



CDRI - Cambodia's leading independent
development policy research institute

Adaptation Capacity of Rural People in the Main Agro-Ecological Zones in Cambodia



NANG Phirun, SAM Sreymom, LONN Pichdara and OUCH Chhuong

Working Paper Series No. 93

June 2014

A CDRI Publication

Adaptation Capacity of Rural People in the Main Agro-Ecological Zones in Cambodia

CDRI Working Paper Series No. 93

**NANG Phirun, SAM Sreymom,
LONN Pichdara and OUCH Chhuong**

A CDRI Publication



CDRI

**Cambodia's leading independent development policy research institute
Phnom Penh, June 2014**

© 2014 CDRI - Cambodia's leading independent development policy research institute

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means—electronic, mechanical, photocopying, recording, or otherwise—without the written permission of CDRI.

ISBN-10: 99950-52-93-5

Adaptation Capacity of Rural People in the Main Agro-Ecological Zones in Cambodia

Suggested full citation:

Nang Phirun, Sam Sreymom, Lonn Pichdara and Ouch Chhuong (June 2014), *Adaptation Capacity of Rural People in the Main Agro-Ecological Zones in Cambodia*, CDRI Working Paper Series No. 93 (Phnom Penh: CDRI)

Responsibility for ideas, facts and opinions presented in this research paper rests solely with the authors. Their opinions and interpretations do not necessarily reflect the views of the Cambodia Development Resource Institute.

CDRI

📍 56, Street 315, Tuol Kork, Phnom Penh, Cambodia

✉ PO Box 622, Phnom Penh, Cambodia

☎ (855 23) 881 384/881 701/881 916/883 603

📠 (855 23) 880 734

E-mail: cdri@cdri.org.kh

Website: www.cdri.org.kh

Layout and Cover Design: Oum Chantha and Men Chanthida

Printed and bound in Cambodia by Invent Cambodia, Phnom Penh

CONTENTS

List of Tables and Figures	v
Acronyms	vi
Acknowledgements	vii
Executive Summary	viii
1. Introduction	1
2. Research Questions	2
3. Research Objectives	3
4. Methodology	4
4.1. Data Collection.....	4
4.2. Site Selection and Mapping	6
5. Conceptual Framework for Examining Local Adaptive Capacity	7
6. Overview of Rural Livelihoodsand Climate Change in Cambodia	9
6.1. Climate Change Projection	9
6.2. Institutional, Legal and Policy Frameworks Related to Climate Change	11
6.3. Adaptation Strategies	13
7. Findings.....	15
7.1. Impacts of Climate and Human System Changes on Rural Livelihoods and Adaptation Strategies.....	15
7.1.1. Tonle Sap Plain	15
7.1.2. Mekong Plain.....	18
7.1.3. Mountains/Plateau	20
7.1.4. Coastal Zone	21
7.2. Observed Rural Adaptive Capacity and Measures under the LAC Framework.....	23
7.2.1. Livelihood Assets (N, P, H, F & S).....	23
7.2.2. Institutions and Entitlements	26
7.2.3. Knowledge and Information.....	27
7.2.4. Fostering Innovation.....	28
7.2.5. Promoting Forward-Looking, Flexible Governance; Decision Making; and Potential Interventions.....	29

8. Discussion.....	30
8.1. Constraints and Challenges Caused by Climate Change	30
8.2. Adaptive Capacity and Strategy and Suggested Course of Action.....	31
8.2.1. Assets and Capital: Improving Equitable Access to Key Resources.....	31
8.2.2. Institutional Arrangements: Building Climate Resiliencethrough Existing Social Capital.....	32
8.2.3. Sharing Knowledge and Scientific Information for Climate Change Adaptation	33
8.2.4. Innovations: Collectively Developing Measures to Respond to Climate Change	33
8.2.5. Decision Making: Enhancing Participation in Decision Making on Climate Change Adaptation	34
9. Conclusion	35
References	36
CDRI Working Paper Series.....	42

LIST OF TABLES AND FIGURES

Table 1. Affected Sub-Sectors, by Agro-Ecological Zone	5
Table 2. Estimated Impacts of Climate Change and Development Activities on Selected Hydrological Indicators in the Tonle Sap Area	16
Table 3. Impacts and Adaptation Strategies of Tonle Sap Plain.....	17
Table 4. Impacts and Adaptation Strategies of the Mekong Plain.....	20
Table 5. Impacts and Adaptation Strategies of the Mountain and Plateau Zone	21
Table 6. Impacts and Adaptation Strategies of the Coastal Zone	23
Table 7. Landholdings (% of households)	24
Table 8. Damage to Agriculture from Both Floods and Droughts	31
Figure 1. Studied Sites	6
Figure 2. Conceptual Framework for Examining Local Adaptive Capacity in Relation to the Impacts of Climate Change on Rural Livelihoods in Different Agro-Ecological Zones.....	7
Figure 3. Future Climate Change Projections in Cambodia: Mean Annual Temperature Change (°C) Using Data from the Centre for Climate System Research (CCSR), the Commonwealth Scientific and Industrial Research Organisation (CSIRO), General Circulation Models (GCMs) and SRES Scenario A2 (SRESA2)	10
Figure 4. Future Climate Change Projections in Cambodia: Mean Annual Rainfall Change (%) Using Centre for Climate System Research (CCSR), Commonwealth Scientific and Industrial Research Organisation (CSIRO), General Circulation Models (GCMs) and SRES scenario A2 (SRESA2)	11
Figure 5. Distribution of Average Annual Rainfall (1981-2004).....	18

ACRONYMS

CAVAC	Cambodia Agricultural Value Chain
CDRI	Cambodia Development Resource Institute
CEDAC	Centre d'Etude de Développement Agricole Cambodgien/Cambodian Center for Study and Development in Agriculture
D&D	Decentralisation and Deconcentration
DFID	Department for International Development
FA	Forestry Administration
FGD	Focus group discussion
FWUC	Farmer Water User Community
GDP	Gross domestic product
LAC	Local Adaptive Capacity framework
MAFF	Ministry of Agriculture, Forestry and Fisheries
MOE	Ministry of Environment
MOWRAM	Ministry of Water Resources and Meteorology
MPF	Multi-purpose farming
NGO	Non-governmental organisation
PADEE	Project for Agricultural Development and Economic Empowerment
PCDM	Provincial Committee for Disaster Management
PCR	Programme for Climate Resilience
PDA	Provincial Department of Agriculture
PDOWRAM	Provincial Department of Water Resources and Meteorology
REDD	Reducing Emissions from Deforestation and Forest Degradation
Sida	Swedish International Development Cooperation Agency
SRESA2	Special Report on Emissions Scenarios A2
SRI	System of Rice Intensification
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

ACKNOWLEDGEMENTS

The authors are deeply grateful for the funding support generously provided by the Swedish International Development Agency (Sida), which made the research possible.

This paper has benefitted from the expertise and kind assistance of several colleagues at CDRI. Special thanks go to Dr Chem Phalla for his review, coordination and extensive comments on this paper. Thanks are also extended to Mr Ros Bansok, Dr Koy Ra and Mr Kim Sour for their significant technical input and support throughout the study but particularly at the start, and to the key informants, too numerous to mention individually, for their substantial contributions at various stages of the study.

The authors are grateful to Dr Jan Taylor, research consultant, Dr Rebecca F. Catalla, former research adviser, and Dr Juha Sarkkula, Natural Resources and Environment Programme adviser, who guided the team, gave comments on the draft paper and helped refine the final report.

Sincere thanks are due to Mr You Sethirith and Mr Allen Myers for editing, reviewing and facilitating the development and publication of this working paper. The authors wish to express their deep gratitude to Mr Larry Strange, executive director, Dr Srinivasa Madhur, director of research, and Mr Ung Sirn Lee, director of operations, for their guidance and insights, which inspired and motivated the development of this report.

EXECUTIVE SUMMARY

Cambodia is divided into four agro-ecological zones—the Tonle Sap plain, Mekong plain, mountains/plateau and coast—representing heterogeneous agricultural activities, population and livelihood systems (UNDP 2011). Climate change impacts and the adaptive capacity of the people differ from one zone to another. Adaptation measures have varied according to the sector and the locality, adaptive capacity and severity of the impacts. Even though co-management by the state and communities of forest, fishery and water resources has been improved, local communities' capacity to respond or adapt to climate change is still limited (Ros et al. 2011; Nang 2013).

This study adopts a qualitative approach. It examines the impact of climate change and then identifies practicable measures for strengthening the capacity of local people and communities to cope with these impacts in the four zones. The Local Adaptive Capacity (LAC) framework has been applied and key issues related to institutions and entitlement—knowledge and information, fostering innovation, promoting forward-looking, flexible governance, decision making and potential interventions—have also been examined.

The study found that the adaptive capacity of rural people and communities, in particular the poor and marginalised in the four zones, is moderately low since they depend mainly on climate-sensitive resources and do not have diversified livelihood sources. In addition, their access to assets to help them to cope with climate-related hazards is notably deficient. In some areas, such assets are more or less out of reach for the poor and marginalised.

It is apparent that actions to minimise the impacts of climate change and weather variability must be undertaken and strengthened at all levels and in all agro-ecological zones. It is noted that the availability of livelihood assets, and of institutions and entitlements, and access to the six LAC issues listed above are key in supporting the adaptive capacity of rural people. Those involved should work cooperatively to ensure that farmers and communities have better access to these assets and support.

Policy Considerations and Suggestions for Future Action

- Improve access to new climate-resilient agricultural practices, services and technologies such as multi-purpose farming and system of rice intensification to improve agricultural products and food security with more focus on marginalised groups such as women and the poor.
- Enhance access to water in both wet and dry seasons by revisiting water storage options such as reservoirs, natural and dug ponds and soil water conservation techniques.
- Expand the financial services of both formal and informal institutions and encourage pro-poor services that have lower interest rates and longer loan repayment periods.
- Provide local people with accurate and timely climate data on more specific locations in their provinces and disseminate appropriate climate change adaptation strategies.
- Improve information in the community through vertical and horizontal channels.

- Foster local innovation in each agro-ecological zone by establishing an enabling environment such as benefit sharing, social networking and collective action.
- Strengthen both top-down and bottom-up approaches, including their integration, and promote local involvement and participation, especially of women and the poor, throughout the planning process. Create an environment in which their voices can be heard and their ideas and suggestions are taken into consideration in climate change-related decisions.
- Encourage academia, research institutions and civil society to facilitate and coordinate (particularly in linking the top-down and bottom-up processes) and to ensure that climate change adaptation policy and strategy have responded effectively to local needs.
- Promote climate resilience projects targeting the poor, women and marginalised groups and expand the coverage of existing climate change adaptation projects to all vulnerable areas.
- Localise sectoral adaptation strategies by considering social institutional arrangements and possible challenges.
- Improve the implementation of the Cambodia Climate Change Strategic Plan at all levels by promoting and consolidating institutional cooperation and conducting further research on climate-resilient agricultural technology/practices.

1

INTRODUCTION

Cambodia's rural people depend on natural resources for their livelihoods and food security. The three main constituents of livelihood resources are agriculture, fisheries and forestry (MOE 2011, cited in AIT-UNEP AAC.AP 2011; Nang 2012). Agriculture, in particular rice production, is the most important sector for rural livelihoods and the only rural sector to boost national economic growth. Enhancing productivity and diversity is one of the five priority programmes in agriculture (MAFF 2013a).

The anticipated impacts of climate change would adversely affect rural people, whose livelihoods depend heavily on climate-sensitive resources. Cambodia is among the countries in Asia most vulnerable to climate change and variability (Yusuf & Francisco 2009). Projections are that Cambodia would be affected by an increase in temperatures and precipitation, causing sea level rise, a longer dry season with less rainfall, more intense rainfall in the rainy season and shifts in timing, duration and intensity of seasons (MOE 2002; MOE 2011, cited in AIT-UNEP AAC.AP 2011). Both natural changes and human-induced changes have been a major concern in natural resource depletion because of the interrelationship between resources, local livelihoods and people (Nuorteva et al. 2010). The Mekong and Tonle Sap ecosystems are likely to be affected by the existing and proposed hydropower dams in Mekong countries (Ros et al. 2011; Keskinen et al. 2013). Those dams would have lasting impacts on river hydrology, sediment and nutrient transport and biodiversity. Community livelihoods and food security would be affected by losses in fish catches and water supply for irrigation, riverbank gardens and downstream floodplain farming (Nang 2013).

Cambodia is divided into four agro-ecological zones: Tonle Sap plain, Mekong plain, mountains/plateau, and coast, representing heterogeneous agricultural, population and livelihood systems (UNDP 2011). Climate change impacts and the adaptive capacity of the local people differ from one zone to another. Adaptation measures have been taken according to the sector, locality, adaptive capacity and the severity of the impacts. People in the Tonle Sap Lake area migrate for alternative sources of livelihood or borrow from moneylenders (Nuorteva et al. 2010). In the northern or mountainous/plateau areas, farmers have to change to rice-field locations that are less exposed to climate hazards (Thuon 2009; Sumaylo 2009; Phearanich 2010).

Recent CDRI studies reveal that even though the co-management of Cambodia's forest, fishery and water resources by state and communities has improved, local communities' capacity to respond or adapt to climate change impacts is still limited (Ros et al. 2011; Nang 2013). Local people mostly develop their own ways of fighting back or surviving during and after extreme weather events or natural disasters. The above studies further suggest that measures for strengthening the capacity of local people and communities in each agro-ecological zone to adapt to climate change should be examined (*ibid.*).

This paper reviews climate change impacts and challenges affecting agriculture and examines how people in each zone adapt to climate change. Through appropriate frameworks, it further aims to identify practicable measures to improve and strengthen local adaptation capacity. As impacts can vary from one zone to another, the study analyses in depth the differences in adaptive capacity and climate adaptation strategy.

2

RESEARCH QUESTIONS

This study attempts to answer the following questions:

- 1) What are the significant constraints and challenges caused by natural and human-induced changes that impact on the resources necessary to support livelihoods in the four agro-ecological zones? Why do those challenges and their effects vary in different zones?
- 2) What are the adaptation measures applied or required by the rural people and communities in those zones? This question can be divided into the following sub-questions:
 - How can all people in the community have equitable access to assets needed to cope with the impacts of climate hazards?
 - How can existing institutional arrangements and interactions be improved to cope with the impacts of natural and human-induced changes on rural livelihoods?
 - How can climate change knowledge and information be provided for rural people so that they can respond to climate change impacts?
 - How can local communities collectively develop measures that would help them to cope with climate change?
 - How can local people and communities be involved in decision making on climate change adaptation?

3

RESEARCH OBJECTIVES

The overall objective of the study is to gain a better understanding of the implications of climate change and its impacts on natural resources and livelihoods, and to identify adaptation strategies in the different agro-ecological zones. The key objectives of the study are twofold:

- 1) To examine significant constraints and challenges that farmers face with current irregular climatic conditions; and
- 2) To assess and analyse different adaptive capacities and climate adaptation strategies in individual zones and to examine possible measures to improve local people's capacity to adapt to climate change.

4

METHODOLOGY

This study adopts a qualitative approach to explore the impacts of climate and human system changes on agriculture based on the agro-ecological zones and experiences of the farmers in coping with them as well as gaps in those strategies. Information relating to existing climate change effects and adaptation strategies has been explored both through a desk review (taking into account the CDRI working paper series on climate change, agriculture, environmental protection and natural resource management, particularly working papers 65 and 82) and field exercises.

4.1. Data Collection

To collect information on the research questions, key informant interviews were undertaken with provincial departments of Environment and of Agriculture, Forestry and Fisheries and provincial committees for disaster management. Ten provinces (in different zones) were chosen based on the vulnerability level determined by the Ministry of Environment (MOE 2013a). Seventeen communes were selected for focus group discussions (FGDs). This selection was based on the level and frequency of climate-related issues (floods, windstorms, droughts and sea level rise), human activities that lead to land use or land cover changes (infrastructure and hydropower development) and their impacts on resources the local people depend on. Each FGD consisted of five or six local men and women. The people were selected in consultation with the chief in each village.

Table 1 presents the major sub-sectors affected that the study examined in depth, and the targeted provinces, districts, communes and villages selected for key informant interviews and FGDs. In total 13 key informant interviews and 18 FGDs were undertaken in 10 provinces.

The FGDs focused on the impacts of climate change on people's resources and livelihoods such as rice farming, livestock raising, fishing and collection of non-timber forest products. They aimed to discover the severity of climate change impacts, people's vulnerability, their existing adaptive capacity and planned adaptation strategies and other related issues. Key informant interviews focused also on the impacts and adaptation strategies, but gathered more in-depth information on the planning related to adaptation as well as other significant information about general aspects of the villages in each zone. Information associated with natural and human-induced changes was also collected and examined.

A series of guide questions following the Local Adaptation Capacity framework (livelihood assets; flexible, forward-looking decision-making and governance; innovation; institutions and entitlement; and knowledge and information) were developed for group or individual discussions. The information collected allowed this study to increase understanding about the status of economic, social, human, natural and physical resources and actions needed (such as fostering innovation, promoting forward-looking and flexible governance, and redefining maladaptive norms, behaviours and institutions).

Table 1. Affected Sub-Sectors, by Agro-Ecological Zone

Agro-ecological Zone	Province	District	Commune	Community	No. of FGD	No. of interviews	Affected sub-sectors
Coast	Preah Sihanouk Koh Kong	Prey Nob	Prey Nob	Prey Nob FWUC	3	1	Agriculture, water and irrigation, land management, sea level rise, mangrove, salt water intrusion, ground water infiltration, and land use/land cover change.
	Kampot	Mondol Seima	Peam Krasaob	Peam Krasaob CPA			
Tonle Sap Plain	Kompong Thom	Kompong Trach	Prek Kroes	Prolay Spean Toch FWUC			Agriculture, water and irrigation, fisheries, credit accessibility, ground water infiltration, and land use/land cover change.
		Stung Saen	Ou Kanthor	Roluos FWUC	5	3	
		Kompong Svay	Kompong Kou Phat Sanday Ngan	Angko FWUC Phat Sanday CFI Chorm Thlok CPA Skor Krouch CPA			
		Sandan	Sandan				
	Pursat	Bakan	Svay Daun Kaev Me Tuek	Kampang FWUC Wat Leap FWUC Chin Tay CFI	3	2	
	Kompong Chhnang	Samaki Meanchey	Thlok Vien		1	1	
Mekong Plain	Prey Veng	Peam Ro Kompong Trabaek	Roka Ansaong		2	2	Agriculture, water and irrigation, ground water infiltration, fisheries, infrastructure, market and credit accessibility.
	Takeo	Kiri Vong Koh Andaet	Phnom Den Romenh	Plov Touk FWUC So Hang FWUC	2	3	
Mountains	Kompong Speu Preah Vihear	Thpong	Year Angk	NA	2	1	Agriculture, irrigation, infrastructure, ground water infiltration, land use/land cover change, and market and credit accessibility.
		Rovieng	Romoni	Chi Ok Boeung Prey CPA			
4	10	14	17	12	18	13	

CPA: community protected areas. FWUC: farmer water user community. CFI: community fishery

5

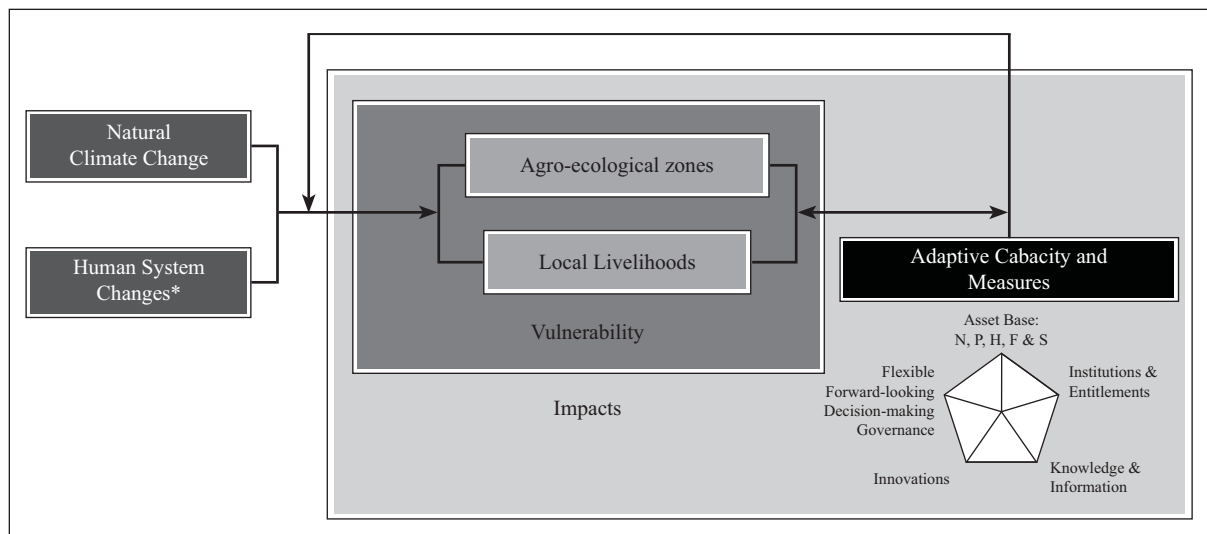
CONCEPTUAL FRAMEWORK FOR EXAMINING LOCAL ADAPTIVE CAPACITY

Human and natural systems have always interacted and caused variations and changes in climate systems (Jianguo et al. 2007). Human use of land, water and forests has markedly changed land cover and hydrological cycles, ecology and even the climate system. Furthermore, natural processes damage human systems through environmental degradation and disasters, such as floods, droughts, hurricanes and diseases (*ibid.*). The interaction between the natural system and the human system impacts on community livelihoods, agriculture, water and fisheries and forestry.

The increase in the Earth's average temperature, the changing patterns, amount and frequency of rainfall and sea level rise will have a tremendous impact on agriculture, forestry, water resources, the coastal zone and health (Karl et al. 2009; IPCC 2012, cited in Nang 2013). Future climate projections contain large areas of uncertainty. However, any impacts will be more manageable if those impacts are properly understood, and coping capacities on site- and context-specific scales are well analysed in respect of current variability and possible extremes: a full understanding of the ecosystem and human sensitivity are a part of this.

The countries in the Greater Mekong Sub-region have been experiencing irregular rainfall, and the associated shocks are increasingly damaging agriculture, livelihood assets and human life. Unreliable rainfall also has an impact on the cultivation season of rice (Ros et al. 2011). In addition to natural and climate-related hazards, changes in natural systems and declining access to the main livelihood resources have intensified local people's vulnerability. This particularly impacts women and marginalised groups (Nang 2013).

Figure 2. Conceptual Framework for Examining Local Adaptive Capacity in Relation to the Impacts of Climate Change on Rural Livelihoods in Different Agro-Ecological Zones



*These include either contextual or localised changes caused by infrastructure and economic activities.

Source: Adopted from Jones 2011

Even as the effects of climate change have intensified and created a need for adaptation, they cannot be assessed separately from other changes in the human system (Warrick 2000). These impacts are diversified due to varied determinants of vulnerability (Iyalomhe 2011). Adaptation is sparked by climate hazards, and local adaptive capacity plays an important role in shaping the adaptation strategy. Improving rural and household adaptive capacity and climate response actions would significantly decrease the impact of climate change and help to build rural people's resilience to climate vulnerability (IPCC 2012: 48).

In DFID's livelihoods framework, the notion of five assets (E: Economic, S: Social, H: Human, N: Natural and P: Physical) is presented as a means to understand fully the characteristics of local livelihood systems (DFID 1999). In addition to this framework, Jones (2011) suggests other intangible assets that can affect the adaptive capacity of local people. These include relevant institutions and entitlements (see section 7.2.2) and knowledge and information. Other factors include the extent to which innovation is fostered, along with forward-looking, flexible governance and decision making. Also assessed is the degree of support that exists for potential interventions. These appear in the pentagon in Figure 2. Both the assessment of natural and human system changes and the identification of adaptive capacity will help to shape adaptation responses to climate changes in the four agro-ecological zones.

6

OVERVIEW OF RURAL LIVELIHOODS AND CLIMATE CHANGE IN CAMBODIA

Of Cambodia's total 2012 population of 14.8 million (World Bank 2013), 86 percent live in rural areas and depend on agriculture and natural resources. In its efforts to tackle poverty, the country has achieved commendable results, reducing the rate from 53 percent of the population in 2004 to 20 percent in 2013 (Peter 2013). This has enabled Cambodia to meet its Millennium Development Goal of reducing the poverty rate to 19 percent of the population by 2015 (RGC 2012). Gross domestic product per capita has quadrupled, increasing from USD216 in 1992 to USD946 in 2012 (World Bank 2013). Available data indicate that income inequality has lessened (Peter 2013). Cambodia will soon progress from a low income to a lower-middle income country (GDP of USD1025 per capita) (Lewis 2013). However, in 2009 about one in five Cambodians still subsisted on daily consumption of less than USD1.25, while one in two had daily consumption of less than USD2 (CDRI 2013).

Cambodia is prone to natural hazards, namely droughts, floods and storms, which cause economic losses and damage livelihoods. Typhoon Ketsana in 2009, for instance, led to agricultural losses of USD132 million and caused damage and destruction in 14 of Cambodia's 24 provinces; further, most of the affected districts are the poorest in the country (Ros et al. 2011). Government response to natural hazards is mainly in the form of emergency relief, including temporary shelters and some livelihood restoration such as the provision of agricultural inputs or subsidies towards their cost. Communication systems and coordination mechanisms for an effective multi-hazard early warning system are lacking, and the preparedness capacity of local communities at risk from natural hazards is low (RGC 2012).

6.1. Climate Change Projection

The pace of global warming and climate change has been increasing over the 21st century (Scott et al. 2008). A scarcity of natural resources, the impacts of climate change and a lack of international mitigation measures will undermine the competitiveness and growth of the country over the next 10 years (Ellis et al. 2013). Fankhauser and Tol (1997) have estimated that climate change will result in a total monetised damage equivalent to 1.5 to 2.0 percent of world GDP; the OECD would face losses equivalent to 1.0 to 1.5 percent of GDP, and developing countries of 2.0 to 9.0 percent.

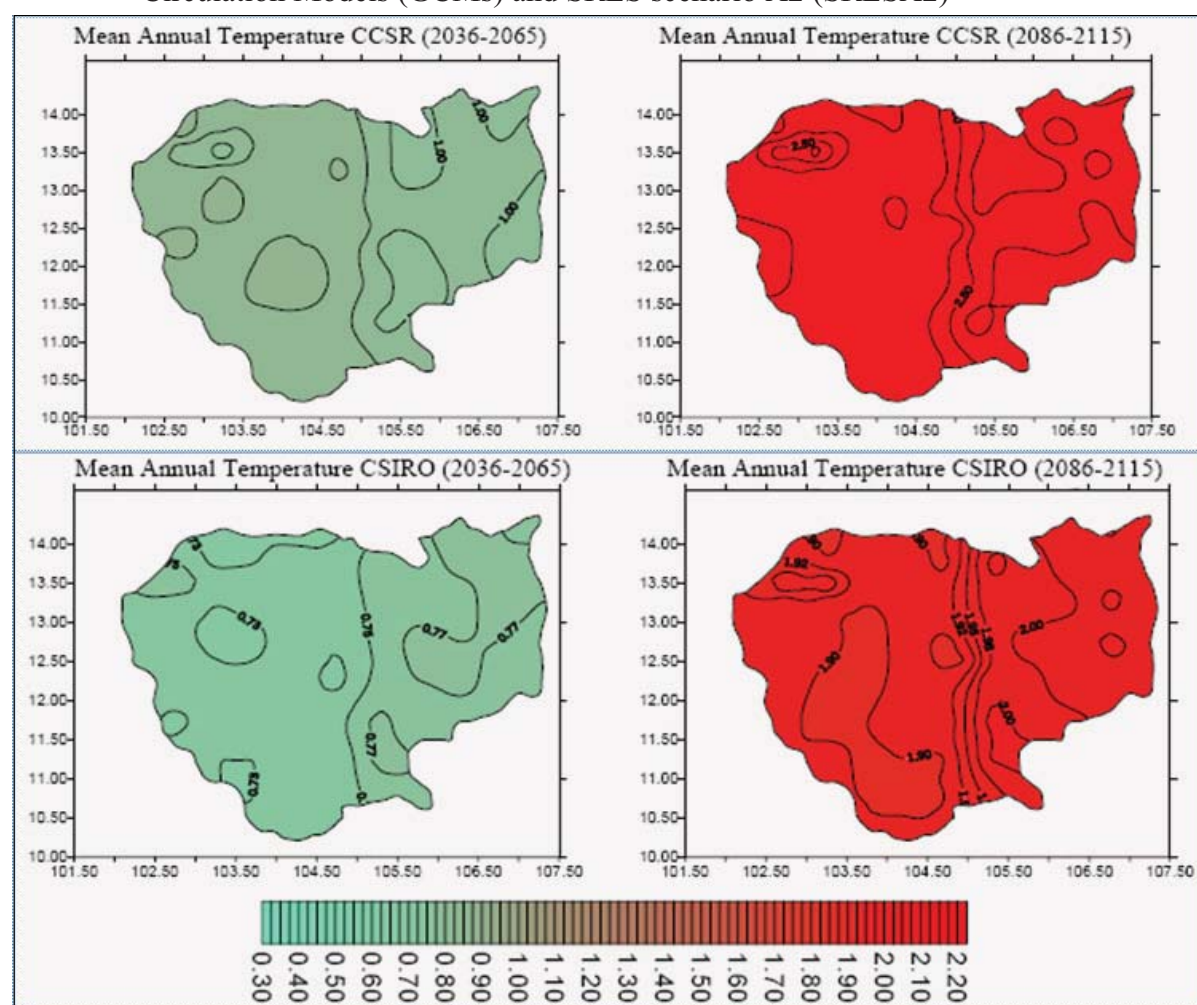
Heng (2012) revealed the main projections of future climate change in Cambodia:

- The mean annual temperature will increase by 0.7 to 2.7°C by the 2060s, and 1.4 to 4.3°C by the 2090s.
- Rainy season rainfalls will increase, partially offset by decreases in dry season rainfalls.

In Cambodia, climate change and its negative impacts are already marked, including higher and more intense rainfall, a shift in the timing of the rainy season, changes in rainfall pattern—the rains start late and end late (Chem 2012). There are frequent floods, droughts, more severe water scarcity and strong storms, which have severely damaged agricultural production (UNDP 2011b). Cambodia is highly vulnerable due to its high level of poverty, lack of infrastructure

and limited adaptive capacity (Yusuf & Francisco 2009). The rural poor can be particularly vulnerable since their livelihoods rely very much on natural resources that are sensitive to climate change. Fragile food security, insecure land titling, many health and education-related constraints and recurrent natural disasters accentuate such vulnerabilities (Peter 2013). Rice and maize are the main crops for food security and agricultural trade, but the price of these will rise under various climate scenarios (Magnan & Thomas 2011). This will negatively impact the poor's ability to buy food.

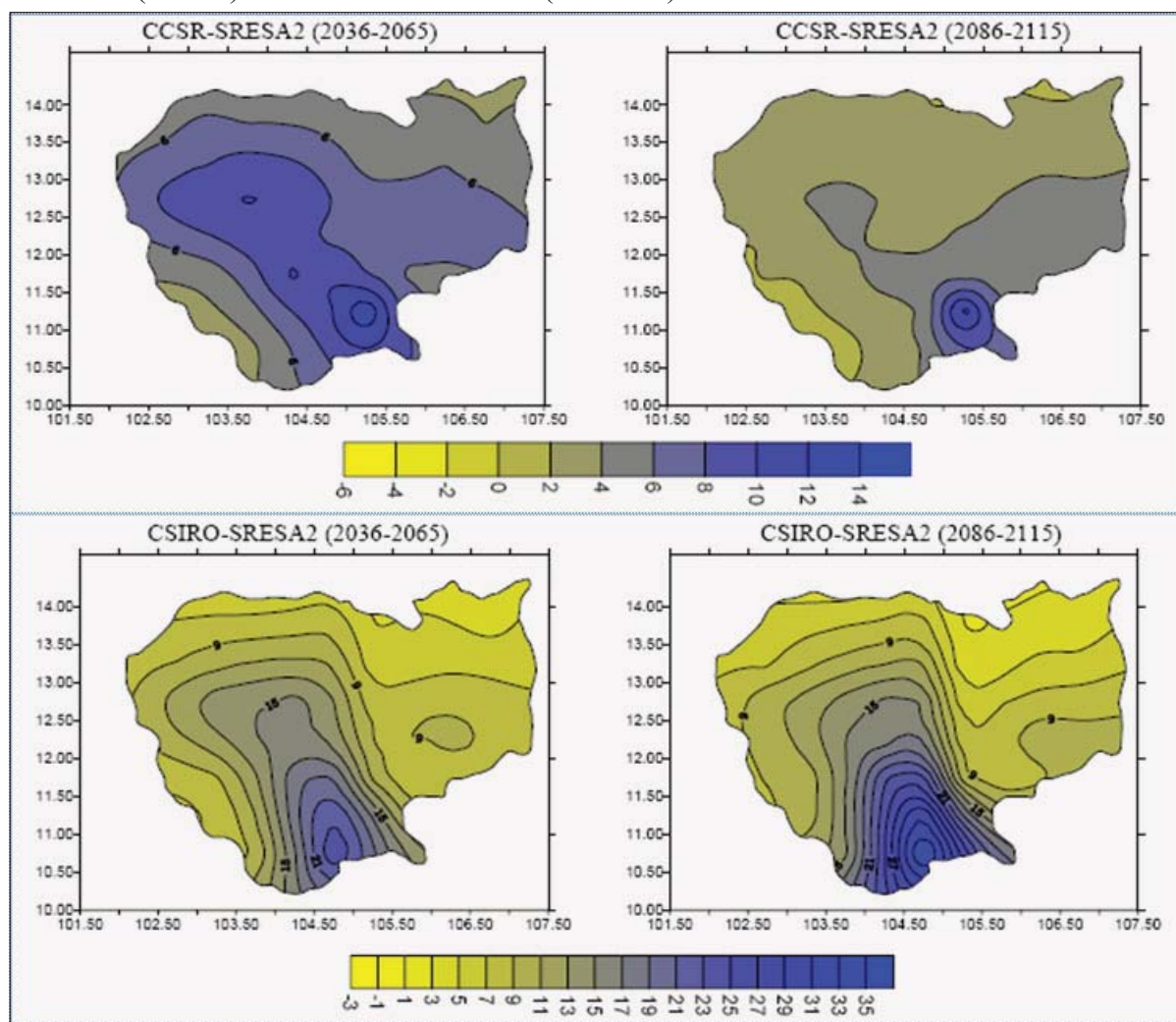
Figure 3. Future Climate Change Projections in Cambodia: Mean Annual Temperature change (°C) Using Data from the Centre for Climate System Research (CCSR), the Commonwealth Scientific and Industrial Research Organisation (CSIRO), General Circulation Models (GCMs) and SRES scenario A2 (SRESA2)¹



Source: MOE 2002, cited in Heng 2012

¹ SRESA2 developed by IPCC is an updated scenario used to analyse climate change. This scenario is characterised by heterogeneous world, regional-oriented economic development, and population growth which represent high greenhouse gas emission in the future (Nakicenovic et al. 2000). See more at <http://www.ipcc.ch/ipccreports/sres/emission/index.php?idp=0>

Figure 4. Future Climate Change Projections in Cambodia: Mean Annual Rainfall Change (%) Using Centre for Climate System Research (CCSR), Commonwealth Scientific and Industrial Research Organisation (CSIRO), General Circulation Models (GCMs) and SRES scenario A2 (SRESA2)



Source: MOE 2002, cited in Heng 2012

6.2. Institutional, Legal and Policy Frameworks Related to Climate Change

Cambodia has been working on its first national communication report to the United Nations Framework Convention on Climate Change (UNFCCC) and other climate change issues since 1999. The Ministry of Environment (MOE) is responsible for a wide range of climate change activities, including planning and policy formulation, implementation of the United Nations Framework Convention on Climate Change (UNFCCC), assessment of new technologies to cope with the adverse effects of climate change or to mitigate greenhouse gas emissions and capacity building and awareness raising. The MOE also serves as a Cambodian secretariat of the UNFCCC, the Inter-governmental Panel on Climate Change, the Kyoto Protocol and the Clean Development Mechanism.

In 2006, the National Climate Change Committee was established to deal with climate change issues, including overall policy. The committee is composed of 20 ministries and governmental departments, including the MOE, the Ministry of Agriculture, Forestry and Fisheries (MAFF),

the Ministry of Water Resources and Meteorology (MOWRAM), the Ministry of Economy and Finance, the Ministry of Industry, Mines and Energy, the Ministry of Health, the Ministry of Land Management, Urban Planning and Construction, the Ministry of Public Works and Transport, the Ministry of Rural Development and the National Committee for Disaster Management. Its responsibilities are: 1) to coordinate the implementation of climate change activities; 2) to develop climate change policies, strategies, legal instruments, plans and programmes; and 3) to integrate climate change concerns into relevant policies, strategies and legal instruments. The minister of environment chairs the committee, while the prime minister is an honorary chairman (RGC 2012).

In MAFF, the Forestry Administration (FA) and the General Department of Agriculture are working on climate change issues, including Reducing Emissions from Deforestation and Forest Degradation (REDD), land degradation and farming and agro-industry plantations. Cambodia has also established a REDD Task Force to improve work on conservation and forest cover rehabilitation. The FA is a REDD focal point. MOWRAM measures changes in the levels of rivers and tributaries, temperature, rainfall distribution, flood and drought. The Ministry of Health is dealing with health, vector-borne disease prevention and sanitation and hygiene services for local communities. The Ministry of Land Management has responsibilities including cadastral administration of state land, public and private state land and individuals' private land registration, as well as the issuance of land titles. The Ministry of Industry, Mines and Energy deals with energy efficiency, clean energy, cleaner production and rural electrification.

Cambodia has also adopted laws and policy frameworks on natural resource management, environmental protection and climate change adaptation including the Forestry Law 2002, Land Law 2001, Fisheries Law 2007, Protected Areas Law 2008, Environmental Protection and Natural Resource Management Law 1996, the Royal Decree on the Creation and Designation of Protected Areas 1993, Sub-decree 83 on the Registration of Land of Indigenous Communities 2009, the National Adaptation Programme of Action to Climate Change 2006, National Forestry Programme (2010-29), National Action Programme for Land Degradation (2010-20), Cambodia REDD+ Road Map 2010, Green Growth Roadmap 2009 and the National Self-Capacity Assessment Action Plan (2007) for United Nations Convention on Biological Diversity UNFCCC and United Nations Convention to Combat Desertification

The Law on Water Resources Management was developed by MOWRAM in 2007, building on the National Policy on Water Resources Management and the Strategic Plan on Water Resources Management and Development (2005-08). The law was set up within the framework of integrated water resources management, recognising the different sectoral interests in water while calling for greater coordination and the balancing of social and environmental considerations. MAFF and MOWRAM produced the Strategy for Agriculture and Water for the period 2010-2013. The strategy will promote regulation, capacity building, research and education, food security, water resource management, agricultural land management and agricultural business marketing (MAFF et al. 2009). Meanwhile, in close collaboration with the Food and Agriculture Organization of the United Nations, MAFF is preparing the Plan of Action for Disaster Risk Reduction in Agriculture to enhance capacities and resilience of farmers and local communities (MAFF 2013b).

With climate change-related legal, institutional and policy frameworks in place, the country is working towards climate change adaptation and mitigation and sustainable economic development.

6.3. Adaptation Strategies

Under the National Adaptation Programme 2006, Cambodia has developed 39 national adaptation projects embracing agricultural development, water supply, irrigation, health care, the fight against malaria, agro-forestry development and coastal zones. The projects aim to provide capacity building, awareness raising and education and infrastructure development.

The government, with funding support from donors including the European Union, Danish International Development Agency, Sida and UNDP, has established a Cambodia Climate Change Alliance with a comprehensive and innovative approach to addressing the issues (RGC 2012). It is to focus on capacity building and institutional strengthening, targeting key national institutions, sub-national authorities and civil society. The alliance includes a horizontal multi-donor Climate Change Trust Fund, administered by the UNDP, which provides resources for the programme and for mainstreaming initiatives, and creates a harmonised engagement point for donors, thereby minimising transaction costs for government. The overall objective of the alliance is to strengthen the capacity of the National Climate Change Committee to fulfil its mandate and to enable line ministries and civil society organisations to implement priority actions.

The government is also implementing a Pilot Programme for Climate Resilience (PPCR) with funding of USD86 million for 2010-2015 (RGC 2012). The objective is to build on the National Adaptation Programme and other relevant country studies and strategies to mainstream climate resilience into national and sub-national development policies, plans and projects. These will be supported by scaled-up financing of adaptation activities in key development sectors, underpinned by: 1) strengthened participation and coordination; 2) science-based adaptation planning; and 3) enhanced links between adaptation and disaster risk reduction measures. Furthermore, the pilot programme is expected to: enhance capacity for mainstreaming climate resilience in planning and budgeting of national ministries; support mainstreaming in sub-national planning and budgeting processes; improve the climate resilience of investments in agriculture, water and rural infrastructure through adaptation measures; and strengthen civil society and private sector engagement and gender considerations in climate change adaptation and enhance policy-relevant climate change adaptation consistent with local capacities and capabilities.

The newly developed Cambodia Climate Change Strategic Plan 2014-2023 is jointly developed by line ministries. It embraces various sectoral strategic plans with the overall aim of creating a greener, climate resilient, equitable, sustainable and knowledge-based society. It aims to reduce vulnerability to climate change of critical natural and social systems and the most vulnerable groups. It also represents a shift towards a green development path by nurturing low-carbon development and appropriate technologies and promoting education and public participation in climate change response actions (MOE 2013b).

Within the strategic plan, MOWRAM has focused on water and meteorology (MOWRAM 2012). The quality and quantity of meteorological services and the capacity of meteorological institutions will be strengthened and improved in line with climate risk assessment and management. Notably, in 2012, MOWRAM constructed and began to operate a modern station (see also <http://www.cambodiameteo.com/articles?menu=115&lang=en>) to improve its ability to forecast weather. In the water sector, efforts have concentrated on farmer water user committees (FWUCs) and strengthening private sector involvement, decentralisation, good governance and water research and development. Likewise, MAFF has developed a sectoral

strategic plan 2013-18 (MAFF 2013c) to reduce the negative impacts of climate change on agriculture, livestock, fisheries and forests. Countering land degradation is a particular concern of MAFF as part of its efforts to ensure agricultural productivity. Agriculture and agro-industry, rubber plantations, animal husbandry, forestry and fisheries are important elements within the main sub-sectors of the strategic plan. Improving and increasing agricultural productivity, mainstreaming low carbon development initiatives in agriculture, farmer capacity building, introducing climate-resilient crops and applying the REDD+ programme are integrated within the strategic plan.

A second version of the National Biodiversity Strategy and Action Plan 1998-2002 is being revised by MOE. Of particular note, among these policies, the National Forest Programme aims to secure forest cover for 60 percent of Cambodia's total territory. One of the central components of this strategy is supporting the establishment of community forestry initiatives and allocating 2 million hectares of forest area to rural communities (FA 2010). In 2013, 457 community forestry initiatives with a total area of 400,167 ha had been established in 21 provinces (FA 2013). So far, 345 community forestry initiatives (308,563 ha) have been approved (FA 2013). In addition, the government has committed to sustainable local forest management. The Community Forestry Sub-Decree 2003 and the Community Forestry Guidelines 2006 enable local communities to obtain rights to forest resources. They lay the foundation for the future expansion of the community forestry or REDD model.

Cambodia REDD+ programmes are also being implemented. A total of 2.96 Gt of carbon is stored in Cambodia's forest ecosystems, with 30 percent of forest carbon stock estimated to be in the forestry concessions managed by the FA (RGC 2012). REDD+ presents significant opportunities for emission reductions and has strong government support. It plays an important part in carbon sink creation. The FA, with development partners Pact and Terra Global Capital, developed Cambodia's first REDD carbon-offset project and introduced it in December 2007. It involves 13 community forestry groups, which protect 67,783 ha of forest in Oddar Meanchey. The project is expected to generate an estimated 7.1 million tonnes of CO₂ offset credits over 30 years (Pact 2008).

FINDINGS

7.1. Impacts of Climate and Human System Changes on Rural Livelihoods and Adaptation Strategies

7.1.1. Tonle Sap Plain

Based on the preliminary data, impacts of climate change in the Tonle Sap plain seem likely to increase. Both river floods² and flash floods³ happen every year. River floods bring sediments and nutrition that maintain soil fertility in the flood plain, benefitting ecosystems, farming and fisheries. The annual flood pulse⁴ enhances soil quality in flood plains. During the flood, fish resources are abundant, and fishing activities are an important part of people's livelihoods and income throughout the area. Although these two types of flood cause the same amount of damage to crops and infrastructure, generally flash floods cannot be as well predicted as river floods. Heavy storms such as Ketsana in 2011 destroyed rice and other crops, houses and infrastructure in Pursat, Kompong Thom and other provinces. Local people have observed an intensification of flood and drought and a change in rainfall over the last decade with late and heavy rainfalls, and more and stronger storms. Small dry spells in the rainy season, which always occur between July and August, have become longer, while the dry season has become drier. This results in a lack of water for irrigation. Outbreaks of pests and weeds are also reported to have occurred with greater regularity, and high temperatures have been observed by local communities in both the rainy and dry seasons.

Many studies predict changes, specifically in the Tonle Sap (including the lake and its floodplain) and Mekong floodplain, caused by either climate change or development (hydropower dams, reservoirs, urban development and irrigation infrastructure). These have presented both negative and positive perspectives on the effects climate change will have on agriculture and water resources. The changes of the hydrology and flood pulse system of the Mekong are not due mainly to local climate changes but to regional ones, particularly development activities in the Mekong basin (TKK & SEA START RC 2009; Keskinen et al. 2010; Kummu & Sarkkula 2008; Västilä et al. 2010; Eastham et al. 2008). Wetter weather and higher water levels, a more extensive flooded area and longer flood duration in the rainy season are the results of climate-related changed hydrology (TKK & SEA START RC 2009, Eastham et al. 2008). Floods start

² River floods occur along the basin of the Mekong, Tonle Sap and their tributaries and are caused by river overflow. Provinces affected include Kompong Cham, Kratie, Kandal, Prey Veng, Stung Treng, Svay Rieng and Takeo (MOWRAM 2012, PDRSEA 2008). In MoE & UNDP (2011), this type of flood is called "seasonal flood". There is one more type, called "severe flood", which results from the coincidence of heavy rains and storms.

³ Flash floods occur during the rainy season, usually after rainfall. The provinces affected are Battambang, Kompong Chhnang, Kompong Speu, Kompong Thom, Kampot, Kandal, Pursat and Ratanakkiri (MOWRAM 2012, PDRSEA 2008).

⁴ The annual flood pulse is defined as affecting "the ecosystems that experience fluctuations between terrestrial and aquatic conditions" (Junk 1997 in Kummu & Sarkkula 2008) or "the cyclical changes between high and low water levels" (Baran et al. 2007). This pulse increases the Tonle Sap lake's volume from 1.3 km³ to 75 km³, while the lake's surface is enlarged from 2500 km² to about 15,000 km², and the water level rises from 1.4 m to 10.3 m above sea level (*ibid.*). The Tonle Sap Lake gets around 57 percent of its water from the Mekong (*ibid.*).

earlier and end later. This also increases the maximum and annual average water levels (Västilä 2009). This brings an abundance of water for farming and fisheries but is very harmful to the Tonle Sap's ecosystem since it alters and degrades the lake's productivity and floodplain vegetation (Kummu & Sarkkula 2008).⁵ Besides flood and drought, changed conditions lead to greater infestations of, for instance, rats and brown hoppers.

Table 2. Estimated Impacts of Climate Change and Development Activities on Selected Hydrological Indicators in the Tonle Sap Area

Hydrological Variable	Impact: development	Impact: climate	Certainty of climate impact
Average water level (Feb-Jul)	↑	↑	Very likely increases
Average water level (Aug-Jan)	↓	↑	Likely increases
Annual cumulative flooded area	↓	↑	Very likely increases
Maximum water level	↓	↑	Likely increases
Maximum flooded area	↓	↑	Likely increases
Flood start date	→	←	Very likely occurs earlier
Flood peak date	-	→ / ←	Occurs possibly later in average years and earlier in driest years
Flood end date	←	→	Likely occurs later
Flood duration	↓	↑	Likely increases
IMPACT TIMESCALE	Short-medium (~5 – 30 years)	Medium-long (~20 – 100 years)	

Source: Adopted from Keskinen et al. (2010)

Flood pulse adaptation measures have become a regular annual practice (food preparation and the creation of other sources of income such as wage labour and fishing). People have changed their cropping calendar due to the intensity of floods and climate variability. Previously, they grew rice from April to December and May to November (long term variety). Under current circumstances, varieties that are able to cope with floods and droughts, and that are demanded by the market, have been selected. Short-term rice varieties are chosen and grown at the beginning of the rainy season and close to its end (receding rice). Fishing remains the main livelihood activity for those living near the lake who do not grow crops during the dry season.

Local people apply various measures to cope with drought. Two major examples were observed during the study: water management and migration. In Pursat, people dig individual or community ponds to store water at the end of the rainy season because of the change to less rainfall and a drier dry season. They also build their own field bunds for storing water and efficient in situ water management. Land levelling is another measure that enables them to better manage water in the fields. These measures are the result of farmers' information exchange and learning by doing. Local communities have also sought help from the provincial Department of Water Resources and Meteorology (PDOWRAM) to share water from upstream. In Kompong Thom, people depend on the irrigation available in their area and on assistance

⁵ The reported impacts of climate change in the dry season differ among the studies. SEA START RC (2009), Nijssen et al. (2001), Hoanh et al. (2004) and Eastham et al. (2008) reveal that precipitation in the dry season is decreased while Keskinen et al. (2010) and Västilä et al. (2010) state that the dry season water level is increased.

from PDOWRAM. Migration is one of the main choices for those who cannot find alternative local livelihoods during the dry season. Non-farm jobs are another solution to help farmers who have suffered from flood, drought or other crises.

The provincial committee for disaster management (PCDM) has the coordinating role in disaster preparedness and response; all relevant provincial departments—PDOWRAM, environment, agriculture and health—take part. Safe places and food aid have been prepared for unexpected disasters. For instance, PDOWRAM finds water sources, prepares pumps and constructs or rehabilitates water reservoirs and canals during droughts. The PDA has responsibility for research and development, and for the provision of extension services, agricultural technology and drought- and flood-tolerant crops. Short-term rice, ponds, vegetable bags, fertilisers, systems of rice intensification (SRI) and multi-purpose farming (MPF) are provided and recommended to farmers by the PDA. In collaboration with both provincial and local institutions, NGOs and development partners have also assisted farmers in coping with climate change. They have mainstreamed climate change and disaster response strategies into their planning and trained farmers via farmer field schools, and have created farmer associations to ensure information exchange among farmers and their communities. Farmers report that MPF is the most effective way to support them and to boost economic, environmental and sustainable agriculture in the face of climate change.

Table 3. Impacts and Adaptation Strategies of Tonle Sap Plain

Changes	Impacts	Adaptation Strategies	Institutions	Remarks
Increased temperature	Hotter weather			Local communities just feel the hotter weather without any noticeable impact on cropping
Changes in rainfall pattern	Late rainfall	Shifting cropping strategies Short-term varieties	Local innovation Market NGOs and PDA PDOWRAM Commune councils	
Increased floods and droughts	Intensive floods Longer mini dry season in the rainy season	Composting and mulching Community ponds Earth bunds Seasonal migration Fishing Safe location, safe water, health care and sanitation provision	Local innovation Market driven NGOs and PDA PDOWRAM Commune councils Community information sharing	
Increased incidence in pests and diseases	Rats Brown hoppers	Pesticides Net fencing	Local innovation NGOs and PDA Commune councils Community information sharing	

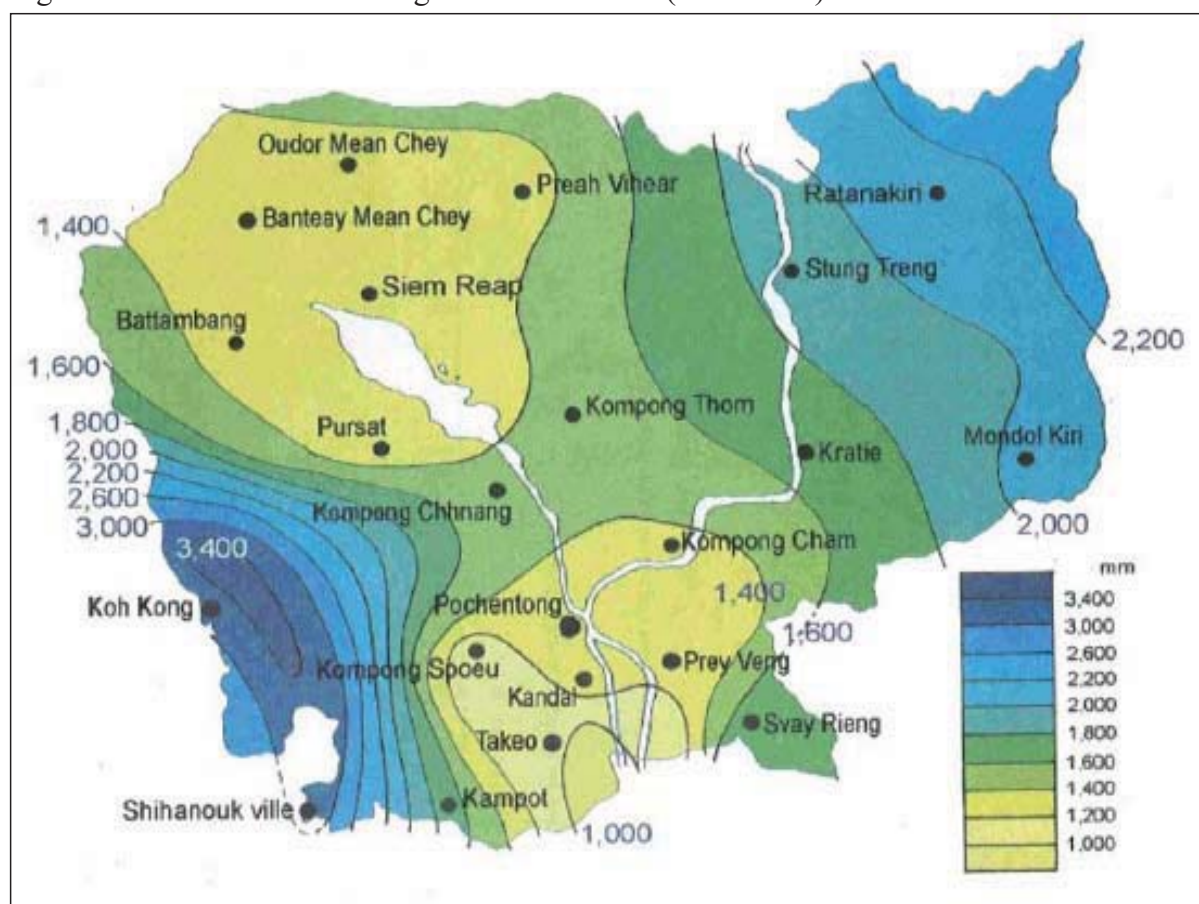
7.1.2. Mekong Plain

The Mekong plain has encountered the same climate change risks as the Tonle Sap plain: floods, droughts, irregular rainfall and pest infestations. Both river and flash floods frequently occur in the area. The Mekong flood always affects the area in October and brings nutrition to the soil. The local community is always well prepared before and after the annual flood. However, if the flood's arrival, duration and location are not well predicted, people are unable to prepare, and the result can be extreme damage to houses, crops, infrastructure and other livelihood assets. Another concern of floods is water quality. Since there are many upstream developments ongoing in the Mekong, water flow that used to bring nutrition to fertilise the soil is changing. As one of the key informants stressed:

"... since 2000, flooding has not brought a lot of humus nutrition like before. Water seems to be more transparent and not as nutritious as before ..." (Prey Veng, 2013)

This is consistent with the study of Kummur et al. (2010) in Grumbine et al. (2012) on sediment trapping by existing and planned mainstream Mekong dams. Not only dams in the upper Mekong would obstruct the sediment, but also proposed dams on the lower Mekong.

Figure 5. Distribution of Average Annual Rainfall (1981-2004)



Source: UNEP 2010

Floods, droughts and rainfall are predicted to change in duration, frequency and severity (MRC 2009). For rural people in the Mekong plain, floods, higher temperatures, droughts and mini-dry seasons in the rainy season and the changes in rainfall pattern pose risks to their living and farming activities. A mini-dry season, which normally occurs between the middle

of July and August and lasts for two to three weeks, can destroy rice crops, particularly where irrigation structures and soil water conservation techniques are limited. Local communities and provincial departments share the concern over the irregularity of floods and rainfall, which prevents farmers from making precise plans for cropping. Rainfall patterns have changed to late and early rainfall in the rainy season in various locations.

The coping mechanisms created by farmers in this zone seem to be better adapted to climate change, particularly in areas that receive annual river floods. However, it is still a big concern in locations where big floods are not common. To cope with this, farmers grow rice just before the flood comes and at the end of the rainy season (receding rice). This response is driven by the market, which prefers short-term rice varieties, and also draws on experiences and information transmitted from farmer to farmer, and dissemination of recommendations by the PDA and NGOs. In drought, farmers in Prey Veng have two water sources: drilled wells and irrigation. According to the Commune Database (NCDD 2013), Prey Veng province has the largest number of drilled wells for agriculture in Cambodia. Farmers who double-crop depend not only on rainfall but also on their individual drilled wells. However, people report that a dropping groundwater table is a concern; from year to year, they have to increase the depth of the well. In Ansaong commune, 10 years ago farmers drilled to a depth of 75 metres to reach the water table, but now they need to use a deep-set pump to get water from the well, and some farmers are having to drill wells deeper. Farmers in Takeo depend on irrigation. For those whose cultivated land has access to irrigation, a small dry spell does not matter in the wet season. Farmers in the areas visited are innovative, learning new cropping techniques with support from the PDA and development partners. Communities have also adopted SRI and MPF to maximise yield as well as to conserve the ecosystem. SRI with a selection of strong seed and green manure application has helped farmers to use less water and allowed the soil to store more moisture. MPF has helped farmers to diversify and increase their production and incomes. In common with people in the Tonle Sap zone, people in this zone also migrate to earn money, especially during cropping and harvesting time. A farmer in So Hang community stressed:

“... we do not want to migrate to other places. But, as long as we do not have our own savings, we have no other choice. But when we earn some money, we come back home and continue our cultivation.” (Takeo, 2013).

Rats and brown hoppers are considered to be particularly troublesome. People deal with them mostly with pesticides. In addition, the rats are eliminated when floodwater remains long enough in the fields.

Table 4. Impacts and Adaptation Strategies of the Mekong Plain

Changes	Impacts	Adaptation Strategies	Institutions	Remarks
Increased temperature	Hotter weather			Local communities just feel the hotter weather without noticing any impact on cropping
Changes in rainfall	Late and early rainfall	Shifting cropping strategies Use of short-term varieties of rice	Local innovation Market NGOs and PDA PDOWRAM Commune councils Community information sharing	
Increased floods and droughts	Intensive floods Longer mini-dry season in the rainy season Irregular flood	SRI and MPF Community ponds Earth bunds Seasonal migration Drilled wells Safe location, safe water, health care and sanitation provision	Local innovation Market NGOs and PDA PDOWRAM Commune councils Community information sharing	
Increased pest infestation	Rats Brown hoppers	Pesticides	Local innovation Market driven NGOs and PDA Community information sharing	

7.1.3. Mountains/Plateau

Due to the topography, the main disasters afflicting this zone are droughts, windstorms, pest outbreaks and floods. With limited rainfall, one crop per season is undertaken. The local community has observed over the last 10 years that drought is lasting longer and damaging their crops. Drought usually lasts two weeks between July and August and is followed by outbreaks of pests—brown leaf hoppers and other insects. Rainfall has never been sufficient for the whole cropping period; if there is sufficient rainfall in the early rainy season, the end of the season always has insufficient water or vice versa. In this zone, with the exception of Kompong Speu, all areas experience annual flood.

To cope with drought, local farmers dig their own wells. They also depend on irrigation to maintain the crop during drought and even to grow dry season crops. To cope with pest outbreaks, farmers learn from their neighbours and other community members as well as from the PDA via agricultural extension services. Even so, the methods employed by these sources are not always effective.

The PDA has disseminated information about some agricultural technologies to help farmers to cope with both climate change and variability. They include SRI, composting, home gardening and cash crops. As in the other zones, PDOWRAM is involved in rescuing crops during the drought by pumping water and restoring canals.

Table 5. Impacts and Adaptation Strategies of the Mountain and Plateau Zone

Changes	Impacts	Adaptation Strategies	Institutions	Remarks
Increased temperatures	Hotter weather			Local communities just feel the hotter weather without noticing any impacts on cropping
Changes in rainfall pattern	Irregular rainfall	Use of drought-resilient rice varieties Migration Drilled wells	Local innovation Market NGOs and PDA PDOWRAM Commune councils	
Increased floods and droughts	Longer mini- dry season in the rainy season	Use of drought-resilient rice varieties Seasonal migration Drilled wells Safe location, safe water, health care and sanitation provision	Local innovation Market NGOs and PDA PDOWRAM Commune councils Community information sharing	
Increased incidence of pests	Insects and brown hoppers Rice diseases	Pesticides	NGOs and PDA Community information sharing	

NGOs and development partners provide the same assistance of agricultural technology as they do in the other zones.

7.1.4. Coastal Zone

In the coastal zone, sea level rise, salt water intrusion, high temperatures, irregular rainfall, flash floods, droughts and storms are the major impacts of climate change. According to some current studies, sea level rise has been a major concern although the communities visited during this study, and the concerned provincial department, are unable technically to monitor such change. However, other studies indicate that sea level rise can be observed through the intrusion of salt water into fresh water (MOE & UNDP 2011). November and December are the months when salt water intrusion increases due to the elevated sea level driven by storm surges. Salt water intrusion has affected agricultural production in coastal communities. All three communes in coastal provinces that were visited for this study share this concern.

Although the main occupation of the people in Peam Krasaob commune is fishing, they still need fresh water to grow vegetables and trees in their homesteads. In Prey Nob the salt water protection dike enables people to cultivate wet season rice, although they still face problems of soil quality, which is affected by salt water. In Kampot province, the Prolay Spean Toch farmer water user community has received major benefits from the Cambodia Agricultural Value Chain's (CAVAC) canal construction, allowing it to boost its agricultural productivity. However, these farmers are also encountering soil quality problems caused by salt water intrusion. Storms frequently occur in the coastal area, and the storm season usually starts in November. Storm surge inundates the coastline, damaging agricultural land and infrastructure. Local people have also observed an intensification of storm surges over the past 10 years. For

example, in Peam Krasaob, where people depend entirely on marine fishing, the intensification in both windstorms and high tides makes fishing, travelling, collecting other marine products and so on more difficult. By 2060, a sea level rise of up to 1 metre is expected, inundating some 25,000 ha and damaging infrastructure and coastal fisheries (MOE & UNDP 2011). Sea level rise is also predicted to have a huge impact on both surface and ground fresh water, putting more pressure on alternative sources (DHI 2012a). The community in Prey Nob commune reported increasing temperatures and intense rainfall at the same time. The pattern of rainfall has also changed. In some areas, flood is not a major concern because dams or dikes are in place to protect crops and drain water from fields. Flash floods occur between June and July. A mini-dry season during the rainy season is also not a problem because the area is low lying, so soil moisture retention is high. Flash floods are also seen as a positive phenomenon because they bring down nutrition from the plateau area. The local community, however, expressed concern about the land use changes caused by agro-industry and hydro dams and the consequently reduced nutrition from upstream.

According to the PDA of Preah Sihanouk, there is technology to reduce salt water intrusion, but it is too expensive for farmers. In coping with salt water intrusion to freshwater sources, the PDA claimed that there were eight possible reservoirs in Preah Sihanouk and urged the PDOWRAM to think about this possibility. This is not seen as a main concern for people in the community since this area offers diversified sources of income such as forest and fisheries, and agriculture is not seen as the major source. However, salt water intrusion is a major concern among other climate-related disasters in Prolay Spean Toch community, since there are no alternative sources of livelihood besides migration. The people of Peam Krasaob commune have created an alternative livelihood by increasing eco-tourism activities and thus lowered their dependency on fishing. They also suggested that the relevant provincial departments build a dike along the coast to halt the intrusion and to protect agricultural production and mangroves. Farmers in Prolay Spean Toch community revealed another option: building a dike to prevent salt water intrusion and constructing more canals to ensure water allocation for farming. For the poor, the way to cope with all the above disasters is to migrate either seasonally or permanently, and this happens in all three provinces visited.

Dissemination of information about rainfall, floods and storms is the main help for people to prepare themselves. National TV and radio stations share such information but it is not yet enough because of the inaccuracy of the information and the limited means of local people to access it (e.g. the lack of electricity). However, people use their social networks to get this kind of information. In Koh Kong, people living near the border rely on information broadcast from Thailand, which is reported to be more accurate specifically for fishers.

The adaptation measures are both autonomous and planned. Autonomous measures are adopted by local people, while planned ones are assisted by local government and NGOs. Autonomous adaptation measures include changing cropping strategies, such as shifting planting dates and using resilient crops, cropping diversification-MPF and diversification of income sources through off-farm jobs and migration. Planned adaptation strategies consist of the provision of seeds and agricultural technology, irrigation canals and dams, water pumps and gasoline, initial savings provided by NGOs and financial inputs for starting livelihoods diversification.

Table 6. Impacts and Adaptation Strategies of the Coastal Zone

Changes	Impacts	Adaptation Strategies	Institutions	Remarks
Sea level rise	Land inundation	None		It cannot be observed, and there is no local scientific data to prove it.
Salt water intrusion	Land inundation Damage to soil quality Damage to water quality	Building effective dike (suggested) Soil cleansing (suggested) Fresh water reservoir (suggested) Digging canal to divert salt water (suggested)	Local innovation NGOs and development partners PDA PDOWRAM Commune councils Community	
Increased temperature	Hotter weather			Local communities just feel the hotter weather with little note of its impact on cropping
Changes in rainfall pattern	Irregular rainfall	Information sharing	Social networks TV and radio Neighbouring TV and radio	
Increased floods	Obstacles to fishing Land inundation Salt water intrusion	Seasonal and permanent migration Information sharing Safe location construction and identification Safe water, health care and sanitation provision	Local innovation Market NGOs and PDA PDOWRAM Commune councils Community information sharing Neighbouring TV and radio	
Storms	Obstacles to fishing Damage to settlements and the shoreline	Information sharing Create measures to protect people's settlements and the shoreline	Social networks TV and radio Neighbouring TV and radio	

7.2. Observed Rural Adaptive Capacity and Measures under the LAC Framework

7.2.1. Livelihood Assets (*N, P, H, F & S*)⁶

Livelihood assets play an important role in determining local adaptive capacity.

Land ownership is important for those whose main source of income is farming. Up to 25 percent of households in the four zones do not own any land (Sophal 2008, cited in MOE & UNDP 2011). Among the four zones, the Tonle Sap area has the most landholding for living and farming. People received land from the state in 1989. The size of the land depended on

⁶ N-natural, P-physical, H-human, F-financial and S-social assets

the number of working members, so the bigger the family, the more land they were given. People could also get land via inheritance from their families. The government has created a countrywide programme to provide certificates of land ownership. Each household has more than one parcel of agricultural land. The Cambodia Socio-Economic Survey 2009 reported that the average number of parcels owned by households was 1.6. Table 6 shows that about 45 percent of landholders own less than one hectare of agricultural land.

Rain-fed farming is commonly practised countrywide since irrigation coverage is not complete: only a small proportion of cultivated plots have access to supplementary irrigation water in the rainy season. Dry season agriculture depends largely on irrigation canals and dams, and access to those structures is limited. Farmer water user communities have been established to share water among their members equally regardless of size of land, gender or location of the plot. This institution has enabled farmers in some locations to access supplementary water in both rainy and dry seasons. However, people whose land is not flat or is located at the end of the canal find it hard to get sufficient water. One more critical issue is conflicts between upstream and downstream users, since catchment governance is not yet practised.

Table 7. Landholdings (% of households)

Agro-ecological zone	Landless	<0.5 ha	0.5-1. ha	1-3 ha	>3 ha	Total
Plains (Mekong)	24.8	26.3	21.6	20.0	7.2	100
Tonle Sap	19.2	17.3	20.5	29.7	13.3	100
Plateau (Mountainous)	11.1	20.6	27.4	31.3	9.5	100
Coastal	22.8	34.1	22.0	17.9	3.3	100
Total	21.1	23.4	22.1	24.4	9.1	100

Source: Sophal 2008, cited in MOE & UNDP 2011

Road networks, drainage systems, flood protection dams and dikes and irrigation facilities protect people.

Infrastructure that could help to protect people from climatic hazards is in poor condition and limited even for basic human needs (MOE 2013b). A study by the ADB (2002) showed that in rural areas road networks were tertiary types, while in urban areas roads were high quality. In Kompong Thom after the Ketsana storm in 2011, flood protection dams were built to protect particularly Stung Saen city. However, there is not enough infrastructure development in the provinces visited. Furthermore, the existing infrastructure is not operated effectively. Prey Nob polder in Preah Sihanouk is now below sea level (DHI 2012b). In Peam Krasaob commune in Koh Kong, the dike is not able to prevent salt water intrusion and floods into either surface water or groundwater (DHI 2012a; interview 2014). In Kampot, where CAVAC has constructed canals and drainage systems, the community still reports problems with low soil quality due to salt water intrusion (interview, 2014). Irrigation and flood protection dams and road systems are insufficient to be used by everyone. Existing irrigation systems are reported to malfunction due to poor operation and maintenance and damage (CEDAC 2009).

People can access personal savings, local or community savings groups, microfinance institutions and banks.

People with medium or high incomes have their own savings to help them in times of crisis. The poor need access to other means. Group savings, which are mostly practised by women's

groups, are seen as an important resource to help the poor to respond to change and crises without needing to rely on other sources. However, the group has limited capability of making loans and facilitating cash withdrawals. Microfinance institutions and banks can lend, and people can obtain money by selling their property or cattle. This strategy is fast and reliable since people do not need assistance from others. Some people can earn from small businesses in the village or cash cropping in upland areas. In the rainy season, the rural poor can earn from wage labour transplanting, weeding or harvesting, and in the dry season planting and harvesting cash crops. They can also migrate either seasonally or annually, to take employment as factory or construction workers or in other jobs in other provinces, Phnom Penh or other countries, legally or illegally.

In acquiring capital, farmers have access to many financial services. Both formal and informal financial institutions—including savings groups, microfinance institutions and banks such as ACLEDA and PRASAC—operate in local areas providing loans to farmers. Savings groups, which exist in all the communes visited, have limited numbers of members and consequently their loans are limited. Both microfinance organisations and banks require land titles as collateral for credit. They provide larger loans to farmers than do savings groups. Land titling is a big issue for the poor. People can access local moneylenders in arrangements that specify repayment at the end of the harvesting period or another time. A money-rice or agricultural inputs/money-rice form of lending is operated by local businesses that give fertilisers, seeds and pesticides to farmers and ask for a return in either cash or crops, usually after the harvest. Moneylenders set quite high interest rates, which means that some farmers are unable to access these loans. Another source of finance is relatives and neighbours, who impose lower or no interest: the time frame for return of the capital is also negotiable. Among all these financial routes, local moneylenders set the highest rates of interest, but the service is fast and convenient. In times of crisis such as flood, drought, pest outbreaks, low yields and personal disaster, informal financial services seem to provide space and a more understanding environment for negotiation on the return of capital than do the formal ones.

Savings groups are seen as social networks in which people collectively save and give loans to members of their community. FWUCs are another resource to which people turn when they have a water problem—either too much water or a shortage—while they go to the commune when they face problems such as conflicts or natural disasters. Agricultural extension services are available in each commune visited; however, the services are not stable since there are not enough human resources or funds. These services are provided not only by provincial departments of agriculture, forestry and fisheries but also in various projects undertaken by development partners such as the Food and Agriculture Organization, International Fund for Agricultural Development, Partnership for Development in Kampuchea, Centre d'Etude de Développement Agricole Cambodgien / Cambodian Center for Study and Development in Agriculture (CEDAC) and Live With Dignity. If farmers are supported by such projects, the service is active and effective. In addition, social capital, through which local people interact in their livelihood systems, is a form of cooperation embedded in Cambodian society. This will be presented in more detail below.

The groups that represent human capital involved with climate change and local agriculture and fisheries are commune councils, FWUCs, agricultural cooperatives, community protected areas, PDA, PDOWRAM, the Red Cross and PCDM. These institutions help people by providing disaster information, agricultural technology, irrigation water, aid before and after disasters. In addition, soft skills and knowledge are also available for local people via institutions such

as FWUCs, agricultural cooperatives, PDA, PDOWRAM and commune councils. These help people to improve the resilience of their agriculture in collaboration with development partners and NGOs. Since climate change has become a hot issue, many related projects from both government and development partners are progressing in dispersed parts of the four agro-ecological zones. They are providing training on SRI and MPF, and are introducing resilient rice varieties to help people adapt to climate change by transforming negative impacts into an opportunity.

As mentioned above, the five assets in DfID's livelihoods framework are interrelated in helping farmers to cope with changes and hazards. However, financial capital is seen as the quickest and most effective in restoring the livelihood and agricultural system and in coping with changes. It also helps poor and medium income farmers to improve their agricultural productivity, enabling them to buy inputs and find alternative sources of livelihood. People from poor and medium income families, however, seem to have restricted access to these resources despite the ongoing interventions throughout the country. It was also reported during field visits that during natural and climate-related disasters, the poor, women, children and vulnerable groups are given insufficient attention not only by the local community but also by the provincial and national agencies, NGOs and development partners.

7.2.2. Institutions and Entitlements

Institutions and entitlements in the LAC framework cover local rules, networks, interactions and institutional arrangements (Jones et al. 2010). Ostrom (2005) defined institutions as "the rules that govern belief systems, behaviour and organisational structure". Woolcock (1998) and Narayan-Parker (1999) argued that the relations between local people of different institutions can be categorised as bonds, bridges and links. In addition, Woolcock pointed out that the norms and networks facilitating collective action for mutual benefit are recognised as social capital and are essential in enabling local people to sustain their livelihoods in the light of changes. The links in social capital are seen through the relationship between local people and provincial departments, NGOs and development partners. The relationship among people in the same community, network or group is defined as bonding social capital, while that among different communities, networks or groups is regarded as bridging social capital.

Formal institutional arrangements with the state are made through provincial departments, which complement each other. In times of crisis, each department is responsible for a certain type of assistance: the PDA is in charge of seeds and fertiliser, PDWORAM of water supply, PCDM and PRC of food, shelter and clothes, and the provincial department of health of protection against vector-borne diseases, general human well-being, sanitation and hygiene. Commune councils facilitate and assist and bridge between local communities and provincial departments. This assistance is reactive and post-disaster, except for identifying safe spots and preparing for annual flooding. Another role of these institutions is disseminating information about and supporting adaptation strategies among local communities. The most active in this role are the PDA and PDOWRAM. The PDA is in charge of disseminating information about new cropping strategies, resilient seed varieties and cropping techniques. The PDOWRAM is in charge of promoting water storage for both wet and dry seasons (canal digging in the paddy fields). Commune councils, again, facilitate these activities.

An informal horizontal relationship among local community members seems to enhance local adaptive capacity. This relationship allows people to cooperate and help each other. For example, in Takeo, Kompong Thom and Pursat, people share land to build canals or dig ponds

to store water. Reciprocal labour arrangements still exist in some areas, although these have been transformed into a cash-based system and people are hired rather than exchanging help in cropping, specifically rice transplanting and harvesting. However, people have ceased to cooperate so positively in reciprocal labour arrangements and water sharing between upstream and downstream users. Water sharing is a very complicated issue that triggers conflicts and requires proper resolution and coordination.

Local community networks including FWUCs, agricultural cooperatives and savings groups also have their own internal financial arrangements to make capitals of each accessible. These arrangements are limited to the members of the group or community. Furthermore, attention to gender roles in these arrangements is still far from sufficient.

Another emerging institutional arrangement is made by external supporters including NGOs and development partners. These institutions have been working with commune councils and provincial departments and have established institutional arrangements specifically for the beneficiaries of their projects. For example, the Project for Agricultural Development and Economic Empowerment (PADEE), CAVAC and CEDAC, in collaboration with PDA, PDOWRAM and local authorities, have built local capacity to minimise the negative aspects of climate change and to adapt appropriately.

Institutional arrangements also allow participation in decision making on how to adapt to climate change and to mainstream adaptation into local planning. The trend to involve local people from the very beginning of the project is speeding up, and this participatory approach has proved very effective in sustaining projects and enhancing their results. However, participation is still limited because mechanisms of interactive discussion are not yet in full use. Social norms and beliefs compel local people to perceive themselves as inferior to government and local officials, making them unable to present their views. Participation also differs between males and females. Observation during local discussions and interviews suggested that although considerable numbers of women join discussions on agricultural issues, they remain muted since they are just replacing their absent husbands in the discussion.

The most important institutions that communities depend on during climate shocks are community members, community networks, commune councils, provincial departments and NGOs. Social capital and local institutions in rural Cambodia help the community to sustain livelihoods. However, these institutions still have limited human, technical and financial resource. Furthermore, due to insufficient social relationships, they are not yet strong and effective enough to build resilient communities.

7.2.3. Knowledge and Information

Access to information about cropping technology, alternative livelihoods, markets, upcoming disasters, reciprocal labour arrangements and financial remuneration can be spread through both formal and informal institutions and social networking. These comprise local neighbourhoods, FWUCs, agricultural cooperatives, savings groups, commune councils, provincial departments and connections with relatives and the media. However, not all the relevant information reaches all the people concerned. The community in Kampot that was studied for this report has not yet updated agricultural technology, specifically the multi-purpose farming techniques. The discussion with farmers in Peam Krasaob of Koh Kong revealed that the dissemination of information about appropriate alternative sources of livelihood is still not in place for them. The extent to which information is accessed depends on the connections between people and

social institutions and networking, the nature of information, access to the media and the target groups.

The climate-related information used to guide cropping strategies and calendars comprises traditional knowledge, early warning systems, TV and radio broadcasts and word of mouth. The current climatic and weather information is reported to be inaccurate. For example, farmers reported that in 2012 they were told that there would be intense rainfall, so that flash flooding could be expected; farmers were warned not to cultivate crops. But the reality turned out to be totally the opposite (interviews in Kompong Thom and Pursat, 2013). An additional point is that a complete climate-related weather information package is not yet available. Early warnings about floods, drought or storms reaches local people mostly from the top down and is not specific enough: it just identifies the province that is going to be hit without any information on specific locations.

Local sharing of information about disasters, agricultural technology, labour arrangements and resources to help each other in cases of hardship is done through local networks or relationships (local communities or authorities, savings groups, volunteer groups). Based on the discussions and interviews with farmers, word of mouth spreads warnings about upcoming disasters more effectively than TV and radio or top-down methods. In the Svay Daun Kaev commune of Pursat, information about building bunds to store water for cultivation in the rainy season has been spread widely by community members.

7.2.4. Fostering Innovation

Because climate variability has hit all the provinces visited for this project, the chance of adopting new practices is very high. To survive in a changeable climate, farmers have shifted the cropping calendar from single rainy season cultivation to double cropping with short-term rice varieties just before and after the arrival of floods or intense rainfall. This innovation exists in the two zones that receive a flood pulse from the Tonle Sap and Mekong. This shift protects crops from flood damage and supports household economies. The practice is conducted on an individual or trial basis by some farmers, and then starts to spread once neighbours see the results. Everyone is keen to adopt new technology and practices if these can improve their livelihoods.

There are two scenarios in adopting innovations. One is that farmers embrace the change if they have enough resources—labour, time and inputs—and the innovation is simple. Another scenario is that they accept it if there is ongoing technical and financial support. Since climate change has put more pressure on livelihood systems, farmers have been pushed to work more on how to adapt to the change and not be affected by the adverse impacts. Another innovation is the selection of rice varieties, which is driven by the market. IR504 is an excellent example; it is not only the market that has made this variety popular among farmers but also its short growth period (three months).

The institutions concerned have done their best to support local people in trying new rice varieties or exploiting new opportunities. For example, PDOWRAM is able to provide weather forecasts and climatic data for local farmers but final decisions about cultivation still rest with the farmers. If a trial fails, farmers themselves still bear the cost, and this can discourage innovation. But there are areas where projects focusing on agriculture and climate change are supporting farmers and encouraging them to conduct experiments. For example, in Prey Veng, where PADEE is undertaking a demonstration on SRI, farmers can acquire rice seedlings free

for trial in their fields. Agricultural extension is also available from this project to help farmers if they face challenges.

Many measures have been taken to ensure that everyone has equal access to improved innovation and technology. Improved water access, sharing information and knowledge and ongoing extension services are among the measures. But because of the limited human, financial and technical resources, state and external support is mainly targeted at vulnerable groups or people living in the most climate-sensitive areas.

7.2.5. Promoting Forward-Looking, Flexible Governance; Decision Making; and Potential Interventions

Climate change strategy, policies and plans, in particular the Cambodia Climate Change Strategic Plan involving many relevant ministry institutions, support local communities to cope with climate-related hazards. Furthermore, NGOs and development partners—including PADEE, Partnership for Development in Kampuchea, Joint Climate Change Initiative, CEDAC, Live With Dignity, CAVAC, Wildlife Alliance, Worldwide Fund for Nature, Pact Cambodia, UNDP, United Nations Environment Programme, Food and Agriculture Organization, International Fund for Agricultural Development, World Bank, Asian Development Bank, European Union, Global Environment Fund—are also working on enhancing the adaptive capacity of local communities. Some of their climate-related activities are conducted in collaboration with communities, commune councils and provincial departments. That said, these institutions' interaction and sharing of climate change information and knowledge with local communities is still insufficient due to limited resources and ways in which interaction and information transfer can take place.

Commune disaster risk reduction measures were already in place before climate variability was taken into consideration. They were incorporated into commune development planning with supporting funds from either the Ministry of Planning or external assistance. A bottom-up approach has been implemented in the commune planning of all four zones. Each village chief collects information about local needs and priorities and then informs the commune councillors in village-commune meetings. The councillors and village chiefs work together in developing a plan to be sent to the district integration workshop, where priority projects are identified based on support from line departments, private institutions, NGOs and development partners. This is how a bottom-up approach works in developing the commune plan. However, although there are planned priorities to follow, ad hoc meetings and plan redesign are possible if unexpected events occur. The commune planning system has a flexible governance structure to respond to changes, but the outcome still depends on how much the system can afford to deal with farmers' needs.

8

DISCUSSION

8.1. Constraints and Challenges Caused by Climate Change

The above preliminary findings suggest that Cambodian agriculture is affected by the impacts of climate change in four ways: an increase in temperature; changes in rainfall patterns; floods and droughts; and sea level rise. The impacts differ according to the geographical conditions of each area (weather, soil type and quality), the dependence on climate-sensitive resources, socio-economic conditions and infrastructure, internal and external support and government. Based on scores for vulnerability and adaptation assessment, the MOE has found that the Tonle Sap zone is the most vulnerable, followed by the delta (lower Mekong) and plateau zones, while the coastal zone is the least vulnerable (MOE 2013b).

Change in rainfall is predicted to affect the duration, intensity and dates of both rainfall and the dry season, in which rainfall will be delayed, last for a shorter time and be higher in intensity: the dry season will be longer and drier (see also MOE & UNDP 2011). Since the rainfall pattern is shifting, drier areas of the country might benefit from the increased precipitation in the rainy season (*ibid.*). The Tonle Sap and lower Mekong zones are likely to be the most vulnerable to floods, while at the same time the Tonle Sap, lower Mekong and plateau are vulnerable to drought (MOE 2006).

Annual flooding of the Tonle Sap and Mekong brings nutrients for soil fertility (MOE 2013a). However, a concern has emerged about the capacity of the rivers to bring nutrients with the flood pulse since hydropower developments in both the main stream and tributaries are likely to reduce the nutrient load. And if flooding is very strong, this could destroy not only crops but also homes, infrastructure and even human life. Historically, there were devastating floods in Cambodia in 2000, 2001, 2002, 2011 and 2013 during which many lives, infrastructure, crops and homes were lost or damaged (*ibid.*).

Scientific calculations have indicated that every 1oC increase in growing season minimum temperature would lead to a 10 percent reduction in average rice yield⁷ (see also IWMI 2010). The impacts of climate change are also expected to be different in wetter and drier zones of Cambodia (MOE & UNDP 2011). If rainy season precipitation increases, the mini-dry season will be minimised, and this would be beneficial for drier areas but harmful to wetter areas, with increased frequency of flooding (Eastham et al. 2008).

In the mountainous region, communities have observed that if there is sufficient rainfall in the early rainy season, the end of the season always has insufficient water or vice versa. Farmers also noted that over the last 10 years the drought can last longer and damage their crops.

To cope with the drought and mini-dry seasons in the rainy season, local community members in all agro-ecological zones dig their own wells or ponds. They also depend on irrigation systems and reservoirs to maintain their crops during drought and even to grow dry season crops. In the coastal area, a mini-dry season is not a major concern since the rainfall intensity is much higher than in the other three zones and soil moisture retention is high.

⁷ Based on IWMI 2010, this would affect all four zones.

In coastal areas, climate change has an impact on marine resources and compels some communities to find alternative sources of livelihood and new adaptation strategies. Sea level rise, salt water intrusion and windstorms are the key impacts. Sea level rise has been a major concern for coastal communities since it would destroy settlements and tourist facilities, marine resources and mangrove forests. Windstorms can not only hamper fishermen but also cause erosion of the shoreline, damage beaches, diminish tourist facilities and hamper coastal settlements. Salt water intrusion has noticeably affected agricultural production. There are insufficient roads, flood protection and salt water intrusion prevention structures, canals, irrigation and water storage facilities to serve all the needs of the population in coastal areas, although ongoing support from relevant institutions is already in place.

Table 8. Damage to Agriculture from Both Floods and Droughts

Flood		Drought	
Year	Damage (ha)	Year	Damage (ha)
1984	400,000	1991	200,000
1995	150,000	1994	250,000
1996	450,000	1996	400,000
2000	400,000	1997	430,000
2001	200,000	2002	150,000
2002	100,000	2004	300,000
2011	267,000	2012	80,000
2013	221,476		

Sources: Ty 2012, MAFF 2012 and HRF 2013

8.2. Adaptive Capacity and Strategy and Suggested Course of Action

The preliminary findings suggest that the existing adaptive capacity and strategy in the four agro-ecological zones ranged from low to medium (mainly for poor and medium-wealth families) to high for the better-off families. The poor frequently have insufficient support from local and national institutions. They are the most vulnerable to the changes and are directly and indirectly compelled to migrate to earn income. Medium-wealth families are better adapted to climate change impacts than the poor since most of them have diversified sources of income, more land and better access to financial resources.

Adaptive capacity and strategy depend heavily on the five components mentioned under the LAC framework. Each of them is discussed in more detail below to identify how local adaptive capacity and strategy can be improved.

8.2.1. Assets and Capital: Improving Equitable Access to Key Resources

Although credit schemes are operated throughout the country, access to these schemes is not yet enough to support the poor. Local credit schemes, influenced by international experience and assisted by NGOs, help the poor to have their own savings and loans (IFAD 2014). Savings groups help people to save and also provide loans. Although they do not handle large sums, their contribution to financial management is significant. Even so, some enabling factors, including training, equal and full access, flexible collateral and reimbursement, and participation in design and management, have to be in place to make sure these rural credit schemes are effective for the poor; training for the members and leaders of such schemes is vital (*ibid.*).

Generally, female members are the largest membership component of savings groups. NGOs and development partners have actively supported and sustained these activities (Pickens 2004). However, a review of savings groups reveals that the enabling factors to make these a reliable resource for coping with unexpected natural disasters or improving livelihoods are not in place. Savings groups are not as flexible in deposits and reimbursement as they would be ideally. To enable the poor to participate, it is suggested that deposits and reimbursements be made either in cash or in kind. Trust-building is also important in sustaining such groups.

To enable everyone to enjoy equitable access to the four other key assets and capitals in the LAC framework, assistance is desperately needed. Water is highly important in helping local communities to improve agricultural products, particularly rice. Access to productive land, in which water is an important element, is achieved through both vertical and horizontal institutional lines. Water provision via irrigation is a priority in the government's agenda. Private sector representatives, development partners, NGOs and local authorities— horizontal lines— are also important in expanding and ensuring equitable access. Building and rehabilitating irrigation infrastructure, establishing FWUCs and support for operation and maintenance and institutional arrangements, as well as capacity building for improving cropping systems and water sharing, should be continuously undertaken.

8.2.2. Institutional Arrangements: Building Climate Resilience through Existing Social Capital

Three types of local relationships (bonds, bridges and links) that are important to build adaptive capacity are identified. Bonding social capital is the strongest of the three since it relates to kinship and neighbourhood relationships (Pellini 2007; Ang et al. 2007). The formation of bridging networks across communities opens opportunities for improving livelihoods and mobility (Ang et al. 2007). This reflects the way that local people share information about agriculture and climate within their community or with other communities so that prevention or remedial actions can be prepared. Other important measures to improve farmers' networks, awareness and experience include exchange visits from one community to another or one province to another. These are generally supported or organised by government institutions, NGOs and provincial departments.

Local institutions are the most effective in enhancing adaptation strategies and capacities due to their long experience in dealing with climate-related disasters. They can also organise the incentive structures such as market for household and community adaptation responses and mediate external interventions (Agrawal & Perrin 2009). It should be noted that access to local institutions is still limited since they are restricted by unfavourable conditions, such as insufficient human, financial and physical resources and social factors.

Due to interventions from government, line agencies, NGOs and development partners, more networks to help people cope with changes have been built (MOE 2013b). However, the sustainability and effectiveness of these arrangements is still questionable. Clear roles and responsibilities for each relevant national and provincial institution and the provision of sufficient resources for them (in particular government agencies) to support rural livelihoods are required. For example, challenges are still observed in the scaling down of roles and responsibilities from national to sub-national level, although the decentralisation and deconcentration reforms and fiscal devolution have been implemented. These challenges include limited budgets, limited participation, restricted representation of and lack of accountability to marginal groups and uncertainty over the stakeholders' mandate on natural resource planning and management (MOE

& UNDP 2011). Local institutions and authorities should use their roles and responsibilities accountably to promote collective action and to build networks to improve local adaptive capacity.

Collective action should be encouraged to support adaptation strategies and to ensure that people are not left vulnerable. Adger (2003) suggests that collective action can be built through networks and the flow of information. Furthermore, community word of mouth as a means of transmitting information and building networks should be encouraged; this can help not only to share information on climate-related disasters and related agricultural techniques but also to build collective action to improve institutional arrangements. Collective action can also be undertaken through local climate change-related projects. For example, the climate-related projects conducted by Cambodia Climate Change Alliance, Joint Climate Change Initiative, PADEE, CAVAC, USAID's HARVEST programme and CEDAC, in collaboration with PDA, PDOWRAM, PCDM and local authorities, have built local capacity and collective action. These include forums, workshops, farmer field schools and exchange field visits and the creation of farmer associations, through which lessons can be disseminated and experiences exchanged.

8.2.3. Sharing Knowledge and Scientific Information for Climate Change Adaptation

The only obstacle here is the accessibility to the information in terms of type, coverage and sharing channels. Knowledge and information are provided by the media and formal training but are also embedded in local social interaction. Local horizontal relationships have allowed access and sharing. New knowledge and information should be provided in a form that fits with communities' existing knowledge, will earn social acceptance and is sufficient as a base for their decision making on cropping strategies. But how can information that fits with local communities' needs be provided? The answer lies in effective dissemination of a combination of indigenous and scientific or technical knowledge. This can be achieved by linking communities to technical experts within local government and NGOs as facilitators. Accurate and specific information about the distribution of rainfall and its intensity in time and place, due to the high variability of local weather, is vitally important for decision making (see also MOE & UNDP 2011).

8.2.4. Innovations: Collectively Developing Measures to Respond to Climate Change

The challenges in fostering innovation to cope with climate change revolve around institutions taking or sharing responsibility for unexpected results from their services and market interventions. For example, compensation or incentives should be provided for farmers whose crops fail after they have applied new cropping methods provided by institutions or NGOs. To motivate farmers to be innovative, a crop insurance scheme has been suggested internationally and locally (MOE & UNDP 2011). Insurance would need to be based on a public-private partnership involving government, farmers and private institutions (Herbold 2010). Also, some projects in some rural areas are supportive in that they provide technical advice and inputs although they do not take responsibility for any losses. In relation to market intervention, CEDAC has been doing a crucial job in encouraging farmers to grow organic crops by buying those products. This sets a good example.

Collective action can be an effective solution to individuals' limited capacity in applying innovation. For local communities collectively to develop measures or adopt new products or processes, they have to be informed of the impacts of the changes as well as given support, advice and guidance. Once people are knowledgeable about what is going on in their communities and about assistance at hand, they become more confident about the future, and

positive development is possible. Indeed, the word “collective” is another major theme in this discussion. Many observers have been working on how collective action helps a community’s capacity to adapt. This social capital does exist in Cambodian culture, and although now there seems to be a change to a more market-driven mode or individualism, it is still alive. Once people see the benefits of such initiatives and innovations, both commitment and willingness emerge, allowing more room for cooperative activities. A good example of this is the digging of a community pool in Pursat, where farmers who wanted to share water from the pond also had to share part of their land. Before this innovation, local people had experienced a rainfall change and water shortage and were experiencing an emerging crisis.

Again, a participatory approach is needed. People have to talk to each other and find out what the major climate changes or natural hazards are in their communities and what measures should be developed to minimise or adapt to such changes. To build systematically and improve adaptive capacity, they should first together identify the impacts and then the existing resources. Planning involving representatives from each institution is effective in identifying the needs, roles and responsibilities and possible solutions for all of them. Since they all operate at the community level, the interaction is good enough to develop suitable plans as long as sufficient financial, physical and technical resources are accessible.

8.2.5. Decision Making: Enhancing Participation in Decision Making on Climate Change Adaptation

Interactive climate change adaptation decision-making involving local men and women should be developed through the decentralisation and deconcentration (D&D) process. D&D requires a participatory approach and process. The current bottom-up approach in village and commune planning is seen by stakeholders as an effective means to bring local voices upward. Meetings between villagers and their local government are an excellent example of how D&D works in rural areas, although there are emerging issues regarding participation, capacity and limited commune funds (MOE & UNDP 2011; Plummer & Tritt 2011). However, the issue of climate change has only recently entered the D&D debate (MOE & UNDP 2011), and specific procedures for discussing the topic locally are reported to be limited. Existing debates and meetings are for brainstorming local needs and priorities to develop local planning, including the comprehensive five-year development plan and annual commune investment plan (MOI 2013). Additional meetings should occur regularly so that local government can update the plan to meet critical situations or respond to natural disasters in good time. In addition to the state-related formal meetings, NGOs and development partners generally have various meetings with their project beneficiaries. Some of these activities directly contribute to commune investment plans, commune development plans, commune climate change adaptation plans and commune disaster risk reduction plans. Participation of rural men and women in these kinds of meetings is of crucial importance.

In women’s participation, important is not just the number of women attending meetings, but also how women can contribute to the proceedings. This requires a focus on social norms and arrangements. Social arrangements are vitally important in enhancing local participation and gender balance, and in promoting the productive and community-oriented role of women. Although the trend of having both sexes attend meetings is better than before and female participation has increased, a participatory atmosphere is still limited, and women are still somewhat inhibited in expressing their ideas. This has meant that the participatory approach has not achieved the expected level of interaction and involvement of local people.

9

CONCLUSION

Climate change, whether current or projected, anthropogenic or natural, has major implications for livelihoods and ecosystems. Actions to minimise the impacts must be undertaken systematically and strengthened at all levels and in all agro-ecological zones. However, the limited accurate information about climate and weather, the lack of appropriate climate-smart agriculture and technology for cropping and mitigating pest infestation and disease and lack of infrastructure for transportation, flood protection and drought management hinder people in coping with major changes. Traditional cropping strategies, low access to financial resources for fast recovery, low access to markets, high input costs and lack of effective support remain key challenges to local climate change adaptation capacity in each zone. In addition, geography and landscape, weather, soil type and soil quality and dependence on climate-sensitive resources increase the vulnerability of people's livelihoods in each of the zones and also determine local adaptive capacity.

In particular, rural adaptive capacity, especially of the poor and marginalised groups in the four zones, is moderately low since they depend mainly on climate-sensitive resources and do not have diversified livelihood sources. Their access to financial, human, infrastructure, social and economic assets to help them to cope with climate hazards is notably deficient. In some areas, such assets are accessible, but only to some extent for the poor and marginalised. This compels them to find off-farm jobs and to migrate to towns or neighbouring countries, and reduces their will to improve their own farming.

Under the LAC framework, livelihood assets and the other four closely interrelated and interdependent components are key to ensuring the effective evolution of rural adaptive capacity. Those involved have to work cooperatively to enhance the adaptive capacity of local people by providing them with better access to the assets that have been discussed in this report: accurate weather and climate information and knowledge about adaptation strategies; local innovation and sharing; and flexible decision making. Furthermore, rural people and communities in each zone should collectively work on climate change adaptation strategies and planning, as well as on innovation, and they should strengthen the existing strategies and measures to cope. At the same time, the impacts of climate change and local adaptive capacity should be further examined at sub-national and community level to build resilience.

The recommendations derived from this study are presented in the Executive Summary.

REFERENCES

- ADB, Asian Development Bank (2002), “Report and recommendation of the president to the board of directors on a proposed loan to the Kingdom of Cambodia for the Greater Mekong Subregion: Cambodia road improvement project” (Manila: ADB)
- Adger, W.N. (2003), “Social Capital, Collective Action and Adaptation to Climate Change”, *Economic Geography* 79(4): 387-404
- Agrawal, Arun, and Nicolas Perrin (2009), “Climate Adaptation, Local Institutions and Rural Livelihoods”, in N. Adger, I. Lorenzoni and K. O’Brien (eds.), *Adapting to Climate Change: Thresholds, Values, Governance* (Cambridge: Cambridge University Press) pp. 350-367
- AIT-UNEP AAC.AP (2011), Desktop Study on Assessment of Capacity Gaps and Needs of South East Asia Countries in Addressing Impacts, Vulnerability and Adaptation to Climate Variability and Climate Change” (Bangkok: AIT-UNEP AACAC)
- Ang, Sophea, Il Oeur and John McAndrew (2007), “Understanding Social Capital in Response to Floods and Droughts,” *Cambodian Development Review*, 11(4): 9-12
- Baran, Eric, Peter Starr and Yumiko Kur (eds.) (2007), *Influence of Built Structures on Tonle Sap Fisheries: Synthesis Report* (Phnom Penh: WorldFish)
- CDRI, Cambodia Development Resource Institute (2013), *Cambodia Development Dynamics: Past Performance and Emerging Priorities* (Phnom Penh: CDRI)
- CEDAC, Cambodian Center for Study and Development in Agriculture (2009), “Irrigation Inventory in 13 Provinces in Cambodia” (Phnom Penh: CEDAC)
- Chem P. (2012), “Climate Change and Water Governance in Cambodia” *Cambodia Development Review*, Vol. 16, No4 (Phnom Penh: CDRI) pp. 1-4
- DFID, Department for International Development (1999), “Sustainable Livelihoods Guidance Sheets” (London: DFID)
- DHI (2012a), “Assessment of Coping strategies of the coastal zone of Cambodia”, http://www.unepdhi.org/~media/Microsite_UNEPDHI/Publications/documents/unep_DHI/Assessment%20Coping%20Strategy%20report%202012_Final%20UD.ashx (accessed 3 March 2014)
- DHI (2012b), “Vulnerability of Existing Agricultural Practices” http://www.unepdhi.org/~media/Microsite_UNEPDHI/Publications/documents/unep_DHI/CARP-1211-Vulnerability-Agriculture-Final%20UD.ashx (accessed 3 March 2014)
- Eastham, Judy, Freddie Mpelasoka, Mohammed Mainuddin, Catherine Ticehurst, Peter Dyce, Geoff Hodgson, Riasat Ali and Mac Kirby (2008), “Mekong River Basin Water Resources Assessment: Impacts of Climate Change,” Water for a Healthy Country National Research Flagship (Canberra : CSIRO)
- Ellis, Karen, Jodie Keane, Alberto Lemma and Lonn Pichdara (2013), *Low Carbon Competitiveness in Cambodia* (London: Overseas Development Institute)
- FA, Forestry Administration (2010), “National Forest Programme 2010-2029” (Phnom Penh: Forestry Administration)

- FA (2013), “Community Forestry Statistics in Cambodia 2013” (Phnom Penh: Forestry Administration)
- Fankhauser, Samuel and Richard S.J. Tol (1997), “The Social Costs of Climate Change: The IPCC Second Assessment Report and Beyond,” *Mitigation and Adaptation Strategies for Global Change*, 1(4): 385-403, http://www.researchgate.net/profile/Samuel_Fankhauser/publication/221678659_The_Social_Costs_of_Climate_Change_The_IPCC_Second_Assessment_Report_and_Beyond/file/72e7e525eb846c21a5.pdf (accessed 7 March 2014)
- Grumbine, R. Edward, John Dore and Jianchu Xu (2012), “Mekong Hydropower: Drivers of Change and Governance Challenges,” *Frontiers in Ecology and the Environment*, 10(2): 91-98
- Heng Chanthoeun (2012), “Climate Change Modelling and Projection”, presentation handout for the national workshop on Building Capacity of Institutions to Help Farmers Better, 26-27 September 2012, Royal University of Agriculture, Phnom Penh
- Herbold, J. (2010), “Crop Insurance in Developing Economies – the Insurers’ and Reinsurers’ Perspective”, http://www.rural21.com/uploads/media/R21_Crop_insurance_developing_economies_01.pdf (accessed 6 March 2014)
- Hoanh, Chu Thai, Hans Guttman, Peter Droogers and Jeron Aerts (2004), *Will we Produce Sufficient Food Under Climate Change? Mekong Basin (South-east Asia)* (Wallingford: CABI Publishing)
- HRF, Humanitarian Response Forum (2013), “Cambodia Humanitarian Response Forum (HRF) Situation Report No. 02”, <http://reliefweb.int/report/cambodia/cambodia-humanitarian-response-forum-hrf-situation-report-no-02-08-october-2013> (accessed 16 January 2014)
- IFAD, International Fund for Agricultural Development (2014), “Empowerment of the Poor”, <http://www.ifad.org/events/past/hunger/empower.html> (accessed 19 March 2014)
- IPCC, International Panel on Climate Change (2012), “Summary for Policymakers”, in C.B.Field, V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.K. Plattner, S.K. Allen, M. Tignor and P.M. Midgley (eds.), *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, http://ipcc-wg2.gov/SREX/images/uploads/SREX-SPM_FINAL.pdf (accessed 23 July 2012)
- IWMI, International Water Management Institute (2010), *Rethinking Agriculture in the Greater Mekong Subregion: How to Sustainably Meet Food Needs, Enhance Ecosystem Services and Cope with Climate Change*, http://www.iwmi.cgiar.org/Publications/Other/PDF/Summary-Rethinking_Agriculture_in_the_Greater_Mekong_Subregion.pdf (accessed 7 April 2014)
- Iyalomhe, F. (2011), “Understanding Developing Countries Vulnerability and Adaptation to Climate Change Using Theoretical Change Vulnerability Framework”, *African Journal of Computing and ICT*, 4(3): 33-40
- Jianguo Liu, Thomas Dietz, Stephen R. Carpenter, Carl Folke, Marina Alberti, Charles L. Redman, Stephen H. Schneider, Elinor Ostrom, Alice N. Pell, Jane Lubchenco, William W. Taylor, Zhiyun Ouyang, Peter Deadman, Timothy Kratz and William Provencher (2007), “Coupled Human and Natural Systems”, http://chans-net.org/sites/chans-net.org/files/CHANS_Ambio_2007.pdf (accessed 19 March 2011)

- Jones, Lindsey (2011), “Towards a Holistic Conceptualisation of Adaptive Capacity at the Local Level: Insights From the Local Adaptive Capacity Framework (LAC)”, <http://www.odi.org.uk/sites/odi.org.uk/files/odi-assets/publications-opinion-files/7177.pdf> (accessed 15 March 2013)
- Jones, L., E. Ludi and S. Levine (2010), “Towards a Characterisation of Adaptive Capacity: A Framework for Analysing Adaptive Capacity at the Local Level”, ODI Background Note, <http://www.odi.org.uk/sites/odi.org.uk/files/odi-assets/publications-opinion-files/6353.pdf> (accessed 15 March 2013)
- Karl, Thomas R., Jerry M. Melillo and Thomas C. Peterson (eds.) (2009), *Global Climate Change Impacts in the United States* (Cambridge: Cambridge University Press)
- Keskinen, M., S. Chinvanno, M. Kummu, P. Nuorteva, A. Snidvongs, O. Varis and K. Västilä (2010), “Climate Change and Water Resources in the Lower Mekong River Basin: Putting Adaptation into Context,” *Journal of Water and Climate Change* 1(2): 103-117
- Keskinen, Marko, Matti Kummu, Aura Salmivaara, Paradis Someth, Hannu Lauri, Hans de Moel, Philip Ward and Sokhem Pech (2013), *Tonle Sap Now and In the Future? Final Report of the Exploring Tonle Sap Futures Study*, <http://www.wdrg.fi/wp-content/uploads/2013/08/Exploring-Tonle-Sap-Futures-Final-Report-30august2013.pdf> (accessed 25 December 2013)
- Kummu, Matti and Juha Sarkkula (2008), “Impact of the Mekong River Flow Alteration on the Tonle Sap Flood Pulse (2008),” *AMBIO: A Journal of the Human Environment* 37(3):158-163
- Lewis, Simon (2013), “Hun Sen Reaches for Ambitious Income Target”, <http://www.cambodiadaily.com/archive/hun-sen-reaches-for-ambitious-income-target-18766/> (accessed 13 December 2013)
- MAFF, Ministry of Agriculture, Forestry and Fisheries (2013a), *Annual Report for Agriculture, Forestry and Fisheries (2012-2013)* (Phnom Penh: MAFF)
- MAFF (2013b), *Action Plan for Disaster Risk Reduction in Agriculture (2014-2018)* (Phnom Penh: MAFF)
- MAFF (2013c), “Climate Change Strategic Plan 2013-2018 (Phnom Penh: MAFF)
- MAFF, MOWRAM, CARDI (2009), “Strategy for Agriculture and Water 2010-2013” (Phnom Penh: MAFF and MOWRAM)
- Magnan, Nicholas and Timothy S. Thomas (2011), *Food Security and Climate Change to 2050: Cambodia, A Policy Discussion Paper*, Special Report 11 (Phnom Penh: CDRI)
- MOE, Ministry of Environment (2002), *Cambodia’s Initial National Communication* (Phnom Penh: MOE)
- MOE (2006), “National Adaptation Program of Action to Climate Change (NAPA)” (Phnom Penh: MOE)
- MOE (2013a), “Synthesis Report on Vulnerability and Adaptation Assessment for Key Sectors Including Strategic and Operational Recommendations”, Preparation of a Strategic Pilot Programme for Climate Resilience (PPCR) Project – Phase I (November 2010–January 2012) (Phnom Penh: MOE)

- MOE (2013b), “Cambodia Climate Change Strategic Plan 2014-2023” (Phnom Penh: MOE)
- MOE and UNDP (2011), “Cambodia Human Development Report 2011 Building Resilience: The Future of Rural Livelihoods in the Face of Climate Change” (Phnom Penh: MOE and UNDP Cambodia)
- MOI, Ministry of Interior (2013), “Case Study: Climate Proofing of Investment Projects in Takeo Province”, <http://www.ppcrcambodia.files.wordpress.com/2013/02/7-sn-casestudy-3.pdf> (accessed 6 March 2014)
- MOWRAM, Ministry of Water Resources and Meteorology (2012), “Climate Change Strategic Plan for Water Resources and Meteorology (2013-2017)”, <http://www.camclimate.org.kh/.../70-sector-plan-development-1st-drafts.html> (accessed 8 November 2013)
- MRC, Mekong River Commission (2009), “Adaptation to Climate Change in the Countries of the Lower Mekong Basin,” *MRC Management Information Booklet Series No. 1* (Vientiane: MRC)
- Nakicenovic, Nebojsa and Robert Swart (eds.) (2000), *Special report on Emissions Scenarios* (Cambridge, UK: Cambridge University Press)
- Nang Phirun (2012), “Challenges of Rural Livelihoods in the Context of Climate Change”, *Cambodia Development Review*, 16(3) (Phnom Penh: CDRI) pp. 1-5
- Nang Phirun (2013), *Climate Change Adaptation and Livelihoods in Inclusive Growth: A Review of Climate Change Impacts and Adaptive Capacity in Cambodia*, Working Paper Series No. 82 (Phnom Penh: CDRI)
- Narayan-Parker, Deepa (1999), “Bonds and Bridges: Social Capital and Poverty”, Policy Research Working Paper 2167 (Washington, DC: World Bank)
- NCDD, National Committee for Sub-National Democratic Development (2013), “Commune Database”, <http://www.db.ncdd.gov.kh/cdbonline/home/index.castle> (accessed 15 November 2013)
- Nijssen, Bart, Greg M. O'Donnell, Alan F. Hamlet and Dennis P. Lettenmaier (2001), “Hydrologic Sensitivity of Global Rivers to Climate Change,” *Climatic Change*, Vol. 50, No. 1-2: 143-175
- Nuorteva, P., M. Keskinen and O. Varis (2010), “Water, Livelihoods and Climate Change Adaptation in the Tonle Sap Lake Area, Cambodia: Learning from the Past to Understand the Future”, *Journal of Water and Climate Change*, 1(1): 87-101
- Ostrom, Elinor (2005), *Understanding Institutional Diversity* (Princeton: Princeton University Press)
- Pact (2008), “Community Forestry REDD Project: Oddor Meanchey Cambodia”
<http://www.pactcambodia.org/Publications/CFP/Carbonbrochure.pdf> (accessed 28 January 2014)
- PDRSEA (2008), “Monitoring and Reporting Progress on Community-Based Disaster Risk Management in Cambodia”, http://www.adpc.net/v2007/programs/CBDRM/INFORMATION%20RESOURCE%20CENTER/CBDRM%20Publications/2008/final_crcambodia_23nov.pdf (accessed 8 November 2013)

- Pellini, Arnaldo (2007), “Decentralisation Policy in Cambodia: Exploring Community Participation in the Education Sector” (Tampere, Finland: Tampere University Press)
- Peter, Zsombor (2013), “World Bank Sees Challenges to Government Income Target”, <http://www.cambodiadaily.com/business/world-bank-sees-challenges-to-government-income-target-45405/>, the Cambodia Daily (accessed 13 December 2013)
- Phearanich, H. (2010), “Mapping Vulnerability to Natural Hazards in Stung Treng” (Phnom Penh: IOM)
- Pickens, Mark (2004). “Savings-Led and Self-Help Micro-finance in Cambodia: Lessons Learned and Best Practices”, http://www.pactcambodia.org/Publications/WORTH_Education/Savings-led_Microfinance_in_Cambodia.pdf
- Plummer, J. and G. Tritt (eds.) (2011), “Voice, Choice and Decision: A Study of Local Governance Processes in Cambodia” (The Asia Foundation)
- RGC, Royal Government of Cambodia (2012), *The Cambodian Government’s Achievements and Future Direction in Sustainable Development*, National Report for Rio+20 United Nations Conference on Sustainable Development (Phnom Penh: MOE)
- Ros B., Nang P. and Chhim C. (2011), *Agricultural Development and Climate Change: Cambodia Case Study*, Working Paper Series No. 65 (Phnom Penh: CDRI)
- Sumaylo, K. (2009), “Mapping Vulnerability to Natural Hazards in Ratanakiri,” (Phnom Penh: International Organization for Migration)
- TKK, SEA START RC (2009), *Water and Climate Change in the Lower Mekong Basin: Diagnosis and Recommendations for Adaptation*, Water and Development Research Group, Helsinki University of Technology (TKK), and Southeast Asia START Regional Centre (SEA START RC), Chulalongkorn University (Helsinki: Helsinki University of Technology, Water and Development Publications)
- Ty Sokun (2012), “Agriculture and Climate Change Policy and Strategy”, National Training Workshop on Building Capacity of Institutions to Help Farmers Better Adapt to Climate Variability and Change in Cambodia, 26-27 September 2012, Royal University of Agriculture
- UNDP, United Nations Development Programme (2011), *Cambodia Human Development Report - Building Resilience: The future for Rural Livelihoods in the Face of Climate Change*, <http://www.unhcr.org/refworld/docid/4e7b5d412.html> (accessed 2 April 2013)
- UNEP, United Nations Environment Programme (2010), “Vulnerability Assessment and Adaptation Programme for Climate Change within the Coastal Zone of Cambodia Considering Livelihood Improvement and Ecosystems”, [http://www.thegef.org/gef/sites/thegef.org/files/gef_prj_docs/GEFProjectDocuments/Climate%20Change/Cambodia%20-%20\(3890\)%20-%20Vulnerability%20Assessment%20and%20Adaptation%20Programme/11-03-2010%20ID3890%20-%20Cambodia_prodoc_.pdf](http://www.thegef.org/gef/sites/thegef.org/files/gef_prj_docs/GEFProjectDocuments/Climate%20Change/Cambodia%20-%20(3890)%20-%20Vulnerability%20Assessment%20and%20Adaptation%20Programme/11-03-2010%20ID3890%20-%20Cambodia_prodoc_.pdf) (accessed 8 November 2013)
- Västilä, K., M. Kummu, C. Sangmanee and S. Chinvanho (2010), “Modelling Climate Change Impacts on the Flood Pulse in the Lower Mekong Floodplains,” *Journal of Water and Climate Change*, 1(1): 67-86

- Warrick, R. A. (2000), "Strategies for Vulnerability and Adaptation Assessment in the Context of National Communications", *Asia-Pacific Journal for Environmental Development*, 7: 43-51
- Woolcock, Michael (1998), "Social Capital and Economic Development: Toward a Theoretical Synthesis and Policy Framework," *Theory and Society* 27(2): 151-208
- World Bank (2013), "World Development Indicators", <http://data.worldbank.org/indicator/NY.GDP.PCAP.CD> (accessed 22 January 2014)
- WTO and UNEP, World Tourism Organization and the United Nations Environment Programme (2008), *Climate Change and Tourism: Responding to Global Challenges* (Madrid: World Tourism Organization)
- Yusuf, A.A. and H. Francisco (2009), *Climate Change Vulnerability Mapping for Southeast Asia* (Singapore: Economy and Environment Program for Southeast Asia-EEPSEA)

CDRI WORKING PAPER SERIES

- 1) Kannan, K.P. (November 1995), *Construction of a Consumer Price Index for Cambodia: A Review of Current Practices and Suggestions for Improvement*.
- 2) McAndrew, John P. (January 1996), *Aid Infusions, Aid Illusions: Bilateral and Multilateral Emergency and Development Assistance in Cambodia. 1992-1995*.
- 3) Kannan, K.P. (January 1997), *Economic Reform, Structural Adjustment and Development in Cambodia*.
- 4) Chim Charya, Srun Pithou, So Sovannarith, John McAndrew, Nguon Sokunthea, Pon Dorina & Robin Biddulph (June 1998), *Learning from Rural Development Programmes in Cambodia*.
- 5) Kato, Toshiyasu, Chan Sophal & Long Vou Piseth (September 1998), *Regional Economic Integration for Sustainable Development in Cambodia*.
- 6) Murshid, K.A.S. (December 1998), *Food Security in an Asian Transitional Economy: The Cambodian Experience*.
- 7) McAndrew, John P. (December 1998), *Interdependence in Household Livelihood Strategies in Two Cambodian Villages*.
- 8) Chan Sophal, Martin Godfrey, Toshiyasu Kato, Long Vou Piseth, Nina Orlova, Per Ronnås & Tia Savora (January 1999), *Cambodia: The Challenge of Productive Employment Creation*.
- 9) Teng You Ky, Pon Dorina, So Sovannarith & John McAndrew (April 1999), *The UNICEF/Community Action for Social Development Experience—Learning from Rural Development Programmes in Cambodia*.
- 10) Gorman, Siobhan, with Pon Dorina & Sok Kheng (June 1999), *Gender and Development in Cambodia: An Overview*.
- 11) Chan Sophal & So Sovannarith (June 1999), *Cambodian Labour Migration to Thailand: A Preliminary Assessment*.
- 12) Chan Sophal, Toshiyasu Kato, Long Vou Piseth, So Sovannarith, Tia Savora, Hang Chuon Naron, Kao Kim Hourn & Chea Vuthna (September 1999), *Impact of the Asian Financial Crisis on the SEATEs: The Cambodian Perspective*.
- 13) Ung Bunleng, (January 2000), *Seasonality in the Cambodian Consumer Price Index*.
- 14) Toshiyasu Kato, Jeffrey A. Kaplan, Chan Sophal & Real Sopheap (May 2000), *Enhancing Governance for Sustainable Development*.
- 15) Godfrey, Martin, Chan Sophal, Toshiyasu Kato, Long Vou Piseth, Pon Dorina, Tep Saravy, Tia Savara & So Sovannarith (August 2000), *Technical Assistance and Capacity Development in an Aid-dependent Economy: the Experience of Cambodia*.
- 16) Sik Boreak, (September 2000), *Land Ownership, Sales and Concentration in Cambodia*.
- 17) Chan Sophal, & So Sovannarith, with Pon Dorina (December 2000), *Technical Assistance and Capacity Development at the School of Agriculture Prek Leap*.
- 18) Godfrey, Martin, So Sovannarith, Tep Saravy, Pon Dorina, Claude Katz, Sarthi Acharya, Sisowath D. Chanto & Hing Thoraxy (August 2001), *A Study of the Cambodian Labour Market: Reference to Poverty Reduction, Growth and Adjustment to Crisis*.
- 19) Chan Sophal, Tep Saravy & Sarthi Acharya (October 2001), *Land Tenure in Cambodia: a Data Update*.

- 20) So Sovannarith, Real Sopheap, Uch Utey, Sy Rathmony, Brett Ballard & Sarthi Acharya (November 2001), *Social Assessment of Land in Cambodia: A Field Study*.
- 21) Bhargavi Ramamurthy, Sik Boreak, Per Ronnås and Sok Hach (December 2001), *Cambodia 1999-2000: Land, Labour and Rural Livelihood in Focus*.
- 22) Chan Sophal & Sarthi Acharya (July 2002), *Land Transactions in Cambodia: An Analysis of Transfers and Transaction Records*.
- 23) McKenney, Bruce & Prom Tola. (July 2002), *Natural Resources and Rural Livelihoods in Cambodia*.
- 24) Kim Sedara, Chan Sophal & Sarthi Acharya (July 2002), *Land, Rural Livelihoods and Food Security in Cambodia*.
- 25) Chan Sophal & Sarthi Acharya (December 2002), *Facing the Challenge of Rural Livelihoods: A Perspective from Nine Villages in Cambodia*.
- 26) Sarthi Acharya, Kim Sedara, Chap Sotharith & Meach Yady (February 2003), *Off-farm and Non-farm Employment: A Perspective on Job Creation in Cambodia*.
- 27) Yim Chea & Bruce McKenney (October 2003), *Fish Exports from the Great Lake to Thailand: An Analysis of Trade Constraints, Governance, and the Climate for Growth*.
- 28) Prom Tola & Bruce McKenney (November 2003), *Trading Forest Products in Cambodia: Challenges, Threats, and Opportunities for Resin*.
- 29) Yim Chea & Bruce McKenney (November 2003), *Domestic Fish Trade: A Case Study of Fish Marketing from the Great Lake to Phnom Penh*.
- 30) Hughes, Caroline & Kim Sedara with the assistance of Ann Sovatha (February 2004), *The Evolution of Democratic Process and Conflict Management in Cambodia: A Comparative Study of Three Cambodian Elections*.
- 31) Oberndorf, Robert B. (May 2004), *Law Harmonisation in Relation to the Decentralisation Process in Cambodia*.
- 32) Murshid, K.A.S. & Tuot Sokphally (April 2005), *The Cross Border Economy of Cambodia: An Exploratory Study*.
- 33) Hansen, Kasper K. & Neth Top (December 2006), *Natural Forest Benefits and Economic Analysis of Natural Forest Conversion in Cambodia*.
- 34) Pak Kimchoeun, Horng Vuthy, Eng Netra, Ann Sovatha, Kim Sedara, Jenny Knowles & David Craig (March 2007), *Accountability and Neo-patrimonialism in Cambodia: A Critical Literature Review*.
- 35) Kim Sedara & Joakim Öjendal with the assistance of Ann Sovatha (May 2007), *Where Decentralisation Meets Democracy: Civil Society, Local Government, and Accountability in Cambodia*.
- 36) Lim Sovannara (November 2007), *Youth Migration and Urbanisation in Cambodia*.
- 37) Chem Phalla *et al.* (May 2008), *Framing Research on Water Resources Management and Governance in Cambodia: A Literature Review*.
- 38) Pak Kimchoeun and David Craig (July 2008), *Accountability and Public Expenditure Management in Decentralised Cambodia*.
- 39) Horng Vuthy and David Craig (July 2008), *Accountability and Planning in Decentralised Cambodia*.
- 40) Eng Netra and David Craig (March 2009), *Accountability and Human Resource Management in Decentralised Cambodia*.

- 41) Hing Vutha and Hossein Jalilian (April 2009), *The Environmental Impacts of the ASEAN-China Free Trade Agreement for Countries in the Greater Mekong Sub-region*.
- 42) Thon Vimealea, Ou Sivhuoch, Eng Netra and Ly Tem (October 2009), *Leadership in Local Politics of Cambodia: A Study of Leaders in Three Communes of Three Provinces*.
- 43) Hing Vutha and Thun Vathana (December 2009), *Agricultural Trade in the Greater Mekong Sub-region: The Case of Cassava and Rubber in Cambodia*.
- 44) Chan Sophal (December 2009), *Costs and Benefits of Cross-border Labour Migration in the GMS: Cambodia Country Study*.
- 45) CDRI Publication (December 2009), *Costs and Benefits of Cross-country Labour Migration in the GMS: Synthesis of the Case Studies in Thailand, Cambodia, Laos and Vietnam*.
- 46) CDRI Publication (December 2009), *Agricultural Trade in the Greater Mekong Sub-region: Synthesis of the Case Studies on Cassava and Rubber Production and Trade in GMS Countries*.
- 47) Chea Chou (August 2010), *The Local Governance of Common Pool Resources: The Case of Irrigation Water in Cambodia*.
- 48) CDRI Publication (August 2010), *Empirical Evidence of Irrigation Management in the Tonle Sap Basin: Issues and Challenges*.
- 49) Chem Phalla and Someth Paradis (March 2011), *Use of Hydrological Knowledge and Community Participation for Improving Decision-making on Irrigation Water Allocation*.
- 50) Pak Kimchoeun (May 2011), *Fiscal Decentralisation in Cambodia: A Review of Progress and Challenges*.
- 51) Christopher Wokker, Paulo Santos, Ros Bansok and Kate Griffiths (June 2011), *Irrigation Water Productivity in Cambodian Rice System*.
- 52) Ouch Chandarany, Saing Chanhang and Phann Dalis (June 2011), *Assessing China's Impact on Poverty Reduction In the Greater Mekong Sub-region: The Case of Cambodia*.
- 53) Chann Sopheak, Nathan Wales and Tim Frewer (August 2011), *An Investigation of Land Cover and Land Use Change in Stung Chrey Bak Catchment, Cambodia*.
- 54) Nang Phirun, Khiev Daravy, Philip Hirsch and Isabelle Whitehead (June), *Improving the Governance of Water Resources in Cambodia: A Stakeholder Analysis*.
- 55) Kem Sothorn, Chhim Chhun, Theng Vuthy and So Sovannarith (July 2011), *Policy Coherence in Agricultural and Rural Development: Cambodia*.
- 56) Tong Kimsun, Hem Socheth and Paulos Santos (July 2011), *What Limits Agricultural Intensification in Cambodia? The role of emigration, agricultural extension services and credit constraints*.
- 57) Tong Kimsun, Hem Socheth and Paulos Santos (August 2011), *The Impact of Irrigation on Household Assets*.
- 58) Hing Vutha, Lun Pide and Phann Dalis (August 2011), *Irregular Migration from Cambodia: Characteristics, Challenges and Regulatory Approach*.
- 59) Chem Phalla, Philip Hirsch and Someth Paradis (September 2011), *Hydrological Analysis in Support of Irrigation Management: A Case Study of Stung Chrey Bak Catchment, Cambodia*.
- 60) Saing Chan Hang, Hem Socheth and Ouch Chandarany with Phann Dalish and Pon Dorina (November 2011), *Foreign Investment in Agriculture in Cambodia*.
- 61) Ros Bandeth, Ly Tem and Anna Thompson (September 2011), *Catchment Governance and Cooperation Dilemmas: A Case Study from Cambodia*.

- 62) Chea Chou, Nang Phirun, Isabelle Whitehead, Phillip Hirsch and Anna Thompson (October 2011), *Decentralised Governance of Irrigation Water in Cambodia: Matching Principles to Local Realities*.
- 63) Heng Seiha, Kim Sedara and So Sokbunthoeun (October 2011), *Decentralised Governance in Hybrid Polity: Localisation of Decentralisation Reform in Cambodia*
- 64) Tong Kimsun, Sry Bopharath (November 2011), *Poverty and Environment Links: The Case of Rural Cambodia*.
- 65) Ros Bansok, Nang Phirun and Chhim Chhun (December 2011), *Agricultural Development and Climate Change: The Case of Cambodia*
- 66) TONG Kimsun (February 2012), *Analysing Chronic Poverty in Rural Cambodia Evidence from Panel Data*
- 67) Keith Carpenter with assistance from PON Dorina (February 2012), *A Basic Consumer Price Index for Cambodia 1993–2009*
- 68) Roth Vathana (March 2012), *Sectoral Composition of China's Economic Growth, Poverty Reduction and Inequality: Development and Policy Implications for Cambodia*
- 69) CDRI Publication (March 2012), *Understanding Poverty Dynamics: Evidence from Nine Villages in Cambodia*
- 70) Hing Vutha, Saing Chan Hang and Khieng Sothy (August 2012), *Baseline Survey for Socioeconomic Impact Assessment: Greater Mekong Sub-region Transmission Project*
- 71) Kim Sedara and Joakim Öjendal with Chhoun Nareth and Ly Tem (December 2012), *A Gendered Analysis of Decentralisation Reform in Cambodia*
- 72) Hem Socheth (March 2013), *Impact of the Global Financial Crisis on Cambodian Economy at Macro and Sectoral Levels*
- 73) Hay Sovuthea (March 2013), *Government Response to Inflation Crisis and Global Financial Crisis*
- 74) Ngin Chanrith (March 2013), *Impact of the Global Financial Crisis on Employment in SMEs in Cambodia*
- 75) Tong Kimsun (March 2013), *Impact of the Global Financial Crisis on Poverty: Evidence from Nine Villages in Cambodia*
- 76) Hing Vutha (March 2013), *Impact of the Global Financial Crisis on the Rural Labour Market: Evidence from Nine Villages in Cambodia*
- 77) Saing Chan Hang (March 2013), *Household Vulnerability to Global Financial Crisis and Their Risk Coping Strategies: Evidence from Nine Rural Villages in Cambodia*
- 78) Tong Kimsun and Phay Sokcheng (March 2013), *The Role of Income Diversification during the Global Financial Crisis: Evidence from Nine Villages in Cambodia*
- 79) Lun Pidé (March 2013), *The Role of Rural Credit during the Global Financial Crisis: Evidence From Nine Villages in Cambodia*
- 80) Saing Chan Hang (March 2013), *Binding Constraints on Economic Growth in Cambodia: A Growth Diagnostic Approach*
- 81) Hing Vutha (June 2013), *Leveraging Trade for Economic Growth in Cambodia*
- 82) Nang Phirun (July 2013), *Climate Change Adaptation and Livelihoods in Inclusive Growth: A Review of Climate Change Impacts and Adaptive Capacity in Cambodia*
- 83) Tong Kimsun, Lun Pide and Sry Bopharath with the assistance of Pon Dorina (August 2013) *Levels and Sources of Household Income in Rural Cambodia 2012*

- 84) Ou Sivhuoch (August 2013), *Sub-National Civil Society in Cambodia: A Gramscian Perspective*
- 85) Ou Sivhuoch and Kim Sedara (August 2013), *20 Years' Strengthening of Cambodian Civil Society: Time for Reflection*
- 86) Sen Vicheth and Ros Soveacha with the assistance of Hieng Thiraphumry (October 2013), *Anatomy of Higher Education Governance in Cambodia*
- 87) Kim Sedara and Joakim Öjendal With the assistance of Chhoun Nareth (November 2013), *Gatekeepers in Local Politics: Political Parties in Cambodia and their Gender Policy*
- 88) Chheat Sreang (December 2013), *Impact of Decentralisation on Cambodia's Urban Governance*
- 89) Nang Phirun and Ouch Chhuong (January 2014), *Gender and Water Governance: Women's Role in Irrigation Management and Development in the Context of Climate Change*
- 90) CDRI Publication (January 2014), *ASEAN 2030: Growing Together for Economic Prosperity—the Challenges (Cambodia Background Paper)*
- 91) Theng Vuthy, Khiev Pirom and Phon Dary (April 2014), *Development of the Fertiliser Industry in Cambodia: Structure of the Market, Challenges in the Demand and Supply Sides and the Way Forward*
- 92) Phann Dalis (June 2014) *Links between Employment and Poverty in Cambodia*

**CDRI - Cambodia's leading
independent development policy research institute**

📍 56 Street 315, Tuol Kork

✉ PO Box 622, Phnom Penh, Cambodia

☎ (855 23) 881 384/881 701/881 916/883 603

📠 (855 23) 880 734

E-mail: cdri@cdri.org.kh

Website: www.cdri.org.kh

Price: USD2.00

