committee (NCCC). Key ministries involved are the Ministry of Environment (MoE), Ministry of Agriculture, Forests, and Fisheries (MAFF), Ministry of Water Resources and Meteorology (MoWRAM), and the Ministry of Health (MoH). Supporting these efforts through various international initiatives are in brief the Least Developed Countries Expert Group (LDCEG), the Inter-government Panel on Climate Change (IPCC), the United Nations Environment Programme (UNEP), and the International Federation of Red Cross and Red Crescent Societies (IFRC) and others including local and national Cambodian Non-Government Organizations (NGOs).

The National Climate Change Committee (NCCC) was established by Ministerial Sub-decree on 24 April 2006. The NCCC is an inter-ministerial mechanism with the mandate to prepare, coordinate and monitor the implementation of policies, strategies, legal instruments, plans and programs of the Royal Government to address climate change issues within the country, thus contributing to the protection of the environment and natural resources and foreseeing and preventing man-made changes in climate that might have adverse impacts on the peoples well-being. The NCCC is inter-ministerial committee, chaired by the Prime Minister – Mr.

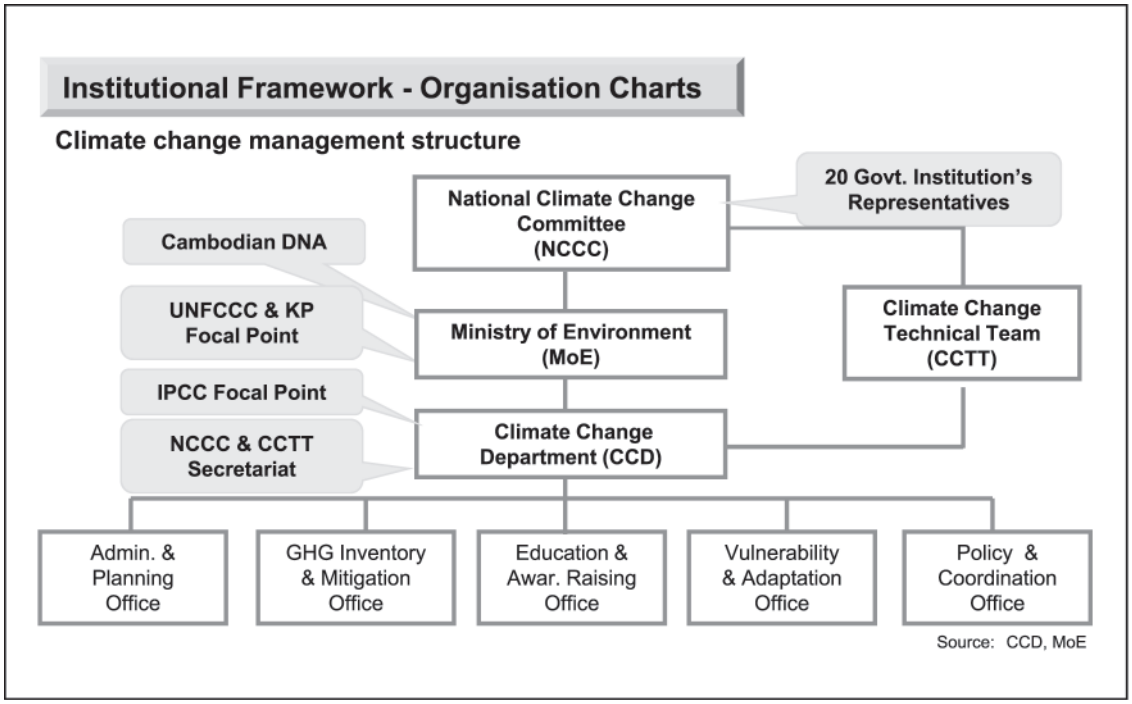
Hun Sen, and is composed of Secretaries and Under-Secretaries of State from 19 Ministries and Government agencies (Mony et al., 2007), see Figure 1.

Cambodian Climate Change Department (CCD): In June, 2003, the Cambodian Government established the Cambodia Climate Change Office, now named the Climate Change Department (CCD), is solely dedicated to climate change issues. The CCD's technical body is embedded with the Ministry of Environment (MoE) mandated with the task of carrying out all technical activities related to the implementation of the United Nations Framework Convention on Climate Change (UNFCCC) and those related to other international environmental conventions. Additional functions of the CCD are to facilitate and coordinate donor funded and private sector activities relevant to climate change with other Government agencies. The CCD also supports and organizes inter-ministerial technical working groups specialized in various sectors, e.g. energy and forestry, and along climate change themes, e.g. Green House Gas (GHG) inventory, mitigation, vulnerability and adaptation, and the Clean Development Mechanism (CDM).

The National Committee for Disaster Management (NCDM): The National Committee for Disaster Management (NCDM) is the national agency responsible for providing emergency relief and developing preventive measures to reduce loss of life and property from disasters. The NCDM was established in 1995 as an inter-ministerial body comprised of members from relevant ministries and the armed forces. Further, committees for disaster management have been established at the province and the district level. In 2006, the Royal Government of Cambodia (RGC) issued a royal decree for the establishment of Commune Committees for Disaster Management (CCDMs) to strengthen local level institutional systems. The Committees' key functions and responsibilities include:

- Manage data of disaster risk and report on disaster situations;
- Propose the level of resource reserves for disaster interventions and emergency responses;
- Provide capacity building and human resource development on disaster management;
- Coordination in implementation of disaster management policies;
- Exchange and sharing of information; and

- Coordination and mobilization of resources for disaster responses.



Designated National Authority for the Clean Development Mechanism (DNA): The RGC appointed the MoE as the Designated National Authority (DNA) for the Clean Development Mechanism on July 15, 2003. The CCD acts as the secretariat of the UNFCCC National Focal Point and of the Designated National Authority under the Kyoto Protocol. There is institutional overlap between the Cambodian DNA, the National Climate Change Committee (NCCC) and the Cooperation Committee of Cambodia (CCC), which provide the country and donor agencies institutional continuity for the implementation of climate change activities. The National Adaptation Programme of Action to Climate Change (NAPA) for Cambodia is based on Decision 28 of the 7th Conference of the Parties (CoP) of the United Nations Framework Convention on Climate Change (UNFCCC). The formulation of the NAPA follows a participatory process that involves those who are most affected by climatic impacts, i.e. rural people and the poor. The Cambodian NAPA is supportive of the Government's development objectives as outlined in the "Rectangular

Strategy for Growth, Employment, Equity and Efficiency" adopted in July 2004, as well as in the "National Strategic Development Plan 2006-2010 (NSDP)" adopted in May 2006.

Strategic National Action Plan 2008-2013 for Disaster Risk Reduction: Cambodia launched its Strategic National Action Plan 2008-2013 for Disaster Risk Reduction (SNAP-DRR) in March 2009, which integrates DRR elements into sector policies and investment planning. Priority actions use a 'matrix approach' to integrating DRR elements into key ministries (such as the Ministry of Land Management, Urban Planning, and Construction, the Ministry of Water Resources, the Ministry of Forestry and Fisheries, the Ministry of Rural Development and the Ministry of Health) (Rinbo, 2009).

CLIMATE CHANGE: Supporting Arrangements and Policies

International arrangements

- UNFCCC ratified December 18 1995, entered it into force on March 16 1996
- Kyoto Protocol ratified July 4 2002, entered into force on August 22 2002

National Policies and Arrangements

- Royal Krom No. 02-94 dated 24 December 1996 promulgating the Law on Environmental Protection and Natural Resource Management
- Royal Krom No. 0196-21 dated 24 January 1996 on the Establishment of the Ministry of Environment
- Royal Krom No. 1296-35 dated 24 December 1996 on the ratification of the United Nations Framework Convention on Climate Change
- Sub-Decree No. 57 dated 25 September 1997 on the Organizations and Functions of the Ministry of Environment
- Sub-Decree No. 30 dated 2002 on the Organization and Functions of the National Committee for Disaster Management

- The Royal Government of Cambodia: The Rectangular Strategy for Growth, Employment, Equity, and Efficiency (RGC, 2)

ANNEX B

QUESTIONNAIRES BASED IN-DEPTH INTERVIEW WITH FARMERS

Village: …… …… Commune: …… …… District: …… …… Province: …… ……	Code: …… …… Date: …… …… Respondent: ……

Part I- General information of respondents

1. Name: …… Sex: …… Age:……years old

   Grade of education: …… Number of family members: ……..persons

   ☐ Female: …persons ☐ Male: ……persons

2. Do you have any special position in your community?

   ☐ Yes ☐ No

3. What are your main income sources?

   (Please rank from 1= most important to 5= least important)

   ☐…….. Rice production ☐ …….. Trading

   ☐ ……Animal husbandry ☐ …….. Employed

   ☐ …….. Others: (specify: ……..)

4. How many times per year do you grow rice?

☐ Wet season rice:…… time(s) ☐ Dry season rice: …… time(s)

5. What is the size of your rice field?

☐Wet season rice field:…… ha ☐Dry season rice field: …… ha.

6. What is your average rice yield per hectare?

☐Wet season.....ton(s); ☐Dry season.....ton(s)

7. Where do get water for your rice crop?

7.1- Dry season	☐ Pond ☐Irrigation system ☐Other.....	☐Well ☐River
7.2- Wet season	☐ Rain Water ☐Irrigation system ☐Other.....	☐Well ☐River

Part II- Climate change events and its impacts

8. What is your village history of flood and drought over the past 20 years?

Events	**1990s**	**2000s**	**2010s**
8.1- What is its frequency ? Please tick the box to rank level from 1 to 5			
Flood	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
Drought	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
Other....	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
Other....	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
8.2- What is its intensity (period and coverage)? Please tick possible answer in the floowing boxes.			
Flood	☐Lasted long period ☐Lasted short period ☐Covered large area ☐Covered small area	☐Lasted long period ☐Lasted short period ☐Covered large area ☐Covered small area	☐Lasted long period ☐Lasted short period ☐Covered large area ☐Covered small area

Drought	☐Lasted long period ☐Lasted short period ☐Covered large area ☐Covered small area	☐Lasted long period ☐Lasted short period ☐Covered large area ☐Covered small area	☐Lasted long period ☐Lasted short period ☐Covered large area ☐Covered small area
Other.....			
8.3- What are main reasons? ☐no idea			
Flood			
Drought			

9. Among above mentioned events, which one did most seriously affect your family?

9.1- 1st event

☐Flood	Year.....	☐Drought	Yea.....	Other.....	Year.....

9.2- Level of damage and impact

Assets	Level of damange and impact		
A/Crops within residential areas	☐Little	☐ Fair	☐Serious
B/Rice crop	☐Little	☐ Fair	☐Serious
C/Cattle	☐Little	☐ Fair	☐Serious
D/Animal	☐Little	☐ Fair	☐Serious
E/House	☐Little	☐ Fair	☐Serious
F/ Soil quality	☐Little	☐ Fair	☐Serious

G/Pest	☐Little	☐ Fair	☐Serious
H/Disease outbreak	☐Little	☐ Fair	☐Serious
I/Other please specify:.....................................	☐Little	☐ Fair	☐Serious

9.3- 2nd event

☐Flood	Year...............	☐Drought	Year..........	Other............	Year............

9.4- Level of damage and impact

Assets	Level of damange and impact		
A/Crops within residential areas	☐Little	☐ Fair	☐Serious
B/Rice crop	☐Little	☐ Fair	☐Serious
C/Cattle	☐Little	☐ Fair	☐Serious
D/Animal husbandry	☐Little	☐ Fair	☐Serious
E/House	☐Little	☐ Fair	☐Serious
F/ Soil quality	☐Little	☐ Fair	☐Serious
G/Pest outbreak	☐Little	☐ Fair	☐Serious
H/Disease outbreak	☐Little	☐ Fair	☐Serious
I/Other please specify:	☐Little	☐ Fair	☐Serious

10. Other than flood and drought, what are other climate events affecting your rice production? How does it affect you?

....
....

11. Can you remark when and how often flood, drought and other events occur?

Event	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flood												
Drought												
....												

12. Up to currently, what are other climate events/ factors (other than flood and drought, such as temperature precipitation and pest outbreak) that are harmful to rice yield? Please describe how they are affecting? ☐ No idea

A/……
……

B/……
……

13. Do you know cause of the above events? ☐ No idea

.....
.....

Part III- Farmers' adaptation to climate change

14. To cope with the events affecting your rice production and to increase rice productivity did you change your rice production practice?

14.1- Rice production seasonal calendar

Activities/practice	**Now**	**In the past**	**Main reasons**
Plowing			
Sowing			
Transplanting			

Maintaining			
Harvesting			
Dealing with stubble			

Please give main reasons for the change of seasonal calendar (list all climate and non-climate factors)

……
……
……..……

Did the above change bring about success or failure to farmers? Please describe the level of success and failure in connection with increase or decrease of rice productivity and the period of practice.

……
……
……..…

14.2- Rice growing technique

Growing technique/ activity	**Now**	**In the past**	**Main reasons**
Preparing land (plowing)			
Choosing rice seed (name, short/middle/ long term rice seed)			
Sowing rice seeds			
Transplanting (e.g SRI)or sowing			
Managing water (rain fed, irrigated, or pumping system)			

Dealing with weeds and pests			
Application of Fertilizer (quantity and type of fertilizer)			
Harvesting (mechanics or manual)			
Threshing (mechanics or manual)			
Drying paddy (sunlight or drying system)			
Transporting paddy			
Storing paddy (in grange or selling paddy immediately after harvesting)			

15. How did you change above growing techniques?

☐ You initiated and conducted own experimentation

☐ You learned from your neighbors

☐ You were trained by officials of the Provincial Department of Agriculture ☐ You learned from NGO staff

☐ Other (please specify)……

16. Please give main reasons for the change of rice growing technique.
……
……

17. If the seasonal calendar and growing technique have been changed, how is your rice yield?

☐ Less than before but better than taking full disaster risks ☐ does not vary ☐ better than before

☐ Other (please specify)……

Please give main reasons for the change of rice yield
……
……..

18. Additional remark of surveyor about the changes of their practice (e.g. outcomes of change such as a change from non- food security to surplus status)

……
……

19. Do you know farmers in other areas have changed and applied similar practice and where the practice was from? ☐ No idea

20. ……
……

Part IV- Farmers' mitigation to climate change

21. How many cattle you have? ……head(s)/ how many buffalos do you have? ……head(s).

22. Have you been using cattle/buffalo dung for your rice field?

☐ Yes ☐ No

23. If yes, please explain the usage of the dung and its benefits

……
……

Do you have bio gas system (bio digester)?

☐ Yes ☐ No

If yes, when did you start using it?.....Is it working till now?

☐ Yes ☐ No

24. Do you or your community use rice husk for paddy drying system? ☐ Yes ☐ No

If no, how they have been used/recycled?

25. ……
……

26. Did you burn the rice stubble? ☐ Yes ☐ No

If yes,why?……
……

If no,
why?……
……

Part V- Farmers' preparedness and response to flood and drought

A- <u>Flood</u>

<u>Preparedness measures</u>

27. Do you have any preparedness measures in your rice production? (e.g. seed, grange construction)

28. Did those measures succeed or fail?

☐ Success ☐ Failure

26.1- Do you know why they succeed or fail?……
…….... ……

26.2- Where did you learn measures from?

☐ From school (or from knowledge of your children)

☐ From conventional practice

☐ From TV or radio

☐ From own trial and experience

☐ From extension by Government staff

☐ From extension by NGOs and development agencies

☐ From extension by local authority

☐ Other (please specify).....

<u>Response action</u>

29. In the past when flood occured, how did you adapt rice production affected by the flood?

30. ……
……
……

31. Did your solutions succeed or fail?

☐ Success (please skip to question ☐Failure

32. What were the challenges when responding to flood?

☐ Insufficient materials and structure

☐ Insufficientmoney ☐Insufficient knowledge

☐ Unsophisticated techniques

☐ Techniques were complicated ☐ insufficient labor

☐ Insufficient incentives

☐ Insufficient participation of other farmers

☐ Other(please specify)……

33. Where did you learn solutions from?

☐ From school (or from knowledge of your children)

☐ From conventional practice

☐ From TV or radio

☐ From own trial and experience

☐ From extension by Government staff

☐ From extension by NGOs and development agencies

☐ From extension by local authority

☐ Other (please specify).....

34. Which institutions and agencies were involved in responding the flood?

☐ Provincial Department of Agriculture

☐ Provincial Department of Water Resource and Meteorology

☐ Provincial Department of Environment

☐ National Committee for Disaster Management (NCDM)

☐ Local authorities

☐ National NGOs and international NGOs

☐ Other (please specify)……

35. From your experience, who are the nearest and able to assist you to respond the flood in time? (please rank them from 1, 2, 3)

Recovery action

36. What steps did you take to ensure family food security after flood? (e.g. re-cultivation of rice, application for loans, sale of assets/properties, looking for other employment, or looking for donations….).

37. Which steps do you think gave you a stable and effective livelihood in a longer run? (Please rank the grade of steps)
……
……

38. Who do you think are able to help you to recover from flood? (Please rank 1,2,3, 4 and 5 for greatest active level to least active level)
……
……

39. What kind of support for flood recovery do you expect?

- ☐ Materials
- ☐ Skills from trainings
- ☐ Incentives and food for work
- ☐ Money
- ☐ Techniques
- ☐ Other (please specify)……

40. Why do you need the support listed on the question 36?
.....
.....

41. When do you need the support listed on the question 36?
.....

B- Drought

Preparedness measures

42. Do you have any preparedness measures in your rice production? (e.g. seed, grange construction)

43. ……
……

44. Did those measures succeed or fail?

- ☐ Success
- ☐ Failure

45. Do you know why they succeeded or failed?……
……

46. Where did you learn measures from?

- ☐ From school (or from knowledge of your children)
- ☐ From conventional practice
- ☐ From TV or radio
- ☐ From own trial and experience
- ☐ From extension by Government staff
- ☐ From extension by NGOs and development agencies
- ☐ From extension by local authority
- ☐ Other (please specify).....

Response action

47. In the past when drought occured, how did you adapt rice production affected by the drought?

48. ……
……
……

49. Did your solutions succeed or fail?

☐ Success (please skip to question ☐ Failure

50. Were there challenges when responding to drought?

☐ Insufficient materials and structure ☐ Lack of cash

☐ Lack of knowledge ☐ Unsophisticated techniques

☐ Techniques were too complicated ☐ insufficient labor

☐ Insufficient incentives ☐ Insufficient participation of other farmers ☐ Other (please specify)…

51. Where did you learn solutions from?

☐ From school (or from knowledge of your children)

☐ From conventional practice

☐ From TV or radio ☐ From own trial and experience

☐ From extension by Government staff ☐ From extension by NGOs and development agencies ☐ From extension by local authority
☐ Other (please specify).....

52. Which institutions and agencies were involved in responding the drought?

☐ Provincial Department of Agriculture

☐ Provincial Department of Water Resource and Meteorology

☐ Provincial department of Environment

☐ National Committee for Disaster Management (NCDM)

☐ Local authorities ☐ National NGOs and international NGOs

☐ Other (please specify)……

53. From your experience, who are the nearest and able to assist you to respond the drought in time? (please rank them from 1, 2,3)

Recovery action

54. What steps did you take to ensure family food security after drought? (e.g. re-cultivation of rice, application for loans, sale of assets/properties, looking for other employment, or looking for donations….).

55. Which steps do you think gave you a stable and effective livelihood in a longer run? (Please rank the grade of steps)
……
……
……

56. Who do you think are able to help you to recover from drought? (Please rank 1,2,3, 4 and 5 for greatest active level to least active level)
……
……
……

57. What kind of support for drought recovery do you expect?

☐ Materials ☐ Skills from trainings

☐ Incentives and food for work ☐ Money

☐ Techniques

☐ Other (please specify)……..

58. Why do you need support listed on the question?
.....

59. When do you need the support listed on the question ?
.....

60. Did you and your community get awareness trainings to flood and drought preparedness, response and recovery measures?

53.1- Flood	53.2- Drought
☐ No	☐ No
☐ Yes	☐ Yes
• When?…… ……	• When?…… ……
• Who?…… ……	• Who?…… ……
• What?…… ……	• What?…… ……

61. What is the most effective media for flood and drought warning/information?

☐ TVs ☐ Radio broadcast

☐ Newspapers ☐ Magazines

☐ Public bulletin boards ☐ Village meetings

☐ Mobile/hand phones ☐ Village mobile ultra-speaker

☐ Other (please specify)……

62. For TV and radio broadcasts, what program do you prefer?

☐ Concert ☐ News

☐ Theatre ☐ Other (Specify)……

ANNEX C: CHECKLIST FOR KEY INFORMANT INTERVIEW

Name of respondent:…….. Position:……	Organization/institution:..... Telephone no.:..... Province:……

1- Do you know if the study areas (district/commune) were affected by flood and drought?
☐ I do not know,
why?.....

☐ I know,
why.....

2- How serious were the events? (please rank from 1 to 5 the severity of events)

Status of event	**1990s**	**2000s**	**2010s**
Flood	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
Drought	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5
Other events	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5

3- Do you know what farmers did adapt their livelihood to flood and drought?

4- Is their adaptative measures successful or defeated?
Why?.....

5- In the past, were you or your organization involved in response to flood and drought in the study areas? When?
.....
If were not,
why?.....
If were, please describe your or your oragnization's activities.....

6- Was you/your organization response successful or defeated?
Why?.....

7- How was severity of flood and drought affecting the rice crop in the study areas?.....

8- What did you and your organization help farmers in the study areas?.....

9- Was the involvment/ assistance part of your organization planning?.....

10- How did your program activities/ action plan assist farmers to better adapt their rice production to flood/ and drought?

.....

By what means?.....

What organizations/ agencies did you/ your organization cooperate to assist farmers?

.....

11- In your opinion, what organizations/ agencies could do best job to response to drought / and flood? Please rank 1,2,3 the following listed organizations.

Organization/agency	Level of effectiveness and reasons
A/	☐1☐2☐3☐4☐5 Why?
B/.....	☐1☐2☐3☐4☐5 Why?
C/.....	☐1☐2☐3☐4☐5 Why?
D/.....	☐1☐2☐3☐4☐5 Why?
E/.....	☐1☐2☐3☐4☐5 Why?
F/.....	☐1☐2☐3☐4☐5 Why?
G/.....	☐1☐2☐3☐4☐5 Why?

12- Up to now, the study areas are still affected by flood/ and drought?
☐ Yes,why? .....
☐ No,why?.....

13- In your opinion, what measures should be taken by farmers before, during and after flood/ and drought in order to reduce the impacts of those events to their rice production?.....

14- And what about measures of your organization?.....

15- What are key challenges for farmers and your organization to adapt to flood / and drought?

Challenges of your organization	**Challenges of farmers**
.....	.....
.....	.....

16- Have you ever been informed or noticed about flood/ and drought?
☐ Yes ☐ No

If yes, where was the information/notice from?
.....

17- How many days did you get informed/ noticed before occurence of the event?.....

18- Was the information true/sure? ☐Yes ☐ No

19- Do you think that the warning/ notice of the disaster event is vital important to reduce disaster impacts?.....

20- What kind of information should be annouced to farmers?.....

21- Does your organization have any specific mechanism of providing information to stakeholders and farmers regarding to the flood/ and drought? .....

22- What are your key strategic activities that are the same as or alined with National Strategic Development Plan 2009-2013 (NSDP2009-2013)?
.....

23- What activities that are new and different ?

24- Do you plan to integrate/ aline your organization strategic plan into/with the next NSDP?

25- Do you have any suggestion/ recommendations/ concerns to improve climate change adaptatives strategies/ measures in rice production of farmers, particularly flood and drought?

ANNEX D: LIST OF KEY INFORMANTS

No	Name	Sex	Position	Institution	Telephone
1	Soy Panha	M	Deputy Director	Department of Agriculture, Kampong Speu	016 421 617
2	Nhanh Cheabhorng	M	Deputy Director	Department of Water Resource and Meteorology,Kampong Speu	012 733 514
3	Ma Savat	M	Member of District Council	Korng Pisey, Kampong Speu	012 473 526
4	Em Sokuntheary	F	Provincial Administrative Staff	Member of Provincial Disaster Risk Management,Kampong Speu	016 581 845
5	Nou Phun	M	Clerk	ToeukLork Commune, Kampong Speu	017 302 026
6	Om Cham	M	Chief of Councilors	Sdok Commune, Kampong Speu	097 4588577
7	Nhep Srorn	M	Director	Provincial Department of Agriculture, Takeo	012 606049
8	Ses Vong Sambath	M	Project Manager	CCK, Takeo	012 951273
9	Nuon Vanhorn	M	Chief of Councilors	CheyChok Commune, Borei Chulsa District, Takeo province	012 818684
10	Chip Voem	M	Chief of Commune Councilors	Som Commune, Kirivong District, Takeo province	012 767459
11	Hong Phearak	M	Deputy Director	Office of Pollution Control and Environmental Education, Provincial Department of Environment, Takeo province	097 9596952

12	Chhory Munly	M	Deputy Director	Office of Administration, Provincial Department of Environment, Takeo province	097 7071559
13	Cheark Rithy	M	Deputy Director	Office of Planning, Provincial Department of Environment, Takeo province	017 576280
14	Men Uon Seryvuth	M	Director of Office	Office of Education and Environment News, Provincial Department of Environment, Takeo province	097 9597375
15	Yuk Narin	M	Deputy Director	Office of Administration, PDoWRAM, Takeo	
16	Heng Sodara	M	Officer	Office of Meteorology, PDoWRA, Takeo	
17	Houl Chamroeun	M	Director	PCDM, Prey Veng	092 640207
18	Khieu Sambath	M	Deputy Director	Provincial Department of Agriculture, Prey Veng	011 722 387
19	Thorn Plally,	M	Community development Officer (former staff)	CARE, Kampong Trobek District, Prey Veng	017 896326
20	Prak Leak,	M	Chief	Agricultural Development of Our Village Community, Prey Veng	097 8358322
21	Sok Siyin,	F	Chief of Councilors	KanSorm Ork Commune, Prey Veng	016 478177
22	Srey Chhun Ly	M	Deputy Governor	Kampong Trabek district, Prey Veng	016 387377

ANNEX E: DEFINITION OF KEY WORDS

1. Adverse effects of climate change means changes in the physical environment or biota resulting from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare.

2. Climate change means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

3. Greenhouse gases means those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation.

4. Weather means to describe of change of temperature used for any given time. (Example: warm raining…).
Source: United Nations Framework Convention on Climate Change (UNFCCC)

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