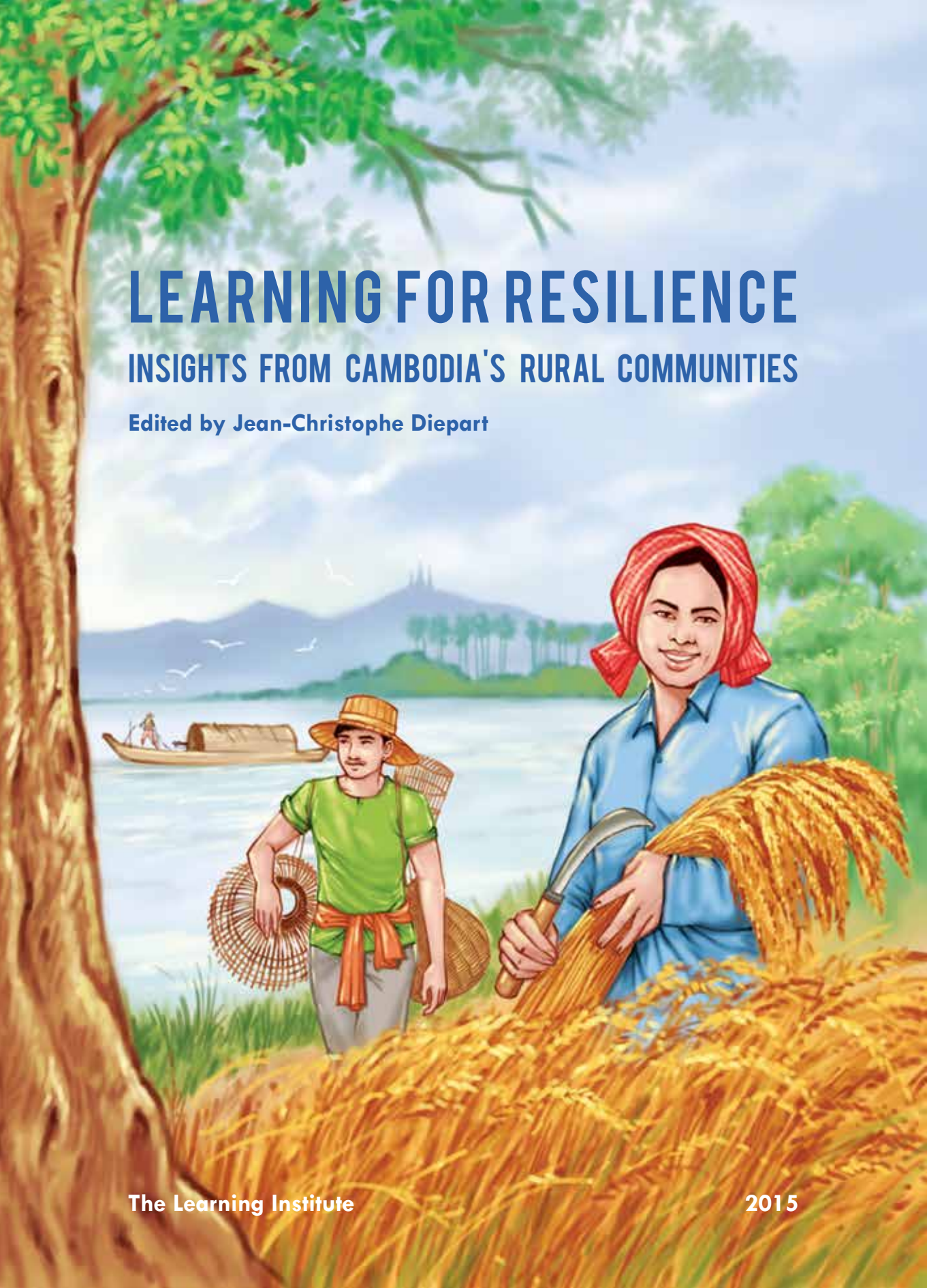
# LEARNING FOR RESILIENCE

## INSIGHTS FROM CAMBODIA'S RURAL COMMUNITIES

Edited by Jean-Christophe Diepart



The Learning Institute 2015

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**Edited by Jean-Christophe Diepart**

**The Learning Institute**

**2015**

The views expressed in the following papers are those of the authors and are not necessarily reflective of the supporting partners.

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# FOREWORD

It is a pleasure to introduce this new Learning Institute publication - Learning for resilience: Insights from Cambodia's rural communities. The idea and proposal for this comprehensive project were initiated while I was Chairman of the Learning Institute's Board of Directors and I am delighted to see the results of what has been a long and complex process. These chapters will not only provide essential guidance for the Cambodians who are tackling the challenges of a changing climate, but also supply evidence to help with government policy-making and implementation. It is also my profound hope that this will focus more attention on the factors that support resilience, and lead to more research and ultimately the evidence that is crucial for interventions that are efficient and effective.

This book is also timely. Cambodians throughout the country have been facing greater instances of flooding, with changing patterns of precipitation. Even in the cities this has caused major upheaval. But for rural farmers, these changes have often challenged the viability of established cropping calendars and crop varieties with catastrophic consequences leading to acute anxiety for the country's most vulnerable people. Even so, as some of these reports show, government interventions in, for instance, encouraging the uptake of new rice varieties and in guiding the people to adopt new agricultural practices, have been having a positive effect. This is particularly heartening for the government in its plans to increase rice exports: there is a growing international demand for our country's high quality rice, and this is already starting to attract much-needed export income. Clearly there is a convergence of interest, supporting the notion that climate adaptation should be mainstreamed within agricultural development.

But, as other chapters show, resilience is being built not just from external intervention, but through the initiative of the farmers themselves. Many have been finding their own ways to cope with a changing climate - through, for instance, different forms of labor and livelihood diversification. The lessons learnt from many of the locations studied will be of benefit to others: in recording these innovative practices, this book can help to inspire people throughout the country to consider and perhaps even adopt new crops, new practices and even new livelihood activities.

There is clearly much to celebrate. But this book also draws attention to problems that persist or have emerged: there is still much to be done. As some chapters reveal, households are not equally equipped to cope with the challenges presented by a changing climate. Indeed, social-economic differentiation has been increasing in some locations. New crop varieties can help with adaptation to new rainfall patterns, but adopting these often requires initial outlay that is beyond the means of the country's poorest people. Without this remedy, they are often forced into wage labor, much of it requiring migration with the consequent threats of family break-down and a lack of cohesion within communities. As another negative response, the need to draw too heavily on natural resources to compensate for diminished agricultural output often depletes forests and fish stocks to an extent that threatens their sustainability. The modernization of farming practices is clearly desirable, but this needs to

take place with due regard to the needs of all community members, as well as the future welfare of the country's agriculture as a whole. Within this process, attention must remain focused on the long-term: the future health of the soil, forests and so on must not be sacrificed for the attractive but short-term financial gains of some business enterprise initiatives. Research conducted for this project shows that there are alternatives to rice mono-cropping intensification that avoid many of these problems: the multi-purpose farming system, for instance, is shown to be environmentally sound, economically beneficial and socially equitable. As such, its wider adoption could greatly support the government's green growth policy.

As another factor, the need to manage water resources in a climate that now presents more floods and droughts than before, is crucial. The evidence presented here shows that arrangements, specifically the Farmer Water User Communities, have great potential to play a positive role in managing water resources, but that they are not yet functioning as well as they might. This publication highlights their difficulties and presents approaches that can help to improve their usefulness and thereby achieve their potential.

In their 2009 seminal study, Yusuf and Francisco showed that Cambodia was particularly vulnerable to climate change and the reports here provide further evidence that unpredictable floods and droughts are threats to people who already struggle to feed themselves and their families. At the same time, in a wider perspective, Cambodia is already challenged to compete in a larger international trading environment with the realization of the ASEAN Economic Community. But along with these threats and challenges, great opportunities have also emerged. It is my profound hope that positive lessons can be learnt from the research reported in this book. While heeding the warnings, we can still take comfort in the initiatives and growing resilience of so many Cambodians who have advice and experience to share with others. There is a growing understanding, even in the poorest communities, that the climate is changing and that they must make consequent adjustments to their lives. In many instances, such changes have turned into opportunities that have enhanced resilience, increased output, and improved the outlook for our country's economy.

I congratulate the Learning Institute and the other organisations for the thoroughness of their research and for the wide scope of their activity. Bringing the many projects together to identify common themes and to put forward suggestions for improvement is an outstanding achievement. Sound government policy needs the support of reliable evidence, and this book sets a good example which I hope will inspire further work in these areas that are so vital to Cambodia's future development.

**H.E. Dr. Hang Chuon Naron**
Minister for Education Youth and Sport
December 2014

# LIST OF ACRONYMS

| | |
|---|---|
| ADB | Asian Development Bank |
| ADG | Aide au Développement Gembloux |
| ADIC | Analyzing Development Issues Centre |
| ANOVA | Analysis of Variance |
| ASEAN | Association of Southeast Asian Nations |
| CARERE | The UNDP Cambodia Reintegration and Rehabilitation project |
| CARP | Coastal Adaptation and Resilience Planning Component |
| CBNRM | Community-based Natural Resource Management |
| CDRI | Cambodia Development Resource Institute |
| CEDAC | Centre d'Etude et de Dévelopement Agricole Cambodgien (or Cambodian Centre for Study and Development in Agriculture) |
| CFi | Community Fishery |
| CFDD-FiA | Department of Community Fishery Development, Fishery Administration |
| CIDSE | Cooperation Internationale pour Développement et la Solidarité (or International Cooperation for Development and Solidarity) |
| CPA | Community Protected Area |
| CPRs | Common Pool Resources |
| CPUE | Catch per unit effort |
| CRS | Catholic Relief Services |
| CZM-DANIDA | Danish International Development Assistance (project to support Coastal Zone Management) |
| DES-RUPP | Department of Environmental Sciences, Royal University of Phnom Penh |
| ELC | Economic land concession |
| FA | Forestry Administration |
| FiA | Fisheries Administration |
| FGD | Focus Group Discussion |
| FWUC | Farmer Water User Community |
| GDANCP-MOE | General Department of Administration for Nature Conservation and Protection of the Ministry of Environment |
| GDP | Gross Domestic Product |
| GTZ | Deutsche Gesellschaft für Technische Zusammenarbeit (German agency for technical cooperation) (now called GIZ) |
| HH | Household |
| IDRC | International Development Research Centre |

| | |
|---|---|
| IPs | Indigenous people |
| IPCC | International Panel on Climate Change |
| IUCN | International Union for Conservation of Nature |
| IWRM | Integrated Water Resources Management |
| KSL | Koh Sralao |
| LI | Learning Institute |
| LTR | Long-term rice |
| LUCC | Land Use and Cover Changes |
| MAFF | Ministry of Agriculture, Forestry and Fisheries |
| MOE | Ministry of Environment |
| MoU | Memorandum of understanding |
| MOWRAM | Ministry of Water Resources and Meteorology |
| MPF | Multi-purpose farming system |
| MRC | Mekong River Commission |
| MTR | Medium-term rice |
| NAPA | National Adaptation Programme of Action to Climate Change |
| NCCC | National Climate Change Committee |
| NCDD | National Committee for Management of Decentralization & Deconcentration Reforms |
| NCDM | National Committee for Disaster Management |
| NGO | Non-governmental organization |
| NSDP | National Strategic Development Plan |
| NTFP | Non-timber forest product |
| NRM | Natural Resource Management |
| OAA | Other aquatic animals |
| PADEK | Partnership for Development of Kampuchea |
| PA | Protected Area |
| PAR | Participatory Action Research |
| PCDM | Provincial Committee for Disaster Management |
| PDA | Provincial Department of Agriculture |
| PDOAFF | Provincial Department of Agriculture Forestry and Fisheries |
| PDOE | Provincial Department of Environment |
| PDOWRAM | Provincial Department of Water Resources and Meteorology |
| PKWS | Peam Krasaop Wildlife Sanctuary |
| PMCR | Participatory Management Coastal Resources |
| PMMR | Participatory Management Mangrove Resources |
| PRA | Participatory Rural Appraisal |
| RCAF | Royal Cambodian Armed Forces |
| REDD | Reduced Emissions from Deforestation and forest Degradation |

| | |
|---|---|
| RUA | Royal University of Agriculture |
| RUPP | Royal University of Phnom Penh |
| SBCA | Seima Biodiversity Conservation Area |
| SES | Socio-ecological systems |
| SID | System of Intensification and Diversification |
| SPF | Seima Protection Forest |
| SRI | System of Rice Intensification |
| STR | Short-term rice |
| TKK | Toul Korki |
| UNDP | United Nations Development Programme |
| USD | US dollar |
| VNP | Virachey National Park |

# Acknowledgements

This book grew out of a research program conducted from 2011 to 2014, entitled 'Food security, climate change and natural resource management in Cambodia'. I would like to thank the International Development Resource Centre (IDRC) of Canada for funding this comprehensive project, particularly Dr. Annie Wesley, Dr. Carrie Mitchell, Dr. Charlotte MacAlister and Dr. Sara Ahmed for the guidance they gave during the program implementation and monitoring.

This book is also the result of close cooperation between the Learning Institute and partners such as the Ministry of Environment (MOE), Analyzing Development Issues Centre (ADIC), the Fisheries Administration (FiA), the Royal University of Phnom Penh (RUPP) and the Cambodian Centre for Study and Development in Agriculture (CEDAC).

My sincere thanks must also go to all of the authors for their dedication and hard work. Dr. Jean-Christophe Diepart provided them with guidance, enthusiastic encouragement and support all the way through. Laura Schoenberger and Ronald Jones supplied additional advisory support, particularly at the beginning of the project and during the completion stages of the book. External peer-review referees provided useful input and comments, and Dr. Jan Taylor did a great job in undertaking the entire final editing work.

In addition, I would like to thank the Learning Institute staff who have contributed to this project, especially Mr. Hay Sochet and Mr. Lim Kimsong for the book layout and design, Mr. Pech Sithan, Ms. Houn Kalyan and Mr. Chan Bunnara for their effective coordination and communication with the researchers, and Ms. Khut Srey Chantheary and Ms. Heng Binmany for monitoring the financial aspects. The researchers involved in the early phase of the program (Ms. Pon Dary, Mr. Jeremy Cuvelier, Mr. Valentin Joyeux, Mr. Tol Sokchea, Mr. Kob Math, Mr. Nhim Tum and Mr. Mean Ratanak) made positive contributions in designing individual research projects and in facilitating field data collection.

My deep gratitude also goes to all partners and respondents in the areas where research was conducted including provincial line departments, sub-national and local administrations, community representatives, farmers, non-governmental organizations, students from public and private universities, as well as representatives from indigenous youth associations. They all provided great assistance in the preparation of, and during, field data collection.

I hope that this book will act as a catalyst, focusing greater attention on the challenges rural Cambodians are now facing, and inspiring further study into the crucial elements of social-ecological resilience.

**Srey Marona**
Executive Director
The Learning Institute

# Introduction

HENG Chinda, SREY Marona and Jean-Christophe DIEPART

## THE RESEARCH PROCESS

The research program on 'Food security, climate change and natural resource management in Cambodia' took place from 2011 to 2014. In implementing this major project, the Learning Institute received financial support from the International Development Research Centre (IDRC) of Canada and acted as a grant-making organization for partners conducting related research projects. However, the Learning Institute also conducted three action research projects of its own as part of the program. Procedures were developed to ensure the transparency and accountability of research grant selection by a Research Advisory Committee consisting of four people with extensive research knowledge and experience related to natural resource management (NRM), climate change and food security in the country and region. Out of the 21 concept notes submitted, five were selected to be developed into full research proposals.

In total, the program has funded eight research projects involving a total of 25 researchers. The five external grantees represented government institutions, academic institutions and local non-governmental organizations namely: the General Department of Administration for Nature Conservation and Protection of the Ministry of Environment (GDANCP-MOE), the Department of Community Fishery Development of the Fisheries Administration (CFDD-FiA), the Department of Environmental Sciences of the Royal University of Phnom Penh (DES-RUPP), the Analyzing Development Issues Centre (ADIC) and the Cambodian Centre for Study and Development in Agriculture (CEDAC). These eight projects have spanned the country (Figure 1) and address specific dimensions of the nexus of 'climate change-food security-natural resources management'.

Prior to the actual implementation of the projects, nine training workshops were organized to enhance the conceptual design of each research project and to help researchers to identify relevant research tools. During the project implementation, two training sessions were organized to further develop the researchers' skills and knowledge in data management and analysis. In addition, there was a constant exchange of communication between the Learning Institute and each research project team through on-the-job training and mentoring sessions. Technical and advisory support throughout the program was provided by an international research advisor with additional assistance from a second advisor during the completion of this volume. After an internal reviewing and editing process of each chapter by the Learning Institute, each chapter was sent out for external peer review. These experts were selected from an international pool who were all experienced researchers and professionals in their field.

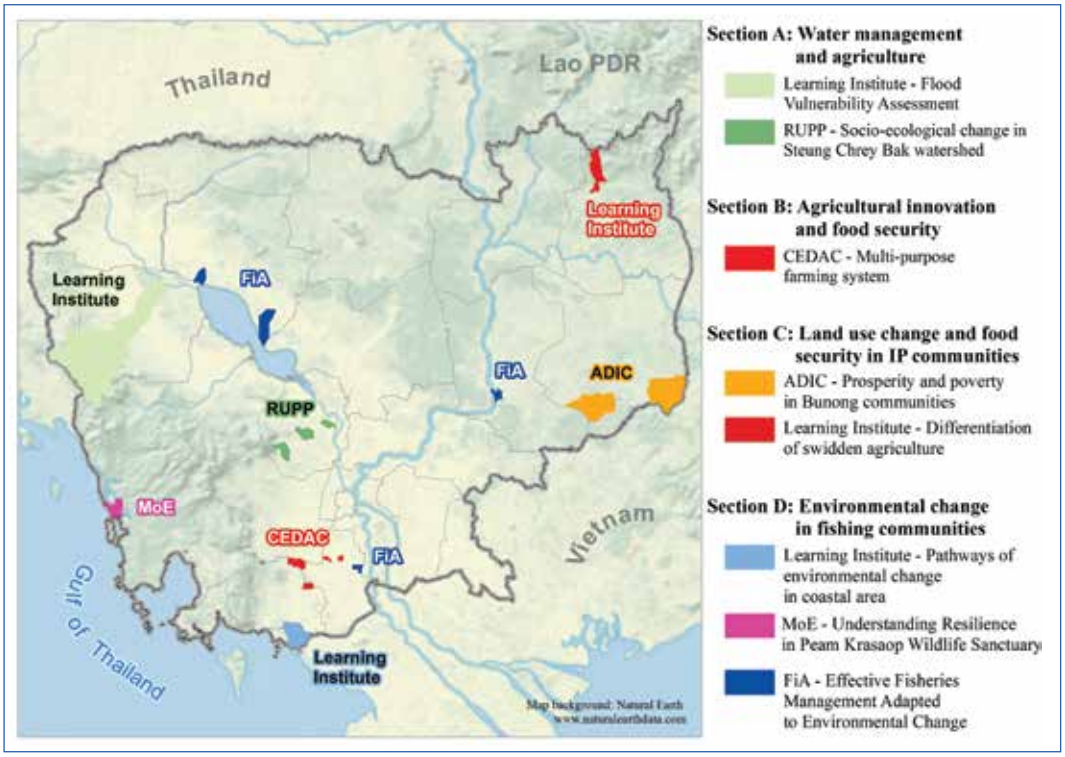


***Figure 1:*** *Research projects and study areas*

In many ways the program has been about learning. In the first place, the changing environment is expected to intensify the challenges that people face, particularly those groups whose livelihoods depend on natural resources. The adaptive capacity of vulnerable actors largely defines the extent to which they will cope with future environmental changes, whether these are caused by climate change or by other factors such as land use changes and water resource development (Nuorteva et al. 2010). Thus, a central concern throughout the program has been to learn from the past experiences of the diverse actors in attempting to adapt to these changes (successfully or not). This is seen as a prerequisite to enhance their adaptive capacity in the future. Second, learning for resilience has emerged conceptually as a central idea of the program. Resilience requires that a social-ecological system is able to absorb disturbance and re-organize while undergoing change (Walker et al. 2004). But Folke (2006) suggests that resilience is also about the opportunities that disturbance opens up in terms of a recombination of evolved structures and processes, a renewal of the system and the emergence of new trajectories. Resilience builds on adaptive capacity to facilitate continuous development, like a dynamic adaptive interplay that allows for development prompted by change (Smit and Wandel 2006). With this perspective, the concept of resilience in relation to social-ecological systems incorporates the idea of learning; learning to manage through change, proactively, rather than simply reacting to it (Folke 2006). Third, the program has been a learning opportunity for the Learning Institute, which has been active in the development of community-based natural resource management (CBNRM) in Cambodia. The Learning Institute researchers have drawn on past experience to

reformulate a number of questions and hypotheses around natural resource co-management and to revisit the CBNRM approach both thematically and conceptually. As a fourth element of the learning process, the Learning Institute has engaged in new partnerships with other research organizations and with stakeholders in the field to support them in the development of their own research experience and expertise.

## STRUCTURE OF THE BOOK

In addition to this introduction, the book includes 10 chapters. The first chapter provides the overview of the conceptual approach of the program and a synthesis of key findings. The core of the book consist of eight chapters which have been grouped thematically in four sections: water management and agriculture; agricultural innovation and food security; land use change and food security strategies in communities of indigenous people; and environmental change in fishing communites. The final chapter is a conclusion proposing some outward looking perspectives to foster social-ecological resilience in rural Cambodia.

# BIBLIOGRAPHY

Folke, C. (2006) Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change, 16*, pp. 253-267.

Nuorteva, P., Keskinen, M. and Varis, O. (2010) Water, livelihoods and climate change ad aptation in the Tonle Sap Lake area, Cambodia: learning from the past to understand the future. *Journal of Water and Climate Change, 1*(1), pp. 87-101.

Smit, B. and Wandel, J. (2006) Adaptation, adaptive capacity and vulnerability. *Global Environmental Change, 16*(3), pp. 282-292.

Walker, B., Holling, C. S., Carpenter, S. R. and Kinzig, A. (2004) Resilience, Adaptability and Transformability in Social–ecological Systems. *Ecology and Society, 9*(2), 5.

# CHAPTER 1

## Learning for social-ecological resilience: Conceptual overview and key findings

Jean-Christophe DIEPART

The land and aquatic systems that form the basis for food security and economic development in Cambodia have changed dramatically over past decades. Under the influence of different social and ecological drivers, these changes comprise a diversity of processes that have interacted across multiple scales, e.g. the gradual change in our climate, the more rapid modifications of land and natural resources tenure regimes, the immediate opportunities and persistent constraints offered by the social-economic transformations of the country, the slow but inexorable degradation of the natural resource base and so on. Usually, these processes are not aligned nor do they proceed in predictable linear fashion (Peluso and Lund 2011); they are often dynamic, surprising, contradictory and usually end in conflict. But they are profound because they affect relationships between people and their environment and result in a repositioning of the role and place of land, natural resources and rural communities in the development of the country.

The research program entitled 'Food Security, Climate Change and Natural Resource Management in Cambodia' has aimed to examine these transformations through a four-year scientific adventure conducted as a joint effort by six institutions. It was conceived as an action-research initiative endeavoring not just to analyze how social-ecological changes affect land use and aquatic systems but also to understand the processes and activities that allow vulnerable people at local level to adapt to these changes while trying to maintain or even improve their food security.

The overall conceptual approach of the research program will be presented below, along with a thematic discussion of the key environmental or governance processes addressed by the authors in this volume.

## RESEARCH FRAMEWORK

The focus of our investigations is land use or water systems that we conceptualize as social-ecological systems (SES). Given that they are produced by the interactions between ecosystems and human social economic systems, SES are inevitably in a state of constant flux (Low et al. 1999). In Cambodia, the production and productivity of land- or water-based SES have undergone an important transformation in recent decades: high levels of deforestation have been reported (Hansen et al. 2013, Save Cambodia's Wildlife 2014), there has been a vast movement of agrarian colonization from lowland rice plains to uplands associated with lowland-upland migration (Diepart et al. 2014), as well as land degradation resulting from

poor soil conservation practices (Bai et al. 2008, Seng 2014), and a decline in aquatic habitat quality and thus yield per fisher (Baran 2005).

In common with other countries, Cambodia's SES are subject to change as a result of the inter-related action of different drivers which can be any natural or human-induced factor acting directly or indirectly on the system, i.e. the environment, economy, institutions, demography and culture. We assess these transformations in a multi-scale framework (Figure 1) to capture the high variability in biophysical environments, social-economic activities, and cultural contexts that have triggered them (Cash et al. 2006).

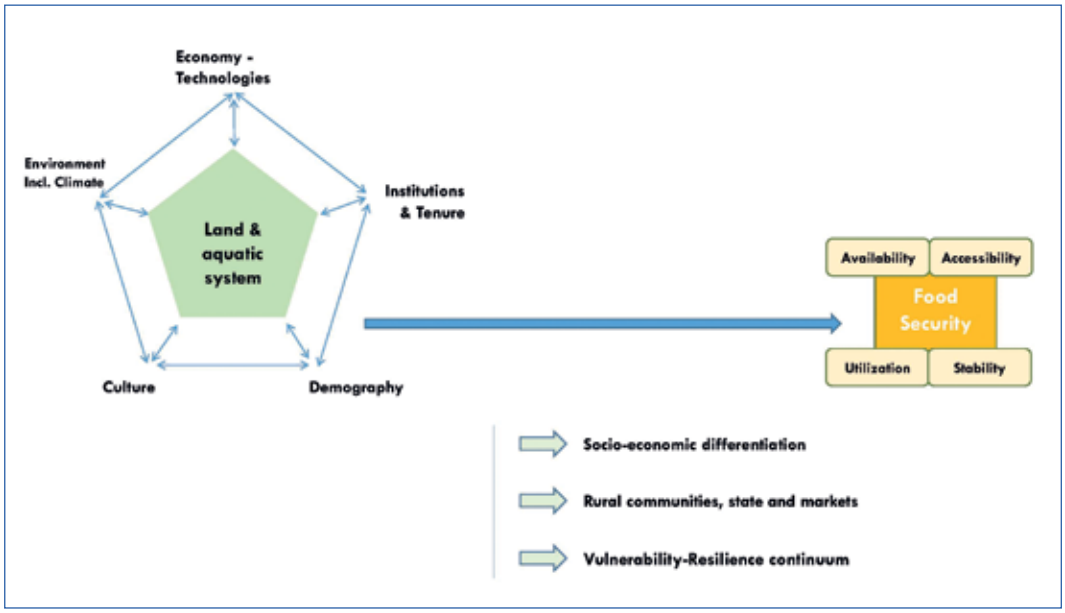


***Figure 1:*** *Conceptual research framework*

## Climate Change

For this study we view climate change as only one driver of environmental change. We therefore assess its effects on SES in conjunction with other drivers. The approach looks at the synergy or the divergence of these various drivers and leads us to recognize multi-scale pathways of change rather than focusing on single driver impacts.

In Cambodia, although there is a plethora of institutions and processes dealing with climate change, the knowledge base that is actually available to address its effects is relatively sparse. As an entry point into the climate change discussion, decision-makers rely on globally or regionally relevant reports from the Intergovernmental Panel on Climate Change (IPCC) (Royal Government of Cambodia 2006). A handy summary of potential impacts can be found in Nang (2013). It is now common knowledge that climate change occurs as a result of changes in the components of the water cycle and a related increase in the frequency of extreme climate events (rainfall causing flood and increases in river run-off, drought, storms, and so on). The IPCC suggests that extreme precipitation events over the wet tropics will very

likely become more intense and more frequent by the end of this century as global mean surface temperature increases (Stocker et al. 2013). At the Mekong basin scale, climate projections suggest that, as early as 2030, total annual run-off from the basin is likely to increase by 21 percent, with increased flooding affecting all parts of the basin and even greater impact in the downstream catchments, i.e. the Tonle Sap catchment of Cambodia (Eastham et al. 2008).

A recurrent theme in the literature is the high vulnerability of Cambodia to climate change due to its relatively low adaptive capacity mostly resulting from the high incidence of poverty and low endowment in physical infrastructure (Yusuf and Francisco 2009). Despite major uncertainties in future climate projection, it is already clear that natural disaster recovery efforts put intense pressure on government budgets; for example, the Royal Government of Cambodia had to request financial intervention from the Asian Development Bank and World Bank to recover from the floods in 2011 (Morton 2014).

## Food security

The changes in land and aquatic resource systems primarily influence the lives of local people through their food consumption habits. But households pursue objectives other than the supply of food; they balance short-term nutrition requirements with long-term aspirations such as education, the safeguard of assets, and so on. In most cases, livelihood diversification is their means of reaching these short-term and long-term objectives. We suggest that livelihood security is a necessary and sufficient condition for food security.

With this livelihood perspective in mind (Frankenberger and McCaston 1998), we unpack the elements of food security and address its four components: the availability of food from people's own production or from remote markets; the accessibility to food, which depends on income, knowledge and prices; the utilization of food, which relates to the ability of the human body to convert food into energy or to store it; and the stability of the food supply, which encompasses the capacity to sustain food availability, access and use over short and long periods particularly in the event of stress or shocks (Maxwell and Frankenberger 1992).

In Cambodia, despite the reduction in poverty that has resulted from the economic growth of the past 20 years, food insecurity remains widespread. From 1990/1992 to 2011/2013, the prevalence of undernourishment in the total population dropped from 39.4 percent to 15.4 percent (FAO 2014). However, in the context of demographic growth, the number of people undernourished remains high: in 2013, for instance, 2.2 million people were still poorly nourished (FAO 2014). In a recent poverty assessment, the World Bank shows that, despite a huge drop in the poverty rate between 2004 and 2011 (from 52.3 percent to 20.5 percent), there has been a lack of progress in combating malnutrition. Between 2005 and 2010, the percentage of children classified as 'wasted' actually increased from 8 to 11 (World Bank 2013). Food insecurity remains a central concern in Cambodia, and the paradox persists: food insecurity is a rural problem mostly affecting a farming population whose primary occupation is to produce food for self-consumption.

## Research approach

In order to analyze the effects that changes in the land use and aquatic systems have on food security, we refer to three main conceptual points:

### Social-economic differentiation

Households are not equally equipped to address, cope with, and adapt to, significant changes occurring in their resource base. An important characteristic of current transformations is the growing inequalities in household wealth and assets. These inequalities are reflected in different income levels and structures, revealing a process of differentiation in the social relations of production (Akram-Lodhi 2007). The rise of agricultural wage labor (World Bank 2013) is, for instance, the direct consequence of a process of land and capital concentration working through market forces or by (violent) dispossession.

To better highlight these processes of social-economic differentiation we asked a number political economy questions following the classic typology presented by Bernstein (2010): How are the means of production distributed - *who owns what?* What are the social divisions of labor - *who does what?* How does the distribution of the fruits of labor work (in-cash and in-kind income) - *who gets what?* What are the modes of reproduction and re-investment associated with this income - *what do they do with it?*

### Rural communities, state and markets

Another dimension of the current transformation is the repositioning of relations between rural households, the state and the markets, particularly as they relate to questions of land and resource tenure. The institutions governing access, use and control of resources are being retooled in ways that pre-empt or follow the commodification of resources or create an institutional pluralism of old and new forms of resource co-management between the state and the users.

To describe these processes we asked a number of questions about resource governance: What is the bundle of rights vested in the different modes of resources access and use - *what can the users do?* Who controls the design and implementation of these rights - *who tells the users what they can do?* What are the contradictions and conflicts between actors and between institutions who grant resource tenure security - *what gives rise to disputes between users and the people who ultimately control the resources on which those users depend?* To answer these questions, we contextualized rural households within networks of actors including business corporations, state representatives, community-based leaders, development agencies and the military.

### A vulnerability-resilience continuum

We used the integrative concept of vulnerability to understand the ways in which rural communities and households may be affected by changes in land and aquatic systems. Vulnerability analysis includes three dimensions, namely exposure (the degree to which a system is at risk, and the nature of that risk), sensitivity (the degree to which a system is affected by change) and adaptive capacity (the capacity of the system to adjust to the changes: i.e. the extent of its ability to moderate potential damages and take advantage of opportunities). We opted here for analysis of vulnerability that is place-based and socially differentiated insofar as access to social, political and economic capital affecting the vulnerability is not equally distributed within a social group (Moench 2011, Ribot 2011).

We envisaged the degrees of vulnerability and resilience along a multidimensional continuum of different states (O'Brien et al. 2004). Any change in exposure, sensitivity or adaptive capacity could move SES towards either the vulnerable or the resilient end of the continuum. We viewed resilience of a social-ecological system as its capacity to absorb disturbance and to re-organize while undergoing change (Folke 2006, Walker et al. 2004). Viewed in a continuum, it can be seen that resilience builds on adaptive capacity to facilitate continuous development, like a dynamic adaptive interplay that allows for development prompted by change (Smit and Wandel 2006).

Two elements are central in our approach. First, the position on the continuum is tied to the scale of analysis (Cash et al. 2006, Gibson et al. 2000, O'Brien et al. 2004). For example, national-level assessments may place a country at the resilient end of the continuum, but regional- or local-level analyses might shift some areas towards the vulnerable end. Second, an important factor that can move the system to the resilient end of the continuum is the ability of the actors (with their resource base and institutions) to learn from change and uncertainty and transform their system in a constant state of flux (Berkes and Folke 1998, Gunderson and Holling 2002). The learning processes will provide important clues for policy recommendations bridging multiple scales (Stagl 2007).

## SYNTHESIS OF KEY FINDINGS

A rich collection of key findings emerged from the projects in this program. These can be linked within the following overarching themes that form the four sections of this volume.

### Water management and agriculture

#### Significant change in rainfall patterns

Computation of long time-series rainfall data (monthly rainfall from 1920 to 2012) available for Kampong Chhnang and Battambang reveals similar place-based rainfall trends (Chapters 2 and 3). Despite the absence of significant alteration in the total annual rainfall in both sites, statistically significant trends in the rainfall have been observed. First, the dry spell

(months with less than 20 mm of rainfall) has increased from 1 to 3 months over the period 1920-2012. Second, the rainfall distribution has significantly changed from a bi-modal distribution (with two peaks in May/June and September/October) to a mono-modal distribution (one peak in October, but more intense). In Battambang (Chapter 2) the computation of extreme rainfall indices based on daily rainfall records for the period 1980-2012 confirms these changes. Most notably, the annual count of wet days (with precipitation >1mm) has increased. In addition, the annual maximum consecutive five-day precipitation and the annual count of days when rainfall >20-30-50mm are similarly increasing with mode of occurrence in October. This intensification is taking place slowly but steadily and is likely to put these provinces at higher risks of flood in the future.

## Multi-level flood vulnerabilities

The flood vulnerability assessment conducted in the Steung Sankgae watershed (Chapter 2) shows to what extent the level and nature of vulnerability depend on the analytical scales used to assess it. At the watershed level, in addition to the normal seasonal flooding on floodplain areas, the survey shows the increasing significance of river-overflow and surface run-off flood. Our results show that upland floods (surface run-off and river-overflow) are also significant and potentially destructive even though they go totally unrecorded in official statistics and plans. At the watershed level, there is no shortage of government bodies and institutions dealing with flood management but there is a clear lack of coordinating mechanisms to deal with flooding. The institutional resilience is low and the capacity of provincial institutions to learn from flood hazards is limited which greatly hinders the reduction of flood vulnerability. At the commune level, the research reveals a diversity of vulnerability profiles which depend on the agro-ecological context in which the communes are situated and the proximity of the commune to the provincial center (which has a clear, positive effect on commune levels of adaptive capacity). At the household level, vulnerability is highly variable within each commune as a result of inequalities in access to land and in people's capacity to maintain food security with non-farming activities. Non-agricultural responses to floods are predominant and are usually short-term responses to cope right after the flood. These responses include access to credit, sale of household assets and change in labor. In most cases these reactions to flood do not reduce vulnerability but actually reinforce it over the long term as household assets are surrendered.

This assessment methodology provides nested pictures of vulnerability at different levels and scales and we argue that a dialogue between these levels and scales is necessary to understand the cause and nature of the vulnerability and to act to reduce it. Based on these different typologies of vulnerability this approach permits recommendations to be formulated that would help to reduce vulnerability through better horizontal and vertical integration of institutions, agencies, and effective collective action.

## Convergence between climate change and the agricultural modernization agenda

Because flood occurrence is highly correlated with rainfall, cropping activities (specifically those related to rice) have been at increasing risk in the period September/October (primarily through crop destruction by flood). The farmers are aware of these changes in rainfall distribution even if they do not relate them directly to 'climate change' of which their technical knowledge might be limited (Chapters 2 and 3). An effective adaptation has taken the form of new cropping calendars to avoid the September/October peak, which farmers report is now too risky for rice cultivation. In areas where the agro-ecology makes it possible, the adoption of early season rice varieties and the intensification of the rice cropping system from March to June has provided a solution. The cultivation of non-photoperiod sensitive early season rice has been trialed by farmers for years. This has particularly been the case where cultivation can be conducted close to villages and in areas where access to water is easier through communal or private ponds, and soil fertility can be more easily maintained through manure (Pillot 2007).

More recently, in an effort to boost rice production and exports, the government has strongly supported the dissemination of non-photoperiod sensitive high-yielding rice varieties. These are well suited to early season or dry season cultivation (Royal Government of Cambodia 2005, Royal Government of Cambodia 2010). The convergence between environmental and agricultural development policy drivers is noteworthy and can partly explain why early season agriculture has developed at such a fast rate in Cambodia. But one should keep in mind the agenda behind what is presented as 'climate friendly' rice varieties. These 'new' rice cropping practices are actually the vehicle for a 'green-revolution' in the form of agricultural development. This modernization path has, however, important social-economic consequences. Farmers are not equally equipped to adopt high-yielding rice varieties: they need appropriate access to water and the necessary upfront capital to invest in all the chemical inputs required, and many do not enjoy these advantages. The social-economic changes that were so well-documented at the start of the green-revolution in the 1980s (Dufumier 2006, Pingali et al. 1997) are crystalized in Cambodia in that the process of innovation has excluded a significant section of the poor peasantry and has reinforced an on-going social-economic differentiation process between an emerging class of successful farmers and the 'proletarianization' of peasants who are forced out of the agricultural sector. This process is documented in both Chapters 2 and 3.

## Inadequate water governance in Steung Chrey Bak catchment

In previous years, water management in Cambodia was relatively unproblematic because water resources were adequate relative to the needs of farmers. But the progression of rice intensification, coupled with demographic increase and lowland-upland migration, has increased the need for water to be better managed and allocated. To tackle new challenges, particularly the increased competition for water resulting from agricultural intensification and from a reshuffling of the cropping calendar, the government has promoted the establishment of Farmer Water User Communities (FWUCs). But as the Kampong Chhnang

investigation showed (Chapter 3), most of the FWUCs in Steung Chrey Bak catchment are dysfunctional, and are failing to address the multiple issues of water governance - and the attendant conflicts - or to support adaptive water management in the face of social-ecological change. This limited performance is largely due to the incomplete devolution of rights and responsibilities which has meant that these new institutions have insufficient accountability to the communities they are established to serve. Effective use of devolved water management institutions will require more diverse and effective participation of local resource users and NGOs (horizontal integration) coupled with better vertical integration and cooperation between levels of government involved in Cambodian water management.

## Agricultural innovation and food security

The multi-purpose farming system (MPF) is an alternative to the rice intensification model inspired by the green-revolution. MPF is formulated according to agro-ecological principles and is being promoted by various actors across the country. Yet this farming system has never really been analyzed in agro-economic terms, and the positive and negative elements of adoption have never been properly aired. The fourth chapter of this volume aims to fill this knowledge gap.

Comparing agro-economic results for MPF and a conventional farming system, the authors show that MPF is not only sound from an environmental point of view, but also makes sense from an economic standpoint. In a wider perspective, it can also promote rural development. When implemented according to agro-ecological principles, MPF demonstrates significant gains in productivity (higher yield), efficiency (lower costs) and profitability (higher value-added) compared with conventional mono-cropping rice-based farming. Furthermore, MPF offers more regular use of labor throughout the year and also, by reducing the need for migration, supports a more cohesive social network. These advantages translate into a significant improvement in total family income.

Multi-purpose farming is sometimes presented as a climate-smart solution for agriculture because it reduces the risks associated with climate variations and extreme conditions. It is, however, not a panacea, and financial and knowledge barriers remain. For it to be fully successful, a co-learning approach between innovative farmers, and field practitioners and supporters is required. The model needs to undergo place-specific trials and experimentation and to evolve within specific social-ecological contexts. Experience shows that the system works if there is adequate support and if farmers are able to experiment and innovate through their own logic. The benefits offered by MPF go beyond agricultural production, food security and climate resilience. Unlike the green-revolution intensification model, the rules of which are determined by global agro-business actors and their technologies, MPF allows for innovation whereby decisions relating to production and consumption are made by the farmers themselves.

## Land use change and food security in territories populated by indigenous people

### Agrarian expansion onto the uplands

Over the past 15 years, Cambodia has seen dramatic changes in land use in the peripheral upland areas of the country. Various contributions in this volume have identified and documented three main pathways of land use change.

First is farmer-driven agricultural expansion from the lowlands of the central rice plain towards the peripheral uplands. This movement has led to massive deforestation associated with the creation of a new agrarian system based on subsistence and commercial crop production. Land pioneering into peripheral uplands has been associated with voluntary in-migration of a very large population from across the country. This migrant population comes particularly from the rice plain provinces where an increasing population density has outstripped the capacity of farmers to secure livelihoods based solely on rice production. This is signnificant in communities studied in Chapter 5.

Second, the colonization of upland forest can also be the result of agro-industrial economic land concessions granted to companies with agro-industrial (rubber, cashew) or mining (iron, bauxite, molybdenum, and so on) interests. These agrarian transformations reflect the integration of the Cambodian state and rural economy into supra-national agricultural markets dominated by agro-industrial groups. In a wider economic context, the setting for this transformation is the inclusion of this area within the Greater Mekong Subregion development corridors along with Thailand, Vietnam, Lao PDR, Myanmar, and the Yunan province and Guangxi Zhuang autonomous region of China. Economic and mineral mining concessions are hotly debated and contested, generating conflict with local communities who have historically-rooted land and natural resource tenure arrangements. The communities studied in Chapter 5 have evolved in this context.

Third, the establishment of Protected Areas for the conservation of natural resources is another driver of land use change. By fixing a forest protection enclosure, the establishment of Protected Areas has forced the relocation of indigenous people in some instances. Very often it has resulted in a sharp decrease in the land available for swidden agriculture and has forced the people affected to convert from rotational to permanent agricultural systems. The communities studied in Chapter 6 have evolved in this context. Forced migrations have historic antecedents as ethnic minority groups were forced out of their swidden land during US bombing raids and Khmer Rouge rule some decades ago. Indeed, migration has been a way of life for some groups for the past 40 years. However, the analyses show the growing tensions between the state-sponsored projects and these groups who have always wanted a swift return to their swidden land. Community resilience is a key dimension of these land use change pathways.

## Livelihood transitions emerging from land and natural resource commodification

Against the backdrop of agricultural growth promoted by land expansions, booming cash-crop cultivation and massive in-migration, the authors of Chapter 5 show that cash income has become a much more important element in the total income of the people involved. People are increasingly affected by the market economy, which exposes them to price fluctuations and rapid social mobility, upward and downward, that works to a large extent through land markets.

The authors show that the decline in resource availability has resulted in a sharp increase in wage labor. This actually reflects the social-economic differentiation between households and in particular the polarization of land/capital and labor, and suggests the deepening of income disparity within communities. On the one hand, a group of efficient and productive households is emerging, and they now have large land holdings, machinery and a high degree of access to agricultural markets. On the other hand, we found dispossessed households who have now become heavily reliant on wage labor and common pool resources to meet their basic food security threshold. However, there are important differences in this development pathway from one village to another. In areas where community mobilization to protect land rights is stronger, the process of differentiation is less pronounced. This suggests that social mobilization and struggle have an impact in acting as a buffer against the income disparities that emerge from the commoditization of resources.

## Livelihood and land tenure transitions emerging from Protected Area management

In Chapter 6, the authors show another picture of livelihood transitions. In this, people have been dispossessed of swidden land as a result of the formation of state-sponsored Protected Areas. The transition in livelihoods here is exemplified by a change from the swidden-based household production system into several composite swidden systems. Prompted by choice or by constraints, and exhibiting different degrees of transformation, these may, for example, take the form of permanent small-scale cashew plantations on uplands and/or rice production on lowlands.

Against this backdrop, the authors show that households who have tried to (partly) maintain swidden agriculture in their livelihood diversification portfolio are better positioned to maintain or improve their food security status. The research also reveals that the imposition of the national parks and the fixing of the population on the lowland paddies have resulted in the fragmentation of collective tenure arrangements prevailing under a swidden system. The fragmentation occurs with increased state control through Protected Area management and the individualization of property rights on privately owned land for permanent agriculture. Efforts currently conducted as part of Protected Area co-management are not addressing the core issues of these transformations or the resulting social fragmentation.

## Environmental change in fishing communities

### Degradation of aquatic resource systems

In the context of post-war, loosely-regulated natural resources management, fisheries-dependent social-ecological systems have been under great pressures. Fish habitats have been severely degraded due to illegal and destructive fishing practices (which can be defined as a proximate cause) and to conflicting economic activities (sand mining, tourism, deforestation) or inadequate coordination and implementation of sustainable fisheries management efforts (which constitute underlying causes).

Climate change is manifest and its effects for fisher folk have been significant. Saltwater intrusion from higher tidal surge has reduced the rice and fish yields from coastal ponds and paddies. Heavy rains allow for fresh water run-off reducing salinity and forcing fish into deeper waters or increasing mortality of sessile organisms such as snails and shellfish. Floods and drought affect the agricultural productivity of land, which is such an important production asset to inland and coastal fishing communities. The different case studies have shown, however, that climate is not the most critical driver of change (Chapters 7, 8 and 9). It actually adds more risks and uncertainty to livelihoods that are already being affected by a decline in fisheries resources, which we see as a mostly institutional problem.

### Pathways of change at household level

Changes in fisheries resources systems - i.e. degradation - affect households in different ways according to their assets, their capacity to cope and adapt, and the degree to which they are reliant on fisheries resources A common theme running through Chapters 7, 8 and 9 is that households, rather than community-based organizations, are the most important actors in addressing the degradation of fisheries resources. They do this through diversifying their production and income generating activities.

But the diversification pathways followed by households are multiple and engage them in different types of relations with natural resources. This multiplicity depends on the wealth, resources endowment, and the demographic structure of the household, as well as the skills and the networked opportunities to which they have access. In coping with declining fish stocks, people have tended to turn to non-fishing livelihood activities to maintain their income. This change is, however, more often the result of the ineffectiveness of national-local fisheries resources management rather than a deliberate move out of fishing.

Associated with the decline of fisheries resources in inland and coastal fisheries systems is an increasing reliance on wage labor, especially in the extent to which it is associated with indebtedness (going into debt usually forces households into wage labor). The increase in wage labor is an important rural transformation in contemporary Cambodia (World Bank 2013), echoing a trend throughout Asia (Wiggins and Keats 2014). However, despite the widespread enthusiasm for increasing wage revenue our results show that going into wage

labor is very often a desperate, last resort to make ends meet and not a sustainable path to upward social mobility. Wage labor is often associated with the surrendering of personal or family assets, and an associated loss in the means of production, which exacerbates a process of social differentiation within the community. In contrast, adaptation mechanisms that are more likely to position households on a path of upwards social mobility in the context of fisheries resources degradation are those that allow for self-employment in non-farm activities (e.g. transport, trade, handicrafts, and petty commodity shops).

## Institutional and community responses to environmental change

Over the past 10-15 years, the degradation of fisheries resources has encouraged the devolution of rights and responsibilities to communities for the management of inland and coastal fisheries resources across the country (Community Fisheries and Community Protected Areas in coastal regions). Co-management principles between communities and the state govern the management of these schemes.

Community Fisheries operate under the jurisdiction of the Fisheries Administration, but the legislation and institutions put in place actually give little scope for a real community-based approach to resources management. The contributions to this volume have identified several limitations. First a one-size-fits-all mainstream approach, which was promoted to develop co-management institutions (regulation, management plans and so on) has tended to leave the communities involved with little flexibility in terms of crafting new institutions to respond to their specific, local social-ecological systems. This has limited their resilience to environmental changes (Chapter 9). Second, through a mainstream approach, devolution to local level has been incomplete in that it has not been followed by a transfer of power that would allow communities to be the real owners and stewards of their resources (Chapters 7 and 9). Third, under these co-management schemes, resource extraction is restricted to traditional and non-commercial activities, thus depriving the state Community Fisheries of revenue. The imbalance is clear in that all the costs of organization and protection are incurred by communities while they have no opportunity to generate financial benefits (Chapters 7 and 9). Fourth, social-ecological systems managed by communities are essentially multi-functional areas in that farming activities are combined with access to, and use of, common pool resources. But the co-management schemes promoted by the government do not address this, and have only a narrow focus on fisheries management, conservation and aquaculture (Chapter 9).

In this context, Community Fisheries are poorly equipped to address the growing tensions and contradictions that exist between decentralized resource conservation policies and the resource development policies of the government that directly promote the commoditization of resources. Communities have come to depend on all kinds of external interventions and support from donors and NGOs. For example, donors have been beneficial to communities in terms of promoting good governance and in the provision of financial resources: they have helped to increase productivity. But where they have withdrawn, fundamental weaknesses have been revealed in the co-management institutions that were put in place.

Our study shows that community-based conservation initiatives that are sustainable are those that have evolved over time and are nurtured within some form of endogenous community initiative. These leave an institutional space for flexibility and for generating options: by promoting a learning-by-doing (passive adaptive) style of management they allow for some experimentation which enables initiatives to emerge that best suit specific needs. The case documented in Chapter 8 records the interest shown by residents of a Coastal Protected Area in establishing a community-managed eco-tourism resort to take advantage of the tourist influx into coastal Cambodia. This initiative further demonstrates a desire to move away from a strict reliance on fisheries resources as a means of income generation, and the benefits this approach can offer.

# BIBLIOGRAPHY


Akram-Lodhi, H. A. (2007) Land, Markets and Neoliberal Enclosure: an agrarian political economy perspective. *Third World Quarterly, 28*(8), pp. 1437-1456.

Bai, Z. G., Dent, D. L., Olsson, L. and Schaepman, M. E. (2008) Proxy global assessment of land degradation. *Soil Use and Management, 24*, pp. 223-234.

Baran, E. (2005) *Cambodian Inland Fisheries: facts, figures and context,* Penang: World Fish Center.

Berkes, F. and Folke, C., eds. (1998) *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*, Cambridge, UK: Cambridge University Press.

Bernstein, H. (2010) *Class Dynamics of Agrarian Change, Agrarian Change and Peasant Studies,* Canada: Fernwood Publishing.

Cash, D. W., Adger, N. W., Berkes, F., Garden, P., Lebel, L., Olsson, P., Pritchard, L. and Young, O. R. (2006) Scale and Cross-Scale Dynamics: Governance and Information in a Multilevel World. *Ecology and Society, 11*(2), pp. 8-19.

Diepart, J.-C., Pilgrim, J. and Dulioust, J. (2014) Migrations. in Save Cambodia's Wildlife, (ed.) *Atlas of Cambodia: Maps on Socio-Economic Development and Environment,* Phnom Penh: SCW, pp. 89-96.

Dufumier, M., ed. (2006) Agriculture in Southeast Asia: An Update. *MOUSSONS* 9-10.

Eastham, J., Mpelasoka, F., Mainuddin, M., Ticehurst, C., Dyce, P., Hodgson, G., Ali, R. and Kirby, M. (2008) *Mekong River Basin Water Resources Assessment: Impacts of Climate Change*. CSIRO: Water for a Healthy Country National Research Flagship.

FAO (2014) *Food security indicators,* Available at: http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ [Accessed July 25 2014].

Folke, C. (2006) Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change, 16,* pp. 253-267.

Frankenberger, T. R. and McCaston, K. M. (1998) *From Food Security to Livelihood Security: The Evolution of Concepts:* CARE, USA.

Gibson, C. C., Ostrom, E. and Ahn, T. K. (2000) The concept of scale and the human dimensions of global change: a survey. *Ecological Economics, 32,* pp. 217-239.

Gunderson, L. H. and Holling, C. S., eds. (2002) *Panarchy: Understanding Transformations in Human and Natural Systems,* Washington DC: Island Press.

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., Thau, D., Stehman, S. V., Goetz, S. J., Loveland, T. R., Kommareddy, A., Egorov, A., Chini, L., Justice, C. O. and Townshend, J. R. G. (2013) High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science, 342,* pp. 850-853.

Low, B., Costanza, R., Ostrom, E., Wilson, J. and Simon, C. P. (1999) Human–ecosystem interactions: a dynamic integrated model. *Ecological Economics, 31,* pp. 227-242.

Maxwell, S. and Frankenberger, T. R., eds. (1992) *Household Food Security: Concepts, Indicators, Measurements: A Technical Review,* New York: UNICEF-IFAD.

Moench, M. (2011) Aren't we all vulnerable: why do vulnerability analysis? *IIED Opinion.*

Morton, E. (2014) Cambodia most vulnerable to climate change: study. *Phnom Penh Post,* Thu, 12 June 2014.

Nang, P. (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.

O'Brien, K., Sygna, L. and Haugen, J. E. (2004) Vulnerable or resilient? A multi-scale assessment of climate impacts and vulnerability in Norway. *Climatic Change, 64,* pp. 193-225.

Peluso, N. and Lund, C. (2011) New frontiers of land control: Introduction. *Journal of Peasant Studies, 38(4),* pp. 667-681.

Pillot, D. (2007) *Jardins et Rizières du Cambodge, les enjeux du développement agricole* Paris: GRET-Karthala.

Pingali, P. L., Hossain, M. and Gerpacio, R. V. (1997) *Asian Rice Bowls. The returning Crisis?,* Oxon&New York: IRRI-CAB International.

Ribot, J. (2011) Vulnerability before adaptation: Toward transformative climate action. *Global Environmental Change, 21,* pp. 1160-1162.

Royal Government of Cambodia (2005) *National Strategic Development Plan 2006-2010,* Phnom Penh.

Royal Government of Cambodia (2006) *National Adaptation Programme of Action to Climate Change (NAPA).*

Royal Government of Cambodia (2010) National Strategic Development Plan Update 2009-2013. Phnom Penh.

Save Cambodia's Wildlife (2014) *Atlas of Cambodia: Maps on Socio-Economic Development and Environment,* 2nd edition, Phnom Penh: Save Cambodia's Wildlife.

Seng, V. (2014) *Cambodia's Agricultural Land Resources: Status and Challenges, Policy Brief No. 1* Phnom Penh: Development Research Forum in Cambodia.

Smit, B. and Wandel, J. (2006) Adaptation, adaptive capacity and vulnerability. *Global Environmental Change, 16(3),* pp. 282-292.

Stagl, S. (2007) Theoretical foundations of learning processes for sustainable development. *International Journal of Sustainable Development & World Ecology, 14,* pp. 57-62.

Stocker, T. F., D. Qin, G.-K., Plattner, L. V. A., Allen, S. K., Bindoff, N. L., Bréon, F.-M., Church, J. A., Cubasch, U., Emori, S., Forster, P., Friedlingstein, P., Gillett, N., Gregory, J. M., Hartmann, D. L., Jansen, E., Kirtman, B., Knutti, R., Kumar, K. K., Lemke, P., Marotzke, J., Masson-Delmotte, V., Meehl, G. A., Mokhov, I. I., Piao, S., Ramaswamy, V., Randall, D., Rhein, M., Rojas, M., Sabine, C., Shindell, D., Talley, L. D., Vaughan, D. G. and Xie, S.-P. (2013) Technical Summary. in Stocker, T. F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S. K., Boschung, J., Nauels, A., Xia, Y., Bex, V. and Midgley, P. M., (eds.) Climate Change 2013: *The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* Cambridge - United Kingdom and New York - USA: Cambridge University Press.

Walker, B., Holling, C. S., Carpenter, S. R. and Kinzig, A. (2004) Resilience, Adaptability and Transformability in Social–ecological Systems. *Ecology and Society, 9*(2), 5.

Wiggins, S. and Keats, S. (2014) *Rural wages in Asia,* ODI report.

World Bank (2013) *Where Have All The Poor Gone? Cambodia Poverty Assessment 2013,* Washington, DC: Work Bank.

Yusuf, A. A. and Francisco, H. (2009) *Climate Change Vulnerability Mapping for Southeast Asia,* Singapore: IDRC, SIDA and EEPSA.


# Section A

## Water management and Agriculture

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## CHAPTER 2

A multi-scale flood vulnerability assessment of agricultural production in the context of environmental change: The case of the Sangkae River watershed, Battambang province

## CHAPTER 3

impacts of social-ecological change on farming practices in the Stung Chreybak catchment, Kampong Chhnang province

# CHAPTER 2

## A multi-scale flood vulnerability assessment of agricultural production in the context of environmental change: The case of the Sangkae River watershed, Battambang province

DOCH Sotheavin, Jean-Christophe DIEPART, HENG Chinda

## ABSTRACT

Flooding on Cambodian land use systems is not a new phenomenon but its significance has increased in the context of global environmental changes. This study aims to assess the vulnerability of agricultural production to floods in the Sangkae River watershed in Battambang province, Northwestern Cambodia. The study was conducted in conjunction with the provincial spatial planning team hosted by the Provincial Department of Land Management and can be viewed as a first step toward a flood management decision-making tool for provincial authorities.

The assessments rest on specific dimensions of vulnerability (exposure, sensitivity and adaptive capacity) at different levels in a multi-scale framework: spatial scale (watershed, commune and household); temporal scale (decade, year and season); and institutional scale (national policy, provincial operating rules and communal agencies). The analysis rests on triangulation of qualitative and quantitative data (time-series rainfall data, land use systems, participatory flood mapping, commune workshops (n=31), social-economic statistical databases, in-depth interviews with relevant institutions (n=5) and household surveys (n=162).

Intensification of rainfall since the 1920s has increased the risk of flooding in the Sangkae River watershed during the late rainy season, particularly in the upstream area. Using an indicator-based approach, we discovered that the vulnerability of communes is highly dependent on the agro-ecology of land use systems. The household assessment reveals the variability of adaptive capacity between households according to their food security status and income portfolio. Agricultural innovation and structural adaptation to flood are scarce; the households mostly cope with flood through credit, external aid and de-capitalization (sale of household assets). These coping mechanisms adopted by farmers do not reduce vulnerability but reinforce it.

The application of this assessment methodology provides nested pictures of vulnerability at different levels and scales and we argue that a dialogue between these levels and scales is necessary to understand the nature of the vulnerability and to act to reduce it. Using these different typologies of vulnerability, this approach enables recommendations to be formulated to reduce vulnerability through better horizontal and vertical integration of institutions and agencies, and effective collective action.

**Key words:** *rainfall pattern; environmental management; agriculture; water resources; adaptation; disaster management; flood; farming systems; food security*

## INTRODUCTION

The impact of flooding on social-ecological systems is of global significance in the context of climate change. There is strong evidence to suggest that ongoing and future global intensification of the hydrologic cycle will continue due to global warming (Huntington 2006). The intensification of the water cycle leads globally to changes in water-resource availability and is manifested in an increasing frequency and intensity of floods and river run-off (Huntington 2006). In its most recent report, the Intergovernmental Panel on Climate Change (IPCC) suggests that extreme precipitation events over the wet tropics will very likely become more intense and more frequent by the end of this century as global mean surface temperature increases (Stocker et al. 2013). Monsoon precipitation, in particular, will likely intensify (Stocker et al. 2013). At the Mekong basin scale, climate projections are fairly uncertain but suggest that total annual run-off from the basin is likely to increase by 21 percent, with increased flooding affecting all parts, with an even greater impact in the downstream catchments, i.e. the Tonle Sap catchment of Cambodia (Eastham et al. 2008).

Flooding is not a new phenomenon for Cambodia. Many parts of the country have a long history of this, particularly the central areas where floods are associated with the reversal of water in the Tonle Sap river and the flooding of the large central floodplain (Keskinen 2006). In response, people have developed agriculture and fishing practices that are well adapted to this unique phenomenon. Flooding is actually a double-edged event. Floods are usually good for rain-fed rice-based agriculture but unpredictability in their occurrence can exert a negative impact on agricultural production and rural livelihood systems (Keskinen 2006). In a wider perspective, the entire social-ecological production system of the Tonle Sap Great Lake floodplain depends on the flood pulse cycle (Keskinen 2008). That said, globally, major floods cause human casualties and injuries, substantial infrastructure damage and agricultural production losses (Centre for Research on the Epidemiology of Disasters 2011). In 2011, for instance, the costs associated with loss of agricultural production and degradation of physical infrastructure resulting from the large flood in Cambodia amounted to more than USD 521 million and affected 1.64 million people, killing 247. It has been estimated that approximately 400,000 hectares of paddy fields were damaged by flood in that year (Gunjal et al. 2012).

The high vulnerability of Cambodia to climate change (flooding in particular) is mostly attributed to a low adaptive capacity, which is the result of the high incidence of poverty and the low provision of physical transport, energy, and water management infrastructures at different levels (Chhinh et al. 2013, Yusuf and Francisco 2009). The national projected increase in frequency and magnitude of extreme rainfall events will exacerbate flooding, particularly in small river watershed areas, and will affect the Cambodian economy and population. Consequently, it is likely that these extreme rainfall events will contribute to increased food insecurity and will substantially increase the challenges faced by populations who are already vulnerable to flood. The consequences for the agricultural sector are particularly significant given its central role in the development of the country; in 2011, the sector contributed 33 percent to the national GDP, employed around 67 percent of the national labor force, and remains a provider of key environmental goods and services (CDRI 2011, World Bank 2013).

These challenges lead to questions about the impacts of flooding on agricultural production. For instance, who, among farmers and stakeholders, are likely to be more or less affected (and where they are located) and how these impacts are amplified or attenuated by different ecological or social circumstances. Policy- and decision-makers, local organizations and development partners, at different levels, are deeply concerned with these questions. The rationale of this research project is, therefore, to provide scientifically sound information to help policy-makers to address these questions and to support effective decision-making to enhance flood preparedness, responses and adaptations. We acknowledge that there is no single 'best way' to bridge the science-policy gap (Vogela et al. 2007) and our endeavor is best understood as a contribution to a complex ongoing dialogue rather than as a universal panacea.

Vulnerability assessments are widely used to determine the impact of climate change, to enable decision-makers to target adaptation funds in the most efficient way, and to monitor the effectiveness of their investments (Moench 2011). But to serve these purposes, vulnerability analysis needs to overcome a number of challenges. First, it has to go beyond obvious simple statements that portray vulnerability as a correlation of poverty. Second, vulnerability analysis must develop robust and credible measures that reflect social processes as well as material outcomes within complex social-ecological systems, and clearly delineate those mechanisms that cause and perpetuate the underlying vulnerability (Adger 2006, Ribot 2011). Third, the vulnerability assessment should be part of a transformative learning process (Diduck et al. 2012). It should engage different actors so that they can contribute their understanding to support resource users and decision-makers in working together through methods of social learning, with the ultimate aim of reducing vulnerability on the ground.

Although we develop a cross-disciplinary approach, we focus on the influence of a single hazard (flood) on one sector (agriculture) in order to come up with specific and localized recommendations. The geographical context of this assessment is the Sangkae River watershed in the province of Battambang (Northwest Cambodia), which is considered to be the province in which flooding has the second highest impact on agriculture (Prey Veng being the most vulnerable province) (Royal Government of Cambodia 2006).

We maintain that there are no simple answers to questions surrounding flood vulnerability in the Sangkae River watershed. The nature and extent of this depends on the analytical scale and the conceptual framework developed to understand it. So, rather than focusing on one particular level, we suggest that a dialogue between and across levels and scales provides an appropriate basis to give the best account of vulnerability and to suggest the most effective path for intervention. The approach we developed allows us to identify typologies of vulnerabilities at different levels and to formulate differentiated sets of recommendations to achieve a more inclusive, multi-level dialogue between institutions to identify ways to reduce vulnerability.

# METHODOLOGY

## Study area

The Sangkae River watershed covers an area of 370,750 ha in Battambang province. The river originates in Phnom Kbal Lan (Pursat province) and extends for about 82 km from Battambang municipality to the Tonle Sap Lake (Figure 1). The catchment stretches along 31 communes in six districts including Samlaut, Ratanak Mondol, Banan, Battambang, Sangkae and Aek Phnom. It includes more than 200 villages comprising 522,725 people (104,035 families) (NCDD 2010).

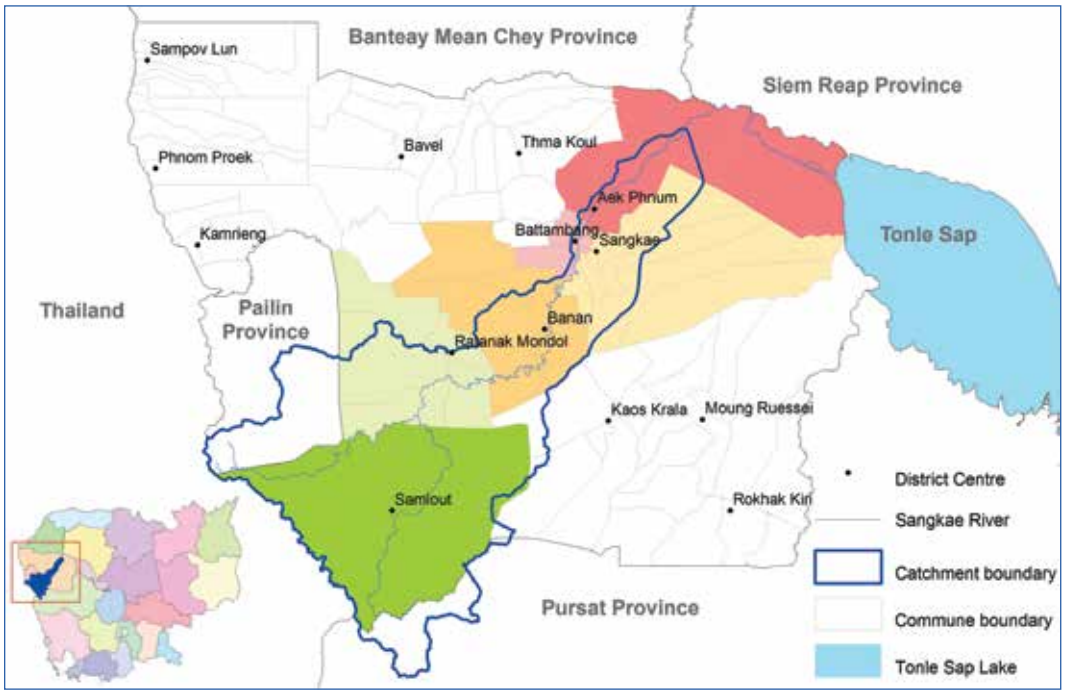



***Figure 1:*** *Sangkae River watershed and its commune boundaries*

## Framing the vulnerability assessment

### Vulnerability

Since the release in 2001 of the third IPCC report on climate change, the term '*vulnerability*' has become a catch-all concept in environmental change research. *Vulnerability* is defined as the "degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes" (McCarthy et al. 2001). In this definition key parameters of *vulnerability* are the *stress* to which a system is exposed, its *sensitivity* and its *adaptive capacity*. The term *exposure* relates to the nature and degree to which a system undergoes environmental or socio-political stress. The characteristics of these stresses include their *magnitude, frequency, duration* and the *area size* (i.e. the geographical region it affects) of the hazard. *Sensitivity* is the degree to which a system is modified or affected by disturbances. *Adaptive capacity* is the ability of a system to evolve in order to accommodate environmental hazards or to respond with relevant policy changes which expand the range of variability with which it can cope (Adger 2006).

In this definition, IPCC places the risk within the hazard - in other words, within climate rather than society (Ribot 2011, Turner et al. 2003); *vulnerability* is conceived as an outcome - a result of the projected impacts of climate change on a particular social-ecological system, offset by adaptation measures. This definition of *vulnerability,* centered on the hazard, has been challenged by scholars who rather consider that both climate variability and change occur in the context of political, institutional, economic and social structures and that they interact dynamically (O'Brien et al. 2007). We adopt this latter approach of contextual vulnerability despite the methodological challenges it poses.

The framework of our assessment rests on a few principles, which now pertain to the mainstream of vulnerability science:

- *Vulnerability* is widely seen as an integrative concept that can link the social and biophysical dimensions of environmental change. The focus on the interactive social-ecological system (Low et al. 1999) suggests that *vulnerability* results from multiple stressors (climate, environmental, political, economic, institutional or cultural) which interact dynamically (O'Brien et al. 2007);
- *Vulnerability* is scale dependent insofar as the scale of analysis affects the vulnerability pattern being identified. Scale also affects the explanation of vulnerability as its drivers are at work at different levels on different scales (Cash et al. 2006, Gibson et al. 2000). The social-ecological system we investigate forms a nested hierarchy, and the analysis of its vulnerability therefore requires both a multi-level and multi-scale approach;
- *Vulnerability* of the social-ecological system is place-based because risks, changes and the ability to cope or adapt differ across space according to site-specific contexts and circumstances;

- *Vulnerability* is socially differentiated insofar as access to social, political and economic capital affecting the vulnerability is not equally distributed within a social group (Moench 2011, Ribot 2011);
- *Vulnerability* is dynamic as it alters over time on account of changes in drivers that are external to the social-ecological system or to the internal capacity of the system to restructure. These drivers amplify or attenuate the vulnerability of the system (Turner et al. 2003).

## A multi-scale/multi-level framework

Our framework for assessment considers a three-tier nested social-ecological system (SES) in which vulnerability resides: household, commune and watershed levels. At the household level, the SES is conceptualized as farming systems, which are nested in the wider context of commune level (the lowest jurisdiction level with elected councils) using administrative boundaries to capture the institutional dimensions of vulnerability. In turn, communes are nested in a larger watershed area. An examination of vulnerability at different levels of political/social organization provides a more in-depth view of vulnerability; e.g. vulnerability might emerge within a commune that might not be considered to be vulnerable at watershed scale (Keskinen 2008).

Our conceptualization of the vulnerability of agriculture production to flooding is based on the framework developed by Turner et al. (2003) (Figure 2). The structure and dynamic of vulnerability at household, commune and watershed level are similar: the flood hazards acting on the system arise from influences outside ❶ and inside ❷ the system. The human-environmental circumstances (and the interplay between both) of the system determine its sensitivity ❸ to flood and condition the capacity of responses of the system, both short-term (coping ❹ ) and long-term (adaptation ❺ ). The agency for coping and adaptation is usually the household, although the driver might be autonomous or driven by external factors, e.g. policy. Importantly, the social and environmental responses or coping mechanisms influence each other, so that a response in the human sub-system could make the environmental sub-system more or less able to cope ❻ . At any given level, the framework considers the link with broader human ❼ and biophysical ❽ conditions and processes, which influence or are influenced by the social-ecological system responses. These influences occur through cross-scale/cross-level interactions: we refer to downward causation if the driver occurs at a higher level ❾ or upward causation if the driver is at play at a lower level ❿ (Gibson et al. 2000).

The multi-scale/multi-level[1] structure of the framework allows us to illuminate the nested scales of vulnerability (how the different drivers of vulnerability operate at various temporal, spatial and institutional scales). It also enables us to understand the vulnerability of a particular place (Turner et al. 2003). There is no, one 'best scale of analysis' to understand vulnerability (O'Brien et al. 2004): indeed, the one-size-fits-all measure is not suitable (Hinkel 2011). A deeper understanding can rather be reached through an analysis of the interactions within/between levels and scales.

[1] For a detailed discussion on scale and level see Cash et al. 2006

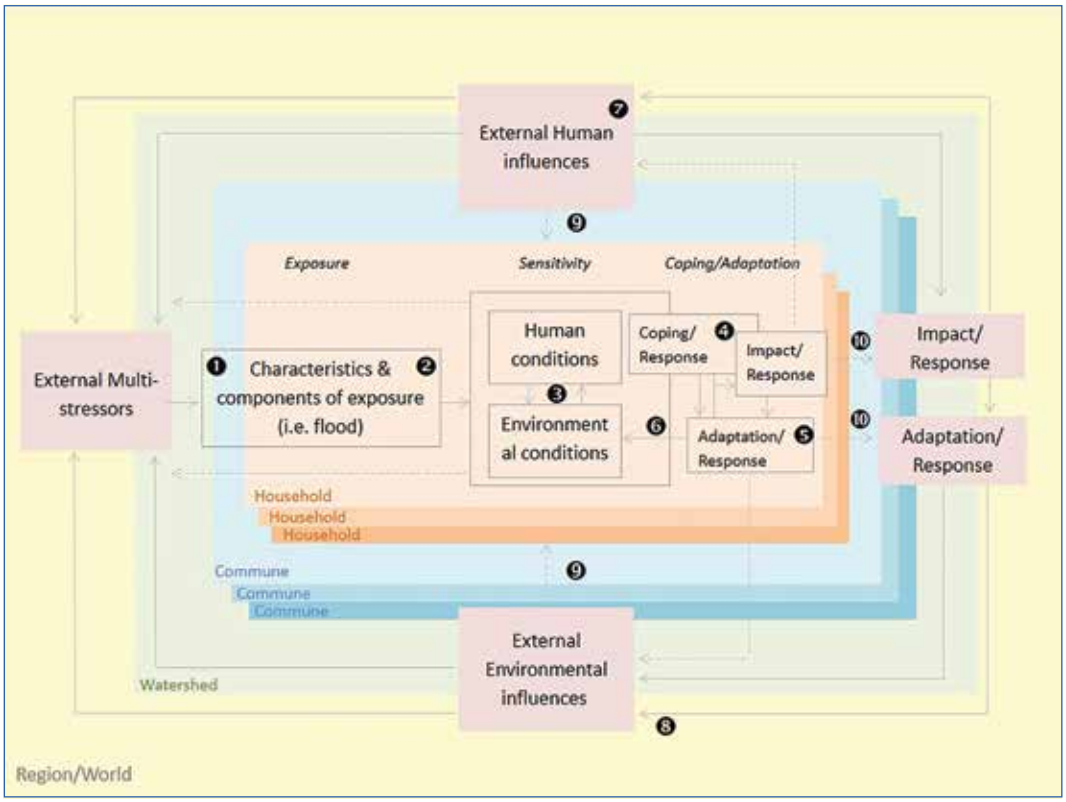



***Figure 2:*** *Framework to study the flood vulnerability of agricultural production, adapted from Turner et al. 2003*

In the following section, we explain how the research conducts analysis on different scales in this framework: the spatial scale (watershed, commune and household), the temporal scale (decade, year and season) and the institutional scale (national policy, provincial operating rules and communal agencies). As the choice and the politics of scales influence the results of any vulnerability assessment (Lebel 2006), we also discuss the rationale for selection of these spatial, temporal and institutional scales.

## Operationalizing the framework

Hinkel (2011) argued that guidance for designing vulnerability assessment methodologies must come from the specific case considered: the research relates to the specific context and to the specific policy questions. We operationalized our conceptual framework in that perspective using a diversity of complementary methods, measures and qualitative/ quantitative indicators at each level on the spatial scale.

### Watershed level

The watershed was chosen as a first spatial level because it is an operational geographic unit to understand hydrological processes. Additionally, flood management is considered a key element of Integrated Water Resources Management at the river basin level (UNESCO

2009). Therefore, this flood vulnerability assessment could be viewed as a contribution to improve the overall management of the Sangkae River watershed.

Information about flood in the Tonle Sap central area is available (Hook et al. 2003), but is restricted in respect of the upper part of the catchment. Consequently, we started the survey by conducting a detailed assessment of the flood hazard through a participatory flood mapping exercise. This was organized in each of the 31 communes located within the watershed boundaries. Each workshop gathered 10-15 participants per commune, including all the heads of villages within the commune and some commune councilors. We defined flood as an 'overflow or inundation that comes from a river or other body of water that causes an impact'[2]. In order to capture the diversity of origin, three types of floods were considered: the central area flood in the Tonle Sap plain; river-overflow flood (Sangkae River and its tributaries); and surface water run-off flood. The combinations of these floods were also considered. Flood magnitude was classified into two categories: 'normal flood' considered as a usual annual flood; and 'severe flood' such as occurred in 2011. According to Mekong River Commission (MRC) standards, these two flood types are classified as 'minor' and 'medium', respectively (Hook et al. 2003).

Updated aerial photos retrieved from the Google Earth[3] server covering the entire communal territory were printed on large A0 size papers (spatial scale 1/5,000) and were overlaid with plastic covers to enable delineation of flooded areas. Not all participants had the knowledge and experience to orientate themselves on the map, so in order to facilitate the mapping process, all participants were first invited to identify the main waterways and water bodies in the commune as well as the agricultural land areas. They were then asked to map agricultural land that had been affected by the 2010 flood (minor) and 2011 flood (medium). For each flood area, they were asked to provide information about the generating mechanism of flood, the flood duration and its impact on the different agricultural productions.

We acquired datasets from the Ministry of Water Resources and Meteorology to identify rainfall and discharge/water levels. We also extracted monthly rainfall data for a time series from one meteorological station located in Battambang for the period 1920-2012[4] so that we could identify any significant trends in rainfall patterns (amount and distribution) to place recent flooding in a wider perspective. In addition, daily rainfall records for the period 1981-2012 enabled us to compute and analyze extreme rainfall indices[5].

[2] http://water.usgs.gov/wsc/glossary.html#F

[3] www.googlearth.com

[4] Data was not available for 19 years including the whole of the period from1941-1950 and from 1975- 1980. Where specific monthly rainfall data was missing for other periods (six years), we replaced the missing values with the average value of rainfall of the specific month in the relevant decade

[5] http://etccdi.pacificclimate.org/index.shtml

We also reviewed policy documents relevant to flood management. These usually have a national scope, so we looked at how they were interpreted and implemented at the watershed level. We also conducted interviews (n=5) with various governmental bodies involved in flood management at the provincial level (Provincial Committee for Natural Disaster Management, Spatial Planning Working Group, Department of Agriculture, Department of Water Resources and Meteorology and the NGO Caritas Cambodia) in order to examine the effectiveness of these institutions in reducing the vulnerability of agricultural production to flood hazards in the watershed.



## Commune level

There were two reasons the commune was chosen as the second spatial level: the existence of reliable statistical indicators that allowed agro-ecological and social-economic indicators to be combined, and the possibility to evaluate the role and importance elected commune councils have in flood disaster management.

At the commune level, the analysis consisted of an indicator-based vulnerability assessment. Vulnerability indicators are useful in identifying particularly vulnerable people, regions or sectors (Hinkel 2011). The indicators combine/link the different dimensions of vulnerability conceptualized at the commune level[6] with a specific and measurable value (Annex 1). However, access to quality and updated data is a primary concern and a limiting factor in establishing indicators (Chann and Kong 2013). So, when comprehensive and reliable data could not be retrieved from secondary sources, we relied on survey methods to generate our own primary datasets. Based on a consideration of the availability of secondary data and the feasibility of primary data collection, we eventually selected 11 quantitative indicators for the assessment (Annex 1):

- The indicators that relate to exposure comprise measures of the flooded areas that were identified during the participatory mapping exercise organized during the commune workshops (*see above*). We focused on the areas of agricultural land that were flooded in 2010 and 2011, which we also weighted according to the duration of the flood in a particular area (Annex 1). Values were expressed as a percentage of the total agricultural area of the commune.
- The values indicating the sensitivity of communes to flood are diverse and are assumed not to be correlated. We first considered the total area of agricultural land in the commune as a percentage of total area. We then considered the actual impact of flood on agricultural production. During the commune workshop we asked the participants to assess the impact (loss and gain) of flood on rice production in 2011 (the year of medium flood), compared with 2010 (the minor flood). We then calculated an *impact coefficient* that was proportional to the loss or gain in production and we used it to weight the flooded area. As a measure of sensitivity, we also considered the percentage of the population who were

[6] We selected only those communes that had their centroid inside the catchment

engaged in agriculture. In addition, we considered the diversification of agricultural production in the dry season, assuming that a higher percentage of cultivated area during this period gives the commune an advantage.

- Commune adaptive capacity was measured using different indicators such as the density of the road network. We took into account two additional indicators, namely the literacy and the poverty rates (Annex 1), assuming that higher literacy rates and standards of living would improve people's capacity to cope and adapt. In order to capture the institutional capacity of the commune to adapt to flood, the survey included qualitative questions on i) the efficiency of the flood warning system, ii) the mobilization of self-help groups in case of flood, iii) the existence and efficiency of external support, iv) the allocation of communal funds for post-disaster management, v) the efficiency of the natural disaster management committee, vi) the provision and quality of training programs for farmers and how well these training programs address flood management, and vii) the existence of farmer organizations in the commune. The answers to each question were coded with ordinal values from 0 to 3. The institutional capacity index for each commune was obtained by summing up the score obtained with the answer to each questions.

All indicators were standardized (Z-score) and summed without weighting into a component index (exposure, sensitivity and adaptive capacity). The three component indices were then standardized and computed into an overall vulnerability composite index by using the usual formula 'Vulnerability = Exposure index + Sensitivity index-Adaptive Capacity index' (see, for instance, Hughes et al. 2012).

We further integrated all standardized indicators within a multivariate hierarchical cluster analysis (Palm 1996)[7] in an attempt to identify groups of communes that were relatively homogenous within each group and heterogeneous between each other. The rationale for this type of multivariate analysis was to synthesize relations between multiple aspects of social-ecological vulnerability and to establish a typology of commune vulnerability across the watershed. The integration of all indicators and values in a geographic information system allows for a spatially-explicit rendering of the commune typology, and for an interpretation of spatial data on agro-ecology (see agro-ecological transect in Annex 2) and land use dynamic across the watershed.

### Household level

As a crucial element of our research we tried to capture the sensitivity of households to food insecurity and to assess the impact of flood on food security, as well as the different types of short-term and long-term adaptive responses that households had developed to deal with flooding. Assuming an increased intensity and magnitude of floods in the future, we

[7] A range of agglomerative cluster classification methods was tested. We selected the number of clusters (i.e. five) using the elbow-rule and used Ward's method of agglomeration as it provides results with low variability (standard deviation) within each group. We have tried to avoid a high degree of co-linearity between the variables, by keeping variables that have a correlation coefficient of less than 0.7

also engaged in a discussion with the interviewees about their readiness to adopt different agricultural and non-agricultural adaptive measures to reduce their future vulnerability. We were particularly interested in understanding the modalities and the extent to which local adaptive responses engaged the household in building flood-resilient cropping systems.

In each commune vulnerability type we selected one representative village (Table 1) to conduct a sampled quantitative household survey (n=162). The sample was randomly chosen from all households in each village using the formula $n=N/[1+N*(e)^2]$ where n=sample size, N=population size and e=level of accuracy (10 percent) for the extrapolation from sample to population (Israel 1992). To some degree, all households in our sample had been affected by flood in both 2010 and 2011.

***Table 1**: Village and household (HH) selection design*

| Vulnerability type | Commune | Village | Total HH | HH Sample |
|---|---|---|---|---|
| Very high | Preaek Luong | Bak Amraek | 299 | 36 |
| High | Samraong Knong | Samraong Tatok | 578 | 42 |
| Medium | Snoeng | Boeng Krasal | 457 | 25 |
| Low | Chheu Teal | Enteak Chit | 273 | 36 |
| Very low | Ta Sanh | Ta Sanh Khang Chheung | 232 | 23 |
| | | | 1,839 | 162 |

The analysis of vulnerability (represented at five levels - 'vulnerability types') is also based on a grouping of households according to their degree of sensitivity (represented at four levels - 'sensitivity groups') in terms of food insecurity. To establish the sensitivity groupings (Figure 3), we first determined if their own agricultural production allowed the household to be self-sufficient year round. To determine the level of self-sufficiency, we considered a milled rice consumption rate of 143kg per capita, per year, and a milled rice/paddy ratio of 0.64 (Gunjal et al. 2012). All agricultural production was taken into account and the monetary value calculated (outputs-inputs). Non-rice crop production was converted into milled rice equivalents based on the average price of milled rice of 3,000 riels/kg (4000 riels= USD 1)

- If the household was food self-sufficient from it own agricultural production during a year with a minor flood event (e.g. 2010), we determined if this remained the case during a year with a medium flood event (2011).
- If the household was not self-sufficient from its own agricultural production in 2010, we took into account the importance of non-farm labor activities in the household's overall income portfolio in securing its access to food. Non-farm labor includes all wage- and self-employed non-farm activities.

In the categorization of households into the four sensitivity groups, each has a distinct land-holding size and income structure derived from farming, non-farm and wage labor activities. The four categories stretch along a gradient of sensitivity to food insecurity and flood, the 1 and 4 grading ranges from less to more sensitive.

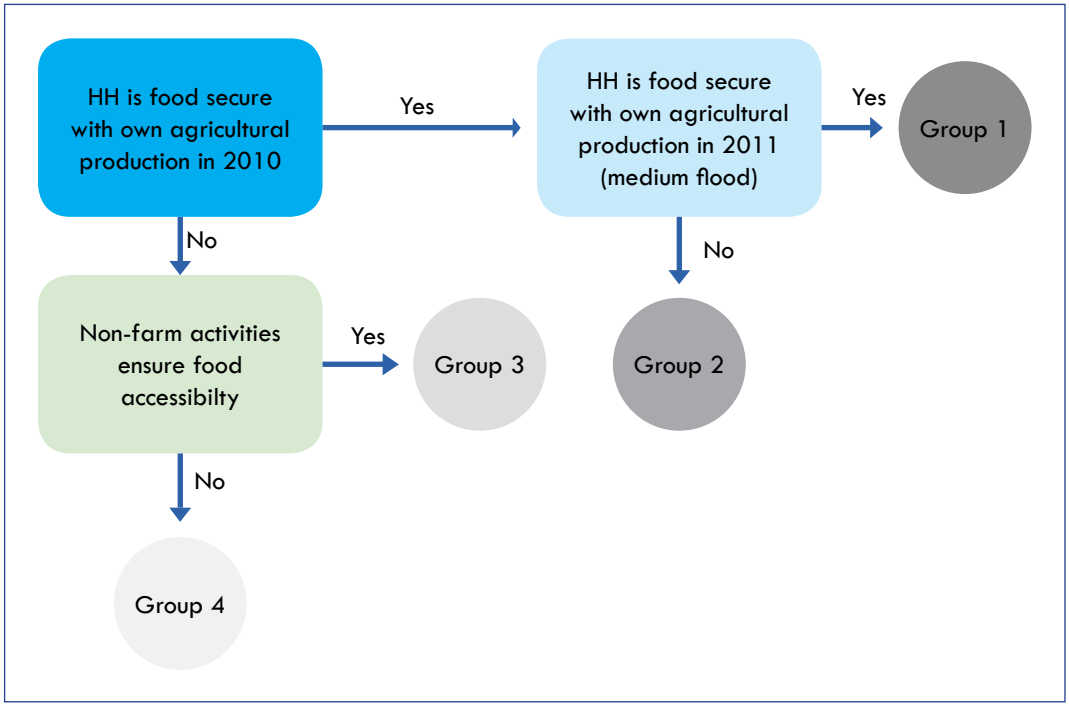


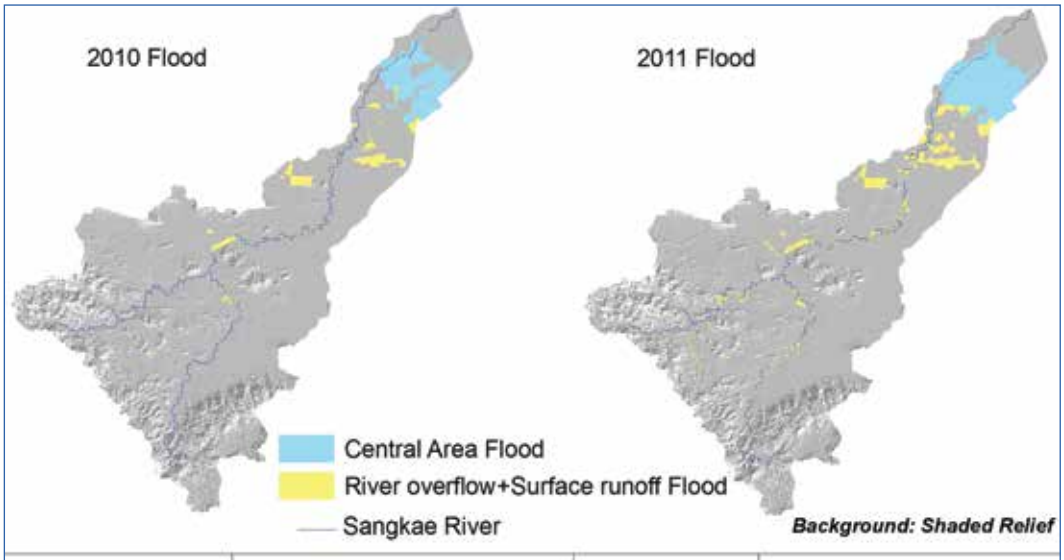

***Figure 3**:Design of the household assessment to determine sensitivity grouping*

# RESULTS

## The multiple floods in a context of changing rainfall distribution

Flooding affected an important area of agricultural land in both 2010 and 2011 (252.8 and 370.2 km$^2$, respectively, totaling 7 and 10 percent of the total catchment area size). In comparison, the central area (Tonle Sap) flood was the largest for both 2010 and 2011 (74 percent and 68 percent, respectively, of the total flooded area in the watershed). However, upstream flood resulting from the combination of river overflow and surface run-off has affected an appreciable area of 65.9 and 118.6 km$^2$ in 2010 and 2011, respectively[8] (Figure 4). These types of flood are obviously more localized along the river (see map), which contrasts with the vast Tonle Sap floodplain. In addition, we noted that the percentage increases in the area flooded between 2010 and 2011 is greater from river overflow (50 percent versus 26 percent in the Tonle Sap floodplain) (Figure 4). This suggests that upstream areas are relatively more vulnerable if these types of floods become more prevalent over time.

[8] Surprisingly, these floods are totally unrecorded in official statistics such as commune databases




| Flood types | Flood on agricultural land (Km²/%) | | | | Difference 2010-2011 flood area size (%) | Flood occurrence (mode of values) | |
|---|---|---|---|---|---|---|---|
| | 2010 | | 2011 | | | 2010 | 2011 |
| Tonle Sap (central area) | 186.96 | 74 | 251.73 | 68 | 26 | Sep-Nov | Sep-Oct |
| River overflow + Surface runoff | 65.86 | 26 | 118.55 | 32 | 50 | Sep-Oct | Aug-Oct |
| **Total** | **252.83** | **100** | **370.15** | **100** | **32** | | |

***Figure 4**:Incidence of floods on agricultural land in the Sangkae River watershed (2010 and 2011)*

Both types of floods have different origins. The magnitude of the Tonle Sap river depends to a large extent on the Mekong River discharge which pulses back into the Tonle Sap and floods the immense central plain. Kummu and Sarkkula (2008) note that the development of hydropower dams on the Mekong River has led to a clear drop in the flood peak and has increased the low water levels. In other words, they have decreased the amplitude of the flooding. They also suggest that the dry-season water levels in the Tonle Sap Lake are expected to rise due to upstream development on the Mekong River, which will lead to an increase in the area that is permanently flooded (Kummu and Sarkkula 2008).

Rainfall is key to explaining river overflow and surface run-off. Analysis of historical rainfall data for the period 1920-2012[9] shows that total annual precipitation has not significantly changed over the past century[10]. However, we note a significant change in seasonal and monthly rainfall distributions[11]. Figure 5 suggests that a higher proportion of rainfall in the

[9] Rainfall records for that period are available only for the Battambang station

[10] Given issues of data availability, the analysis allows for a comparison of rainfall between two distinct time periods: 1920-1939 and 1990-2009

[11] We owe the idea of this analysis about monthly and seasonal rainfall change to Someth Paradis who used a similar rainfall dataset in Kampong Chhnang with similar findings (see Chapter 3 of this volume)

rainy season (May to October) is due essentially to a reduction of rainfall in the dry season (November to April). Our analysis suggests that this has resulted from an increase in the dry period (with monthly precipitation less than 20 mm) from 1 month in 1920s-1930s to 3 months in 1990-2000s. Comparing the same time periods, the monthly rainfall distribution has also changed (Figure 6). Whereas the distribution used to be bi-modal (with two distinct peaks of rain in May and September), it has shifted to a mono-modal distribution with one peak in October. This suggests an intensification of rainfall towards the end of the year. The computation of extreme rainfall indices based on daily rainfall records for the period 1980-2012 confirms this intensification. Most notably, the annual count of wet days (with precipitation >1mm), the annual maximum consecutive five-day precipitation and the annual count of days when rainfall >20-30-50 mm are all increasing with the mode of occurrence in October (Annex 3). This intensification of rain towards the end of the year (October) is perceptible but has taken place very slowly. It is likely to put the upstream areas at higher risks of flood in the future.

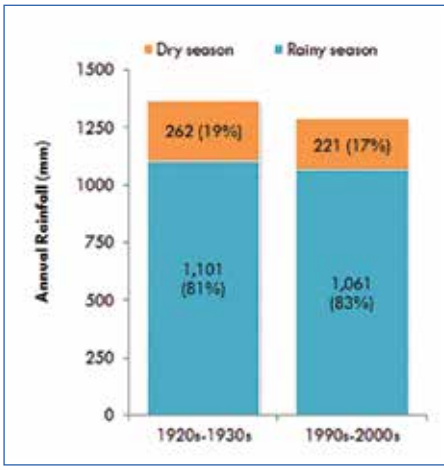



*Figure 5*:Seasonal rainfall distributions

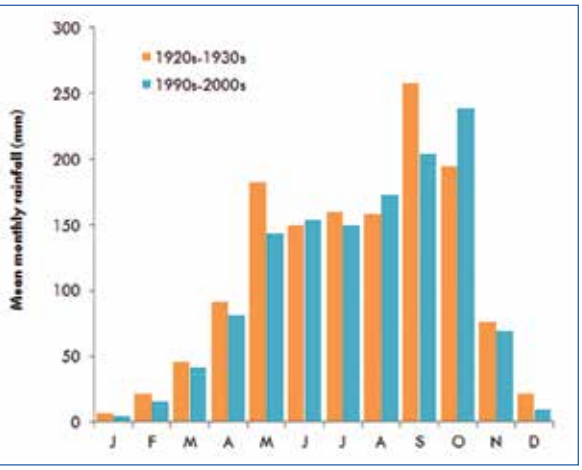



*Figure 6*:Monthly rainfall distribution change

## Institutions are weak in dealing with flooding

In Cambodia there is no shortage of governmental bodies and institutions dealing with flood management. They have different approaches according to their roles and responsibilities. In addition to line administrations, which have an historical mandate in flood management, the programmatic strategies of the Royal Government of Cambodia relating to flooding have recently intensified in the context of the new 'Climate Change Governance'. Currently, flood management intersects the mandate and policies of at least four key governmental bodies.

The National Strategic Development Plan (NSDP, 2009-2013) promotes an alliance between the Ministry of Water Resources and Meteorology (MOWRAM) and the Ministry of Agriculture, Forestry and Fisheries (MAFF), which is outlined in a detailed policy paper 'Strategy for Agriculture and Water 2006-2010' (Ministry of Agriculture, Forestry and Fisheries and Ministry of Water Resources and Meteorology 2007). As far as floods are

concerned, MOWRAM is responsible for pre-flood intervention measures such as rainfall records monitoring and early warning systems while MAFF is primarily focused on post-disaster intervention, assisting in the rehabilitation of rice fields after a flood. The strategy paper suggests that water resources are to be used and developed at the river basin level and according to the principles of Integrated Water Resources Management so as to minimize degradation of aquatic resources and avoid competition among users. The program aims to enable rural communities to avoid or respond without serious loss to the adverse effects of damaging floods, droughts or unexpected dry spells, for instance through participatory irrigation management and the development of flood and drought preparedness.

The National Committee for Disaster Management (NCDM), whose engagement is also part of the NSDP 2009-2013, is an inter-ministerial and multi-level body. It is a front-end institution in flood management responsible for disaster risk reduction - including early warning - evacuation and recovery strategic plans and actions. However, a recent ADB (2014) study concluded that NCDM operations are severely challenged. It drew attention to non-functional organizational structures that it attributed largely to the lack of financial resources (ADB 2014).

With respect to climate change, the Ministry of the Environment (MOE), and in particular the National Climate Change Committee (NCCC), has a lead role in coordinating and implementing the inter-ministerial policies, strategies, plans and programs contained in the National Adaptation Program of Action to Climate Change (NAPA) (Royal Government of Cambodia 2006). The NAPA mandate is to provide multi-sector mechanisms to guide the coordination and implementation of adaptation initiatives but it consists mostly of a list of spatially targeted and prioritized projects (39) to be implemented to enhance adaptive capacity. Five of the projects concern flood management. In the NAPA, adaptation is very much conceived of as a set of tools aligned to national development policies which frame the conditions under which adaptations are to take place. Little space is offered to develop and implement locally-designed and context-specific approaches with inclusive mobilization of actors. There is no indication that a transformative learning process is in place to frame the adaptation measures. More recently, the MOE has been involved in developing a Climate Change Strategy Plan (2013-2027) but this document does not provide a significant improvement.

The institutional scales for our research included the provincial level. The Provincial Committees for Disaster Management (PCDM) have been given the responsibility to lead disaster management efforts at their respective administrative levels without being provided with adequate resources. Although they have played an active role in coordinating the delivery of emergency relief aid, the role of these provincial committees in respect of flooding is now merely to tell different local and international organizations where to deliver rescue aid. The impacts of flood are addressed and managed post-disaster by these organizations with priority given to the downstream lowland (central area flood) and a clear emphasis put on providing emergency relief (food distribution, evacuation of people, and so on).

The Provincial Departments of MOWRAM have no reliable tools in place to study and predict a flood event. These provincial departments also face serious budget constraints in implementing a rigorous pre-disaster preparedness plan. For instance, although Battambang province is equipped with a spatial plan (Battambang Provincial Spatial Plan Sub-Working Group 2009) that covers a large number of land-related issues, natural disaster management is not mainstreamed in this plan.

Institutionally, there is a clear lack of balance between the plethora of institutions and coordination mechanisms designed to deal with flooding, and their effectiveness on the ground. The institutional resilience and the capacity of provincial institutions to learn from flood hazards are still limited, and this greatly hinders the reduction of flood vulnerability. However, repeated occurrences of large-scale flooding over the past five years have resulted in a notably increased awareness about the scope of flooding across the watershed, including in the upstream areas.

## A diversity of commune vulnerability profiles: The importance of agro-ecology and access to the city

Five types of communes were identified on the basis of the hierarchical cluster analysis that integrates the 11 vulnerability indicators. These five 'vulnerability types' are primarily ranked according to the mean value of the total vulnerability index, scaled 0-1, in order to extract a preliminary measure of the overall vulnerability (Table 2). But a stand-alone metric value is of limited use and relevance as it tends to over-synthesize vulnerability and is actually very difficult to interpret. This limitation is apparent in other vulnerability assessments (Chann and Kong 2013, Yusuf and Francisco 2009). In contrast, it is more interesting - and meaningful - to characterize the actual types of vulnerability by looking at how the indicators relate to each other within each commune type, and to examine how they differ between types. To interpret and make sense of this classification, we compute the mean value of each indicator for each vulnerability typing (on a 0-1 scale for easier interpretation). We further map the commune vulnerability composite index and interpret its spatial distribution with the land use system classification established by the spatial planning working group.

***Table 2:** Typology of commune vulnerability*

| | | Commune vulnerability types | | | | |
|---|---|---|---|---|---|---|
| | | Type 1 Very High (n=4) | Type 2 High (n=6) | Type 3 Medium (n=11) | Type 4 Low (n=5) | Type 5 Very Low (n=5) |
| Exposure | % of flooded area in 2011 (relative to total agricultural land area) | 0.83 | 0.74 | 0.03 | 0.23 | 0.03 |
| | % of flooded area in 2010 (relative to total agricultural land area) | 0.74 | 0.53 | 0.03 | 0.06 | 0.01 |
| | Flooded area in 2011 weighted by duration (relative to total 2011 flooded land area) | 0.69 | 0.56 | 0.01 | 0.06 | 0.01 |
| Sensitivity | % agricultural area size (relative to total commune area) | 0.40 | 1.00 | 0.75 | 0.98 | 0.33 |
| | % population involved in agriculture (relative to total population) | 0.83 | 0.56 | 0.82 | 0.81 | 0.92 |
| | Flooded area in 2011 weighted by damage (relative to total 2011 flooded land area ) | 0.71 | 0.77 | 0.57 | 0.33 | 0.43 |
| | % cultivated area during flood period (relative to total cultivated area) | 0.96 | 0.98 | 0.87 | 0.95 | 0.45 |
| Adaptive Capacity | Flood management institutional capacity | 0.64 | 0.69 | 0.35 | 0.71 | 0.39 |
| | % literate population (relative to total population) | 0.79 | 0.81 | 0.51 | 0.90 | 0.64 |
| | % population above poverty line (relative to total population) | 0.43 | 0.83 | 0.34 | 0.55 | 0.63 |
| | Road density (km/sq. km) | 0.08 | 0.43 | 0.12 | 0.51 | 0.06 |
| **Legend:** Values are scaled from 0 to 1 into 5 classes | | [1-0.8[ Very High | [0.8-0.6[ High | [0.6-0.4[ Medium | [0.4-0.2[ Low | [0.2-0] Very Low |

**Type 1** (overall very high vulnerability) consists of communes located in the flat lowland Tonle Sap floodplain area (Figure 7) with very high exposure to flood in 2011 and high exposure in 2010. The proportion of agricultural area in these communes is relatively small due to the prevalence of flooded forest in the location, overall. However, the sensitivity of Type 1 communes remains important given that a very high percentage of the population are involved in agriculture and the concomitance between the cultivation and flood risk periods. Despite long-term experience in flood management, the communes have only a moderate institutional capacity to manage flood. The communes receive a fair amount of support from outside but remain particularly weak in terms of engaging internal mechanisms to deal with flood such as self-help groups or the mobilization of the commune budget. This poor performance is reinforced by a high incidence of poverty and low endowment in road infrastructure limiting accessibility and mobility, and, with it, the opportunities for coping and adaptation.

**Type 2** communes (overall high vulnerability) are also located in the Tonle Sap floodplain and were highly exposed to the 2010 and 2011 floods. However, the variations in the topography allow farmers to keep agriculture out of the flood reach. Despite the fact that a more limited percentage of people live on the land and are engaged in agriculture, the sensitivity of this group of communes is high due to the prevalence of agriculture land in the land use inventory. As in Type 1, cropping activities are concomitant with the time of the rainy season when floods hit, and these have, therefore, a highly negative impact on crop production. The major difference between Types 1 and 2 revolves around their adaptive capacity, which we explain by the fact that these communes are located in the peri-urban area of Battambang city. They have a much better road network which improves mobility and gives better access to non-farm job opportunities (for coping or longer-term livelihood diversification strategies). This group of communes also performs well in mobilizing internal resources to manage flooding (organizing self-help groups and using commune budgets).

**Type 3** communes (overall moderate vulnerability) comprise those that are not located in the Tonle Sap floodplain. Flooding occurs as a combined result of river over-flow and surface run-off. The degree of exposure is logically much lower than it is in communes in Types 1 and 2, and the flooded areas are geographically concentrated along waterways. The communes are mostly rural with large areas of land allocated to agriculture and a population mostly living off this occupation. Geographically, the zone comprising the Type 3 communes is large. It can be differentiated into two areas (Figure 7): the old alluvial terraces where current cropping systems are mostly dedicated to rice-based production; and an upland area with a cropping mosaic of rice and non-rice (usually agro-industrial) cash crops. Where flooding occurs, there is high impact, notably on cash crop productions. The institutional capacity of the commune to deal with flooding is weak in terms of both external support and internal capacity to mobilise resources. Flood is not a major concern and so communes are not well prepared or equipped to manage it. This low performance is reinforced by high incidences of poverty and illiteracy and a low endowment of road infrastructure that limits access to coping opportunities.

**Type 4** (overall low vulnerability) communes are located at the edge of the Tonle Sap floodplain and, overall, the degree of exposure is higher than it is for communes of Type 3. They have a very low exposure when Tonle Sap flooding is minor (e.g. in 2010) but this becomes slightly higher when the Tonle Sap is in medium flood (e.g. in 2011). These communes are dedicated to rice-based agricultural production (both in terms of land use and labor force allocation) even if they are located in a peri-urban area of Battambang city (Figure 7). The proximity to Battambang gives this group of communes a large spectrum of adaptive capacity measures that actually balance the relatively high sensitivity. They have better road networks facilitating access to the city (which offers opportunities to support both long-term adaptation and short-term coping), and a high degree of mobility to cope when flood hits. The institutional capacity of these communes to deal with flooding is particularly high both externally and internally.

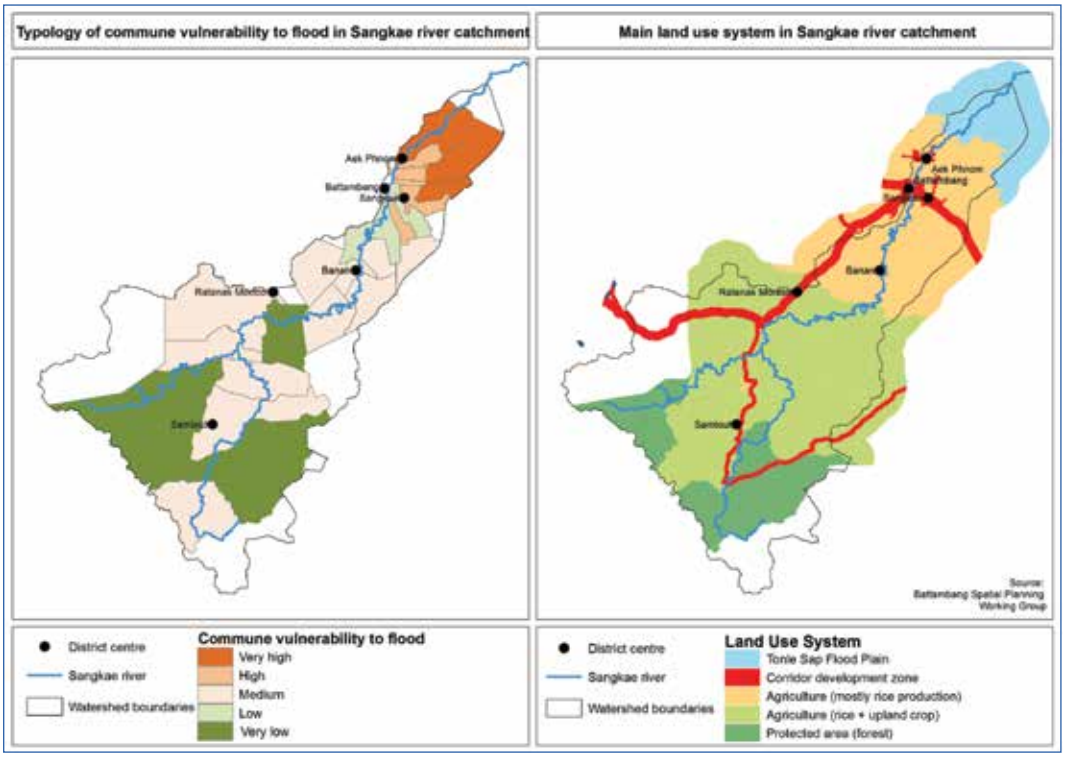



***Figure 7:*** *Commune vulnerability and land use systems in Sangkae River watershed*

**Type 5** (overall very low vulnerability) communes have a very low degree of exposure as they are located in mountainous upland areas. They were, therefore, away from the main flooded areas in both 2011 and 2010. Floods, when they do occur, are due to combined river overflow and surface run-off (as with Type 3). The overall sensitivity is very low due to a prevalence of upland forest in the overall land use system as well as a high degree of crop diversification in the dry season, thus limiting the impact of flood on the overall agricultural production (Figure 7). The adaptive capacity is rather low due to inexperience in flood management (no flood management mechanisms are in place) reinforced by a high incidence of poverty and a low endowment in road infrastructure.

## Moving in and out of agriculture: The challenges of household adaptation to flood

Households cope with the impact of flooding in various ways. These include taking advantage of external support, and the internal adjustment of production systems, which can be either non-agricultural or agricultural. The difference between non-agricultural and agricultural responses is central here. The first moves the household further away from the system that has been affected, while the second changes it. Agricultural responses do not necessarily enhance resilience but at least they attempt to address the problem at its core.

However, the assessment of the households in this project against these coping strategies shows that a significant number do not seem to adapt at all (n=53, 33 percent of the total

sample); they neither receive any external assistance nor do they internally adjust their production system. Some of these households have a low sensitivity (22 percent of HH pertaining to Group 1, and 6 percent to Group 2 in the sensitivity groupings shown in Figure 3) and have less need to adapt. The remaining 5 percent of households pertain to Group 4 (the most sensitive) and, for them, the absence of any adaptation measures means that the burden of the flood translates into a reduction in food consumption and food insecurity.

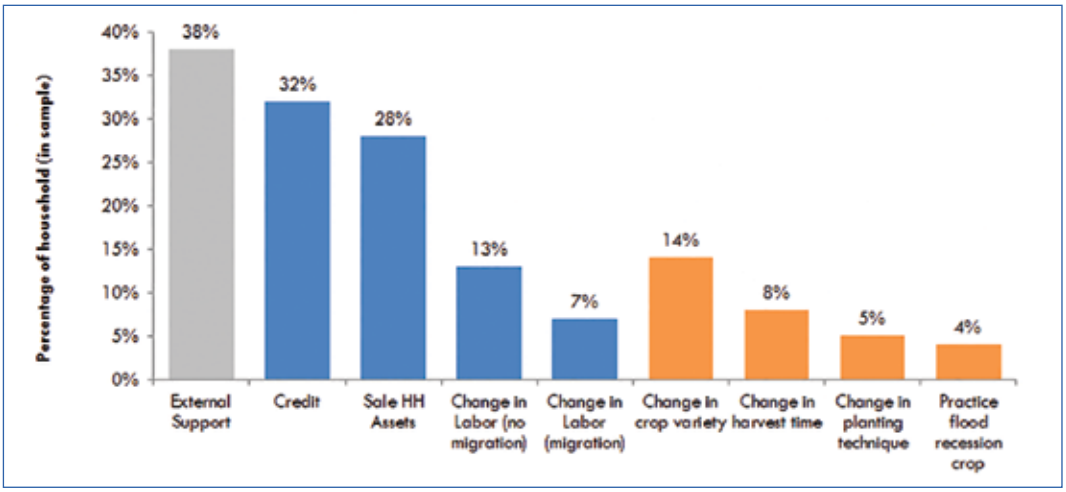



***Figure 8:*** *Distribution of frequency of households by responses to flood*

NGOs involved in natural disaster relief - including the Cambodian Red Cross - usually provide external support for households by channelling aid packages to the target villages. These packages comprise rice bags, drinking water, and so on. Our survey shows that this external support to flood-affected households was not comprehensive as only 38 percent of households that were investigated had received such assistance in 2011 (Figure 8). As Figure 10 illustrates, we found that external aid reaches a higher percentage of households in more vulnerable zones but we also attribute this to an accessibility issue as most vulnerable areas are close to Battambang city. This Figure also shows that the external assistance actually reaches remote villages in the upland far less than it gets to downstream villages. We further note that a higher proportion of households with lower sensitivity (Groups 2 and 3) actually receive proportionally more emergency aid assistance than those in the highly sensitive Group 4, who should be prioritized (Figure 9).

The non-agricultural internal adaptations usually take the form of short-term responses to cope right after the flood. These include access to credit, sale of household assets and changes in labor (including possible migration). In 2011, a significant number of households (51 percent) relied on at least one of these non-agricultural responses. The most important is credit (32 percent of HHs sought credit to help them to cope immediately after the flood) and second most important is the sale of household assets such as cows, motorbikes, and jewellery (28 percent of HHs resorted to this) (Figure 8). In both cases, these responses to flood do not reduce vulnerability but actually reinforce it over the long-term in that people

are surrendering their assets. We note that household non-agricultural coping is more important in regions of higher vulnerability (Figure 10) but our findings suggest that there are no sensitivity-group-specific, non-agricultural responses (Figure 9).

Unlike the adaptive responses that have previously been discussed, agricultural adaptation implies a change in household cropping systems. The number of households involved in at least one agricultural response (23.9 percent) sharply contrasts with those who adapt with non-agricultural means. The responses can be short-term adjustments - such as the practice of flood recession agriculture (4 percent) - or a change of harvest period (8 percent), while some other responses engage the households in more structural changes in their cropping systems such as the adoption of new planting techniques (usually favoring broadcasting rather than transplanting, 5 percent) or choosing alternative crop varieties (14 percent) (Figure 8). These observations emphasize the underlying difficulties faced by the household in building flood-resilient cropping systems.

A change in the varieties of rice cultivated is a clear strategy to deal with the period of high rain intensity and flood risk (October). The change of varieties implies abandoning rain-fed, photoperiod sensitive rice crops, harvested in October-November, for non-photoperiod sensitive short-cycle rice varieties. These shorter cycle varieties are usually improved varieties with higher potential yield. With access to water from irrigation or reservoirs, this non-photoperiod sensitive, short-term rice can also be cultivated in the early rainy season, from March/April to June. This change is substantial as it considerably alters the cropping and labor calendar. Yet changes in the rainfall pattern alone do not explain the adoption of these new rice varieties. In a move to boost rice production and rice export, the Ministry of Agriculture, Forestry and Fisheries has been active in promoting high yield non-photoperiod sensitive rice varieties (Ministry of Agriculture, Forestry and Fisheries and Ministry of Water Resources and Meteorology 2007). Another push factor for the adoption of those varieties has been the increased food demand driven by population increase. However, this pathway of adaptation has a high cost. It is reserved for households who can adopt the innovation because they have the necessary upfront investment capital to purchase seeds, fertilizers and pesticides. Our findings suggest that a higher percentage of Group 3 (more sensitive - see Figure 3) households have adopted the new rice varieties because they have a non-farm income to support upfront investment and to provide back-up in case of crop failure (Figure 9). This innovative form of adaptation also reinforces a social differentiation process between two categories of producers: successful farmers and coping peasants.

These difficulties were largely echoed by the farmers in our survey when they were asked about future prospects. A large majority of them were not willing to abandon agriculture (88 percent) or to sell land (91 percent), and an important part (52 percent) were considering reinforcing non-farm activities as a preferred adaptation option in the future, especially those who were most at risk (Group 4). Households who said they were ready to change their rice varieties represented 39 percent of the total but they were in the low sensitivity Groups 1 and 2.

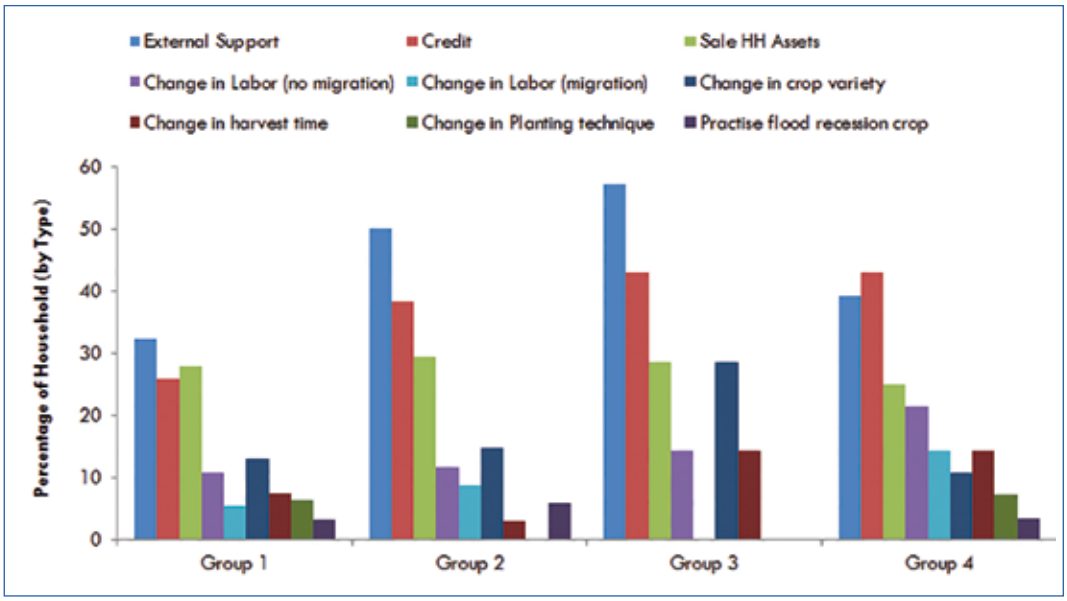



***Figure 9:*** *Distribution of frequency of households by responses to flood and by sensitivity grouping*

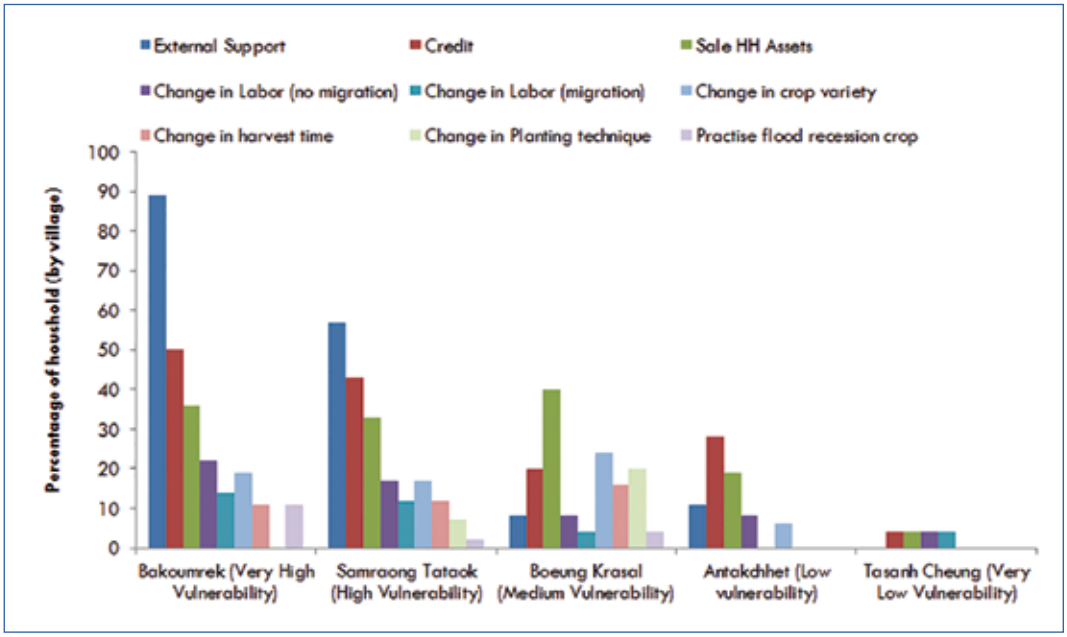



***Figure 10:*** *Distribution of frequency of households by responses to flood and by vulnerability zone*

## TOWARDS REDUCING FLOOD VULNERABILITY: WHAT IS NEEDED?



We have created a typology of vulnerability at different levels which is produced through the interaction of multiple and cross-scale drivers. This now allows us to make recommendations that are relevant at different levels of decision-making (provincial down to household levels). A particular concern is to find the fit between the scale of the vulnerability drivers (where and how they originate) and the scales of solutions. We are also concerned about providing recommendations that are directly meaningful and effective in enhancing flood-resilient agriculture for farmers and their communities.

Intensification of rainfall puts a higher pressure on all flood-prone areas across the watershed with a higher risk in the uplands where flood results from a combination of river-overflow and surface run-off. In mid-stream, the continued construction of irrigation canals will help to increase floodwater storage capacity within the watershed thus reducing flood exposure. But given the nature and magnitude of work needed here (engineering and infrastructure), the national and provincial agencies are best positioned to tackle it. In the upland area, though, low-key options to reduce exposure could be achieved by working concomitantly on limiting surface run-off (by soil terracing or ensuring a permanent land cover) and on improving the channelling and the reception of run-off water into natural or man-made storm-water basins.

As far as pre-disaster flood management measures are concerned much better coordination is needed between ministerial and inter-ministerial line agencies at provincial level. Provincial institutions need to join forces in order to provide more efficient responses to flooding across the watershed. The mandates of institutions with regard to flood management are actually quite explicit but a clear and definitive commitment to share efforts and information is lacking (World Bank 2003). All relevant institutions and government agencies should unite as a specific provincial flood management taskforce or *ad hoc* working group where information about rainfall data, flood prone areas, good practices and lessons learned could be shared and easily accessed by the stakeholders. Improved coordination could also be addressed through watershed management and spatial planning organizations. We recommend more systematic integration of natural disaster management in the provincial spatial plan, a district land use master plan and commune land use plan.

An early warning system could be greatly enhanced by rehabilitating existing rainfall stations throughout the watershed to make them operational. Accurate and reliable rainfall and water river level/discharge data could be recorded, monitored and disseminated quickly to all stakeholders. This could be done at low cost via a communication network that connects these stations and would enhance place-based flood management decision-making.

With regard to agriculture, the development of the so-called early season agriculture is central to promote flood adaptation but more generally to build a disaster-resilient cropping system. While early season agriculture would reduce the impact of flood, it would also

enable cropping intensification and diversification. First of all, detailed social and agro-ecological diagnosis of the potential of, and constraints on, developing early season agriculture is necessary. The promotion of early season agriculture should be an inclusive process that supports all categories of farmers. This obviously requires the details of different farming systems to be understood, as well as support for farmers in discovering and pursuing their own adaptation pathway. At the household level, the promotion of integrated farming systems along agro-ecological principles is a key strategy in building disaster-resilient smallholder agriculture.

Support for this early season agriculture is not a panacea. Provincial authorities need also to promote innovative partnerships with commune councils, building information and knowledge bridges between provincial agricultural and resource authorities, and the farmers (e.g. through local development planning and budgeting processes). Key here is to build legitimate and inclusive dialogue forums with a strong and definitive commitment to learning between multi-level organizations and associated institutions involved in flood management. Local level stakeholders could also be supported in their own efforts at small-scale infrastructure construction (storm-water reservoirs) to better enable early season agriculture. Local authorities also have a role to play in monitoring the land markets to prevent land rent capture and land concentration in the hands of a few well-connected and wealthy famers.

As far as post-disaster flood management is concerned, the selection of target zones and households for aid rescue distribution should be improved and better based on sensitivity criteria.

## TYPOLOGIES OF VULNERABILITY: CONCLUDING REMARKS

The multi-scale assessment we have proposed suggests that there is no simple answer to the questions posed in respect of flood vulnerability in the Sangkae River watershed. The nature and extent of vulnerability always depend on the analytical scale (O'Brien et al. 2004) and the politics of the assessment (Lebel 2006). To capture the complex nature of cross-scale and cross-level interactions, we have defined different typologies of vulnerability at different levels of analysis.

The analysis of historical rainfall patterns and extreme rainfall events in the watershed allowed us to identify a trend towards the intensification of the water cycle and the change of rainfall pattern into a mono-modal (one peak) distribution that culminates in October. So, throughout the watershed, flooding has become a more frequent problem. We found the risk has become higher in the upland area than on the Tonle Sap floodplain, through a combination of surface run-off and river overflow. However, if similar studies are to take place in other watershed areas, we recommend taking into account (if possible) rainfall data from other stations located in the catchment in order to allow for a more dynamic modeling of flood patterns. A more detailed analysis of vulnerability at the commune level provides a stronger basis for understanding where, how, and why certain regions are more vulnerable than others

to flood. Our analysis reveals that the agro-ecology diversity and the accessibility to/from main urban centers are key in explaining this diversity. When the assessment takes into account the uneven distribution of land and income within villages, it is possible for social groups to be identified that are more vulnerable to flood than others.

The methodology we developed provides nested pictures of vulnerability at different levels and scales and our argument suggests that a dialogue between these levels and scales is necessary to make sense of vulnerability and to act to reduce it. This dialogue should be coordinated by the Provincial Committees for Disaster Management, with participation from provincial institutions of line ministries, NGOs and development partners, in order to improve pre-flood preparedness and foresee the interventions that would best help vulnerable areas. Based on these different typologies of vulnerability this approach supports the identification of sound recommendations that can contribute towards reducing vulnerability through better horizontal and vertical integration of institutions and agencies and through effective collective action.



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# BIBLIOGRAPHY


ADB (2014) *Project Data Sheet (PDS): Strengthening Coordination for Management of Disasters (46230-001)*, Available at: http://www.adb.org/projects/46230-001/main.

Adger, N. W. (2006) Vulnerability. *Global Environmental Change, 16*, pp. 268-281.

Battambang Provincial Spatial Plan Sub-Working Group (2009) *Battambang Spatial Plan 2010-2030*. Battambang.

Cash, D. W., Adger, N. W., Berkes, F., Garden, P., Lebel, L., Olsson, P., Pritchard, L. and Young, O. R. (2006) Scale and Cross-Scale Dynamics: Governance and Information in a Multilevel World. *Ecology and Society, 11*(2), pp. 8-19.

CDRI (2011) *Irrigation water productivity in Cambodian rice system. Working Paper No. 51*. Phnom Penh: Cambodia Development Resource Institute.

Centre for Research on the Epidemiology of Disasters (2011) *The International Disaster Database*. Brussels: Université Catholique de Louvain - Available at: http://www.emdat.be/.

Chann, S. and Kong, S. (2013) Climate Change Vulnerability Mapping: commune level assessment in Kampong Speu Province. in Chhinh, N., Heng, N., Chann, S., Kong, S., Cheb, H. and Sen, R., (eds.) *Climate Change Vulnerability Assessment. Kampong Speu Province, Cambodia*, Phnom Penh: Royal University of Phnom Penh. pp. 23-52.

Chhinh, N., Heng, N., Chann, S., Kong, S., Cheb, H. and Sen, R., eds. (2013) *Climate Change Vulnerability Asssessment. Kampong Speu Province, Cambodia*, Phnom Penh: Royal University of Phnom Penh.

Diduck, A., Sinclair, A. J., Hostetler, G. and Fitzpatrick, P. (2012) Transformative learning theory, public involvement, and natural resource and environmental management. *Journal of Environmental Planning and Management, 55* (10), pp. 1311-1330.

Eastham, J., Mpelasoka, F., Mainuddin, M., Ticehurst, C., Dyce, P., Hodgson, G., Ali, R. and Kirby, M. (2008) *Mekong River Basin Water Resources Assessment: Impacts of Climate Change*. CSIRO: Water for a Healthy Country National Research Flagship.

Gibson, C. C., Ostrom, E. and Ahn, T. K. (2000) The concept of scale and the human dimensions of global change: a survey. *Ecological Economics, 32*, pp. 217-239.

Gunjal, K., Sheinkman, M., Burja, K., Jeong, J. and Long, Y. (2012) Crop and food security update mission to Cambodia. Food and Agricultural Organization & World Food Programme.

Hinkel, J. (2011) "Indicators of vulnerability and adaptive capacity": Towards a clarification of the science–policy interface. *Global Environmental Change, 21,* pp. 198-208.

Hook, J., Novak, S. and Johnston, R. (2003) *Social Atlas of the Lower Mekong Basin.* Me kong River Commission, (ed.), Phnom Penh.

Hughes, S., Yau, A., Max, L., Petrovic, N., Davenport, F., Marshall, M., McClanahan, T. R., Allison, E. H. and Cinner, J. E. (2012) A framework to assess national level vulnerability from the perspective of food security: The case of coral reef fisheries. *Environmental science & policy, 23,* pp. 95-108.

Huntington, T. G. (2006) Evidence for intensification of the global water cycle: Review and synthesis. *Journal of Hydrology, 319*, pp. 83-95.

Israel, G. D. (1992) *Determining Sample Size*. Factsheet PEOD-6, University of Florida.

Keskinen, M. (2006) The Lake with Floating Villages: Socioeconomic Analysis of the Tonle Sap Lake. *International Journal of Water Resources Development, 22* (3), pp. 463-480.

Keskinen, M. (2008) Water Resources Development and Impact Assessment in the Mekong Basin: Which Way to Go? *AMBIO, 37* (3), pp. 193-198.

Kummu, M. and Sarkkula, J. (2008) Impact of the Mekong River Flow Alteration on the Tonle Sap Flood Pulse. *AMBIO, 37* (3), pp. 185-192.

Lebel, L. (2006) The Politics of Scale in Environmental Assessments. in Reid, W. V., Berkes, F., Wilbanks, T. J. and Capistrano, D., (eds.) *Bridging Scales and Knowledge Systems Concepts and Applications in Ecosystem Assessment,* Washington: Island Press.

Low, B., Costanza, R., Ostrom, E., Wilson, J. and Simon, C. P. (1999) Human–ecosystem interactions: a dynamic integrated model. *Ecological Economics, 31*, pp. 227-242.

McCarthy, J. J., Canziani, O. F., Leary, N. A., Dokken, D. J. and White, K. S. (2001) *Climate Change 2001: Impacts, Adaptation, and VulnerabilityContribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge - United Kingdom and New York - USA: Cambridge University Press.

Ministry of Agriculture-Forestry and Fisheries and Ministry of Water Resources and Meteorology (2007) *Strategy for Agriculture and Water 2006-2010*. Phnom Penh.

Moench, M. (2011) Aren't we all vulnerable: why do vulnerability analysis? *IIED Opinion.*

NCDD (2010) *Commune Database Online*. Available at: http://www.ncdd.gov.kh

O'Brien, K., Eriksen, S. and Nygaard, L. (2007) Why Different Interpretations of Vulnerability Matter in Climate Change Discourses. *Climate Policy, 7* (1), pp. 73-88.

O'Brien, K., Sygna, L. and Haugen, J. E. (2004) Vulnerable or resilient? A multi-scale assessment of climate impacts and vulnerability in Norway. *Climatic Change, 64*, pp. 193-225.

Palm, R. (1996) *La classification numérique: principes et application,* Gembloux: Faculté Universatire des Sciences Agronomiques de Gembloux.

Ribot, J. (2011) Vulnerability before adaptation: Toward transformative climate action. *Global Environmental Change, 21*, pp. 1160-1162.

Royal Government of Cambodia (2006) *National Adaptation Programme of Action to Climate Change (NAPA)*. Phnom Penh.

Stocker, T. F., D. Qin, G.-K., Plattner, L. V. A., Allen, S. K., Bindoff, N. L., Bréon, F.-M., Church, J. A., Cubasch, U., Emori, S., Forster, P., Friedlingstein, P., Gillett, N., Gregory, J. M., Hartmann, D. L., Jansen, E., Kirtman, B., Knutti, R., Kumar, K. K., Lemke, P., Marotzke, J., Masson-Delmotte, V., Meehl, G. A., Mokhov, I. I., Piao, S., Ramaswamy, V., Randall, D., Rhein, M., Rojas, M., Sabine, C., Shindell, D., Talley, L. D., Vaughan, D. G. and Xie, S.-P. (2013) Technical Summary. in Stocker, T. F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S. K., Boschung, J., Nauels, A., Xia, Y., Bex, V. and Midgley, P. M., (eds.) *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* Cambridge - United Kingdom and New York - USA: Cambridge University Press.

Turner, B. L., Kasperson, R. E., Matsone, P. A., McCarthy, J. J., Corell, R. W., Christensen, L., Eckley, N., Kasperson, J. X., Luers, A., Martello, M. L., Polsky, C., Pulsipher, A. and Schiller, A. (2003) A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences, 100* (14), pp. 8074-8079.

UNESCO (2009) *IWRM at River Basin Level. Part 1 Principles*, Paris.

Vogel, C., Moser, S. C., Kasperson, R. E. and Dabelko, G. D. (2007) Linking vulnerability, adaptation, and resilience science to practice: Pathways, players, and partnerships. *Global Environmental Change, 17*, pp. 349-364.

World Bank (2003) *Cambodia Environment Monitor*, Phnom Penh: World Bank.

World Bank (2013) *Where have all the poor gone?* Policy note. Phnom Penh: World Bank.

Yusuf, A. A. and Francisco, H. (2009) *Climate Change Vulnerability Mapping for Southeast Asia*, Singapore: IDRC, SIDA and EEPSA.

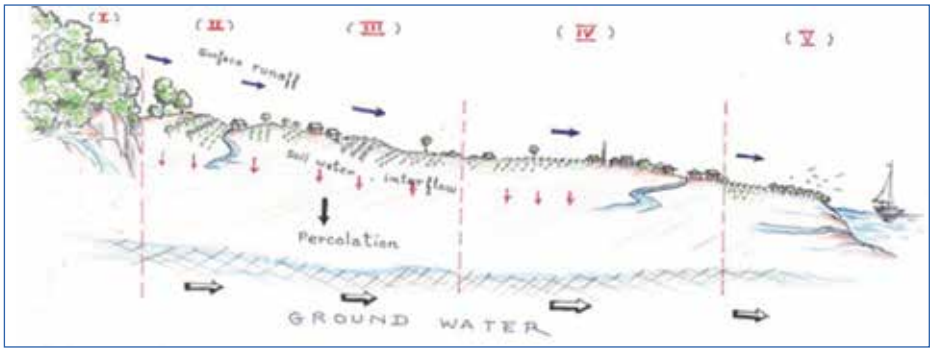
# ANNEXES

**Annex 1:** List of indicators for commune vulnerability analysis

| Dimension | Indicators | Data source |
|---|---|---|
| Exposure | % of flooded area in 2011 (relative to total agricultural land area) | Commune workshop conducted in 2012 |
| | % of flooded area in 2010 (relative to total agricultural land area) | |
| | Flooded area in 2011 weighted by duration (relative to total 2011 flooded land area) | |
| Sensitivity | % agricultural area size (relative to total commune area) | Interpretation of Landsat satellite image (2010) |
| | % population involved in agriculture (relative to total population) | Commune database online (2010 update) |
| | Flooded area in 2011 weighted by damage (relative to total 2011 flooded land area ) | Commune workshop conducted in 2012 |
| | % cultivated area during flood period (relative to total cultivated area) | Commune database online (2010 update) |
| Adaptive capacity | Flood management Institutional Capacity | Commune workshop conducted in 2012 |
| | % literate population (relative to total population) | Commune database online (2010 update) |
| | % population above poverty line (relative to total population) | GIS-based calculation based on road information (2010) |
| | Road density (km/sq. km) | Commune database online (2010 update) |

**Annex 2:** Agro-ecological transect across Sangkae River watershed from the south-west (left) to the north-east (right)

An agro-ecological transect is a useful way to present the agro-ecological features of the watershed. A virtual line oriented south-west to north-east is drawn to simulate a walk across the watershed. The transect aims to describe the evolution of the agro-ecological features. Four distinct zones are identified. The figure shows the diversity and the transition in the social-ecological landscape.




| | | | | |
|---|---|---|---|---|
| **Landform-Elevation** (meters above sea level) | Moderate or steep inclines High: 1000-1250 m | Gently rolling highland with some lowland areas to rivers 250-1000 m | Mainly rain-fed lowland prone to flooding 15-50 m | Gently rolling low-lying land, entirely inundated for long periods 5-15 m |
| **Water resources** | Seasonal and perennial stream | Non flooded, perennial and season stream | Larger stream and river - occasional lake and ponds (perennial). Partly flooded | Seasonal flood, numerous lakes/ ponds |
| **Climate** | High rainfall (>2000 mm/ year) - 2 months dry | Rainfall: 1500–2000 mm/year Low drought risk, rains start east to west | Rainfall: 1000-1500 mm/year 3-month dry | Rainfall: 1000-1500 mm/year 2-month dry |
| **Geology** | Sandstone Triassic | Quaternary colluviums (pedi-ments) + limestone | Quaternary lake deposits | Quaternary or-ganics deposit |
| **Soils** | High drainage, superficial, erodible, fragile *Leptosols* | *Cambisols-leptosols-Nitisols* | *Luviols–Vertisols* | *Gleysols–Fluvisols* |
| **Land use (2002) and main crop** | Forest (timber extraction), hunting, charcoal, non-timber forest product (NTFP) collection | Highland agriculture with fruit production and livestock Abandoned crops covered by grass or shrub Some lowland paddy in depressions | Main rice plain - settlement, main infrastructure Significant fruit tree farming system Limited area of irrigated farming | Flooded plain (flooded grass-land, flooded shrub and forest) Capture-fish-based livelihood systems Migratory (sea-sonal) livestock systems Deep water rice |
| **Land use dynamic** | Conservation and effective production | Slight decrease in the forest cover Complete decrease of the wood-shrub land into agricul-tural land | Maintain or enhance the agricultural land and mainly rice production | Varied density between grass and shrub land |

***Source:*** *Battambang provincial spatial plan*

**Annex 3:** Computation of extreme rainfall indices

| Comment | Trends 1981-2012 | Month of Occurrence (Mode) | Slope | $R^2$ (linear) |
|---|---|---|---|---|
| Wdays>1mm Annual Count of wet days when precipitation >1mm | Increase | September (500 days btw 1981-20012) | 0.3000 | 0.0705 |
| PRCTOTO = Annual Total Precipitation on wet days (rainfall > 1mm) | Increase | N-A | 2.3116 | 0.0141 |
| SDII: Simple Precipitation Intensification Index = PRCTOT/Nb Wet days (rainfall>1mm) | Decrease | N-A | -0.0196 | 0.0206 |
| Max. CWD>1mm CWD= (Annual) Number of consecutive Wet Day (when rainfall > 1mm) | Decrease | September (10 series out of 31 ) | -0.0065 | 0.0005 |
| Rainfall during Max CWD>1mm | Increase | N-A | 0.0155 | 0.000008 |
| Max CDD<1mm CDD= (Annual) Number of consecutive Dry Days (when rainfall<1mm) | Decrease | N-A | -0.1343 | 0.0072 |
| Rx1Day = (Annual) Maximum 1 day precipitation | Decrease | October (13 days out of 31) | -0.0638 | 0.0007 |
| Rx5D = (Annual) maximum consecutive 5-day precipitation | Increase | October (12 series out of 31) | 0.1086 | 0.0004 |
| R20mm=Annual Count of days when Rainfall>20mm | Increase | October (124 days) | 0.0157 | 0.0012 |
| R25mm=Annual Count of days when Rainfall>25mm | Increase | October (89 days) | 0.0056 | 0.0003 |
| R50mm=Annual Count of days when Rainfall>50mm | Increase | October (32 days) | 0.0234 | 0.0248 |

# CHAPTER 3

## IMPACTS OF SOCIAL-ECOLOGICAL CHANGE ON FARMING PRACTICES IN THE STUNG CHREYBAK CATCHMENT, KAMPONG CHHNANG PROVINCE

HAM Kimkong and SOMETH Paradis



## ABSTRACT

This paper outlines the complex relationships between the experiences of farmers in coping with climate-rainfall patterns, changes to agricultural practices and irrigation management, drivers of land use change and the impacts and implications of these social-ecological changes on farming communities in Stung Chreybak catchment. Longitudinal rainfall analysis shows shifts in rainfall patterns resulting in more intense rainfall at the end of the year (September) and an increase in dry spell duration. At the same time, the Royal Government of Cambodia has promoted increased rice production for export as a key income generating policy. This policy promotes the cultivation of non-photoperiod sensitive high yield rice varieties during the early rainy season, just before the usual rain-fed rice cultivation. This new agricultural practice requires upfront cash investment and better water management. To address the increased competition for water resulting from this agricultural intensification and from a reshuffling of the cropping calendar, the government introduced the devolved Farmer Water User Communities (FWUCs). We have argued that in Stung Chreybak catchment, these FWUCs are functioning inadequately in addressing the multiple issues and conflicts of water governance and in supporting adaptive water management in the face of social-ecological change. This inadequate performance is due to the incomplete devolution of rights and responsibilities which has meant that these new institutions have limited accountability to the communities they are established to serve. Effective use of devolved water management institutions will require more diverse and effective participation of local resource users and NGOs (horizontal integration) coupled with better vertical integration and cooperation between levels of government involved in Cambodian water management.

**Key words:** *rainfall amount/pattern; environmental management; agriculture; water resources; flood; farming systems; food security*

# INTRODUCTION

In the Lower Mekong Basin, climate change has exerted both a direct and indirect impact by altering precipitation and river run-off as well as increasing the vulnerability of the people to floods, drought and infectious diseases (Eastham et al. 2008, Xu 2011, Parry et al. 2007). Climate change has had an impact on land and natural resources and therefore affects the communities who depend on those resources for their livelihoods.

Climate change has persuaded the scientific community to formulate a new set of questions relating to environmental sustainability and management (Stocker et al. 2013). They have realized that they now need to address the underlying causes of vulnerability to these changes (Ribot 2011) and to assess the capacity of the communities affected to adapt to these new social-ecological circumstances (Kaoru 2013).

In Cambodia, livelihoods largely depend on land and on the natural resources it supports. Agriculture not only contributes to the food security of a growing rural and urban population but also generates revenue from export. National rice production has increased rapidly during the past decades - by 81 percent between 1993 and 2000 - and this trend continues. Rice export is expected to reach one million tonnes by 2015 (Hoanh et al. 2010). Given the central role that agriculture and natural resource production play in national development there is no doubt that climate change will continue to have a profound impact in Cambodia.

Climate change is not the only driver affecting the productivity and management of land and natural resources. Land use and water management are also significant, and these are affected by institutional, cultural, demographic and economic factors. The case of Stung Chreybak catchment in Kampong Chhnang province is an example. Over the past 15 years, rice production, which constitutes the central livelihood activity of farming communities living in the catchment, has been affected by broader social-ecological factors including variations in rainfall patterns, land use and land cover change, and the evolving social and institutional arrangements of water resource governance.

Change in the rainfall pattern due to climate change is thought to directly affect the hydrological cycle and water quality. Indirectly it results in changing vegetation patterns, altered food chains and increased soil erosion (Xu 2011). Moreover, the rainfall pattern/intensity affects water quantity and quality; therefore, it also has an impact on food security and stability and leads to increased vulnerability among poor rural farmers. Changes in rainfall amount/pattern can be expected to exacerbate water scarcity, as well as to contribute to multiple social-economic stresses (Xu 2011). Furthermore, surface- and ground-water availability depends on the seasonality and inter-annual variability of rainfall amount/pattern. In addition, high or low amounts of rainfall correlate strongly with a high risk of rain-generated extreme floods, and, at the other end of the spectrum, droughts. Finally, change affects the function and operation of existing water infrastructures, especially hydropower, irrigation and drainage systems (Bates et al. 2008). This will directly and indirectly affect population and economic development. The term '**change in rainfall amount/pattern**' *refers specifically to changes in the mean and/or variability of rainfall intensity that persists for an extended pe-*

*riod, typically decades or longer. In this study, the term refers to rainfall variability attributable to natural causes rather than to the human activities that alter atmospheric composition.*

Several research projects have been conducted in the area. A land use change survey (Chann et al. 2011) revealed that fragmentation and decline of evergreen forest quality have occurred in the upper catchment. This research suggests that the historical roots of disturbance go back to the Khmer Rouge period, though more recent changes in the forest cover are a result of demographic increase, forest encroachment and illegal logging by local people and outsiders, charcoal production and commercial agriculture. The main agricultural crop is rice. Although rain-fed rice production is common across the whole catchment, farming communities located downstream of the catchment have started to expand dry rice cultivation irrigated from the Stung Chreybak River. Chem and Someth (2011) suggest that the irrigated areas have expanded because of population growth: in order to meet an increasing food demand, people have exploited more natural resources and have intensified agricultural production. Many farmers who grow dry season rice lack irrigation, not just because of a lack of water in the catchment, but also because irrigation infrastructure and a proper water allocation mechanism are lacking. Chem and Someth 2011 also suggest that the allocation of water between different irrigation schemes and also between users within the same scheme is neither timely nor equitable. This creates intense competition for local water.

Using this earlier work as a basis, this research project examines how farming practices in Stung Chreybak catchment have adapted in the context of recent social-ecological change. We analyze different social-ecological change factors affecting agricultural practices and in particular rainfall, land use and water resource management. We then examine how these changes have affected local cropping systems, and the resulting food security strategies of farming communities. We are particularly interested in looking at adaptation and innovation strategies adopted at household and local institutional levels that are central to the current agrarian transformation.

In this paper we present the changes in seasonal and monthly rainfall patterns over the past century, which have led to more intense rainfall at the end of the year (September) and an increase in dry season duration. Over the past 20 years, this change in rainfall pattern, combined with population increase and policies favoring export-oriented rice production and the development of irrigation infrastructures, has resulted in a large increase in total annual rice production. We suggest that shifting social-ecological factors have converged to result in a comprehensive change to local rice cropping systems resulting in increasing competition for water in the dry season. The institutional innovation that emerged to address this new set of issues took the form of a decentralization of water management to local Farmer Water User Communities (FWUCs). We argue that in Stung Chreybak, these FWUCs are inadequately equipped to address the multiple issues and conflicts of water governance. This inadequate performance is due to the incomplete devolution of rights and responsibilities and has resulted in ineffective management decision-making and limited accountability of these institutions to their constituents.

# METHODOLOGIES

## Analytical approach

According to Chambers and Conway (1991) a livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living. They suggest that a "livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generations; and which contribute net benefits to other livelihoods at the local and global levels and in the short and long term".

Livelihoods essentially revolve around resources (such as land, crops, seed, labor, knowledge, money and social relationships) but these resources cannot be disconnected from the issues and problems of access, and the changing political, economic and socio-cultural circumstances (Rakodi 2002). In fact, the livelihoods of farming communities mainly focus on on-farm activities (rice, livestock and gardening) or activities associated with common pool resources (forests and fisheries). Rural livelihoods also include off-farm employment (agricultural wage labor) and a large array of activities that are not related to land or natural resources such as handicrafts, sugar palm making and home-gardening.

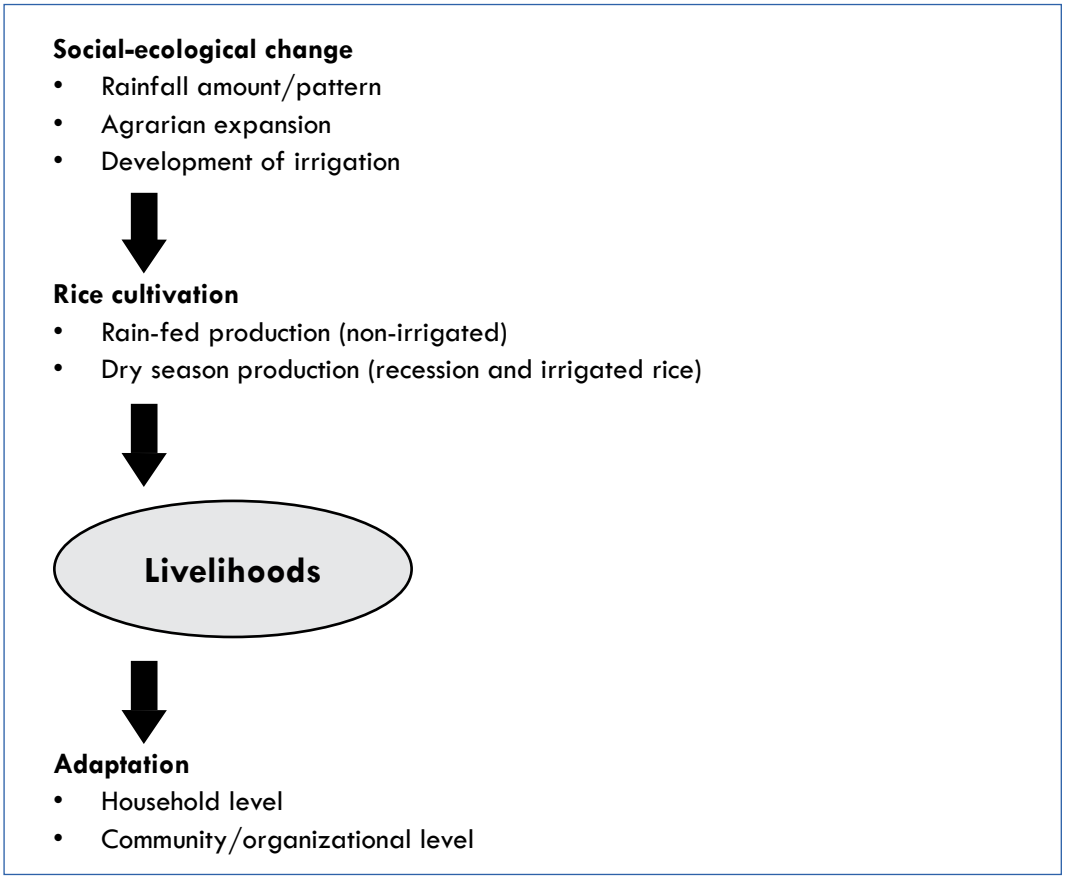



***Figure 1:*** *Research Analytical Framework*

In Stung Chreybak catchment, rice production is the central activity. We suggest that different rice cropping activities and systems have been influenced by either the ecological or the social dimensions (or their interactions) of the resources themselves. Through this research, we address changes in rainfall amount and distribution, agrarian expansion and the intensification of rice cultivation through the establishment of irrigation infrastructures and institutions (Figure 1).

The effects these social-ecological changes have on the land and resources give impetus to stakeholders involved in agricultural production to change their farming practices; this is what we refer to as '**adaptation**', *meaning the changes and transformations occurring at household level as well as at the local institutional level. We suggest that some adaptation results in modification of agricultural production systems whereas other forms tend to engage the household and local institutions in activities away from the land resources*. Both are considered in this research (Figure 1).

## Site selection

Three farming communities were selected, namely Pok Pen, Tang Krasang and Trapang Trabek, which are located in different parts of the catchment - upper, middle and lower, respectively (Figure 2). The term '**farming community**' *refers here to a group of villagers living near to each other in a particular place, most of them farmers, having similar interests and using common resources such as natural resources and engaged in traditional rice cultivation*. Each community consists of four villages located around one irrigation scheme: Pok Pen (Sleng, Srey Cha, Trapang Smach and Lor Tang), Krasang Krang (Tamom, Tang Krasang, Chas and Kok) and Trapang Trabek (Kouk Beanteay, Popeal Pork, Meanchey and Proneam Pich).

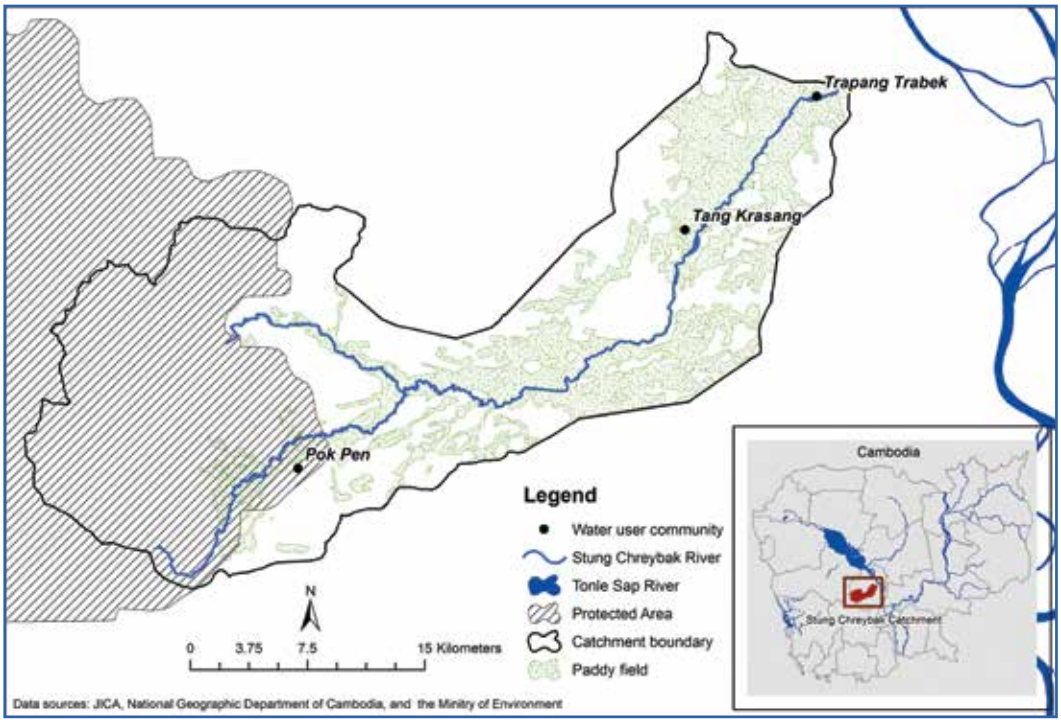



***Figure 2:*** *Study Area in Stung Chreybak catchment*

In the downstream area, Trapang Trabek community receives flood water from the Tonle Sap river in the wet season. The cultivation of deep water rice, once grown along Stung Chreybak canal, has ceased as a result of low yields and has been replaced by the cultivation of irrigated rice.

## Research tools

### Quantitative data collection

An important quantitative dataset used in this research, acquired from JICA and MOWRAM (2009), consists of rainfall records available at Kampong Chhnang station (12°14'31.5", 104°39'59.7", 11.5 m) for the period 1920-2000s (specifically up to 2007). Data does not exist for all of the years in the period, but there is sufficient for reliable analysis.

Land cover in a 10 km radius around the station is presented in Figure 3. It is classified into six categories: (1) agricultural land (field/garden crops and paddy fields); (2) forest cover (secondary and deciduous forest); (3) grassland (fields covered by grass and flooded grassland); (4) shrub-land (fields covered by shrubs, flooded shrub-land, woodland and scattered trees); (5) urban areas (built-up and settled areas); and (6) water features (lakes and rivers).

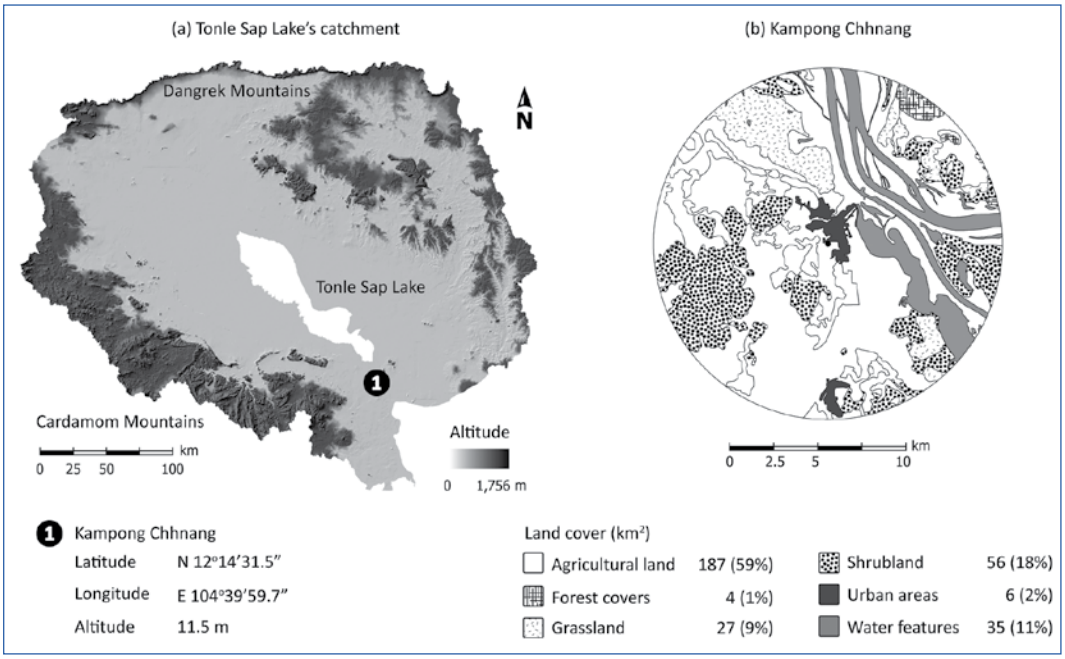



***Figure 3:*** *(a) The Tonle Sap Lake catchment, location of Kampong Chhnang station; (b) Land cover of an area (314 km²) of 10 km radius around the Kampong Chhnang station.*

**Wet season rainfall** *is defined as the total amount of rain falling in the wet season (May to October),* while **dry season rainfall** *is the total amount of rainfall occurring in the dry season (November to April).* **Dry month** *is a month during which rainfall is less than 20 mm.* **Annual rainfall** *is the total sum of the rainfall during all 12 months (January to December).*

Table 1 presents the availability of rainfall data for the period 1920-2007 (JICA and MOWRAM 2009). Records are not complete or available for every single year. For example, data could not be obtained for the 1940s. Additionally, the data for the 1950s and 1970s was insufficient for a comprehensive analysis. Thus, the data for the early and late 20th century was used for a trend analysis, i.e. 1920s-1930s (a timespan for which 15 years of data is available) and 1980s-2000s (for which we have records for 26 of the relevant years).

***Table 1:*** *Availability of rainfall data for the different decades of the period 1920-2007*

| Decade | Kampong Chhnang (12°14'28'', 104°40'00'') for 55 years |
|---|---|
| 1920s | 1920, 1922, 1923, 1924, 1925, 1927*, 1929* (7 years) |
| 1930s | 1931, 1932, 1933, 1934, 1935, 1937, 1938*, 1939 (8 years) |
| 1940s | No data |
| 1950s | 1952*, 1953 (2 years) |
| 1960s | 1961*, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969 (9 years) |
| 1970s | 1971, 1972, 1973 (3 years) |
| 1980s | 1982, 1983, 1984, 1985, 1986*, 1987*, 1988*, 1989* (8 years) |
| 1990s | 1990*, 1991, 1992*, 1993*, 1994, 1995, 1996, 1997, 1998, 1999 (10 years) |
| 2000s | 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007 (8 years) |

**Note:** * *denotes instances where some monthly rainfall data for the year is missing and where the average value(s) of the month(s) of other years in that decade have consequently been substituted*

Trends in rainfall amount/pattern were analyzed in respect of three different time scales: monthly, seasonal and annual. The monthly rainfall was averaged for monthly analysis and summed for seasonal and annual analyses. Annual rainfall was summed and then averaged for the relevant period.

Secondary data sources were also consulted and reviewed. These included annual national reports from different line ministries, for example, the Ministry of Environment, Ministry of Water Resource and Meteorology and the Provincial Departments of that latter ministry and of the Ministry of Agriculture, Forestry and Fisheries. In addition to these sources, reports and minutes of meetings, and newsletters produced by relevant local organizations and communities were also collected. These included the Cambodia Development Resource Institute (CDRI), the NGO Forum and local authorities such as commune councils and district offices.

## Qualitative data collection

Qualitative data collection involved different research methods including field observation, focus group discussions, key informant interviews, household questionnaires and validation workshops.

Field observations were conducted from 5th to 10th December, 2011. This activity aimed to identify key provincial and local people in order to set up network and research partners. From this, three representatives from each of the farming communities of Pok Pen, Tang Krasang and Trapang Trabek were assigned as research partners. During the meetings, mostly qualitative information relating to the overall situation of the community's natural resources, such as forest land and livelihoods, was gathered.

Three focus group discussions (FGDs) were conducted from the 5th to 9th February, 2012. These concentrated on general livelihoods, land use and land cover change and water use problems. The history of the villages and the inhabitants' farming practices, their cropping systems and crop calendars, were critically discussed using resource mapping. Some

perspectives relating to resource use and water allocation among and within communities both upstream and downstream were recorded. On the 5th February, the research team conducted a community meeting in Sleng village in Pok Pen farming community. On 6th February, a meeting was organized in Chas village in Tang Krasang farming community. Fifteen participants, seven of whom were women, attended and were actively involved in the discussion. The meeting focused on village history, livelihoods and farming conditions. It involved participatory resource mapping, crop calendars and a discussion about climate change as it related to an alteration in rainfall. The last focus group discussion was conducted in Kok Beanteay village within Trapang Trabek farming community on 7th to 8th February, 2012.

The household questionnaire process for the field survey was conducted from 9th to 15th March, 2012. Twelve villages were randomly chosen, from which 240 households were selected from three farming communities. Key informant interviews (KIIs) were conducted from 21st to 25th of November, 2012. The 17 key informants selected came from the four different social levels including village, commune, district and provincial. They included seven village chiefs, six commune officers (commune chiefs, commune council members and clerks), two district governors, and two officers from provincial departments.

# RESEARCH RESULTS

## Rice production and livelihood strategies

The majority of livelihoods across the catchment are centered on agricultural production. Rice production provides the main source of income and is fundamental for household food security strategies.

Yet rice production is sensitive to climatic changes insofar as it depends primarily on water availability for both rain-fed and irrigated production. In this context, the impacts of both flood and drought can be profound (Chea et al. 2011). Also, the demand for water extracted from Stung Chreybak river is subject to heavy competition given the limitation of the resource itself, the growing numbers of users, and multiple use (e.g. irrigation schemes and commercial plantations) (Molden 2007).

Rice cropping systems develop according to ecological factors, topography and water movement, and we can differentiate between irrigated and non-irrigated fields. Irrigated fields are adjacent to canals where water used for irrigation is extracted from the main river. The remaining fields are rain-fed. The key role of water in rice production was illustrated by a comment made by one of the research respondents: "*When there is good rainfall, there is good rice production.*"

## Wet season

Given the diverse agro-ecological context, farmers are engaged in a variety of rice cropping systems (Wokker et al. 2011). Furthermore, the duration of the rice cultivation period is closely associated with the topographic-water conditions. In rain-fed agriculture, three main cropping varieties are practiced based on the topography and especially on the level and flow of water in the area. First, a lowland type (*srae kraom*), cultivated where water accumulates for a long period. This focuses on the so-called long-term rice (LTR - *srov thgnoun*), which is a photoperiod sensitive rice that is cultivated over quite a long period from May/June to October/early November (flowering in November). The second relates to a medium-term rice (MTR - *srov kandal*) which can be photoperiod sensitive and is cultivated in middle-elevation plots over a shorter period of time (120 to 150 days) from May/June to September/October. The third involves short-term rice (STR - *srov sraal*) varieties, which are non-photoperiod sensitive and are cultivated on higher land (*srea leu*) over a relatively shorter period (120 days) from May/June to July/August (in Stung Chreybak catchment).

In areas with very deep water levels, there is a fourth variety involving the cultivation of so-called deep water rice (*srov laeung teuk* or *srov via*). Deep-water rice varieties show accelerated growth in the inter-nodal of the stem, which allows the plant to keep some of its foliage on top of the water. Deep-water rice is found in Trapang Trabek farming community, but according to interviews, it is no longer popular and will not be grown in future. For the Pok Pen and Tang Krasang farming communities it has been a low yield, traditional long duration rice, which has required little attention as it grows naturally with rising water levels.

## Dry season

In the dry season, we distinguish two main types of rice cropping variety. Recession rice (*srov bradeng teuk*), which is a non-photoperiod sensitive short-term, dry season rice cultivated after the flood peak, and as flood water recedes. Recession rice does not require sophisticated irrigation infrastructure. In contrast, the so-called dry season irrigated rice receives additional water supply from canals. Irrigated, dry season rice varieties are usually modern hybrid varieties such as IR 66.

The farming communities combine all of these different types of rice according to specific local agro-ecological conditions. In upstream Pok Pen, there is no dry rice cultivation because there is not enough water in irrigation canals. Farmers are engaged in rain-fed rice production combining LTR, MTR and STR systems. Tang Krasang is located at the edge of the Tonle Sap flood plain and is endowed with a functioning irrigation system so farmers cultivate mostly dry season rice. In Trapang Trabak, which is located in the flood plain, a majority of farmers are engaged in only dry season rice cultivation, which depends on irrigated water from the Stung Chreybak River. It was found that dry season rice cultivation is a central source of income. Deep water rice is also grown in the wet season but in small areas (interviews, Chas village, 2012). About 90 percent of respondents (n=240 households) indicated that rice is used to fund health care, education, weddings and religious ceremony; thus, rice is

the main capital for the communities. Furthermore, the responses of most of the interviewees indicated that land is the main asset for farming to support their livelihoods.

Even though rice production is the primary source of income and food security, it does not meet all of their livelihood needs. In fact, all households are engaged in livelihood diversification strategies involving other on- and off-farm activities. In recent years, garment and brewery factories have invested in the local economy and, as a result, these have presented attractive employment opportunities for young people.

In Pok Pen, instead of growing dry season rice, farmers cultivate different varieties of cash-crops such as watermelons, sweet potatoes, cassava and fruit trees, which demand less water. This cash-crop production generates additional income to support the family. For instance, sweet potatoes and watermelons are generally grown in early December and are harvested in an early March. Last year, however, the wet season was delayed, and the timetable was shifted so that the cash crop was planted in late December and harvested in early April, with poor yield and low prices (fieldwork, 2012). In addition, non-timber forest products (NTFPs), wildlife hunting and seasonal migration are significant sources of income for Pok Pen community members. Most of the farmers here voiced concern about the increased limits of access to, and collection of, NTFPs from Aural Mountain. NTFPs contribute about 30 percent of the total income for the Pok Pen community.

In Tang Krasang farming communities, about 60 to 70 percent of young people work as laborers or garment workers and their families depend on the remittances they send back to the village. Interviews with FWUC members, and focus group discussions indicated that each community faced some challenges with their economic activities. People in Tapang Trabek were concerned that shortage of water for irrigation would occur as it did last year leading to more loss of income, while those in Tang Krasang were challenged by a lack of farm labor as their children were mostly working off-farm.

The extent to which the local economy has become commoditized was indicated by the comments of a deputy chief of Koukbanteay commune (2012). He reported that "recently, with support from relevant provincial departments, the economic condition of people living in Stung Chreybak catchment has improved…The livelihoods of people have changed because they earn more income from dry season rice cultivation and engage more in cash-income commercial agriculture".

## Social-ecological change

Over the past 20 years, a number of changes have occurred in the social and ecological components of the resource system in which local farming has evolved. We identify three main types of transformations: first, the change in the amount and distribution of rainfall; second, agrarian expansion; and third, the intensification of rice cultivation through the establishment of irrigation infrastructures and institutions.

## Historical changes in rainfall patterns

### *Overall rainfall*

The overall rainfall pattern recorded by the station in Kampong Chhnang was mono-modal with a peak in September (Figure 4a). Large fluctuations in average monthly rainfall could be observed, especially in the wet season. The highest spans in this fluctuation were found in July (719 mm). However, the highest monthly rainfall occurred mostly in September during the 55 years in which data was collected. Data shows that the annual mean rainfall over the available period (as shown in Figure 4b), was 1,672 mm (ranging from 1,088 mm in 1931 to 2,853 mm in 1991) of which 1,413 mm, or 84 percent, occurred in the wet season.

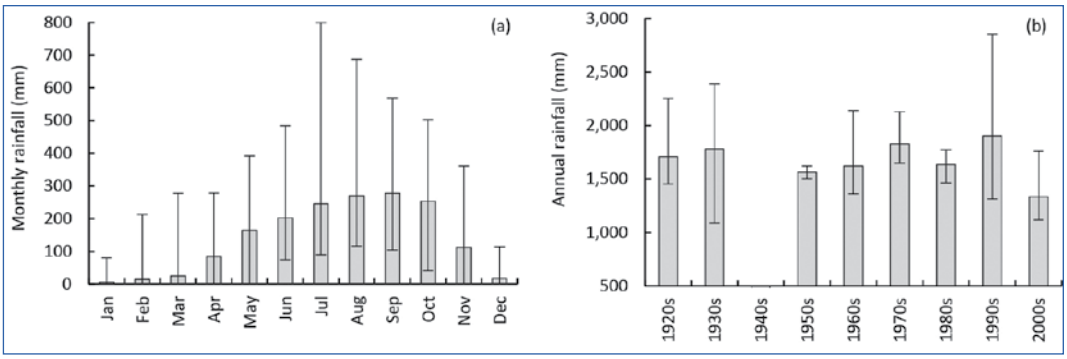



***Figure 4:*** *Monthly and annual rainfall over the observation period (1920s-2000s): (a) Average monthly rainfall; (b) annual rainfall measured during the 55 years for which records are available*

***Note:*** *Boxes indicates average values while the upper and lower limits of lines indicate maximum and minimum values*

### *Trends data*

Monthly rainfall was also analyzed for the 1920s-1930s and 1980s-2000s and these show a shift in rankings. In the 1920s-1930s, monthly rainfall in Kampong Chhnang was greatest in July and September. These top rankings were shifted to September and August in the 1980s-2000s. Furthermore, spells of dry weather have become more prolonged. Dry months (monthly rainfall <20 mm) were extended from one month (January) to three months (December, January and February) as shown in Figure 5a. The rainfall pattern has also changed. In the 1920s to 1930s it was bi-modal with peaks in July and September, but the pattern has since changed to mono-modal with a peak in September.

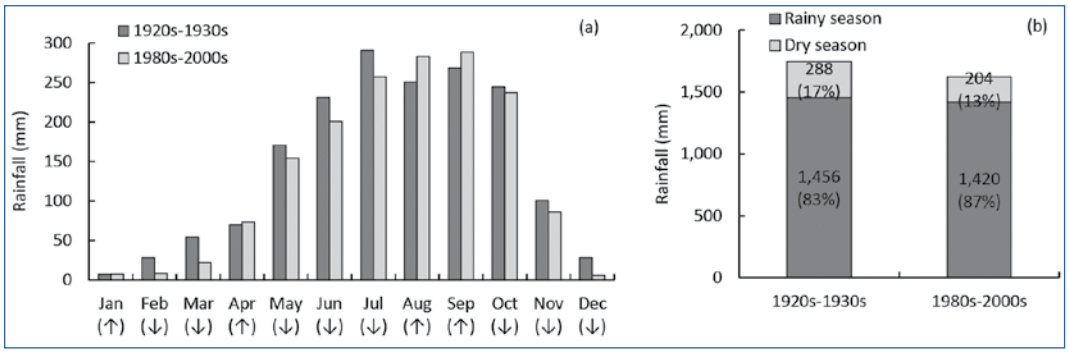



***Figure 5:*** *Trends in mean rainfall in the 1920s - 1930s and 1980s - 2000s: (a) monthly mean rainfall (arrows indicate increasing or decreasing monthly mean rainfall); (b) seasonal and annual mean rainfall (sum of the two seasons)*

Analysis of seasonal changes shows little difference between the two periods. The wet season was still from May to October and the dry season was from November to April. Comparing the annual mean rainfall for the 1920s -1930s, and for the 1980s - 2000s, the trends of change in the rainfall amount could be described as decreasing from 1,744 mm to 1,624 mm (minus 120 mm or minus 7 percent). Figure 5b shows that dry and wet seasonal rainfalls were 288 mm (17 percent) and 1,456 mm (83 percent), respectively, for the 1920s to 1930s period. For the 1980s to 2000s period they were 204 mm (13 percent) and 1,420 mm (87 percent), respectively. The observed decrease in annual mean rainfall, though not statistically significant, appears to be associated with a decrease of rainfall in the dry season resulting in a higher proportion of rainfall during the wet season. As a result, the concentration of rainfall in the wet season is extremely likely to have affected the amount of water and flow regime of streams in the Stung Chreybak catchment.

## Deforestation and agrarian expansion

The clearing of land for intensive agricultural has been taking place over many decades and has severely affected areas of evergreen forest. This has resulted in conversion to commercial plantations, with post-conflict logging and plantation revenues supporting members of both the Khmer Rouge and the Royal Cambodian Armed Forces (RCAF) (Le Billon 2002).

Over the past 20 years, land use changes have been dramatic in the Stung Chreybak catchment. The most prominent feature of these changes has been the conversion of natural forest to agricultural land. Agrarian expansion associated with deforestation has occurred through two main drivers and has resulted in two different (though partly overlapping) land use trajectories.

First, rice field expansion has been an important feature of land use change, particularly after the Khmer Rouge regime. During the war, secondary forests and shrub-land vegetation grew on many abandoned rice fields. But post-war population growth, associated with agricultural land appropriation in the context of massive migration, has considerably

increased the demand for land. These secondary forest areas close to villages have been the main target of this post-war agriculture colonization. But, second, migration and land appropriation in upland regions have continued. This has resulted in insecure land tenure as the current Land Law considers any post-2001 appropriation of state-owned forest land and/or protected areas illegal. Men (2011) indicates that there is a clear lack of distinction between state public land and state private land, which has resulted in problems for the registration of rural household landownership. Article 16 of the Land Law states that 'state public property is inalienable', yet most rural community lands are located in forest areas, which falls under state public property (Men 2011). By reducing forest access, the opening of the agricultural frontier - and the attendant opportunities to quickly improve income - has negatively affected the livelihoods for those who depend upon non-timber forest products. This is particularly true in the Phnom Aural Protected Area, which is managed under the authority of the Ministry of Environment.

The 2001 Land Law made agrarian expansion through Economic Land Concessions (ELCs) or large-scale land acquisitions for agro-industrial purposes, possible. In theory, ELCs aim to promote industrialization and poverty alleviation through the employment of local villagers. In Stung Chreybak catchment, a private company named Pheapimex signed an ELC contract with the government in 2007 to exploit an area of 330,000 hectares, which actually overlaps with thousands of hectares of forest land. This land concession covers a large part of Teuk Phos district territory, which includes some local rice fields and chamkars (Chann et al. 2011).

The qualitative field survey shows that ELCs have affected households living in the villages of Pok Pen. The majority of households own from 1 to 1.5 hectares that they use for rice cultivation, but a large part of these overlaps with the Pheapimex land concession. In many cases, economic land concessions have been the focus of land use and livelihood conflicts with surrounding communities. Conflicts are typically sparked by the local loss of access to customary resources and rice fields, and by overlapping and statutory resource tenure systems (Barney 2007). The people have deep concerns about the sustainability of their livelihoods. The Tang Krasang commune clerk reported that "the map of the Pheapimex land concession extends from Pok Pen to Tang Krasang commune, overlapping with district offices, a military site, village lands and rice paddies".

### Intensification of rice cultivation through the development of irrigation

Over the past 20 years there has been substantial investment in the development or rehabilitation of irrigation infrastructures. This has been designed to support the intensification of rice production through the promotion of dry season activity (Figure 6). The need to boost production has resulted from the food demands of a growing population and the policies of the government to promote rice exports. Irrigation systems have also played an important role in catchment hydrology as they allow for regulation and improved efficiency of water availability and access to water throughout the year. Irrigation systems can store water in the wet season, reducing flooding and preventing drought in the dry season. Flood and drought are becoming increasingly significant as the rainfall change analysis, shown above, indicates.

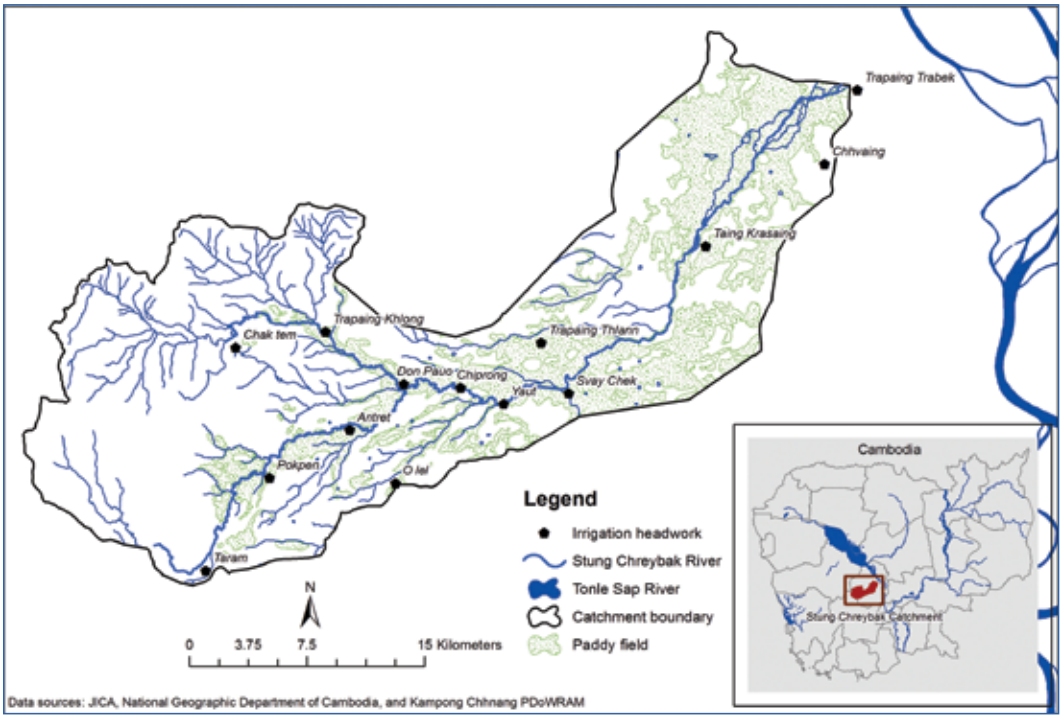



***Figure 6:*** *The location of irrigation schemes within Stung Chreybak catchment*

The study also found water resource conflicts between early settlers and newcomers. In the case of a village in Pok Pen farming community, more than 20 early settlers had sold their land, which was of poor quality for rice cultivation, to newcomers from different communes. Whereas early settlers were unable to establish irrigation systems, new migrants had managed to build small-scale varieties to divert water from Stung Chreybak River to irrigate and convert this land to rice fields. This was resulting in competition - and conflict - in the allocation of scarce water resources between early settlers and newcomers.

The development of physical irrigation infrastructure was matched by the development of water management institutions aiming to assign responsibilities for the maintenance of the infrastructure and also to organize the management and distribution of water between the different water users. Different ministry line agencies from national to sub-national levels were involved in water resource management in Stung Chreybak catchment including those of Water Resources and Meteorology (MOWRAM); Agriculture, Forestry and Fisheries (MAFF); and the Environment (MOE). At the provincial level, these line agencies work closely with local authorities at district, commune and village level, as well as helping the committees in charge of the Farmer Water User Communities.

The Provincial Department of Water Resources and Meteorology (PDOWRAM) has responsibility for supplying adequate mechanisms for water governance and management for irrigation. The department also provides advice and helps communities to cope with issues such as drought, flood and water conflicts on the ground. At the local level, water management works

through a Farmer Water User Community (FWUC). Registration is compulsory for farmers wishing to benefit from an irrigation system and it involves paying an irrigation service fee, negotiated by all members.

Specifically, FWUCs are in charge of distributing and controlling the water supply and for maintaining irrigation canals and reservoirs. Two foundational regulation vehicles support the creation of FWUCs. The first is Circular No.1, Legal Framework on Implementation Policy for Sustainable Irrigation Systems, with policy guidance on the management of FWUCs. The second is the *Prakas* 306 on the legal and technical framework of MOWRAM. FWUCs register through MOWRAM's FWUC department. According to the Law on Water Resource Management, adapted in 2007, and the draft sub-decree on FWUCs (Royal Government of Cambodia 2013), FWUCs receive technical assistance from PDOWRAM. Tang Krasang dry season rice cultivation has received financial and technical support for dry season rice demonstration to help farmers to adopt new and better varieties, to rehabilitate the canals and to restore reservoirs. PDOWRAM also assists FWUCs in organizing elections for their committee members.

In Stung Chreybak catchment, three FWCUs have been established and are supported by PDOWRAM in collaboration with non-governmental organizations including the American Friends Service Committee (AFSC) and the microfinance institution PRASAC. These FWUCs are based in Pok Pen, Tang Krasang, and Trapang Trabek, and Table 2 provides a short description of each.

***Table 2:*** *Description of the main Farmer Water User Communities in Stung Chreybak catchment*

| | Formation | Number of Members | Irrigated land area (in hectares) | Irrigated service fee |
|---|---|---|---|---|
| Pok Pen | 2005 | 163 | 140 | 0 |
| Tang Krasang | 2005 | 630 | 250 | 0 |
| Trapang Trabek | 1991 (support by AFSC) | 500-600 | 500 | USD 5 per ha per member per cropping season |

Additionally, the Provincial Department of Agriculture (PDA) supports FWUCs by providing agricultural extension services and by encouraging the farmers to practice agricultural intensification by cultivating varieties of rice such as IR66, *Malis*, and *Sen Pidor*. The Provincial Department of Environment (PDOE) assists farming communities by offering short training courses on environmental issues, pesticide health care awareness and wildlife protection.

## Adaptation to social-ecological change

The social and ecological changes we have presented have considerably altered the context in which people in Stung Chreybak catchment pursue livelihoods and in particular agricultural production. Adaptations to these changes have been an integral part of these transformations. Several agencies are involved when it comes to adaptation - households/families, their community and state institutions. The household level is arguably the central agency for

adaptation, and here the response to change engages farmers in different trajectories that either maintain them in the agricultural sector or take them away from land and agriculture. At community level, adaptation runs though the development of irrigation infrastructure and associated FWUCs.

## Dynamic farm-based adaptations at the household level

The change in rainfall patterns and distribution has had at least two significant consequences for farming:

- The increased dry spell duration (when monthly rainfall is less than 20 mm) increases risks of drought affecting dry season crop production
- The intensification of rainfall with mono-modal distribution towards the third quarter of the year (September) with increased flash flood risk.

Although these environmental changes have been gradual, they have been combined with increasing food demand driven by population growth and more recently with the government's policy to increase rice exports.

The interaction of these factors on and across different levels and scales has been the driving force for modifying rice cropping systems throughout the watershed:

- A widespread adoption of high-yield, non-photoperiod sensitive, short-term rice varieties (cropping cycle of three month or so) requires more inputs (labor, N-fertilizers, pesticides). The rice varieties that the MAFF promote - through their provincial departments (PDOAFF) - are these high yielding varieties. The adoption of improved varieties is reflected by the interviews in Teuk Phos district, 2012:

  '*The new rice species was introduced in Tang Krasang in 2010 by PDOAFF. It was a short-term rice variety (IR66) and was, at that stage, tried by just a few families. The yield was good. So the number of families using it rose to more than 30 in 2011, and that number increased again - to 100 families - in 2012.*'

- Farmers try to avoid cultivating rice in September, the month with the highest average rainfall. This means that some reduce the cultivation period of their rain-fed rice (thus relying on shorter duration varieties). If access to water allows it (via irrigation or more simple reservoirs), others also cultivate another short-term rice crop early in the wet season, from March to June.
- For plots located within the area of irrigation, farmers are usually able to double the annual harvest by cultivating dry season rice.

The current rice cropping calendar appears in Figure 7 below:

In Pok Pen, the irrigation system is not fully functioning and farmers are thus limited to rain-fed rice production. In certain areas where farmers can use water from the main canal, they cultivate short-term rice in the early wet season. In lower lying areas, they continue to cultivate photoperiod sensitive long-term rice that is more resistant to possible flood.

In Tang Krasang, the same methods as in Pok Pen are adopted in that farmers try to cultivate early wet season short-term rice with supplemental water available in irrigation systems. Additionally, in a limited (though expanding) area of approximately 300 ha, farmers cultivate a dry season irrigated rice.

In Trapang Trabek, rice cultivation is in the Tonle Sap floodplain with a focus on dry season rice. Dry season dry rice cultivation starts in early December and lasts until late March or early April when waters recess to Tonle Sap River. Most farmers now grow hybrid rice varieties (IR66 and *Sen Pidor*) that are suitable for this recession agriculture. These rice varieties provide 3-4 tonnes of rice per hectare (interview: village head in Tang Krasang community). Dry season agriculture is also practiced via irrigation.

The redistribution of rice cropping seasonality results in an increased demand for water. Competition for water between upstream and downstream is particularly strong at two times of the year:

- During early season rice cultivation, when supplemental water is needed at the same time in Pok Pen, Tang Krasang and Trapang Trabek.
- During dry season rice cultivation, when water is needed from the irrigation for cultivation.

| | | Dry season | | | Early wet season | | | Main wet season | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov |
| Pok Pen | *Rain-fed short-term rice (srov sraal) (non-photoperiod sensitive)* | | | | ← | ● | → | | | | | | |
| | *Rain-fed short-term rice (srov sraal) (photoperiod sensitive)* | | | | | | | ← | | → | | | |
| | *Long-term rice (photoperiod sensitive)* | | | | | | | ← | | | | | → |
| Tang Krasang | *Rain-fed short-term rice (srov sraal). With limited additional irrigation* | | | | ← | ● | → | | | | | | |
| | *Short-term rice (srov sraal) (photoperiod sensitive)* | | | | | | | ← | | → | | | |
| | *Irrigated dry season short-term rice* | ● | → | | | | | | | | | | ← |
| Trapang Trabek | *Rain-fed short-term rice (srov sraal). With additional irrigation* | | | | ← | ● | → | | | | | | |
| | *Short-term rice (srov sraal) (photoperiod sensitive)* | | | | | | | ← | | → | | | |
| | *Long-term rice (photoperiod sensitive)* | | | | | | | ← | | | | | → |
| | *Irrigated dry season short-term rice* | ● | → | | | | | | | | | | ← |
| | *Receding rice or irrigated dry season rice* | → | | | | → | | | | | | | |

***Figure 7:*** *New rice cropping calendar in the areas studied*

## Migration: Households move away from land and agriculture

Livelihoods in Stung Chreybak catchment do not only depend on agriculture and livestock production. There is a portfolio of other activities households rely on to generate in-kind or in-cash incomes. These activities include the collection of non-timber forest products, palm sugar making, home-garden activities or handicrafts. Given the rising opportunities offered in the industrial sectors developing close to Kampong Chhnang, wage labor has also become an important source of income in the Stung Chreybak area. In general, these activities are common to all farming communities. These practices are adopted as soon as the farmers finish the rice cultivation work. Considered as secondary employment sources, they are important as they help to meet household consumption needs and provide the cash needed to buy goods and services, in particular the agricultural inputs (FGD at Tang Krasang with commune council members, 2012).

Livelihood diversification has always been a way of life for farmers in Stung Chreybak catchment but several factors are now at play to make non-farm or off-farm activities necessary for the survival of a growing number of households. For a start, the collection of timber and non-timber forest products is diminishing given the overall decrease in natural resources in the area. In conjunction with loss of resources and lower access

to these natural resources, the development of irrigation systems has put higher pressure not only on water allocation but also on the market for land. This has resulted in a change in agricultural practices increasing the upfront capital needed for farmers to engage in this new, more intensive agriculture. Those who cannot afford this have no other option than to seek wage labor through migration.

The focus group discussion conducted in Tang Krasang in 2012 revealed that migration has occurred in Stung Chreybak catchment for many generations in the form of a seasonal movement of the farming population to the Tonle Sap river where they have bartered rice for fish and stayed a few weeks to make *prohok* (fish paste).

Nowadays, however, migration primarily takes place along two other routes. First, depending on the active labor composition of the household, some families send members to seek employment in different factories in Kampong Chhnang city. Given the proximity of industrial sites, the distances involved in this type of migration are short. This type of daily migration has been found across the whole catchment and an increasing number of young villagers rely on it. It brings additional income to the family but it also leads to labor shortages for rice cultivation.

In addition, a more long-distance/long-duration type of migration takes place in the area. Teenagers and young adults migrate inside or outside the country to seek jobs usually over periods of more than six months. This livelihood strategy has grown significantly, especially in Pok Pen community. Villagers migrate from here to seek wage labor in Thailand and Malaysia (sometimes for several years). More recently, a higher proportion have opted to work in South Korea. Some migrants who return from South Korea build new houses and buy equipment. In the village, these success stories have encouraged further migration especially on the part of villagers who are not good at farming or do not have land for agriculture (interviewee in Chas village, 2013). Overall, permanent out-migration is widespread in Pok Pen. From 2009 to the present, 50 to 60 percent of the entire population of some villages in Pok Pen community have migrated internationally in order to seek jobs.

## Learning from adaptation: The case of FWUCs

The creation of the FWUCs has aimed, of course, to address the increased competition for water that has been sparked by the development of irrigation systems. Ideally, they represent the diverse interests of all stakeholders.

The roles and responsibilities assigned to these community-based associations illustrate changes that have recently taken place in Stung Chreybak water management. Previously, water management was relatively unproblematic because water resources were not scarce relative to need so that there was no need for the assignment of such duties. But the water issues that FWUCs have to address now are many. They must: manage and regulate the distribution of water from main canals to rice fields; address flood/drought problems; mobilize the water users to rehabilitate and repair canals when needed; and negotiate with other FWUCs to address upstream/downstream conflicts.

However, our investigation found that most of the FWUCs are dysfunctional. Their ineffectiveness is due to several, inter-related factors, partly beyond the control of the FWUC members. So far, the statutes, internal rules and regulations of FWUCs have been drafted and endorsed by provincial authorities and other stakeholders, but they have no official or legal standing at national level in the Ministry of Water Resources and Meteorology that would be needed to pave the way for the management, use and maintenance of the irrigation schemes. Without this official back-up, the power and authority of FWUCs to enforce the rules and regulations is limited. It also weakens the accountability of FWUCs to water users. This problem of authority is reinforced by the fact that the FWUCs do not have the capacity to work with or to implement these new water institutions.

Another central issue is that the FWUCs have insufficient budget to enable them to carry out the work (Wokker et al. 2011). The contribution of water user fees is very limited and the decentralization of roles and responsibilities in water management to local level by the central administration has been carried out without financial support. FWUC members work on a voluntary basis for many years and the absence of incentives limits their work and commitment. The management committee of a FWUC consists of a nominal five people per each irrigation scheme, but only one person - the head of the FWUC - actively works on these issues. The others are hard to find or to gather for a meeting as they are busy with their own businesses (field survey, 2012). Consequently, the lack of staff involvement means that the quality of the water allocation process, the management of water allocation and the maintenance of irrigation schemes, suffer. Thus, a vicious circle ensues: the canal leaks, water is not distributed properly so the farmers are not willing to participate in monitoring and maintaining the irrigation system (interview with villagers, 2012).

Another issue associated with water management is the sharing of water between irrigation schemes upstream and downstream as is typically the case between Tang Krasang and Trapang Trabek farming communities. The release and use of water in the upstream scheme (Tang Krasang) affects the quantity of water available downstream. As a result, Trapang Trabek irrigation scheme faces water shortages for dry season rice cultivation because at the same time Tang Krasang farmers are blocking the water upstream to retain it for their own dry season rice cultivation.

To address this problem, coordination processes need to take place. In a context where there is no catchment-level coordination body such as a federation of FWUCs, cooperation takes place in both formal and informal ways. The informal negotiation encompasses direct communication between downstream and upstream FWUCs, which is settled through face-to-face meetings and telephone calls to request the release of water from Tang Krasang for downstream use. However, this type of coordination is not effective because the management of a specific scheme tends to prevail over a more integrated approach to watershed-level irrigation water. Usually, upstream schemes refuse to release water because they need it for their dry season rice farming. Partisan interest is illustrated by the comment of one particular head of commune (2012):

"*You think about your people because they voted for you. For me, my people vote for me, so I need to think about them.*"

When informal coordination and/or negotiation fail, a more formal institutional coordination comes into play through state approved administrative procedures. FWUCs have to write a request letter to ask for the release of water from the upstream source. The request letter has to be signed by the head of the village, the commune chief, the district governor and then requires final approval from the provincial governor. The process takes at least two working days. Then it has to be sent to PDOWRAM, district, commune offices and all the upstream communities in order for the water to be released downstream. A more efficient coordination of FWUCs may not be able to directly augment the availability of water in the catchment but would allow for a more just distribution amongst upstream and downstream users during periods when competition for water is high. The absence of a federated body to coordinate the work of FWUCs is usually blamed on a lack of financial and material assistance.

## CONCLUSION AND RECOMMENDATIONS

Stung Chreybak catchment is becoming increasingly challenged by four key social and ecological drivers of change: a change in rainfall patterns; population increase; policies favoring export-oriented rice production; and the development of irrigation infrastructures. The resulting changes have become serious issues because of the rapid and profound impact on rice cultivation and associated environments.

We have argued that, over the past 20 years, the convergence of these four factors, operating at multiple scales across multiple levels, has resulted in comprehensive changes in rice cropping systems and increased competition for water in the early wet season and dry season.

Though total rainfall has not significantly changed over the past 90 years, the monthly and seasonal distribution of rainfall has shifted. The dry spell duration has increased and rain now intensifies around a single peak in September. To avoid cropping risks associated with flood, some farmers have changed their cropping activities by shifting to shorter duration, non-photoperiod sensitive, higher yielding varieties. Where and when supplemental irrigation is available, this change has allowed farmers to cultivate two rice crops in the wet season; one early season harvest and one in the main wet season.

But this adaptive pathway contains contradictions. It now makes it possible for successful farmers to pick up new technology (they have upfront investment capital for seeds, fertilizers, pesticides, pumps, and so on) and to increase their yield. But these innovations have unaccounted social and environmental costs. The farmers who cannot afford the new technologies are excluded and usually left with no alternative other than to migrate or to exploit forest products. In other words, this type of adaptive innovation tends to reinforce the social differentiation between two groups of producers: successful farmers and coping peasants. All local decision-makers, practitioners and people who provide agricultural extension services should be clearly aware of these mechanisms and address them in a way that better aligns the innovation with the local social and agro-ecological context and allows all farmers to take advantage.

The new technological packages also increase the use of agro-chemicals. This may prompt the local purchase and use of banned or restricted pesticides that can have serious impacts on the environment and on farmers' health. This needs to be rigorously addressed by decision-makers, practitioners and the providers of agricultural extension services to ensure that only legal chemicals are being imported into Cambodia and used here. In addition, farmers must be taught about safe application practices and monitored to check that they are complying.

FWUCs emerged to address the increased competition for water resulting from agricultural intensification and from the reshuffling of the cropping calendar. We have argued that in Stung Chreybak catchment, these FWUCs function inadequately in addressing the multiple issues and conflicts involved in water governance and in supporting adaptive water management in the face of social-ecological change. This inadequate performance is due to the incomplete devolution of rights and responsibilities which has led to the limited accountability of these institutions to the people they are meant to serve.

Two sets of problems emerge. First, there is the challenge of 'vertical integration' at different levels of political organizations involved in water management. The devolution of water management to local FWUCs does not have enough political and financial support from national authorities. At the local level more inclusive water management between water users and FWUCs is needed, through, for example, a more systematic collection of irrigation fees. These are essential preconditions for FWUCs to develop as legitimate community-based organizations. Secondly, the work of these FWUCs should be integrated/coordinated as part of a wider effort at river basin management. The creation of a river basin level coordinating body would focus on implementing Integrated Water Resources Management (IWRM) principles. It would be able to focus on allocating and delivering reliable water services in a fair and just manner (UNESCO 2009). Research also indicates the particular importance of establishing clear mechanisms for conflict resolution to deal with the impacts of water scarcity in the early wet season and the dry season.

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# BIBLIOGRAPHY


Barney, K. (2007) A Note on Forest Land Concessions, Social Conflicts and Poverty in the Mekong Region. *International Conference on Poverty Reduction and Forests: Tenure, Market and Policy Reforms,* 3-7 September, Bangkok.

Bates, B., Kundzewicz, Z. W., Wu, S. and Palutikof, J. (2008) *Climate change and water, IPCC Technical Paper VI,* Geneva: IPCC Secretariat.

Chambers, R. and Conway, G. R. (1991) *Sustainable rural livelihoods: practical concepts for the 21st century*. Discussion Paper 296. Brighton: University of Sussex: Institute of Development Studies.

Chann, S., Wales, N. and Frewer, T. (2011) *An Investigation of Land Cover and Land Use Change in Stung Chrey Bak Catchment, Cambodia, Working Paper Series No. 53*, Phnom Penh: Cambodia Development Resource Institute.

Chea, C., Nang, P., Whitehead, I., Hirsch, P. and Thompson, A. (2011) *Decentralised Governance of Irrigation Water in Cambodia:Matching Principles to Local Realities, Working Paper Series No. 62,* Phnom Penh: Cambodia Development Resource Institute.

Chem, P. and Someth, P. (2011) *Use of Hydrological Knowledge and Community Participation for Improving Decision-making on Irrigation Water Allocation, Working Paper Series No. 49*, Phnom Penh: Cambodia Development Resource Institute.

Eastham, J., Mpelasoka, F., Mainuddin, M., Ticehurst, C., Dyce, P., Hodgson, G., Ali, R. and Kirby, M. (2008) *Mekong River Basin Water Resources Assessment: Impacts of Climate Change*. CSIRO: Water for a Healthy Country National Research Flagship.

Hoanh, C. T., Jirayoot, K., Lacombe, G. and Srinetr, V. (2010) *Impacts of climate change and development on Mekong flow regime. First assessment – 2009*. MRC Technical Paper No 29. Vientiane: Mekong River Commission

Ichikawa, K. (2013) Understanding Socio-Ecological Production Landscapes in the context of Cambodia. *International Journal of Environmental and Rural Development, 41*(1), pp. 57-62.

JICA and MOWRAM (2009) *Basin-wide basic irrigation and drainage master plan study in the Kingdom of Cambodia, Final Report, Volume 3*: Japan International Coopera tion Agency - Ministry of Water Resources and Meteorology.

Le Billon, P. (2002) Logging in Muddy Waters: The Politics of Forest Exploitation in Cambodia. *Critical Asian Studies, 34*(4), pp. 563-586.

Men, P. (2011) *Land acquisition by non-local actors and consequences for local development: Impacts of Economic Land Concessions on the Livelihoods of Indigenous Communities in Northeast Provinces of Cambodia*. Phnom Penh: Royal University of Phnom Penh.

Molden, D. (2007) *Water for food and water for life, a comprehensive assessment of water management in agriculture,* Colombo: International Water Management Institute.

Parry, M., Canziani, O. F., Palutikof, J., van der Linden, P. and Hanson, C., eds. (2007) *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* Cambridge: Cambridge University Press.

Rakodi, C. (2002) Livelihoods and the Poverty Context. in Tony, R. C., (ed.) *Urban livelihoods: a people centered approach to reducing poverty:* Earthscan. pp. 5-8.

Ribot, J. (2011) Vulnerability before adaptation: Toward transformative climate action. *Global Environmental Change, 21*, pp. 1160-1162.

Royal Government of Cambodia (2013) *Draft Sub-Decree on Farmer Water User Communities.*

Stocker, T. F., D. Qin, G.-K., Plattner, L. V. A., Allen, S. K., Bindoff, N. L., Bréon, F.-M., Church, J. A., Cubasch, U., Emori, S., Forster, P., Friedlingstein, P., Gillett, N., Gregory, J. M., Hartmann, D. L., Jansen, E., Kirtman, B., Knutti, R., Kumar, K. K., Lemke, P., Marotzke, J., Masson-Delmotte, V., Meehl, G. A., Mokhov, I. I., Piao, S., Ramaswamy, V., Randall, D., Rhein, M., Rojas, M., Sabine, C., Shindell, D., Talley, L. D., Vaughan, D. G. and Xie, S.-P. (2013) Technical Summary. in Stocker, T. F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S. K., Boschung, J., Nauels, A., Xia, Y., Bex, V. and Midgley, P. M., (eds.) *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* Cambridge - United Kingdom and New York - USA: Cambridge University Press.

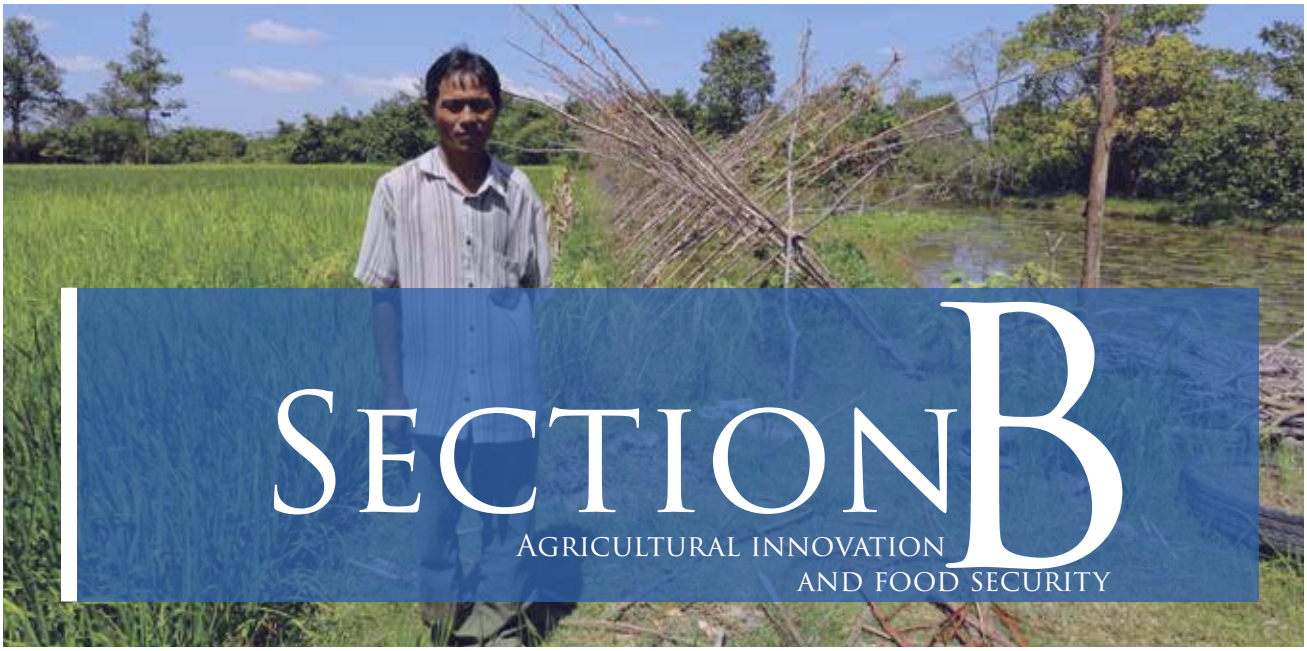
UNESCO (2009) *IWRM at River Basin Level. Part 1 Principles,* Paris.

Wokker, C., Santos, P., Ros, B. and Griffiths, K. (2011) *Irrigation water productivity in Cambodian rice systems, Working Paper Series No. 51*, Phnom Penh: Cambodia Development Resource Institute.

Xu, J. (2011) Climate Change in the Asain Highlands: Socio-economic implications for the Mekong Region. in Lazarus, K., Badenoch, N., Dao, N. and Resurreccion, B., (eds.) *Water Rights and Social Justice in the Mekong Region*,Washington: Earthscan.


# Section B

## Agricultural innovation and food security



# Section B

## Agricultural innovation and food security

# CHAPTER 4

## The contribution of multi-purpose farming to the food security of small-scale farmers: An agro-economic analysis in the lowland Mekong alluvial plain

# CHAPTER 4

## The contribution of multi-purpose farming to the food security of small-scale farmers: An agro-economic analysis in the lowland Mekong alluvial plain

TONG Chantheang and Jean-Christophe DIEPART



## ABSTRACT

Agricultural development models are the focus of intense debate in the Cambodian policy-making arenas. A model inspired by the 'Green Revolution', which promotes industrialization of rice cropping systems and is mainly dependent on external inputs, is usually contrasted with multi-purpose farming (MPF) in which rice cropping is integrated with other production to maximize their interactions and complementarities. The purpose of this research is to present some economic arguments based on the experience in promoting MPF of CEDAC (Centre d'Etude et de Dévelopement Agricole Cambodgien, also known as the Cambodian Center for Study and Development in Agriculture).

We develop a comparative analysis between conventional rice cropping systems and MPF to analyze the production economics and the overall patterns of household labor diversification. Focusing primarily on rainy-season rice production, we attribute significant advantage to MPF against non-MPF practices. These differences are perceptible in higher rice yield, lower cash-paid costs, and higher value-added per hectare. However, these differences become less significant when multi-purpose farming is only partially implemented, i.e. if some elements of the system are missing. MPF provides employment opportunities that represent a reliable alternative to job migration. Under MPF, family labor is used more on-farm than is the case with non-MPF farms and is more homogenously distributed throughout the year.

However, we identify barriers that curb the scaling-up of this innovation, which include limited access to information, anticipated lack of labor, lack of capacity or technical skills, lack of up-front capital to make the initial investment in land conversion to MPF, and land plot sizes that are too small to be converted to this model. We also discuss the opportunities to create markets for products of differentiated quality produced under multi-purpose farming.

**Key words:** *multi-purpose farming, agriculture, food security, agro-ecology*

# INTRODUCTION

Despite a significant reduction in poverty over the past 20 years, food insecurity remains widespread in Cambodia. According to the FAO's indicators (2002), from 1990-1992 to 2011-2013 the prevalence of undernourishment[1] in the total population dropped from 39.4 percent to 15.4 percent. But in a context of demographic growth, the number of people who are undernourished remained high in 2013 (2.2 million people) (FAO 2014). In a recent World Bank poverty assessment, despite a huge drop in poverty between 2004 and 2011 (from 52.3 percent to 20.5 percent), there has been a lack of progress in combatting child malnutrition: the percentage of children who, between 2005 and 2010, could be described as `wasted' actually increased from 8 to 11 (World Bank 2013). In Cambodia, the paradox represented by food insecurity is well-recognized (Royal Government of Cambodia 2014); it is a rural problem affecting a farming population whose primary occupation is to produce food for self-consumption.

In the context of high agricultural prices, there is an increasing consensus that agricultural development is particularly effective in reducing hunger and malnutrition (FAO et al. 2012). To reduce poverty, action should be focused where the poor live and on the endowments of the poor (World Bank 2013). But the challenges facing small-scale farmers are immense: they need to increase food production for a growing rural population, address the increase and diversification of food demand from the urban population which is growing at an even faster rate than its rural counterpart (National Institute of Statistics 2009), and generate surplus for export.

Some institutional circumstances make these tasks challenging: national investment for small-scale agricultural development remains low (World Bank 2013); agricultural land holdings have become heavily fragmented in the context of high demographic pressure on land (Royal Government of Cambodia 2008); and the domestic food price index remains volatile (FAO 2014). Scarcity of labor as people transfer from agriculture to secondary and tertiary sectors through rural-to-urban migration, raises production costs (Diepart et al. 2014).

In order to address these challenges, two contrasting models of agricultural development are being promoted in Cambodia. The first is a 'Green Revolution' model which promotes industrialization of rice cropping systems through use of high-yielding rice varieties (and their required chemical and other inputs) developed abroad. It also promotes increased rice production for export and the development of irrigation infrastructure for early season or dry season cultivation (Royal Government of Cambodia 2005, Royal Government of Cambodia 2010). This model implies rice production intensification and very often results in a very limited degree of crop diversification. The second system is multi-purpose farming (MPF) which is an alternative model for sustainable agriculture. In MPF, rice cropping

[1] Undernourishment is measured as the proportion of the population below the minimum level of dietary energy consumption. That is, the MDG indicator number 1.9, which uses the distribution of dietary energy consumption on per person per day as a base

is integrated with other products and production activities and processes (livestock, aquaculture, orchards, forage, annual crops, and so on) to maximize their interactions and complementarities (Agri-Sud 2010). It includes several types of agro-ecological practices and resource-conserving technologies that can be used to improve the stocks and use of natural capital, for example, integrated pest management, conservation tillage, livestock integration, water harvesting, aquaculture and agroforestry (Pretty 2006).

There are several significant differences between these two models of agricultural development models. First, there is a clear distinction between the societal aspects of each. Integrated farming systems and agro-ecology are knowledge-intensive and are based upon dialogue between farmers and their supporters. Agro-ecology is a source of emancipation for farmers: instead of receiving advice, they become development co-actors (De Schutter 2010) and are not just implementers of a productivity-enhancing modernization scheme as tends to be the case with the `Green Revolution' model. Second, there is a clear environment management divide between both models. Unlike rice mono-cropping, which relies on chemical fertilizers and pesticides, MPF recognizes and uses the complexity of the agro-ecosystem. It mimics nature in that production activities integrate into food production processes such biological and ecological processes as nutrient cycling, nitrogen fixation, soil regeneration, predation and parasitism (Pretty 2006). The system builds on positive interactions and nutrient transfers between crop and livestock sub-systems. In the context of environmental changes, MPF can be climate-smart, as it may provide protection against drought, flood, and storm hazards that is better and more integrated (Lipper et al. 2010). Third, the economic logic of the two models is notably different. MPF operations draw on recycled by-products and locally-made bio-pesticides and organic fertilizers and rely less on costly chemical products that can cause harm to the environment. If yield is maintained, lower costs that are related to the reduced use of off-farm chemical inputs may keep the production cost low with a net positive effect on profitability and overall farm income.

The purpose of this research is to shed light on these economic arguments, which are the subject of intense debate among agro-economists and policy-makers. We examine cases of multi-purpose farms supported by CEDAC, focusing on the economic advantages and constraints of MPF against conventional rice field systems. A comparative approach is used to analyze the costs incurred by both and the consequent values created during the operation of a multi-purpose farm. We also compare the overall patterns of household labor diversification, and the structure of total family income. Based on this analysis, the rationality of the MPF system is assessed, along with its appropriateness and the potential for scaling it up.

# CEDAC APPROACH TOWARDS MULTI-PURPOSE FARMING

After introducing the System of Rice Intensification (SRI) to Cambodia in 2000, CEDAC started supporting farmers to experiment with the conversion of their rice fields into diversified farming systems. Experiments included digging canals, building surrounding dikes, planting 'living fences' of multi-purpose trees, digging small ponds to improve water storage and accessibility, and growing additional crops on the dikes, upper fields and in the rice fields as inter-crops. What was then called the System of Intensification and Diversification (SID) evolved into an improved integrated farming system that CEDAC now refers to as Multi-Purpose Farming (MPF). This combines rice production with the growing of fruit trees, perennial crops, vegetables and seasonal crops, as well as animal husbandry and aquaculture. Since 2001, the initiative has encouraged more than 400 farmers across Cambodia (in CEDAC target areas) to convert their small plots of land to multi-purpose farms. Other NGOs like Partnership for Development of Kampuchea (PADEK) and Catholic Relief Services (CRS) have also promoted integrated farming and, all together, the innovation has been adopted by approximately 2,400 farmers.

MPF is an agricultural innovation that aims to enhance the production capacity of small-scale farmers as well as the quality and diversify of their food intake. The model rests on the assumption that better soil management and diversification in farming activities will result in increased yield and diversified food production, thus contributing to improved family income and nutrition.

The conversion of rice fields into an MPF system requires an important change in land use (Figure 1). A fully functional, multi-purpose farm comprises several sub-systems. Farmers retain about 60 percent of their land area for rice cultivation. The rice plot is surrounded by a deep canal to store water and allow for efficient mobilization of water resources, to limit irrigation expenses (work time and water quantity used) or to serve as drainage when there is too much water (water logging) in the farm. The canal and rice field are surrounded by a dike that helps to keep fish and soil nutrients within the farm area and that also prevents minor flooding. The rest of the farm is divided into two or three areas: a pond serving for aquaculture production, and an upper area for seasonal crops and vegetables, for fruit trees, and for livestock rearing. Sediments from the pond and canal are collected annually. This, and manure from animal raising, is recycled as fertilizer, either directly or combined with crop residues to produce compost (making nutritional elements more easily available to plants and limiting the risk of propagating weeds, pests, and disease organisms contained in the manure and straw). Multi-purpose trees (often leguminous, which are effective as nitrogen fixers) planted on the dike as a living fence, limit damage from wind or animal grazing and reduce soil erosion. Living fences function as hedgerows, and are favorable to crops through providing shade, and increasing the presence of natural enemies to pests (diversity). These living fences also reduce the leaching of mineral elements from the farm to outside areas, provide biomass resources for use on the farm, and create ecological habitats conducive to maintaining agro-ecological diversity.

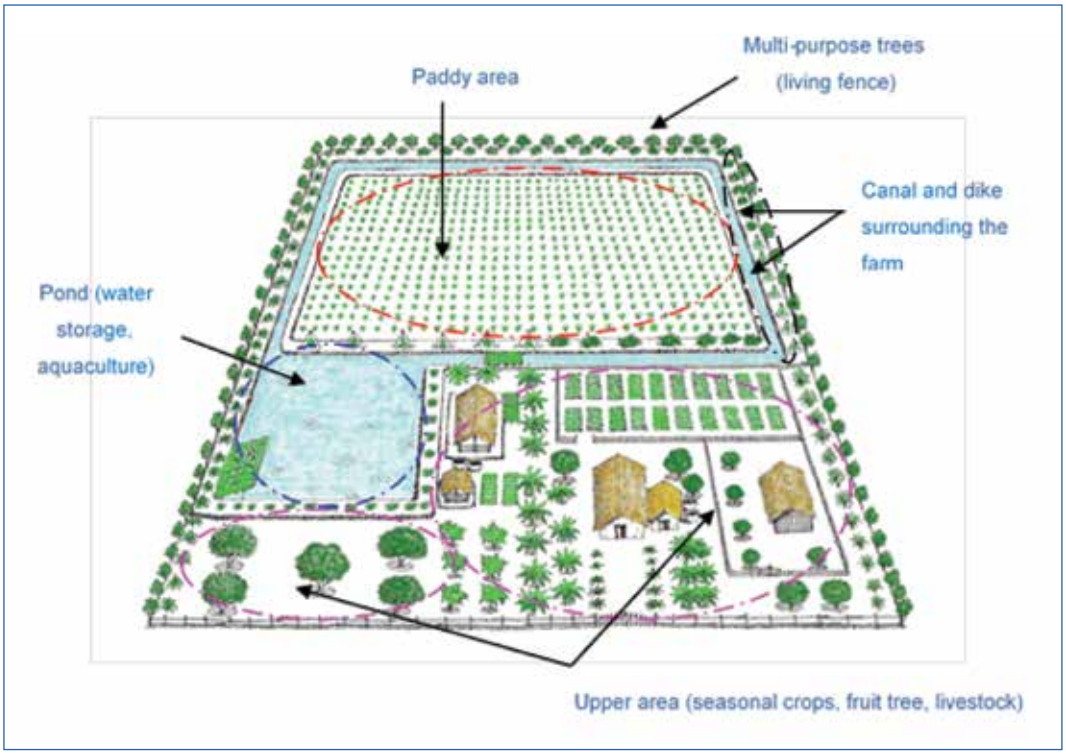



***Figure 1:*** *General design of a Multi-Purpose Farm (Lim 2007)*

In the rice area, CEDAC promotes the System of Rice Intensification (SRI). This involves integrated agro-ecological farming practices designed to provide optimal growing conditions to individual rice plants to maximize tillering (Lim 2007). SRI practices involve raising seedlings in non-waterlogging nurseries, then gently transplanting single, young (8-15 days old) seedlings using wide plant spacing, and providing intermittent irrigation to avoid permanent flooding during the vegetative growth phase. Compost is used instead of chemical fertilizer, and intensive manual or mechanical weed control avoids the need for herbicides (Uphoff et al. 2002). Previous research has shown that the potential for SRI is high for resource-poor farmers (Dobermann 2004) in areas close to the homestead where the transfer of organic fertilizers is easily achieved (Anthofer 2004).

Preliminary research conducted by Lim (2007) indicated that the MPF system is suitable for areas of between 0.2 and 0.6 ha, with the water surface representing 15 percent of the area, the rice field 60 percent and the upper area for seasonal crops, fruit trees and livestock representing 25 percent. The up-front investment costs (in cash) necessary to convert 0.5 ha of rice field into an MPF system is approximately USD 830. This covers the cost of renting the machine to dig the pond and surrounding canal (USD 1 for each cubic meter of soil). Additional labor for soil digging is usually provided in-kind by the family, and represents approximately USD 600 for 0.5 ha (USD 2 for each cubic meter of soil).

The perception of the farmers on the contribution an MPF system can make to household food security is very positive. Earlier surveys showed that farmers who had adopted this system observed increased food supply - thus reducing their expenditure on food - and greater

income from the sale of surplus produce. In terms of nutrition, they reported that their farms were able to produce a greater variety of food for consumption and that this had improved the health of family members (Lim 2007, Pean 2004).

# METHODOLOGY

## Study area and action-research process

The research was conducted in Takeo province located in the Mekong alluvial plain (Figure 2) in south-central Cambodia. The selection of Takeo is based on the following criteria: high incidence of poverty and food insecurity; livelihoods are subsistence-rice based; households possess small landholdings; and CEDAC is currently involved in supporting multi-purpose farming in this region.

This province is a rain-fed lowland area, highly prone to drought, and is located about 78 km from Phnom Penh. Around 93 percent of the total 186,247 families living there produce rice and most of them grow one crop a year. The average agricultural land area is one hectare per household, and 57 percent of households have less than one hectare of rice land (NCDD 2010). The average rice yield is 1.74 tonnes per hectare and about 40 percent of farmers are unable to produce enough rice for family consumption. The production of vegetables and other crops, as well as animal husbandry, are the secondary farming activities after rice. Limited irrigation is one of the main constraints for farmers wishing to increase agricultural production (CEDAC 2010).

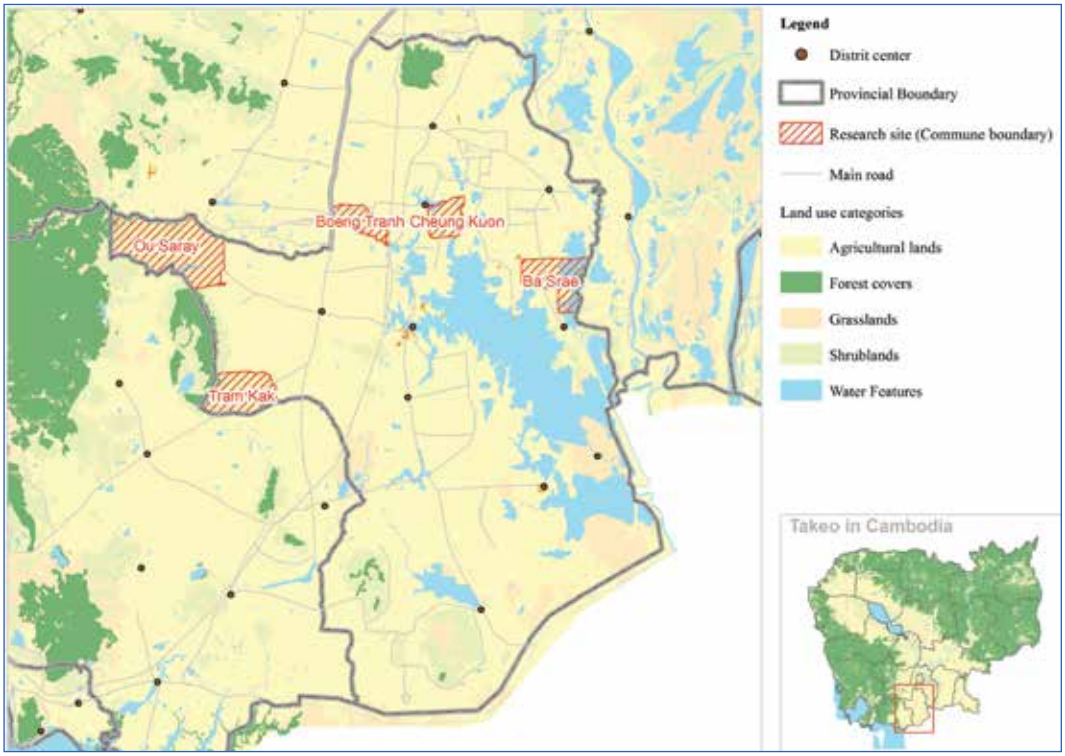



***Figure 2:*** *Overall land use in Takeo province and the study area*

The action-research included two distinct steps: a diagnostic and then a monitoring phase.

## Diagnosis and classification of multi-purpose farms

The diagnostic phase was conducted to understand the specific agro-ecological context and the type of multi-purpose farming activities in which households were engaged. The preliminary phase was also used as a forum to review past experiences in implementing multi-purpose farming in each village, to present the action-research project, and to probe the capacities and willingness of households to engage in a detailed survey of their farming systems. Two participatory rural appraisal (PRA) tools were used: focus group discussions with community representatives; and semi-structured interviews with selected households. This phase was carried out in January and February 2012 with 66 sample households selected from four villages, using the purposive sampling techniques for MPF farmers and simple random sampling for non-MPF farmers. Two of the villages studied already featured examples of MPF, and two others did not. The sample households represented three groups: MPF farmers and non-MPF farmers in the same village where MPF was already practiced, and non-MPF farmers from other villages. The sample size was determined with a confidence interval of 90 percent using the Yamane Taro formula (Israel 1992).

An important output of this diagnostic phase was the classification of farming systems into three groups according to the degree to which the MPF system had been adopted; this distinction was important in calculating rainy season rice production:

1. 'MPF complete' farms were those that had:
    - paddy fields fully converted into MPF with the existence of all sub-systems (Figure 1)
    - canal and dike (some had a completed dike surrounding the whole farm, some only on one or two edges of the farm)
    - seasonal crops/vegetables all year round as they benefited from better access to water sources for irrigating their crops via the pond and canal. More flexible water management also allowed for intermittent irrigation (alternating between dry and wet soil conditions) which is an important aspect in the System of Rice Intensification (SRI)
    - farmers who had been engaged in the system for a long time with significant coaching and mentoring from CEDAC.

2. 'MPF incomplete' farms were those that had:
    - farming systems comprising a limited number of MPF activities, usually a pond, seasonal crops/vegetables, small livestock or fish rearing, and rice production. No canal or dike. These farmers mainly focused on livestock production (in particular poultry rearing) or vegetables for market
    - farmers who, although they had received support from CEDAC, had a more recent experience in agro-ecology: they were in a process of transition from conventional rice farming to fully integrated multi-purpose systems.

3. Non-MPF farmers were those that were:
    - mostly engaged in conventional rice cropping systems, although some of them had received agro-ecology training from CEDAC covering subjects such as SRI. They were also involved to varying degrees in several farming activities (rice, livestock, fish rearing and non-rice crops), but these sub-systems were running in parallel and were not integrated as is the case in MPF.

Information from the diagnostic phase formed the basis for household selection for the next (monitoring) phase. Households were selected in five communes in two districts located in very similar agro-ecological environments. The selection of households followed an *ad hoc* procedure. First, there was purposive selection of households involved in MPF. In total 26 MPF farmers were selected (eight from 'MPF complete' farms, and 18 from ones that were `MPF incomplete'). Then, in order to make the most robust comparison possible, an equivalent number of households (n=26) were selected who were not involved in MPF but in mono-cropping farming. The sample size was limited as the comprehensive recording and monitoring work required a lot of resources. The total sample is presented in Table 1.

***Table 1:*** *Key characteristics of sample households (HH)*

| | Number of HH | Agricultural land area (ha) | | | Rice intensification index[2] |
|---|---|---|---|---|---|
| | | Total | Upper land | Rice field | |
| MPF complete | 8 | 0.85 | 0.12 | 0.73 | 1.17 |
| MPF incomplete | 18 | 1.09 | 0.11 | 0.98 | 1.15 |
| Non MPF | 26 | 0.99 | 0.01 | 0.98 | 1.07 |
| Total sample | 52 | 1.01 | 0.6 | 0.94 | 1.11 |

## Monitoring multi-purpose farms

The monitoring phase was implemented over the course of one year and was based on a record of all production activities (products and expenses), labor use and level of consumption in respect of each household. The participating farmers were asked to record the relevant data in a daily datasheet format in a logbook. Once a month (from May 2012 to April 2013), the research team visited to copy the farmers' data record and/or ask for more information/clarification if any data was missing or unclear. To enable the process of data recording and collection to be conducted thoroughly and accurately, the team gave farmers extensive training in record keeping through a monthly workshop. This time-consuming effort paid off, and we are confident that accurate data was collected from the farm households. Furthermore, most of the households had participated in CEDAC's projects and training for many years and had a keen interest in discovering their actual household income and expenses.

[2] The rice intensification index is a specific measure of rice intensification derived from the ratio between the total rice cultivated area (ha) and total usable rice land area (ha)

## Analytical framework

The comparison of performance between multi-purpose and non-multi-purpose farming systems is based on production processes, household labor management and income generation.

A number of production indicators were used to evaluate and compare the productivity, efficiency and profitability of the two systems. While the primary focus was on land productivity, indicators were also developed to take into account the return on labor in both systems.

### Value of production and value-added

The analytical approach was centered on the notion of value-added, which represents the wealth created during the production process (Dufumier 1996). The value-added equals the gross value of the production (in-kind and in-cash) minus the cost values of production inputs called consumables i.e. that are entirely consumed during the production process (fertilizers, pesticides, renting of equipment, seeds, and so on) (Figure 3). The value-added serves to pay for the services supplied during the production process: the external labor; the payment of interest rates to credit institutions; and taxes paid to the state or landowners. After deduction of these external services, the balance is the income left to the family engaged in the production process.

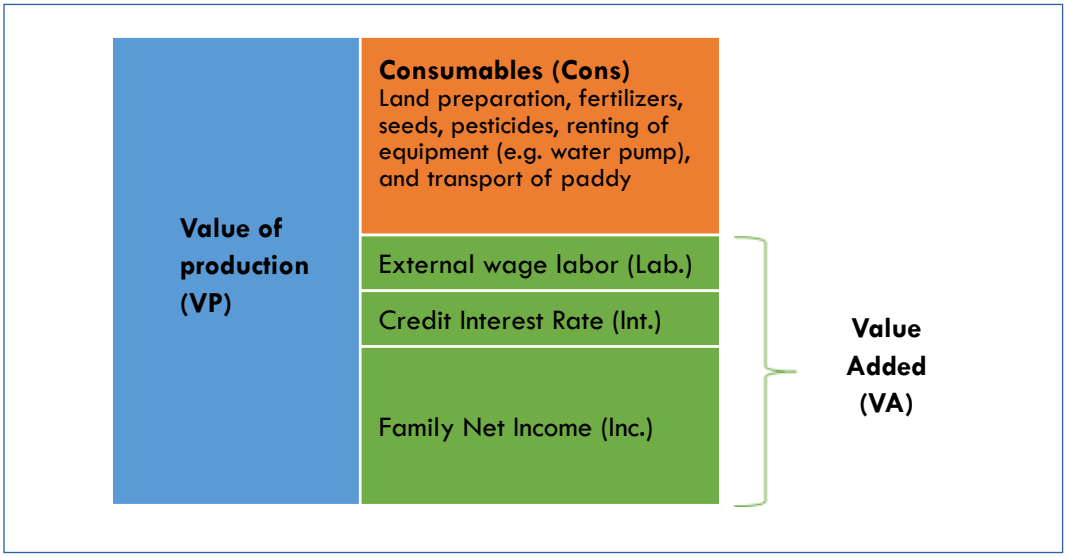



***Figure 3:*** *Structure of key indicators in the agro-economic analysis*

### Productivity indicators

Indicators of productivity are derived from the value of the product for both direct consumption and for sale. Land and labor productivities indicate the production per unit of land (kilograms per hectare) and labor (kilograms per each man.day), respectively. The rice intensification index is a specific measure of rice intensification derived from the ratio between

the total rice cultivated area (hectares) and the total usable rice land area (hectares). The costs calculated per unit of land (USD/ha) indicate the level of intensification while cost per unit of product (USD/kg) is the so-called unit cost price. This quantifies how much it costs to produce one kilogram of product (e.g. rice).

### Research limitations

The initial aim was for the sample size to comprise 52 housheolds (26 MPF farmers and 26 non-MPF farmers) to allow for a consistent statistical comparison. As our research project developed, however, we realised that it was necessary to split the group of MFP farmers into two categories - complete- and incomplete-MPF. Indeed, multi-purpose farming is at full potential only when farmers are selecting and undertaking all necessary investments. If one element of the system is missing, the complementarity within the farming system is disrupted. We had, therefore, to take these major differences in production systems into account and, as a consequence, the basis for comparison is not as solid as initially intended.

The absence of household social-economic classification - to reflect the importance of non-farm employment and wages in the production system - was another limitation. It could be argued that non-farm and off-farm activities are factors that can affect the capacity of households to undertake innovations and improve their farming systems, such as engagement in MPF.

## THE EFFICIENCY OF MULTI-PURPOSE FARMING SYSTEMS

In order to assess and compare the efficiency of multi-purpose farming against conventional rice cropping, we examined the production of rainy season rice - a key component of all farming systems in Takeo - and compared the degrees of productivity and efficiency between both production systems. We then widened the scope of the assessment between MPF farmers and non-MPF farmers by addressing the overall family labor management in the different household production sub-systems (farming, non-farm and wage labor) and scrutinized the resulting family income level and structure.

### Rainy season rice production

Statistically significant differences were found in rainy season rice yield (Table 2) between complete MPF farms (3,153 kg per hectare) and non-MPF farms (2,357 kg per hectare) ($p = 0.02$). The rainy season rice yield of incomplete multi-purpose farms fell between these two categories (2,755 kg per hectare) but the difference with the other two is not statistically significant. In order to make sense of these differences, the factors that determine yield were also examined. These included rice varieties, water management, intensity of labor use and the use of inputs including chemical or organic fertilizers.

Farmers involved in rainy season rice production under the three different farming systems use mostly the same rice varieties in very similar proportions. Farmers grow jasmine rice (known as *romdoul*), mainly for sale, in areas ranging from 0.20 to 0.50 hectares, and a

local variety (*chhma prom*) for family consumption. Both varieties have the same growing period and similar potential yield. As indicated in Table 2, the intensity of labor use as well as labor productivity for rainy season agriculture do not differ significantly between the three types of farming systems. As far as the costs of production are concerned, cash-paid costs of production (consumable inputs) are less important for multi-purpose farmers (Table 2) but these differences are not statistically significant. Figure 4 shows that incomplete-MPF farmers use fertilizer in the same proportion as non-MPF farmers; our research further revealed that incomplete-MPF farmers are also engaged in SRI cultivation techniques but they do not fully follow the SRI principles and rather specialize in livestock production (chicken, pig and fish rearing). The structure of cash-paid costs (Figure 4) reveals that the expenses of the multi-purpose farmers are lower for all items (water management, manure, fertilizers, soil preparation and seeds).



**Table 2:** *Indicators for rainy season rice production*

| **Indicator** | | **Complete Multi-Purpose Farm** | | **Incomplete Multi-Purpose Farm** | | **Non Multi-Purpose Farm** | |
|---|---|---|---|---|---|---|---|
| Yield | *Kg/ha* | 3,153 | | 2,755 | | 2,357 | |
| Family labor use | *Man.days/ha* | 76 | | 73 | | 81 | |
| Labor productivity | *Kg/man.day* | 54 | | 57 | | 52 | |
| Costs of production (consumables inputs) | *USD/ha* | 30 | | 84 | | 66 | |
| Unit cost price | *USD/kg* | 0.0105 | | 0.034 | | 0.0305 | |
| Value Added | *USD/ha* | 985 | (100%) | 781 | (100%) | 621 | (100%) |
| Including external labor | *USD/ha* | 54 | (5%) | 118 | (15%) | 57 | (9%) |
| Including payment of interest | *USD/ha* | 56 | (6%) | 13 | (2%) | 13 | (2%) |
| Including family income | *USD/ha* | 875 | (89%) | 650 | (83%) | 551 | (89%) |

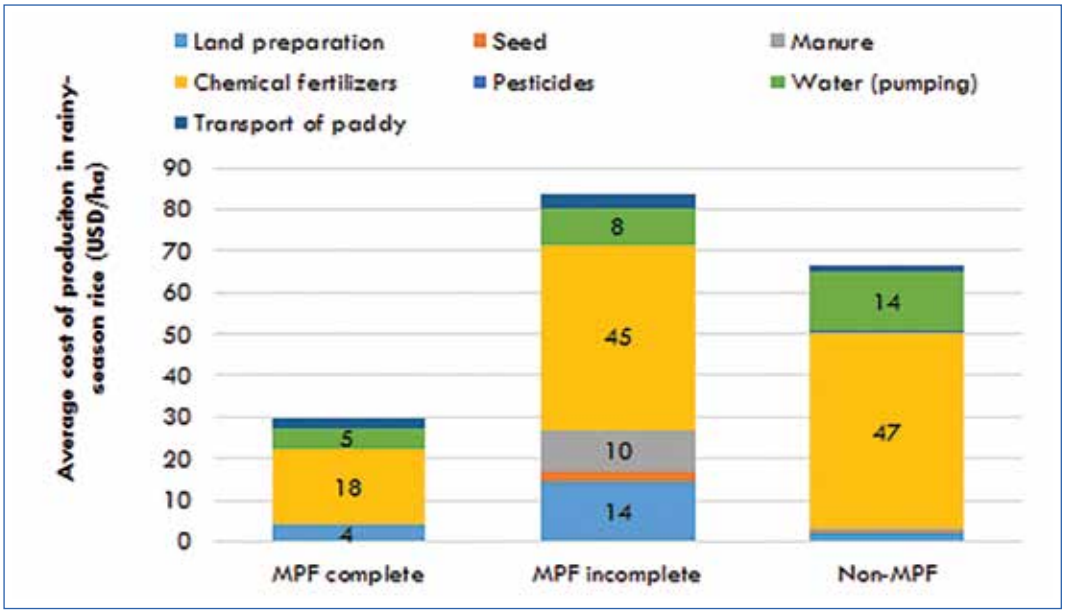



***Figure 4:*** *Level and structure of production costs in rainy season rice (per hectare)*

In a context where there are no major differences in soil quality between the sites, these results suggest that complete MPF allows for much better management of soil fertility through the recycling of organic matter from other farming sub-systems such as livestock manure, cover crops grown in the dry season, leaves from trees/crops, and waste water from fish ponds. These practices, in association with the System of Rice Intensification (SRI), enable farmers to obtain significant productivity gains.

As Table 2 shows, the unit cost, which measures yield against the cost of production, is low for complete-MPF farmers suggesting that they are at a competitive advantage in rain-fed rice production compared with their non-MPF counterparts. The value-added per hectare sum, which describes the wealth created per hectare during the production process, is significantly higher for complete-MPF farmers (USD 985 per hectare) than for non-MPF farmers (USD 621 per hectare) ($p = 0.002$). While 5 percent of that value goes to pay external labor on complete-MPF farms, this value is much higher for incomplete- and non-MPF farmers (15 and 9 percent, respectively). As Figure 5 shows, the share of the value-added that goes on payment of interest is higher for complete-MPF farmers as a result of the up-front investment needed to transform the system. The resulting family income per hectare is significantly higher for complete-MPF farmers (USD 875 per hectare) compared with non-MPF farmers (USD 551 per hectare) ($p = 0.006$) but not significantly different for incomplete-MPF farmers (USD 650 per hectare).

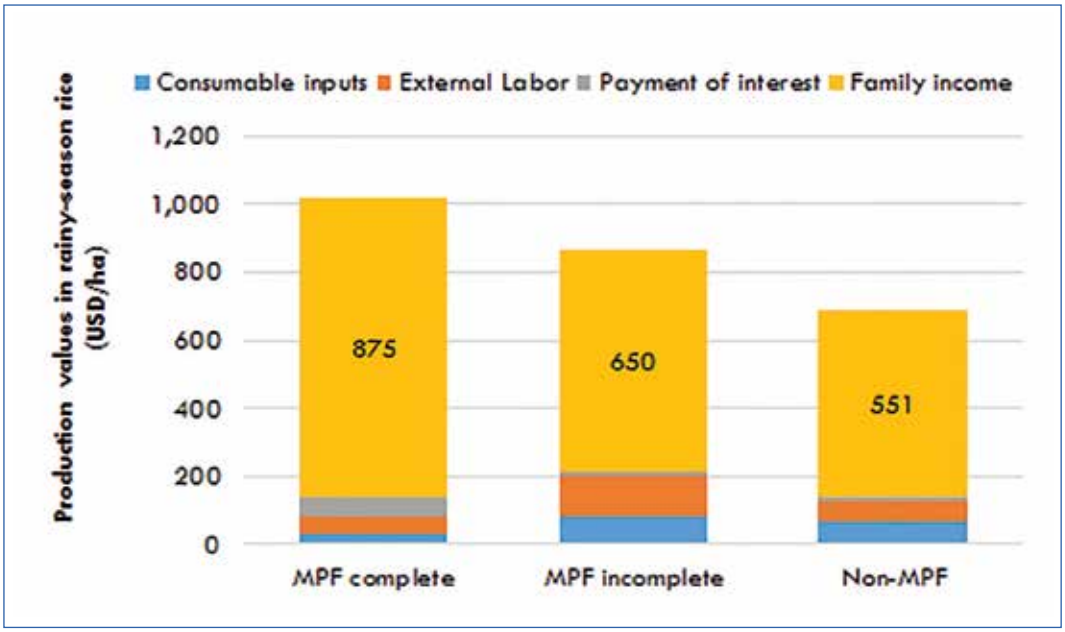



***Figure 5:*** *Distribution of production values in rainy season rice production*

These results strongly suggest that wet season rice production under a complete-MPF model makes a lot of economic sense. Significant gains in productivity attributed to better labor, and water and soil fertility management, combined with lower level cash costs of production resulting from recycling of sub-products within the farm, increase production, making it more efficient and profitable. However, our data shows that these gains in productivity and profit margin are not significant for incomplete-MPF farmers. This suggests that in order to realize the full potential of multi-purpose farming, farmers need coaching and mentoring support so that they can follow the MPF principles more precisely.

## Labor management

Family labor is engaged not only in farm activities; off-farm wage labor and non-farm work are frequently central elements in the income diversification portfolio of households. Takeo province, along with the other provinces in the Mekong delta, is known for high job migration rates especially among young people (Diepart et al. 2014). A wider picture of family labor management is thus necessary to assess multi-purpose farming in the overall context of livelihood diversification. The data allows us to group livelihood activities into three categories:

- Farming, which comprises self-employed activities such as rice production, livestock husbandry, fishing and upland crop production
- Non-farming, which includes self-employment, for example in small shops or in handicraft production, and
- Salaried jobs and wage labor, which include agricultural or non-agricultural wage labor sometimes involving migration (Figure 6).

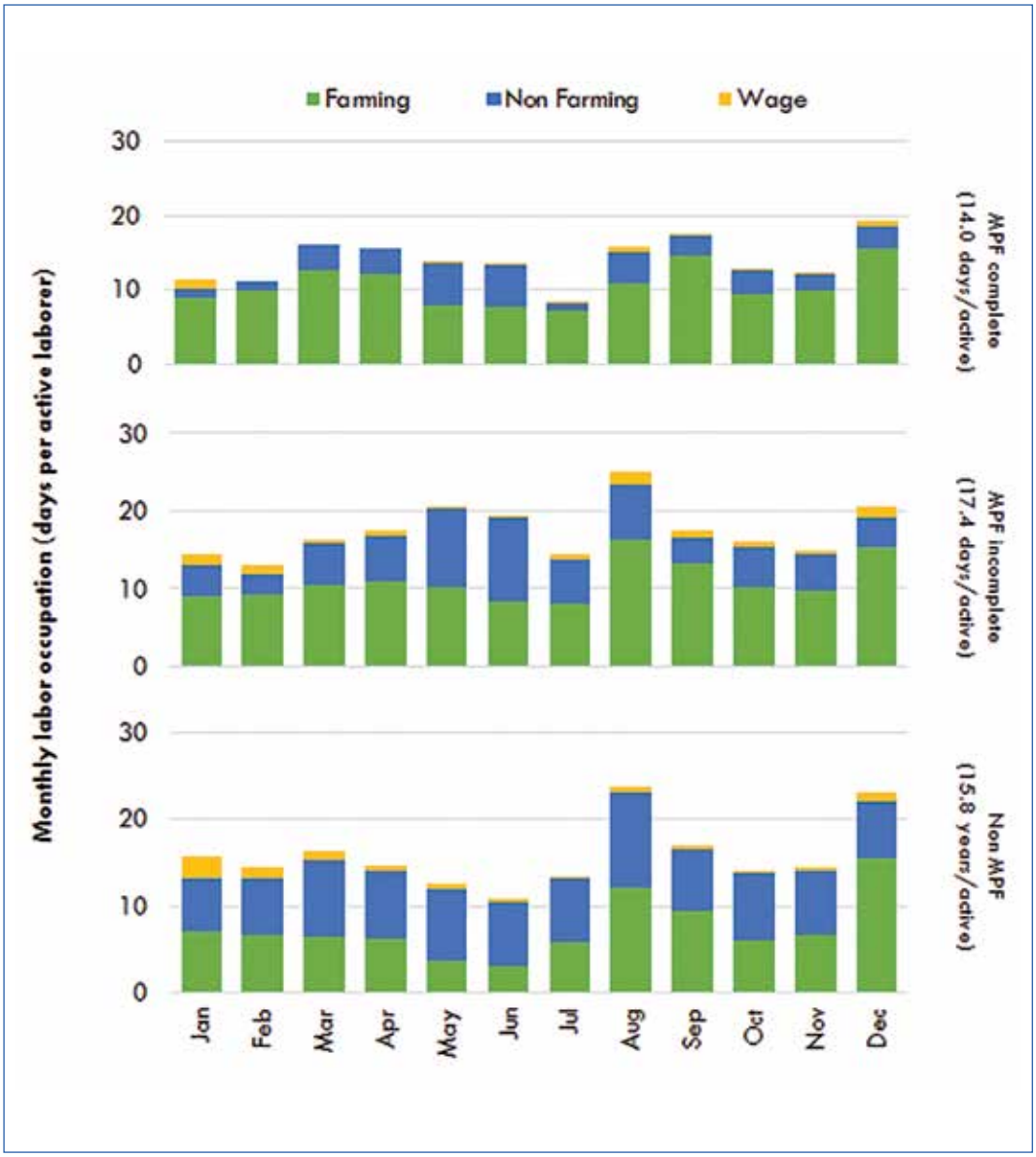



***Figure 6:*** *Monthly distribution of labor*

Important observations can be drawn from Figure 6. First, it can be seen that the number of active working days tends to be lower for complete-MPF farmers (14.0 days/active/month) than for incomplete-MPF farmers (17.4 days/active/month) or non-MPF farmers (15.8 days/active/month). Furthermore, the share of labor devoted to farming activities is much higher for complete-MPF farmers (75 percent) against 63 percent and 47 percent for incomplete-MPF and non-MPF farmers, respectively.

A particularly important contribution of multi-purpose farming is that labor occupation in farming activities is significant in the dry season (especially on livestock or upper crop cultivation), a period when family labor is traditionally under-utilized or allocated to non-

farm activities and very often to migration. Therefore, by providing productive employment at the farm level, multi-purpose farming also contributes to reducing migration. Another advantage of a multi-purpose farming system is that it allows for fuller employment and a more regular use of labor throughout the year (Figure 6).

## Household income

These differences in labor management patterns also influence income structure. Incomes were computed separately for all livelihood activities and then averaged and aggregated into a hypothetical average family income. Incomes from farming activities covered those derived from rice, other crops and livestock (including aquaculture). Non-farm incomes included revenues from all self-employed and salaried activities, while agriculture or non-agricultural wage labor was accounted for in a separate category. The so-called 'external income' comprised all types of income generated outside (by family members or not) and transferred to the family through remittances or gifts.

The average annual income of complete-MPF households is significantly higher than that of non-MPF families (USD 1,155 per active laborer against USD 944) but slightly smaller than incomplete-MPF households. This is the result of the fact that households in our sample specialized in livestock production, and this does not necessarily reflect the situation of other incomplete-MPF households in the country.

Figure 7 indicates the differential in total income per active laborer (i.e. income attributed to household members who were capable of active labor). It can be seen that complete-MPF farmers gain in income generated by farming activities (rice and other crop production, and animal raising): these represent 64 percent of total income in the case of complete-MPF households, against 61 percent for incomplete-MPF and 45 percent for non-MPF households.

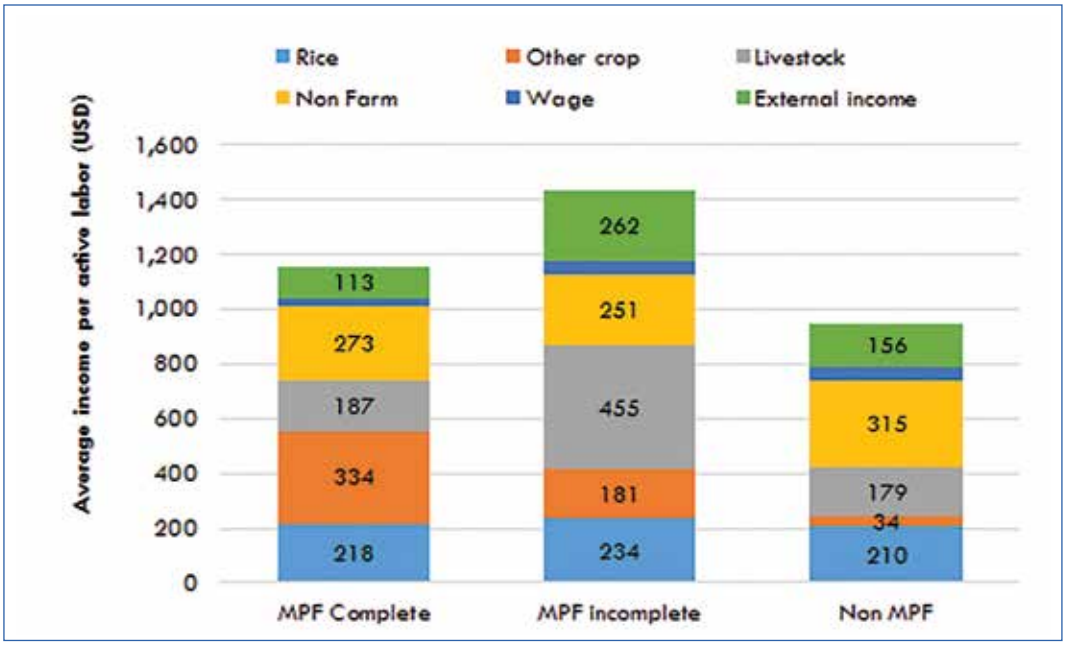



***Figure 7:*** *Average family income per active laborer*

A corollary of this gain in agricultural income and diversification is the reduction of risk associated with specialization in mono-cropping. And in the context of environmental change, these risks have become higher as increased occurrence of flood or drought can have rapid and substantially negative effects on rice production and can jeopardize the family economy through indebtedness or survival migration.

However, Figure 7 indicates that income derived from wage, non-farm activities and external sources is not fundamentally different among the three types of household. This suggests that multi-purpose farming, even if it consolidates farm activities, assets and income, does not constrain livelihood diversification to solely farm activities. Non-farming activities remain accessible and even an important part of the income portfolio. This is an important observation to be interpreted in the wider perspective of agrarian transition and the transfer of labor from agriculture to the industrial and service sectors that is taking place in Cambodia. Despite the strong push from the government to accelerate this transition (Diepart et al. 2014), there is a growing consensus about the limited capacity of the industrial and services sectors to absorb labor from agriculture and to offer quality jobs to people who quit agriculture (Murshid and Phim 2007, World Bank 2013). In this context of non-linear and incomplete transition, multi-purpose farming helps to consolidate a farming sector in ways that reduce risks of failed transition.

## PROMOTING MULTI-PURPOSE FAMING SYSTEMS

Understanding the factors that constrain the uptake of MPF is key. It is the basis on which policy makers and practitioners need to work to ensure the scaling-up of this innovation.

First of all, the survey reveals that a large proportion of households (82 percent) living close to MPF farmers have actually never heard about it. It seems that information and knowledge about this agricultural innovation are still very compartmentalized. Therefore, there is a need to break these barriers in order to promote it. In addition to this information gap, an important proportion of households (54 percent) do not want to engage in MPF and have definite reasons for that choice (Figure 8).

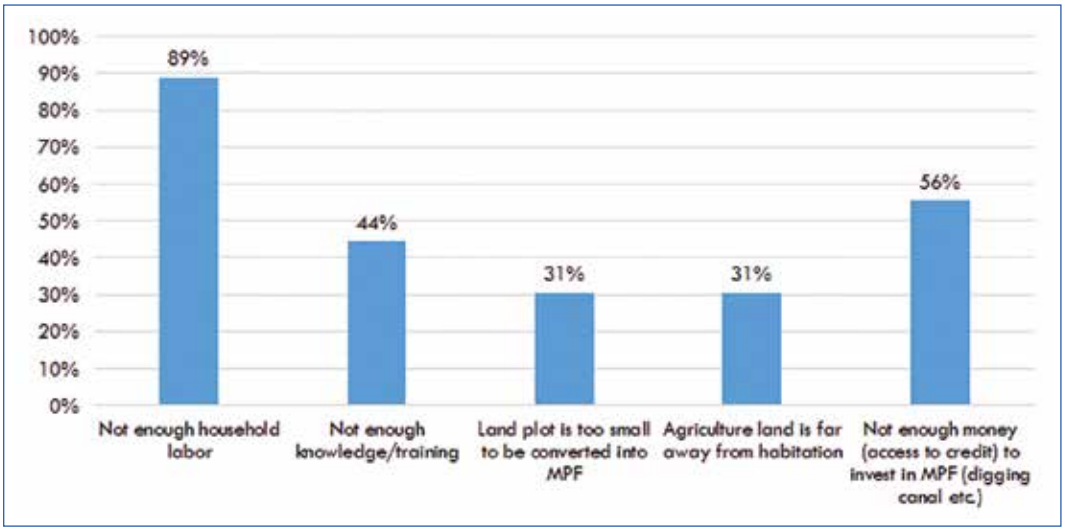



***Figure 8:*** *Reasons for not adopting MPF*

Among those households not willing to engage in multi-purpose farming, 89 percent anticipate lack of labor as a key constraint. Our results suggest, however, that MPF does not necessarily make a more intensive use of labor but rather changes the labor employment patterns. Based on our results, we would argue that the key underlying question here has not so much to do with the amount of time and labor needed to conduct farming, but more with the interest on the part of the household, especially the young, to engage professionally in agriculture. But the development of multi-purpose farming is not so narrowly limited to farming as it brings a wide range of economic opportunities to create diversified services upstream and downstream of production itself, e.g. agro-processing, packaging, marketing, and so on. Capacity development and vocational training could be promoted along these lines to stimulate new vocations that would support this model of agriculture, especially among rural youth and young graduate students from faculties of agriculture.

A substantial 44 percent of households consider that a lack of capacity is a constraint that impedes them in engaging in multi-purpose farming. To address this, farm schools that facilitate farmer-to-farmer knowledge transfer should be promoted. For it to be fully successful, a co-learning approach between innovative farmers, and field practitioners and supporters is required. The model needs to undergo place-specific trials and experimentation, and to evolve within specific social-ecological contexts. Experience shows that the system works if there is adequate support and if farmers are able to experiment and innovate based on their own observation and analysis.

Another significant constraint (56 percent of households) is the lack of up-front capital to make the initial investment in land conversion to multiple-purpose farming. Credit is generally available in the area but at a high interest rate (e.g. 2.5 percent per month). This is arguably a key element to consider. The generalization of MPF is possible if adequate and affordable credit is made available to farmers or if there is sufficient public investment to equip farms with canals and small-scale irrigation systems (for instance through commune or district

funds). This could also be achieved via a redirection of funds from mega-irrigation projects towards small (family) scale irrigation. Community/farmer-led savings groups currently exist in many rural villages and can provide access to financial capital.

For 31 percent of the households, the land plot size is considered too small to be converted into MPF. In reality, the degree of application of MPF is somewhat limited because the lands of small-scale farmers are parceled out in small plots scattered outside the household and even outside the village boundaries. Indeed, there are few instances of farms exhibiting the ideal layout as depicted in Figure 1.

But to push multi-purpose farming forward there is a need for a strong enabling policy framework that recognizes and promotes the approach as a credible component of sustainable agricultural development. The institutionalization of multi-purpose farming can be advanced through the creation of a market for products of differentiated quality produced under multi-purpose farming (eco-label, green products, and so on). Innovative marketing is needed to raise awareness among consumers and to stimulate their interest and demand for better quality products. New forms of partnerships between producers and consumers need to be developed through alternative agro-food networks (Kremen et al. 2012). One of these alternatives is the so-called 'community-supported agriculture', a partnership of mutual commitment between a farm and a community of supporters that provides a direct link between the production and consumption of food. Supporters usually cover a farm's yearly operating budget by purchasing a share of the season's harvest and in some cases they assist with the farm work. In return, the farm provides, to the best of its ability, a healthy supply of seasonal fresh produce (Hinrichs 2000).

## A RESILIENT MODEL OF AGRICULTURE: CONCLUDING REMARKS

This chapter has presented multi-purpose farming as a resilient form of agriculture: for a start, it has demonstrated that this model makes strong economic sense. Compared with the conventional mono-cropping rice-based farming system, it shows significant gains in land productivity, efficiency and profitability for rainy season rice production. It helps consolidate the role and importance of farming in household economics both in terms of labor employment and income formation. It is a source of resilience in that it i) limits the dependence of farmers on international agricultural inputs and commodity markets, ii) provides them with a credible solution to the high variability and incompleteness of non-farm labor markets and iii) offers opportunities for the development and diversification of the local economy upstream and downstream of the agricultural production itself.

Second, we have suggested that multi-purpose farming is environmentally resilient because the biological diversification across ecological, spatial, and temporal scales maintains and regenerates the ecosystem services that provide critical inputs to agriculture. These include maintenance of the soil quality, nitrogen fixation, pollination, and pest control. Agro-biodiversity is sustained by diversified farming practices, thus reducing negative environmental externalities (i.e. the negative effects on the environment for which no compensation is delivered) and the need for off-farm inputs (Kremen and Miles 2012).

Third, multi-purpose farming is also resilient from a societal point of view as it represents a credible path to re-peasantization (Rosset and Martínez-Torres 2012). Nurturing a built-in learning process within communities of farmers allows farmers to retain a better control over their decision-making environment and the chance to innovate and adjust according to their specific circumstances.



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# BIBLIOGRAPHY


Agri-Sud (2010) *Agroecology, best practices,* Paris: Agri-Sud.

Anthofer, J. (2004) The Potential of the System of Rice Intensification (SRI) for Poverty Reduction in Cambodia. *Deutscher Tropentag 2004: Conference on International Agricultural Research for Development*, Berlin.

CEDAC (2010) *Baseline survey for the project "Enhancing the Participation of Farmer associations in local governance and development through capacity building and cooperation with local authorities in five districts of Kampong Speu and Takeo Provinces, Cambodia"*. Phnom Penh: CEDAC.

De Schutter, O. (2010) Preface. in *Agroecology, best practices,* Paris: Agri-Sud.

Diepart, J.-C., Pilgrim, J. and Dulioust, J. (2014) Migrations. in Save Cambodia's Wildlife, (ed.) *Atlas of Cambodia: Maps on Socio-Economic Development and Environment,* Phnom Penh: SCW, pp. 89-96.

Dobermann, A. (2004) A critical assessment of the system of rice intensification (SRI). *Agricultural Systems, 79(3),* pp. 261-281.

Dufumier, M. (1996) *Les projets de développement agricole. Manuel d'expertise,* Paris - Wageningen: CTA - Karthala.

FAO (2002) Proceedings. in *International scientific symposium on Measurement and assessment of food deprivation and undernutrition,* Rome: FAO.

FAO (2014) *Food security indicators,* Available at: http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/ [Accessed July 25 2014].

FAO, WFP and IFAD (2012) *The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition*. Roma: FAO.

Hinrichs, C. C. (2000) Embeddedness and local food systems: notes on two types of direct agricultural market. *Journal of Rural Studies,* 16, pp. 295-303.

Israel, G. D. (1992) *Determining Sample Size*. Fact Sheet PEOD-6: University of Florida.

Kremen, C., Iles, A. and Bacon, C. (2012) Obstacles, and Enabling Policy Frameworks Diversified Farming Systems: An Agroecological, Systems-based Alternative to Modern Industrial Agriculture. *Ecology and Society, 17(4),* pp. 44-62.

Kremen, C. and Miles, A. (2012) Ecosystem Services in Biologically Diversified versus Conventional Farming Systems: Benefits, Externalities, and Trade-Offs. *Ecology and Society, 17*(4), pp. 40-64.

Lim, S. (2007) *Experiences in multi-purpose farm development: raising households incomes in Cambodia by utilizing productivity gains from the System of Rice intensification* Phnom Penh: CEDAC.

Lipper, L., Mann, W., Meybeck, A. and Sessa, R. (2010) *"Climate-Smart" Agriculture Policies, Practices and Financing for Food Security, Adaptation and Mitigation, The Hague Conference on Agriculture, Food Security and Climate Change,* Roma: FAO.

Murshid, K. A. S. and Phim, R. (2007) A Review of Poverty and Vulnerability in Cambodia, with special reference to the Tonle Sap Region. in Ballard, B., (ed.) *We are living with worry all the time. A Participatory Poverty Assessment of the Tonle Sap,* Phnom Penh: Cambodia Development Resource Institute. pp. 21-47.

National Institute of Statistics (2009) *General Population Census of Cambodia 2008: National Report on Final Census Results.* Phnom Penh: Ministry of Planning - Royal Government of Cambodia.

NCDD (2010) *Commune Database Online,* Available: http://db.ncdd.gov.kh/cdbonline/ [Accessed March 25 2014].

Pean, S. (2004) *The Development of Family Agriculture in the Lowland of Cambodia through Multi-purpose Farm*. Unpublished MSc, Royal University of Agriculture Phnom Penh.

Pretty, J. (2006) *Agroecological approaches to agricultural development. Contribution to the preparation of the World Development Report 2008 "Agriculture for Development"*: Rimisp-Latin American Center for Rural Development.

Rosset, P. M. and Martínez-Torres, M. E. (2012) Rural social movements and agroecology: context, theory, and process. *Ecology and Society, 17*(3), pp. 17-28.

Royal Government of Cambodia (2005) *National Strategic Development Plan 2006-2010,* Phnom Penh.

Royal Government of Cambodia (2008) *Strategic Framework for Food Security and Nutrition in Cambodia 2008-2012,* Phnom Penh.

Royal Government of Cambodia (2010) *National Strategic Development Plan Update 2009-2013*, Phnom Penh.

Royal Government of Cambodia (2014) *National Strategy for Food Security and Nutrition (NSFSN 2014-2018*), Phnom Penh.

Uphoff, N., Fernandes, E. C. M., Yuan, L. P., Peng, J. M., Rafaralahy, S. and Rabenandrasana, J. (eds.) (2002) *Proceedings of an International Conference on the Assessment of the System of rice intensification (SRI)*, Sanya-China.

World Bank (2013) *Where Have All The Poor Gone? Cambodia Poverty Assessment 2013,* Washington, DC: Work Bank.


# Section C

## Land Use Change and Food security strategies in communities of indigenous people

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## Land Use Change and Food security strategies in communities of indigenous people

## CHAPTER 5

Prosperity and poverty: Livelihood transitions emerging from land use change in two Mondulkiri communes

## CHAPTER 6

Differentiation of swidden agriculture in Northeast Cambodia: Kavet swiddeners, the state and the markets in Kok Lak commune

# CHAPTER 5

## Prosperity and poverty: Livelihood transitions emerging from land use change in two Mondulkiri communes

HAK Sochanny, SO Dane, OEUR Il, and John McANDREW



## ABSTRACT

This chapter focuses on livelihood transitions emerging from land use change in Dak Dam and Srae Preah communes in Mondulkiri province. The study argues that the rapid expansion of the market economy in these communes has resulted in dispossession from land and forest resources, a reliance on cash crops, land commodification, land concentration, social differentiation and economic inequality. The study explores these concerns within the literature on agrarian transitions. The methodological approach is both longitudinal, deriving insights across two points in time, and comparative, examining the disparate effects of land use change and market integration within the two study sites. Surveys based on random samples comprising 25 percent of the households were conducted in the two communes in 2002/03 and in 2012. In 2013, follow-up case study accounts were conducted with individually selected households.

Between the years 2003 and 2012 Dak Dam and Srae Preah households experienced a transition in agricultural production from the cultivation of upland staple crops, mainly for subsistence, to the production of cash crops for the market. As income shares from the cultivation of crops increased, those from forest products, hunting and trapping decreased. Economic growth gave rise to land concentration and high income inequality among households. Farmers who were better off cultivated larger upland areas and earned more from cassava production than did other income groups. Indigenous households in Srae Preah commune retained more access and control over their natural resources and achieved greater participation in the governance of these resources than did their counterparts in Dak Dam commune. The pathway pursued by the Bunong indigenous people in Srae Preah commune, while fraught with threats posed by the cassava boom crop and by economic land concessions and mine development, translated into greater prosperity and less poverty for more households than the pathway taken by the Bunong in Dak Dam commune.

**Key words:** *land cover and land use; rural livelihoods; food security; livelihood diversification; agriculture; economic land concessions; indigenous people; forest products*

# INTRODUCTION

Modulkiri province in Northeast Cambodia is largely inhabited by the Bunong indigenous people who for centuries have effectively exploited the natural resources of their upland forested habitat. Since the 1990s, the opening up of the Cambodian economy has had far reaching consequences for the province. Forest concessions and illegal logging, economic land concessions (ELCs), corporate mining concessions, and the unregulated hunting of wildlife have diminished the rich natural resources of the province. Rapid in-migration has exacerbated the decline. As natural resources become more circumscribed, indigenous people have been forced to make adaptations to preserve their way of life (McAndrew and Oeur 2009).

Mondulkiri's land size of 14,288 square kilometers makes it the largest province in Cambodia, and its rich natural resources make it a prime attraction for corporate concessions. In January 2002, the government banned logging operations under large-scale forest concessions but not before the Samling Corporation concession in Kratie and Mondulkiri provinces had logged 73,199 hectares of forest (McKenney et al. 2004). Meanwhile the government's policy to grant ELCs continues unabated.[1] In 2012, 21 companies held ELCs covering nearly 148,410 hectares in Mondulkiri primarily for the development of rubber plantations.[2] In addition, in 2012, 21 mining corporations held mining licenses to explore almost 6,144 square kilometers or 43 percent of the province's total land area.[3]

Population growth in Mondulkiri rose exponentially from 32,407 in 1998 to 61,107 in 2008 due mainly to Khmer in-migration. This represents an annual growth rate of 6.34 percent compared with 1.54 percent for Cambodia as a whole during the same years. From 2004 to 2008, 42 percent of the overall migrations in Cambodia took place from rural to rural areas (Chheang and Dulioust 2012). Notably, 29 percent of Mondulkiri's 2008 population had in-migrated from other areas. The proportion of Khmer residents increased while that of the indigenous inhabitants declined: estimates suggest that the proportion decreased from 71 percent in 1998 and 57 percent in 2004, to 47 percent in 2008 (Asian Development Bank 2000, Backstrom et al. 2007, National Institute of Statistics 2009). Khmer in-migration intensified population pressure on land resources and increased property values which increased the rates of land alienation among indigenous Bunong.

Khmer in-migration in Mondulkiri province and the establishment of ELCs are interlinked. Net out-migrations occur mainly from the central areas of Cambodia where population densities are high and agricultural land is scarce. Government policy encourages displaced and landless populations to resettle in peripheral provinces such as Mondulkiri and promotes ELCs in these areas as opportunities to generate revenue and create jobs locally. Landless

[1] On 7th May, 2012, Prime Minister Hun Sen signed Order 01 that provisionally suspended the granting of ELCs but subsequent announcements in the Royal Gazette showed that the Order was being ignored

[2] Open Development Cambodia - www.opendevelopmentcambodia.net/consessions - downloaded 11th November, 2012

[3] Provincial Department of Industry, Mining and Energy, Mondulkiri province, 22nd May, 2012. Some concession areas may overlap

migrant farmers are often contracted upon arrival by agricultural companies to clear land. Many then go on to encroach upon open and degraded forest areas and unused or non-occupied land near the concessions. These areas are invariably located within indigenous domains. Conflicts often arise between the in-migrants and the concessions holders over boundary intrusions. Conflicts also arise between the in-migrants and indigenous people over intrusions into ancestral territories (Chheang and Dulioust 2012).

Substantial investments in ELCs in Northeast Cambodia have taken place in parallel with the conversion of small-holder subsistence farming into crop production for the market. Small-farmer cultivation of rubber, cashew and cassava has in turn precipitated a move away from shifting cultivation to the production of crops on permanent farms (Fox et al. 2008). In Mondulkiri, cassava production increased dramatically in the new millennium from 546 tonnes in 2001 to 89,993 tonnes in 2007. Harvested areas of cassava in the province likewise rose from 52 hectares in 2001 to 5,806 hectares in 2007 (Ministry of Agriculture, Forestry and Fisheries 2008). This upsurge reflected a change in cassava cultivation from a food crop to an industrial crop with multiple uses such as animal feed and ethanol. The high export demand for cassava resulted in rising market prices for the crop locally albeit with some volatility in recent years.

The increased price of cassava was due primarily to a growth in the number of processing factories. This created high market demand and strong competition among the factories in buying cassava root directly from farmers (Sopheap et al. 2011). In 2007, Mondulkiri's cassava crop was generally processed locally in Kampong Cham province for export to Thailand or Vietnam or it was exported directly to Vietnam for processing there. While cassava became an increasingly important cash crop for Mondulkiri's upland farmers, cassava processors sought to produce the crop themselves through ELCs, thus bypassing supply problems with local farmers.[4]

As Bunong indigenous villagers struggle to adapt to the rapid depletion of their natural resource base, progressive legislation enacted in Cambodia since 2000 has provided a legal framework for preventing further decline. The Forestry Law of 2002 recognizes and guarantees the traditional user rights of local communities to collect forest by-products. The Land Law of 2001 enables indigenous communities to gain communal titles to their traditional lands and protects the rights of indigenous communities, formed as legal entities, to use and manage these lands, even before their full ownership rights have been recognized in a communal title. This makes the sale of indigenous land outside the community illegal. However, amid increasing rates of indigenous land alienation, the government has lacked the political will to implement communal land titling (Analyzing Development Issues 2010): by 2012, only three villages in Cambodia had received their communal titles from the government. The situation became further complicated in July 2012 when the government

[4] For example, the Khaou Chuly Development Corporation planned to invest USD 7 million to grow cassava on 5,000 hectares of land in Mondulkiri. The company also planned to build a factory to process 150,000 tonnes of cassava per year for export to China (Ministry of Commerce, Trade Promotion Department 2011)

halted all communal land title processes under Order 01. The Order intended to expedite the issuance of private land titles and thousands of student volunteers were recruited to demarcate lands in conflict with ELCs. This not only formalized prior alienation and fragmentation, it rendered communal and individual titles mutually exclusive and thereby accelerated land commodification (Milne 2013).

## RESEARCH PROBLEM

In 2003 CIDSE (Coopération Internationale pour le Développment et la Solidarité) Cambodia conducted a study that focused on changes taking place among Bunong indigenous people in two Mondulkiri communes as a result of increased market activity and diminished natural resources (McAndrew et al. 2003). Despite the destruction of forest resources through forest concessions, illegal logging, and unregulated hunting, Bunong villagers in Dak Dam and Srae Preah communes remained largely dependent on forest resources for their subsistence. In attempting to adapt to the decline in natural resources the people had been subsisting on less and further exploiting their diminished resource bases. This led to intensive hunting in Dak Dam and the tapping of young resin trees in Srae Preah. Diminished income from forest resources placed greater importance on the cultivation of crops and the raising of livestock and poultry. However, declining soil fertility and irregular rainfall, which the villagers linked to deforestation, limited crop production. Market demand for cash crops such as cashew nuts had also been less than expected. Meanwhile increased market activity had not transformed the local residents into entrepreneurs or traders, nor had it provided them with remunerative and sustained opportunities as wage workers. Given the inward orientation of household subsistence strategies and the lack of viable short-term alternatives, access to and control over natural resources remained critical for household survival.

This study takes as its baseline the 2003 CIDSE study and assesses how land use change has affected livelihood transitions in Dak Dam and Srae Preah communes over the past nine years. Since 2003, corporate incursions have continued in both communes with the expansion of ELCs and mining exploration. The construction of the national concrete road and bridges from Kratie province to Mondulkiri's provincial capital of Sen Monorum has likewise accelerated Khmer in-migration and market activity in the two communes. In recent years, cash crop production of cassava and cashew nuts has increased rapidly, particularly in Srae Preah commune, in response to market demand. This in turn has spurred the in-migration of Khmer agricultural laborers in Srae Preah commune and areas nearby (Milne 2013). These developments led the authors to undertake a diachronic study of livelihood transitions and land use change in the two communes from 2003 to 2012.

## RESEARCH FOCUS

In this research, therefore, we focus on livelihood transitions emerging from land use change in Dak Dam and Srae Preah communes. The rapid expansion of the market economy in these largely indigenous communes has resulted in dispossession from land and forest resources, a reliance on cash crops, land commodification, land concentration, social differentiation and economic inequality. Market integration has likewise transformed Bunong livelihoods providing

a measure of prosperity for some while allowing others to remain in, or fall into, poverty. Our study explores these consequences and concerns within the literature on agrarian transitions drawing particularly on research undertaken in Southeast Asia and in Cambodia. The methodological approach is both longitudinal, deriving insights across two points in time, and comparative, examining the disparate effects of land use change and market integration within the two study sites. The research also benefits from a comparison of four household income groups in each commune in 2012, and follow-up case study accounts in 2013 from individually selected households. The study aims to contribute to the understanding of livelihood transitions and market integration taking place among indigenous people in Mondulkiri and to inform government policy making and NGO development programming relating to indigenous groups.



# METHODOLOGY

In building the conceptual framework of our study we explore the links between the notions of livelihood transitions and land use change and maintain that participation of indigenous groups in natural resource governance is crucial to ensure household well-being in the transition process.

## Livelihood transitions

We use the concept of transitions in our research as a heuristic to describe and explain the iterative process of livelihood and land use change in Dak Dam and Srae Preah communes. Martens and Rotmans (2005) define a transition as "a gradual, continuous process of societal change where the structural character of society (or a complex sub-system of society) transforms…. A transition process is not set in advance, because during a process of change, humans are able to adapt to, learn from and anticipate new situations. Rather, transitions are possible development paths where the direction, size and speed can be influenced through policy and specific circumstances." This research explores the development paths pursued by households within the two communes as they come to terms with the expansion of the market economy.

Land use transitions in Mondulkiri province are strongly associated with the transformation of swidden farming. Cramb et al. (2009) examine swidden transformations in Southeast Asia within households and communities for whom this method of farming has been integral to their livelihoods but who through choice or necessity have partly or wholly transformed their swidden systems in recent years. Following Ellis (2000), the authors consider that households or communities have a livelihood platform consisting of various assets. Access to these is modified by prevailing social relations, institutions, and organizations in the context of exogenous trends (population growth, new technology and market expansion) and shocks. These circumstances influence the choice of livelihood strategies (intensification, commercialization, migration or diversification) that comprise activities, some based on natural resources (swidden, cash crops or forest collection) and others that are not based on natural resources (non-farm work, trade or remittances).

In Cambodia, policymakers often view swidden farming as an obstacle to more efficient crop production systems such as the plantation model espoused in ELCs (Cramb et al. 2009, Fox et al. 2008). However, Cramb et al. (2009) argue that swidden farmers are not resisting appropriate and supportive forms of development. They note that cash crops often improve household livelihoods even though total reliance on specialized crops exacerbates vulnerability. Nonetheless, the authors maintain that growing differences within and between communities resulting from swidden transformations can leave some groups marginalized and worse off than before. Specifically, they indicate that externally imposed change such as restrictive land use zoning, resettlement and commercial estates can have adverse effects on swidden farmers. They maintain, as do we, that local people need to be actively involved in planning, implementing, monitoring and evaluating development and conservation programs in swidden lands.

We argued in the introduction to this chapter that livelihood transitions in the two communes have resulted in prosperity for some and impoverishment for others. De Koninck et al. (2012) review a half-century of agrarian transformations in Southeast Asia and ask a question pertinent to this point: What are the conditions that characterize situations where most people have improved, and, likewise, the conditions where people have stagnated or become marginalized? The authors maintain that states of wealth and poverty should be understood as the outcomes of processes of improvement and impoverishment brought about by the interplay of local and specific conditions, but set against a structural context that might be connected to majority-minority relations or to the extraction of natural resources by powerful actors. In Mondulkiri the structural context that provides the backdrop to local interactions involves a nexus of majority Khmer and minority Bunong relations as well as the active pursuit of ELCs and mining exploration by powerful corporate and state actors.

In the cases reviewed by De Koninck et al. (2012) the impoverishment of significant numbers of people involved displacement from land and other productive natural resources in the face of rapid wealth generation. This had been brought about by capital-intensive extractive ventures, combined with displaced people's lack of access to other agrarian and non-agrarian livelihood opportunities. Vandergeest and Rigg (2012) pursue this discussion and reiterate that where exit options are limited, vulnerability to marginalization and displacement grows as does impoverishment induced by commercialization and resource extraction. Our research in Dak Dam and Srae Preah communes documents how corporate ventures have led to villages being dispossessed of land and forest resources and reveals how the exclusionary effects of market integration inhibit indigenous residents from participating in certain types of wage work and from becoming entrepreneurs and traders. We affirm the position of Vandergeest and Rigg (2012) that where exit options are impeded or of poor quality, the governance and allocation of land and natural resources remain critical. This is particularly the case in upland areas inhabited by indigenous people who have been marginalized in part due to their ethnicity.

In Mondulkiri the widespread adoption of cassava as a cash crop appears to generate wealth sufficient to make it a viable exit option to those dispossessed from ancestral land and forest resources. But this should be viewed with caution in consideration of boom crops

and market integration. Li (2012) examines the effects of cacao production as a boom crop in Upland Sulawesi in terms of social differentiation among swidden farmers. Shortly after the transition to cacao, some farmers had accumulated large tracts of land, while many of their neighbors and kin had become landless and jobless, with little demand for their labor. The author argues that indigenous hill tribes who have not previously experienced limitations to their access to agricultural land, likewise have no mechanisms to prevent the accumulation of land by a few, to claim a right to work, or to share the profits. The author maintains that when indigenous groups who have relatively open access to land rapidly adopt boom crops, social differentiation proceeds far too quickly for protective countermeasures or moral arguments against differentiation to arise.



## Bunong livelihood systems

We asserted in the introduction to this chapter that the rapid expansion of the market economy in the two communes has resulted in land commodification, land concentration and a reliance on cash crops. At this point it will be helpful to review how these developments took place. Prior to French colonialization most Bunong practiced swidden cultivation usually within the territorial limits of Bunong-defined villages, on land cleared by slash and burn. Swidden provided rice, vegetables, corn, plants for dyeing, and textiles such as cotton. After two or three years, the swidden plots were left fallow for five to 20 years, allowing time for the vegetation and soils to regenerate. The Bunong entered the forest to gather the wax of wild bees, tubers and non-timber forest products like rattan wood or wood oil. They also hunted small and large game for food. The forest was considered to be inhabited by spirits that the Bunong respected and feared (Guerin 2007).

At the end of the 20th century swidden cultivation was still the major rice system among indigenous people in Mondulkiri. Forest areas were cleared and planted with rice for two to five years before farmers shifted to new areas. From February to April trees and other plants were cut, left to dry and burned. From April to June seeds were dibbled into the soil. From August to December the rice was harvested depending on the growth duration of the varieties planted. In the mid-1990s Mondulkiri was only one of two Cambodian provinces where upland rice cultivation was the major rice ecosystem. In the 1994/95 crop season, upland rice was cultivated on 2,280 hectares in Mondulkiri, early lowland rice on 920 hectares, medium lowland rice on 750 hectares, and late lowland rice on 1,550 hectares.[5] Vegetables and fruits were commonly grown in the swidden plots. Some indigenous groups cultivated lowland rice in addition to upland rice (Javier 1997). At the dawn of the new millennium the collection of liquid resin as a non-timber forest product was a valuable income source (Evans et al. 2003, McAndrew et al. 2003). By 2007, the production of cassava as a cash crop had grown rapidly in response to market demand and had become increasingly important to indigenous livelihoods (Sopheap et al. 2011).

[5] By contrast the upland rice ecosystem in Cambodia as a whole was the smallest. In the 1994/95 crop season 354,300 hectares in Cambodia was cultivated to early lowland rice, 721,380 hectares to medium lowland rice, 671,000 hectares to late lowland rice, 169,210 hectares to dry season rice and only 37,910 hectares to upland rice (Javier 1997)

Hill-tribe land and forests were traditionally held as communal property. Land was not sold or transferred, but was seen as a resource held in trust by the community for future generations. According to customary law, families had use-rights over the land that they currently worked and over produce from fallowed land that might be farmed again. Village boundaries set limits to swidden cultivation, and indigenous farmers did not cross land that was under cultivation by a neighboring village. In the past, the abundance of land prevented major land conflicts between villages. In recent years these long-held customs have undergone change. The national government has extended its claims to indigenous lands as part of the state's public land domain. Moreover, the influx of migrants and outside investors has intensified land competition, with land increasingly considered as a market commodity, even by local people (Fox et al. 2008).

Milne (2013) examines the evolution of the land market in O Rona village located near Srae Preah commune in Keo Seima district. The author notes that the process began in the 1990s with logging undertaken first by military groups and later by the Samling Corporation concession when the loss of resin trees induced villagers to rely increasingly on cultivation. The turning point came in 2005/06 when the villagers began to grow cassava after a Vietnamese company helped them to clear land, provided them with seedlings and guaranteed to purchase their harvest. Since then, cassava cultivation has become the most profitable land use option, stimulating the land market. The effects of market integration have appeared to foster the accumulation and concentration of assets and land among a few wealthy individuals. Meanwhile land commodification and land dispossession have been linked as rich and powerful entrepreneurs or state officials from outside the village have purchased or grabbed land while indigenous O Rona villagers have engaged in voluntary land sales as an opportunity to make money.

## Land use change

The concept of transition as defined above by Martens and Rotmans (2005) is useful for understanding the dynamics of land use change. Lambin et al. (2003) argue that land use change is driven by a synergy of factors such as resource scarcity, which intensifies pressure of production on resources, changing opportunities created by markets, and policy intervention from outside. Further factors include the loss of adaptive capacity and increased vulnerability, and changes in social organization, in access to resources and in attitudes. Several factors, such as resource scarcity, increased vulnerability and changes in social organization, are mostly endogenous. Other factors, such as changing market opportunities and policy intervention, are largely exogenous. Transitions in land use are thus seen as multiple and reversible processes with large variability in specific pathways.

## Land use change in Cambodia

In her review of literature on land use change in Cambodia, Taylor (2011) notes that changes in land use acutely affect vulnerable populations, especially indigenous people, and cover a wide spectrum including agriculture, forests, and the fishery sector. Taylor argues that agricultural land use in Cambodia has expanded considerably during recent years as the

population has expanded and as ELCs have been awarded for corporate agribusiness. The rapid change resulting from a growing population in particular and economic growth in general has changed land use patterns and land markets and has led to rural migration and land disputes. These factors have all exerted pressure on natural resources, leading to deforestation and forest degradation. Meanwhile ELCs and mining concessions continue to pose a threat to community land holdings and foster an uncertain land tenure environment. Land use trends reviewed by Taylor are all relevant to our research in Dak Dam and Srae Preah communes.

In Cambodia, cash crop production, land commodification, land concentration and social differentiation are linked in ways that resonate with Li's (2012) study of cacao production in Upland Sulawesi that was discussed earlier. Diepart and Dupuis (2014) have presented case studies from Northwest Cambodia revealing how profit from cash crop production increases land values and develops the land market reinforcing land concentration within the village. Land concentration occurs when indebted smallholders sell and rent-out land to more enterprising farmers. This results in land-poor peasants who rely on agricultural wage labor as a source of income. The influx of new migrants simultaneously increases the pressure on land and decreases wage labor opportunities in the village. Marginalized families are forced to migrate to areas where demand for labor remains high. Land access change thus engenders a process of social differentiation and the polarization of households in relation to agricultural production.

Crucially our review of literature on land use change underscores the importance of upholding indigenous rights in the transition process. McAndrew and Oeur (2009) present case studies from Northeast Cambodia, including those from Dak Dam and Srae Preah communes, that show how the market economy, particularly the market for land, seriously erodes local governance structures and the communal solidarity of indigenous groups. Land sales are seen not only to diminish the natural resources required for sustainable livelihoods but also to debilitate cultural and social resources needed to deal with the exigencies of change itself. The authors argue that hill tribes who retain control over their communal land and forest resources are in a stronger position to adapt to the rapid and inevitable change brought by the market economy than those who do not. This requires that government policies, laws, and practices protect communal land rights and accommodate indigenous peoples in the development of the Northeast.

## Data collection methods

The original study was conducted in Dak Dam and Srae Preah communes in late 2002 and early 2003. Dak Dam commune is located in Ou Reang district 18 kilometers from Sen Monorum town, while Srae Preah commune is located in Keo Seima district and borders Kratie province (Figure 1). Dak Dam commune includes the three villages of Pou Less, Pou Chob, and Pou Antreng. For its part, Srae Preah commune contains the five villages of Pou Kong, Ochra, Pou Cha, Gati, and Srae Preah. In 2002 local officials maintained that Srae Ampil

village of contiguous Srae Khtum commune was about to be incorporated into Srae Preah commune and so Srae Ampil village was included in the original study. While the transfer never materialized, the researchers of the present study have continued to consider Srae Ampil village as a part of Srae Preah commune for comparative purposes.

The baseline study undertaken in 2002/03 and the present research conducted in 2012 employed mixed methods approaches: household surveys; key informant interviews; focus group discussions; participatory rural assessments (PRAs); and the use of secondary sources. The household survey conducted in 2012 incorporated the questions of the 2002/03 survey on livelihood strategies, earning sources and land transactions. The researchers followed the method used in the original survey and selected a random sample comprising 25 percent of households in each village of the two communes for interview. Household lists requested from the respective commune and village chiefs were validated and updated through a process that included drawing up spot maps to ensure on-the-ground verification. Table 1 presents the household samples and populations of the household surveys conducted in 2002/03 and 2012.

***Table 1:*** *Household (HH) samples and populations of household surveys, Dak Dam and Srae Preah communes, 2002/03 and 2012*

| | 2002/03 | | 2012 | |
|---|---|---|---|---|
| | HH Sample | HH Population | HH Sample | HH Population |
| Dak Dam | 65 | 257 | 85 | 316 |
| Srae Preah | 74 | 316 | 106 | 430 |
| Total | 139 | 573 | 191 | 746 |

In 2002/03 and 2012 Bunong interviewers were recruited and trained to conduct the household surveys. Of note, two of the Bunong researchers who participated in the 2002/03 survey comprised the core members of the five-person team that conducted the 2012 survey. The Bunong interviewers asked the survey questions primarily in the Bunong language and recorded the responses in Khmer. In both surveys the researchers computed the cash values of subsistence crops and products and then combined these with cash income obtained from goods sold and wages earned in the past year. This allowed them to use income as a proxy indicator for livelihood security. Income sources included those available from crop production, gathering and hunting, and those accessible from wage work and trade.

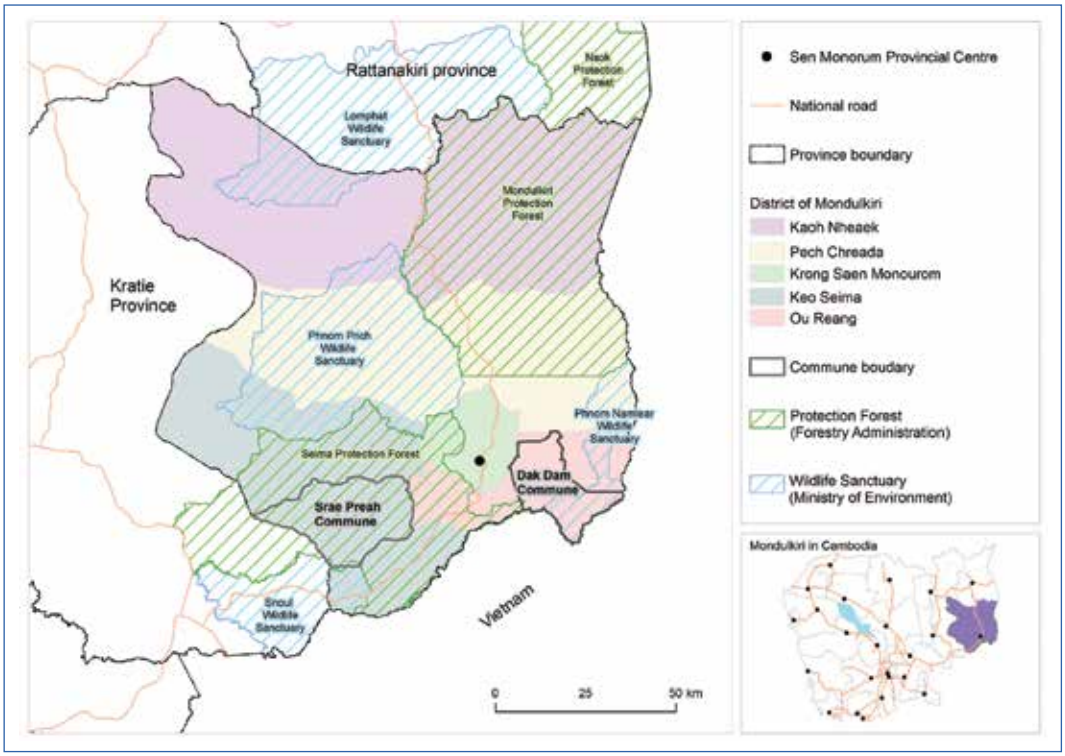


***Figure 1:*** *Dak Dam and Srae Preah communes, Mondulkiri province*

Cash values for wages earned and for profit realized from goods made and sold (e.g. rice wine, baskets and winnows) and from goods traded (e.g. livestock, resin and honey) were provided directly by the respondents. Average cash values for subsistence crops and products were determined through focus group discussions with key informants conducted in the villages of both communes. The average cash values were used to compute cash equivalents for the subsistence products and crops delineated by the respondents. These cash equivalents were then combined with actual cash earnings to estimate annual household incomes.[6] Fieldwork for the present study was conducted in Dak Dam and Srae Preah communes from January to May 2012. In December 2012 the World Bank provided the researchers with poverty line calculations that enabled them to stratify the household survey respondents into groups above and below the poverty line. In June 2013 the researchers returned to Dak Dam and Srae Preah communes and conducted follow-up key informant interviews with households from the various stratified income groups.

[6] While the emphasis was on net income earned it was not always possible to factor out costs of production

# FINDINGS AND ANALYSIS[7]

We argued in the introduction to this chapter that market integration in the two communes resulted in dispossession from land and forest resources, a reliance on cash crops, land commodification, land concentration, social differentiation and economic inequality. This section presents findings and analysis that support this argument. It starts with an overview of the land use changes that have taken place in Dak Dam and Srae Preah communes from 2003 to 2012. The focus then shifts to households in Dak Dam and Srae Preah communes and examines livelihood transitions from 2003 to 2012, differential earnings and land transactions in diverse income groups, and overall levels of poverty and inequality.

## Land use changes in Dak Dam and Srae Preah communes (2003-2012)

From 2003 to 2012 a major agricultural transition took place in the two communes as villagers moved from the cultivation of staple crops, mainly for subsistence, to the production of cash crops for the market (Fox et al. 2008). In Dak Dam commune the development of cassava as a cash crop took place primarily in Pou Antreng village. Of note, residents of Pou Chob and Pou Less villages also had upland farms in Pou Antreng village. In Srae Preah commune the development of cassava occurred mainly in Srae Preah and Pou Cha villages, while the development of cashew nut cultivation took place mostly in Gati and Srae Preah villages. In Srae Preah commune the expansion of paddy rice production took place mainly in Srae Ampil and Srae Preah villages (Figure 2). Srae Preah commune residents likewise cultivated upland and lowland farms outside of their own villages.

Parallel to the changes taking place in smallholder cultivation, the establishment of ELCs in the two communes from 2003 posed serious short- and long-term threats to indigenous access to land and forest resources. In Dak Dam commune the Chinese Wuzhishan L.S. Group in 2004 started to develop a 10,000 hectare pine tree plantation which adversely affected grazing areas and the expansion of indigenous farms (McAndrew and Oeur 2009). In 2010 the Chinese Huor Ling (Cambodia) International Insurance Company was granted a concession to develop an 8,400 hectare pine plantation that included areas accessed by Dak Dam residents. In 2012 the Malaysian Mega First Corporation Berhad was awarded a concession of 9,477 hectares in the Namlear Wildlife Sanctuary Zone within Dak Dam commune to develop a rubber plantation.

[7] A summary of the major study findings first appeared in So et al. 2012

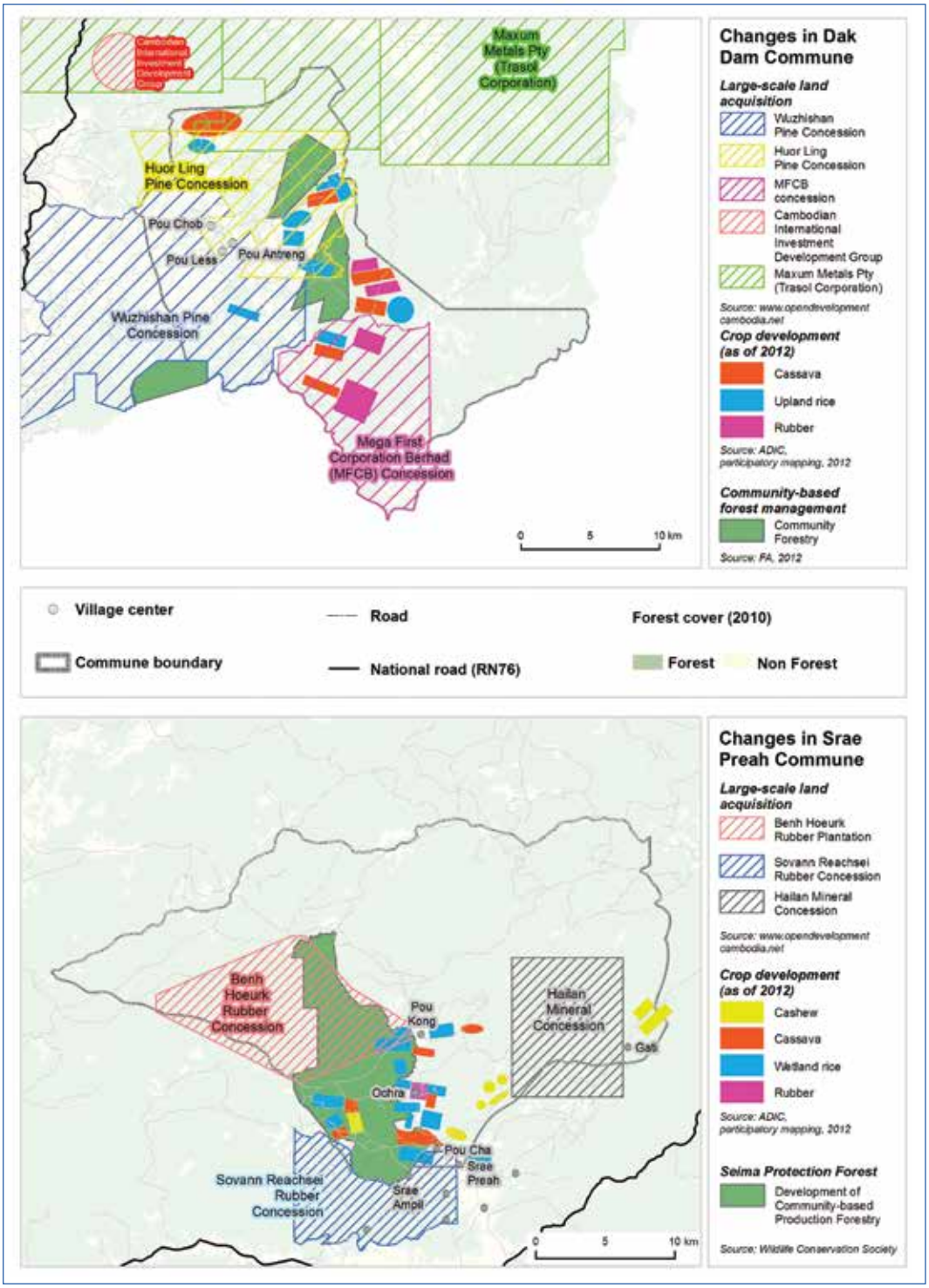


***Figure 2:*** *Land use changes in Dak Dam and Srae Preah communes (2003-2012)*

Note: *Crop development areas, derived from sketch mapping with local communities, indicate the approximate location and size of land use changes that have taken place*

In Srae Preah commune ELCs posed similar threats to indigenous access to land and forested areas. In 2011 the Sovann Reachsei Company was awarded a 6,525 hectare concession to develop a rubber plantation in the Snoul Wildlife Sanctuary. As part of its initial operations the company cut down an estimated 2,000 resin trees in Srae Ampil village. In 2011 the Vietnamese Benh Hoeurk Kratie Rubber 1 Company Limited was granted an 8,926 hectare concession to develop a rubber plantation within areas of Srae Preah commune which likewise contained resin trees tapped by villagers (Figure 2).

Corporate incursions resulting in resource dispossession in Dak Dam and Srae Preah communes were not limited to ELCs. Since 2003, mine exploration has likewise posed actual and potential threats to indigenous access to land and forest domains. As of 2012, mine exploration in Dak Dam and Srae Preah communes had occasioned some, albeit not major, dispossession for local inhabitants. However, as mineral prospecting proceeds from the initial grassroots and advanced exploration stages on to deposit and mine development, and the start of mine operations, more serious social and environmental impacts are inevitable (Eggert 2010).

From 2006 to 2009, BHP Billiton and Mitsubishi Corporation undertook mining exploration for bauxite in a 996 square kilometer area that included Dak Dam commune. In 2008 Dak Dam villagers, interviewed in an NGO study, mentioned loss of sacred land, and animals falling into exploration pits as issues arising from the company's mining activities (Beaumont 2008). In 2011 China's Mongolia Erdos Hongiun Holding Group and its local partner Cambodia International Investment Development Group started bauxite mining exploration in a 360 square kilometer area that covered lands in Dak Dam commune formerly under the BHP Billiton and Mitsubishi concession. The company's development plans included the establishment of an aluminum refinery. In 2011 The *Cambodia Daily* reported that more than 369 families in the three villages of Dak Dam commune had raised concerns about the mining project (Hul and Marks 2011). In 2010 Maxum Metal Pty Limited owned by Transol Corporation was granted licenses for mine exploration covering 821 square kilometers that included areas nearby Dak Dam commune (Figure 2).

In Srae Preah commune the Chinese Hai Lan Company in 2006 started to explore for gold in a 20 square kilometer area around Gati village and in 2009 announced that it would extend its exploration activities to the full 80 square kilometer area covered by its license into Pou Cha, Pou Kong and Ochra villages. As of 2010, the initial mining exploration in Gati village had already exerted some adverse effects on the livelihood security of indigenous households. These included a drop in the number of wildlife hunted and trapped, the reduction of resin and other products gathered from the forest, and a dip in fish catches (Analyzing Development Issues 2010). Subsequently, the Hai Lan concession was reportedly transferred to the Alumina Company, a Cambodia-Vietnam joint venture (Figure 2).

Corporate claims to land and forest resources in Dak Dam and Srae Preah communes did not go uncontested. In Dak Dam commune villagers working with the NGO My Village joined with the Forest Administration (FA) in 2008 to establish community forests in the villages of Pou Antreng (1,334 hectares), Pou Chob (904 hectares) and Pou Less (1,573 hectares). In

2009 a Prime Ministerial sub-decree created the 292,690 hectare Seima Protection Forest (SPF) which covered the entirety of Srae Preah commune. The SFP, managed by the FA with support from the NGO Wildlife Conservation Society, was known as the Seima Biodiversity Conservation Area (SBCA) from 2002 to 2009 before changing to its current name (Evans et al. 2013). A Community-based Production Forestry initiative was established within 12,000 hectares of the SPF buffer zone (Figure 2). A REDD (Reducing Emissions from Deforestation and forest Degradation) pilot project was also initiated in the SPF core zone (Evans et al. 2012). Amid these overarching land use developments, Dak Dam and Srae Preah households experienced changes in their livelihoods.



## Livelihood transitions in Dak Dam and Srae Preah communes

The shift from the cultivation of staple crops for subsistence to the production of cash crops for the market led to a reliance on cash crops in Dak Dam and Srae Preah communes. Meanwhile the loss of forest resources led to a diminished reliance on forest products in both communes (Fox et al. 2008, Taylor 2011). We present here the livelihood transitions that took place separately in each commune and then discuss the comparative pathways pursued by households in the two communes.

### Dak Dam commune

Cash values of household income in Dak Dam commune from 2003 to 2012 reveal important changes taking place within the local economy (Table 2).[8] Of major significance, the average annual household incomes of the sample groups increased 3.4 times from 1,871,631 riels (USD 468) in 2003 to 6,312,832 riels (USD 1,578) in 2012.[9] Economic growth in Dak Dam commune was due mainly to earnings derived from cash crop production of cassava on upland farms and from wage work principally from agricultural labor on small farms within the commune. High inflation rates during the interim years likewise contributed to the high income increase. Earnings from upland crops increased from 24.8 percent of overall household income in 2003 to 38.4 percent in 2012. Earnings from cassava production alone accounted for 22.9 percent of total household income in 2012. Similarly, earnings from wage work rose from 8.6 percent in 2003 to 20 percent in 2012. Gains in wage work resulted primarily from indigenous involvement in agricultural labor in cutting and clearing upland farms and planting and harvesting rice and cash crops.

While the proportional numbers of sample households cultivating upland farms in Dak Dam commune dropped slightly from 2003 to 2012, the absolute numbers did not. In 2003, 64 sample households cultivated upland parcels that averaged 1.3 hectares. By comparison, in

[8] As explained earlier under data collection methods, cash values of household income include the economic valuation of non-cash crops and products as well as actual cash earnings

[9] In constant 2003 prices the 2012 average household income in Dak Dam commune equaled 3,527,511 riels (USD 882) or 1.9 times that of 2003. The conversion rate of 2012 income to constant 2003 prices is made at 149.624/83.606 equals 178.96/100 based on the IMF website: world-economic-outlook.findthedata.org/1/934/Cambodia

2012, 80 sample households cultivated upland parcels that likewise averaged 1.3 hectares. These figures point to an expansion of upland areas under cultivation, likely resulting from the extended cultivation of cassava. Notably, the expansion of farmlands did not translate into an even distribution of farm sizes. Among the 80 upland cultivators surveyed in 2012, 23 percent cultivated an average 0.5 hectare, 56 percent cultivated an average 1 hectare, and 21 percent cultivated an average 2.9 hectares.

***Table 2:*** *Average cash values of household income in past year,* Dak Dam commune, 2003 and in 2012 (in riels)***

| | 2003 | | | 2012 | | | |
|---|---|---|---|---|---|---|---|
| Strategy | Percent of house-holds earning from source | Average total income in riels | Percent of average total income | Percent of house-holds earning from source | Average total income in riels | Average total income at constant 2003 prices in riels*** | Percent of total average income |
| Upland crops (total) | 98 | 464,877 | 24.8 | 94 | 2,425,270 | 1,355,202 | 38.4 |
| Upland rice | 97 | (193,292) | (10.3) | 76 | (371,265) | (207,457) | (5.9) |
| Upland crops (other than rice) | 98 | (271,585) | (14.5) | 94 | (2,054,005) | (1,147,745) | (32.5) |
| Cassava | 83 | **** | **** | 80 | (1,444,172) | (806,980) | (22.9) |
| Cashew nut | 15 | **** | **** | 11 | (3,176) | (1,775) | (0.05) |
| Wet land (paddy) rice | 5 | 4,615 | 0.2 | 2 | 53,235 | 29,747 | 0.8 |
| Pigs raised | 91 | 242,308 | 12.9 | 58 | 377,459 | 210,918 | 6.0 |
| Chickens raised | 97 | 65,077 | 3.5 | 64 | 99,247 | 55,458 | 1.6 |
| Ducks raised | 34 | 7,692 | 0.4 | 19 | 12,647 | 7,067 | 0.2 |
| Food gathered from the forest | 92 | 46,769 | 2.5 | 93 | 190,691 | 106,555 | 3.0 |
| Other products gathered from the forest | 88 | 252,376 | 13.5 | 98 | 856,175 | 478,417 | 13.6 |
| Liquid resin | 15 | (34,415) | (1.8) | 1 | ( 635) | (355) | (0.0) |
| Animals hunted or trapped | 69 | 527,405 | 28.2 | 62 | 576,486 | 322,131 | 9.1 |
| Fish caught | 92 | 32,412 | 1.7 | 79 | 69,494 | 38,832 | 1.1 |
| Goods made and sold | 43 | 40,708 | 2.2 | 31 | 98,082 | 54,807 | 1.6 |
| Goods bought and sold | 14 | 26,069 | 1.4 | 13 | 141,176 | 78,887 | 2.2 |
| Wage work | 55 | 161,323 | 8.6 | 88 | 1,265,529 | 707,157 | 20.0 |
| Remittanc-es***** | **** | **** | **** | 5 | 147,341 | 82,332 | 2.3 |
| **Total** | | **1,871,631** | **99.9** | | **6,312,832** | **3,527,510** | **99.9** |
| | N=65 | | | N=85 | | | |

*Figures are averaged across the total commune sample, and not only across the households earning from the particular source
**4,000 riels equal one US dollar
*** Conversion rate of 2012 income to constant 2003 prices is made at 149.624/83.606 equals 178.96/100
****Data not available
***** From children and relatives not considered as household members

The proportionate increase in the cash value of upland crops is particularly notable because it was accompanied by a proportionate decline in the cash value of upland rice.[10] From 2003 to 2012, the cash value of upland rice production decreased from 10.3 percent to 5.9 percent of total household income. This resulted from the low productivity of upland rice cultivation and the proportionate decline in household upland rice cultivators. Moreover, the cash values of upland rice and upland crops (other than rice, cashew nuts and cassava) were much lower than that of cassava. In 2012, in Dak Dam commune the average cash value of upland rice for the 65 upland rice cultivators surveyed was 485,500 riels, the average cash value of upland crops (other than rice, cashew nuts and cassava) for the 77 upland cultivators of these crops surveyed was 669,681 riels, and the average cash value of cassava production for the 68 cassava cultivators surveyed was 1,805,221 riels.

Clearly, high cash returns provided Dak Dam households with an incentive to adopt and expand the cultivation of cassava on their upland farms; an incentive that was reinforced by middlemen who actively promoted cassava cultivation in the commune. At the same time the pursuit of this pathway left households vulnerable to the exigencies of the cassava market. The story of Srem Poeun and Veang Nak illustrates a better-off household in Dak Dam commune and indicates the better returns gleaned from the cultivation of fruits and cassava on their 2 hectare upland farm than from rice (Box 1). By contrast, the story of Keng Klok and Tok An shows a very poor household in Dak Dam commune who devote a major portion of their 1 hectare upland farm to rice cultivation and suffer recurrent food shortages (Box 2).

Household earnings from wetland or paddy rice production were negligible in 2003 and remained so in 2012. Dak Dam commune is located in an area of rolling hills that makes it difficult to convert lands into paddy rice fields and to control the downward flow of water into catchment areas. Earning shares from pig-, chicken- and duck-raising each declined by half or more than half in the same years. Pig- and chicken-raising provided households with food to eat on special occasions as well as products easily sold or bartered for other goods. Diminished involvement of households in these pursuits revealed a broadening of opportunities to earn cash income for buying food and consumer goods.

[10] The method for determining cash values of subsistence crops and products is explained under data collection methods

***Box 1:*** *The story of Srem Poeun and Veang Nak*
*A better-off household from Pou Less village, Dak Dam commune*

Srem Poeun and her husband Veang Nak live in Pou Less village, Dak Dam commune. The indigenous Bunong couple were married in 2007 and, at the time of the study, their son was four years old. In 2012 Poeun was 26 years old and Nak was 31years old. Poeun had not attended school but had completed Khmer literacy classes. Nak had completed grade 12.

The couple had ownership rights to 3 hectares of upland. They did not have rights to wetland. In the five years prior to 2012 they had sold rights to 1 hectare of upland and cleared 1 hectare of forest land. In the 2011/2012 crop season Poeun and Nak cultivated 2 hectares of their upland farm. The couple used a large portion of the farm to plant fruit trees and cassava and only a small portion for upland rice. The couple started to cultivate cassava in 2009 as the farm price for the cash crop rose and other villagers began to adopt it. Traders now came into the village to buy cassava and even transported bulk harvests directly from upland farms to the market.

In 2012 Poeun and Nak earned about 55 percent of their household income from upland cultivation. Specifically, about 34 percent of their household income came from the cultivation of fruit, mainly mangos, avocados and durians. Another 20 percent came from cassava production and only one percent from growing upland rice. In 2012 the couple's yearly household earnings from fruits and vegetables amounted to 3,947,500 riels (USD 912), their earnings from cassava amounted to 2,250,000 riels (USD 563), and their income from upland rice amounted to 130,000 riels (USD 33). In 2012 the couple also earned supplementary household income, about 9 percent of their total income, from raising pigs and chickens. However, rising costs incurred for treating pig and chicken diseases had reduced earnings and made this pursuit less attractive.

In 2012 Poeun and Nak earned about 19 percent of their household income from gathering forest food such as mushrooms and bamboo shoots and from gathering other forest products such as gum resin, honey, thatch and medicinal plants. The couple also earned about 10 percent of their yearly income from agricultural labor although in recent years their involvement in wage work and exchange labor had decreased. In addition, the couple operated a small store that sold small grocery items and rice wine. Buying goods from the market to sell in the village was made easier with the motorbike they had purchased from their cassava earnings. In 2012 the couple earned an estimated yearly income of 11,475,300 riels (USD 2,869). The average daily per capita income of this household of three was 10,480 riels (USD 2.6).

Somewhat unexpectedly, household income from gathering food and other products from the forest remained proportionally the same in the nine-year interval, although households gathered food and forest products less frequently. This underscored the continuing importance of forest resources particularly bamboo shoots and fuel wood for supporting subsistence in household livelihoods. Meanwhile earnings from hunting and trapping as a share of overall household income fell from 28.2 percent in 2003 to 9.1 percent in 2012. However, the cash value of animals hunted and trapped in absolute amounts was higher in 2012 than in 2003, which indicated that a market for wildlife still existed in and around Dak Dam commune. Fishing by sample households was mainly for home consumption and the cash values of fish caught in both 2003 and in 2012 were small. Household frequency of hunting and trapping and fishing also declined from 2003 to 2012.

Earnings from goods made and sold, and goods bought and sold, likewise remained small in the nine-year period. While some indigenous households opened up small grocery stores in Dak Dam commune they were generally not as successful as their Khmer counterparts. The indigenous storekeepers often lacked sufficient capital and the business skills to maintain the viability of their stores. The story of Srem Poeun and Veang Nak highlights a better-off household in Dak Dam commune who rely on forest food and other products for less than one-fifth of their income. The household members also supplement their income through working as operators of a small grocery store and as agricultural laborers (Box 1). By comparison, the story of Keng Klok and Tok An demonstrates a very poor household in Dak Dam commune who rely on forest food and other products for more than one-fourth of their income. The household members further supplement their income by working as occasional agricultural laborers (Box 2).

Dak Dam household income shares by source illuminate the major shifts taking place in commune livelihoods from 2003 to 2012. The share of household income from cultivating crops rose from 25 percent in 2003 to 39 percent in 2012. Similarly, income from wage work and remittances increased from only 8 percent in 2003 to 22 percent in 2012. By contrast, income from forest products, hunting and trapping fell from 44 per cent in 2003 to 26 percent in 2012, while earnings from pig- and poultry- raising dropped from 17 per cent in 2003 to 8 percent in 2012 (Figure 3). Overall, the expansion of the market economy in Dak Dam commune encouraged a shift away from subsistence upland agriculture to cash crop production of cassava. The labor demands in cassava cultivation likewise brought about increased agricultural labor opportunities. With greater access to cash from cassava production, households became less involved in pig- and poultry-raising. Stronger conservation measures enacted by the Forest Administration and diminished availability of wildlife also reduced household shares of income from hunting and trapping. The incursions of ELCs and mine exploration likewise restricted access to forest resources.

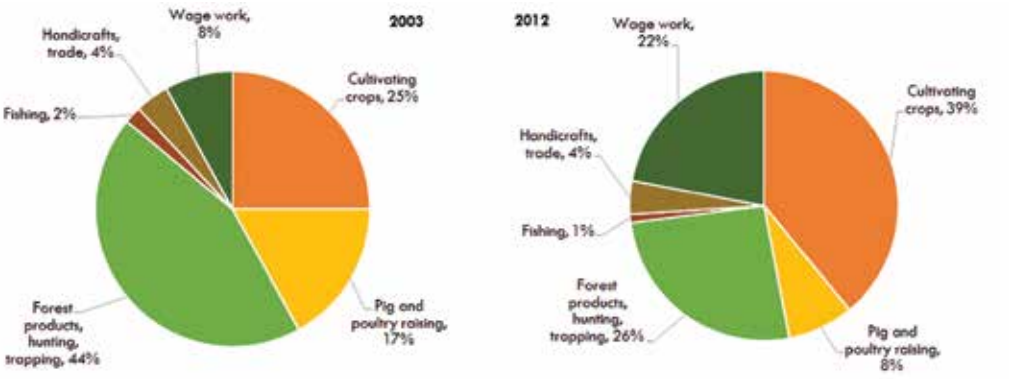


***Figure 3:*** *Dak Dam household income shares by source 2003 and 2012*

***Box 2:*** *The story of Keng Klok and Tok An*

*A very poor household from Pou Antreng village, Dak Dam commune*

Keng Klok and his wife Tok An live in Pou Antreng village, Dak Dam commune. The indigenous Bunong couple were married in 2002 and have four young children. In 2012 Klok was 37 years old and An was 34 years old. Klok had completed two years of school. An had never attended school.

In 2012 Klok and An had ownership rights to 1 hectare of upland which Klok had cleared from the forest. The upland farm was surrounded by the Wuzhishan pine plantation and a community forest and could not be expanded further. Klok's parents had died before his marriage and Klok had lived with his brother and sisters. When he left the family home to marry, he did not receive any land inheritance from his siblings. Nevertheless, Klok still sought support from his siblings in times of need. Klok and An had not bought or sold any land in the five years prior to 2012.

In the 2011/2012 crop season Klok and An cultivated their 1 hectare upland farm without help from their children. Indeed Klok did the bulk of the work because An tired easily and required long rests as the result of a prolonged illness. For years Klok and An had produced upland rice and vegetables such as chili, corn, string beans and gourds on their upland farm. More recently the couple had started to cultivate cassava as a cash crop. As the price of cassava increased, Klok planned to rent upland from others to augment their production of cassava. At the same time he was determined to continue the cultivation of upland rice on their own farm in keeping with the traditions of their ancestors.

In 2012 the couple earned 63 percent of their household income from upland farming - 17 percent from upland rice, 23 percent from cassava, and 23 percent from vegetable and fruit crops. In 2012 the couple's earnings from upland rice amounted to 364,000 riels (USD 91), their earnings from cassava amounted to 500,000 riels

(USD 125), and their earnings from vegetables and fruits amounted to 487,500 riels (USD 121).

Due to the small size of their upland farm and relatively low yields, the household suffered recurrent food shortages. At times the family was able to eat only once a day. To supplement the household earnings Klok gathered forest food such as bamboo shoots, mushrooms and vegetables. He likewise gathered forest products such as gum resin, honey, thatch and rattan. In 2012, the household earned 28 percent of their yearly income from gathering food and other products from the forest. Klok and An had also worked as agricultural laborers on the upland farms of Khmer migrants clearing forest lands, planting, and weeding cassava. In recent years wage work from clearing forest lands had declined as upland areas had become more circumscribed. In 2012 the couple earned an estimated annual income of 2,145,500 riels (USD 536). The average daily per capita income of this household of six was 980 riels (less than 25 cents).



## Srae Preah commune

Cash values of household income in Srae Preah commune from 2003 to 2012 similarly point to major shifts occurring within the local economy (Table 3). Strikingly, average annual household incomes of the sample groups increased 4.8 times from 2,114,125 riels (USD 529) in 2003 to 10,169,218 riels (USD 2,542) in 2012.[11] Economic growth in Srae Preah commune was due principally to earnings derived from cash crop production of cassava and cashew nuts on upland farms. High inflation rates during the interval years also contributed to the high income increase.

From 2003 to 2012 the number of Srae Preah sample households cultivating upland farms in the last crop season increased as did the average size of their upland plots. In 2003, the average plot size of the 61 upland household cultivators surveyed was 0.7 hectares. In 2012 the average plot size of the 97 upland household cultivators surveyed was 1.8 hectares. These figures point to an expansion of upland areas under cultivation, which is the likely consequence of expanded household production of cassava and cashew nuts. At the same time, in 2012, the upland farm sizes of the household cultivators varied considerably. Among the 97 upland cultivators surveyed 12 percent cultivated an average 0.5 hectare, 40 percent cultivated an average 1.0 hectare, and 47 percent cultivated an average 2.8 hectares.

[11] In constant 2003 prices the 2012 average household income in Srae Preah commune equaled 5,682,398 riels (USD 1,421) or 2.7 times that of 2003. See footnote 9 for an explanation of how the conversion rate was made

***Table 3:*** *Average cash values of household income in past year,* Srae Preah commune, 2003 and in 2012 (in riels)***

| | **2003** | | | **2012** | | | |
|---|---|---|---|---|---|---|---|
| Strategy | Percent of house-holds earning from source | Average total income in riels | Percent of average total income | Percent of house-holds earning from source | Average total income in riels | Average total income at constant 2003 prices in riels*** | Percent of total average income |
| Upland crops (total) | 82 | 248,802 | 11.8 | 92 | 3,550,342 | 1,983,875 | 34.9 |
| Upland rice | 68 | (87,986) | (4.2) | 36 | (270,632) | (151,225) | (2.7) |
| Upland crops (other than rice) | 82 | (160,816) | (7.6) | 92 | (3,279,710) | (1,832,650) | (32.3) |
| Cassava | 32 | **** | **** | 66 | (1,996,226) | (1,115,459) | (19.6) |
| Cashew nut | 15 | **** | **** | 48 | (729,764) | (407,792) | (7.2) |
| Wet land (paddy) rice | 58 | 259,297 | 12.3 | 61 | 1,665,759 | 930,800 | 16.4 |
| Pigs raised | 73 | 211,149 | 10.0 | 57 | 285,896 | 159,754 | 2.8 |
| Chickens raised | 92 | 58,784 | 2.8 | 82 | 114,547 | 64,007 | 1.1 |
| Ducks raised | 14 | 2,567 | 0.1 | 14 | 13,160 | 7,354 | 0.1 |
| Food gathered from the forest | 93 | 42,239 | 2.0 | 92 | 130,980 | 73,189 | 1.3 |
| Other products gathered from the forest | 96 | 870,799 | 41.2 | 98 | 2,303,842 | 1,287,350 | 22.7 |
| Liquid resin | 85 | (600,845) | (28.4) | 46 | (411,415) | (229,892) | (4.0) |
| Animals hunted or trapped | 70 | 133,755 | 6.3 | 74 | 774,730 | 432,907 | 7.6 |
| Fish caught | 93 | 51,342 | 2.4 | 82 | 247,325 | 138,201 | 2.4 |
| Goods made and sold | 31 | 35,270 | 1.7 | 19 | 28,491 | 15,920 | 0.3 |
| Goods bought and sold | 18 | 67,635 | 3.2 | 9 | 227,146 | 126,926 | 2.2 |
| Wage work | 42 | 132,486 | 6.3 | 66 | 814,453 | 455,103 | 8.0 |
| Remittances***** | **** | **** | **** | 5 | 12,547 | 7,011 | 0.1 |
| Total | | 2,114,125 | 100.1 | | 10,169,218 | 5,682,397 | 99.9 |
| | N=74 | | | N=106 | | | |

*Figures are averaged across the total commune sample, and not only across the households earning from the particular source

**4,000 riels equal one US dollar

*** Conversion rate of 2012 income to constant 2003 prices is made at 149.624/83.606 equals 178.96/100

**** Data not available

***** From children and relatives not considered as household members

Earnings from upland crops as a part of overall household income increased from 11.8 percent in 2003 to 34.9 percent in 2012. Earnings from cassava and cashew nut production alone accounted for 26.8 percent of total household income in 2012. However, from 2003 to 2012, the cash value of upland rice as a proportion of total average income decreased. Meanwhile paddy rice yields increased from 1.2 tonnes per hectare in 2003 to 1.86 tonnes per hectare in 2012 due to the adoption of high-yielding rice varieties. As a consequence of this increased productivity and the expansion of wetland rice farms, from 2003 to 2012 the cash value of paddy rice as a proportion of total average earnings increased. This made paddy rice cultivators less vulnerable to the volatility of the cash crop markets.

The story of Kreun Khan and Svay Sok depicts the prosperity of a better-off household in Srae Preah commune, which combines agricultural earnings from cassava and cashew nut production on 3 hectares of upland with agricultural earnings from wetland rice production on 3 hectares of paddy rice land (Box 3). By comparison, the story of Ngok Senh and Chet Heurt portrays the struggles of a very poor household in Srae Preah commune who derive agricultural earnings solely from the cultivation of a 1 hectare parcel of paddy rice land (Box 4).

***Box 3:*** *The story of Kreun Khan and Svay Sok*
*A better-off household from Pou Cha village, Srae Preah commune*

Kreun Khan and his wife Svay Sok live in Pou Cha village, Srae Preah commune. In 2012 Khan was 65 years old and Sok was 62 years old. The indigenous Bunong couple had seven married children. Their youngest daughter, her husband and their three children lived as a separate household in the house of her parents.

In 2012 Khan and Sok had ownership rights to 3 hectares of upland and 3 hectares of paddy rice land. In the five years prior to 2012 they had not bought, sold or cleared any upland or wetland. They had, however, transferred upland parcels to their children. Khan maintained that there was no more land available in the area for the expansion of upland or wetland farms.

For years Khan used his upland farm to cultivate rice and vegetables such as pumpkins, cucumbers and gourds. He also plowed his paddy rice fields with buffaloes and used traditional rice varieties. Khan maintained that their family always had sufficient food to eat and enough to share with other people in need.

In recent years Khan and Sok stopped growing upland rice and started to cultivate cash crops such as cashew nuts and cassava. They retained some upland plots, though, to grow vegetables. In 2007 the couple bought a hand tractor for the plowing of their paddy rice fields. Similarly, they adopted high yielding rice varieties that could be harvested in six months. The elderly couple now did less work on their upland and wetland farms although they still transplanted and harvested rice. To meet their labor

needs the couple hired their children, and sometimes others, as wage workers to help with the plowing, transplanting and weeding.

In 2012 Khan and Sok earned about 77 percent of their household income from upland and wetland cultivation. Specifically, 31 percent of these earnings came from cassava production, 19 percent came from cashew nut production, 6 percent came from vegetable production, and 21 percent came from paddy rice production. In 2012 the couple's estimated earnings from cassava production amounted to 4,000,000 riels (USD 1,000), their earnings from cashew nut production amounted to 2,500,000 riel (USD 625), their vegetable production amounted to 727,000 riel (USD 182), and their paddy rice production amounted to 2,700,000 riels (USD 675).

In 2012 the couple raised pigs and chickens to supplement their earnings. They also gathered forest food such as mushrooms and leafy green vegetables and other forest products such as bamboo for making baskets for home use. Khan hunted and trapped wildlife such as squirrels, civet cats, rabbits and wild pigs near his upland farm and sold some of the meat to others. Khan also caught fish for home consumption. In 2012 the couple's estimated yearly household income amounted to 12,993,000 riels (USD 3,248). The average daily per capita income of this household of two was 17,799 riels (USD 4.4).

Earning shares from pig-raising declined from 2003 to 2012, as did earning shares from chicken-raising albeit less sharply. Overall, household pig- and poultry-raising remained an integral feature of Srae Preah household earning activities although their decline signaled a transition from subsistence activities to more market-oriented pursuits.

In 2003 food and other products gathered from the forest accounted for 43.2 percent of total household income. This underscored the reliance of Srae Preah households on forest resources for their livelihoods. By contrast, in 2012 food and other products gathered from the forest accounted for only 24 percent of total household income. The diminished reliance on forest resources was largely the result of a rapid decline in liquid resin tapping as a major source of household earnings. Resin trees in several Srae Preah villages were over-tapped and unproductive in 2012. In Srae Ampil village alone an estimated 2,000 resin trees were cut down in 2011 by the Sovann Reachsei rubber company under an ELC. Remarkably, total household income from the collection of liquid resin plummeted from 28.4 percent in 2003 to only 4.0 percent in 2012. As a consequence, Srae Preah households no longer had a strong incentive to protect the forest and resin trees, and the trade in illegal timber came to flourish throughout the commune. Indeed many Srae Preah households, including resin tappers, were actively involved in the illegal timber trade.[12]

[12] While an attempt was made to determine earnings from timber sales in the household survey, anecdotal evidence from key informant interviews indicates that these earnings were generally not acknowledged by households involved in the illegal timber trade

Of note, from 2003 to 2012, the proportionate cash value for animals hunted or trapped increased slightly. A perception among some households was that the cutting and clearing of forest areas by companies in neighboring areas had decreased the habitat of wildlife making them more accessible to Srae Preah hunters and trappers. However, diminished habitats would ultimately have consequences for wildlife populations. At the same time the proportionate cash value for fish caught in these years remained constant. For the Srae Preah households fishing was mainly a subsistence activity that supplemented household diets with an important source of protein. Within the broader shift from subsistence to market-oriented activities fishing endured at least for the moment as a crucial aspect of household livelihood strategies.

Earnings from goods made and sold, and goods bought and sold, were rather negligible in 2003 and even more so in 2012 despite the further expansion of the market economy. The inability of indigenous households to take advantage of opportunities opening up in the buying and selling of goods involved such factors as lack of access to capital, a dearth of business skills, and indigenous traditions of sharing and exchange which discouraged profit-making. In general Khmer and Vietnamese traders dominated small-scale entrepreneurial activities in Srae Preah commune in 2012. This points to the exclusionary effects of market integration that made it difficult for indigenous households to succeed as entrepreneurs and traders.

***Box 4:*** *The story of Ngok Senh and Chet Heurt*
*A very poor household from Srae Ampil village, Srae Preah commune*

Ngok Senh and her husband Chet Heurt live in Srae Ampil village, Srae Preah commune. At the time of the study, the indigenous Bunong couple had five children ranging in age from 4 to 13 years old. In 2012 Senh was 36 years old and Heurt was 33 years old. Neither Senh nor Heurt had attended school. While Senh was native to Srae Ampil village, Heurt was originally from nearby Snoul district in Kratie province. From the time of her marriage Senh had ownership rights to 2 hectares of her family's wetland or paddy rice land. In the five years prior to 2012 Senh and her husband had not bought or sold any upland or wetland. They had cleared 1 hectare of forest land. In the 2011/2012 crop season Senh did not cultivate their upland. The main reason for this was that she could not rely on her husband to prepare the upland plots. She also lacked vegetable seeds.

As a consequence of leaving their upland uncultivated, Senh and Heurt relied entirely on the cultivation of their paddy rice farm for agricultural production. For several years after their marriage Senh and Heurt plowed the paddy fields with water buffaloes. At that time the couple were able to rely on their own labor and that of their draft animals. But when the draft animals died of disease the couple were forced to contract operators and hand tractors to prepare their paddy rice lands. In 2012 in Srae Ampil village it cost 400,000 riels (USD 100) to hire an operator and hand tractor to prepare 1 hectare of wetland.

In the 2011/2012 crop season Senh and Heurt cultivated only 1 hectare of their 2 hectare paddy rice farm. They hired an operator and hand tractor to do the plowing and harrowing. They likewise incurred costs for pesticide and fertilizer. The couple relied on their own labor and that of their eldest child to prepare the dikes, and to do the sowing, weeding and harvesting. As a result, their eldest child was frequently absent from school. Often Senh arrived late from the fields to cook rice for the younger children. In 2012 the couple earned nearly 40 percent of their household income from paddy rice production. In 2012 their earnings from paddy rice amounted to 1,440,000 riels (USD 360).

In 2012 Senh and Heurt earned 34 per cent of their household income from gathering forest food and other forest products and from hunting and trapping wildlife. Senh collected bamboo shoots, green leafy vegetables, and mushrooms. She also collected gum resin, fuel wood, vines and medicinal plants. Heurt hunted and trapped squirrels, frogs, monitor lizards, rabbits, snakes and mouse deer. Senh and Heurt use to collect liquid resin from their resin trees in the surrounding forest. However, in 2010 these trees and those of other villagers were cut down by a rubber company. Despite the complaints of the resin tappers, the company paid no compensation for the loss of the trees.

Senh and Heurt also earned daily wages as agricultural laborers helping others in the village to plant and weed cassava. In 2012 the couple earned 16 percent of their household income from wage work. In 2012 the couple's estimated annual household income amounted to 3,736,000 riels (USD 934). The average per capita daily income of this household of seven was 1,462 riels (less than 40 cents).

Earnings from wage work as a share of total income increased only slightly - from 6.3 percent in 2003 to 8.0 percent in 2012. In 2012, two-thirds of households earned from wage work mainly in the form of agricultural labor. In the nine-year period, households had not come to rely on wage work as a major source of their income. Rather, the generation of wealth from cassava and cashew nut production, amidst the decline of resin tapping, stood out prominently as the major feature of Srae Preah household earning sources from 2003 to 2012.

The story of Kreun Khan and Svay Sok illustrates the situation of a better-off household in Srae Preah commune who earn more than three-fourths of their income from agricultural production and need only to supplement their livelihood with other earning activities (Box 3). By contrast, the story of Ngok Senh and Chet Heurt represents a very poor household in Srae Preah commune who earn only two-fifths of their income from agricultural production and need to gather forest food and other products, hunt and fish, and work as agricultural laborers to ensure their subsistence (Box 4).

Srae Preah household income shares by source highlight the major shifts taking place in commune livelihoods from 2003 to 2012. In 2003 households made nearly one-half of their income from forest products and hunting and trapping. By 2012 earnings from this source constituted less than one-third of their income. Conversely, in 2003 households earned less than one-fourth of their income from cultivating crops. By 2012 earnings from this source made up more than one-half of their income. Less prominently, shares from pig- and poultry-raising dropped from 2003 to 2012, while shares from wage work rose slightly (Figure 4).

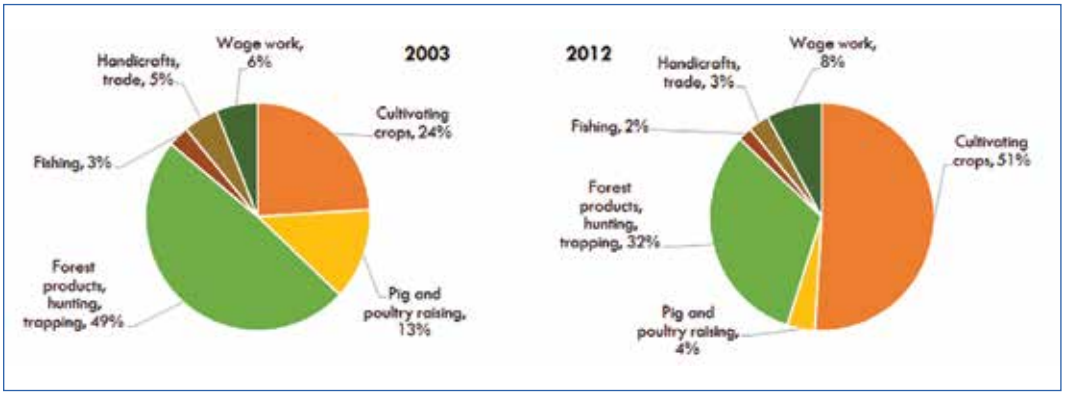


***Figure 4:*** *Srae Preah household income shares by source, 2003 and 2012*

Overall, the expansion of the market economy in Srae Preah commune precipitated a shift away from upland subsistence agriculture to increased wetland cultivation and the production of upland cash crops for the market. It likewise reduced involvement in pig- and poultry-raising. The expansion of ELCs and mine exploration diminished household reliance on forest resources, particularly liquid resin. Although opportunities for wage work increased, jobs were generally seasonal, local and low paying.

## Discussion

In Dak Dam and Srae Preah communes the principal livelihood transition to emerge from 2003 to 2012 was the shift away from the reliance on forest products, hunting and trapping to the cultivation of cash crops such as cassava and cashew nuts for the market. This resulted in more households being involved in upland farming and the expansion of upland areas under cultivation. That noted, in 2012 upland farm sizes varied greatly among cultivators suggesting that households in each commune benefited unequally from the cash crop market. As upland farmers converted more land to cash crops, upland rice cultivation declined in both communes. In Srae Preah commune wetland rice production, rice productivity and earnings increased, while wetland rice production in Dak Dam remained negligible. The low-land areas of Srae Preah commune were suitable for paddy rice farming, while the rolling hills of Dak Dam commune were not. Households who engaged in wage work rose noticeably in both communes, due mainly to expanded agricultural labor opportunities in cutting and clearing upland farms and planting and harvesting rice and cash crops. However, the proportional increase of earnings from wage work was much higher in Dak Dam than in

Srae Preah. Households in Dak Dam earned proportionally less from agricultural production than did households in Srae Preah, and relied more on agricultural labor to supplement their earnings. Of note, while indigenous households in Dak Dam worked on the upland farms of Khmer migrants, in Srae Preah Khmer migrants worked on the upland farms of indigenous households.

## Differential earnings in diverse income groups in Dak Dam and Srae Preah communes

The literature on land use change reviewed above reveals how the expansion of the market economy accelerates land commodification, land concentration and social differentiation among village households (Li 2012, Diepart and Dupuis 2014, Milne 2013). We examine here differential earnings in 2012 in four income groups (very poor, poor, above-poor and better-off) and explore how the pursuit of cash crop production leads to land concentration and social differentiation among households in the two communes.[13] We present findings from each commune separately and then discuss the comparative experiences of market integration in the two communes.

### Dak Dam commune

Overall income disparities in Dak Dam commune between the very poor and better-off households are pronounced, and even those between the very poor and poor households are noticeable (Table 4). Comparatively, income inequalities between the poor and above-poor households are less prominent.[14] Of note, the average annual income of the nine Khmer households (i.e. households where both the husband and wife were Khmer) in the sample was 12,661,444 riels (about USD 3,165). This was more than double the average annual income of the 76 indigenous and mixed indigenous households in the sample at 5,561,065 riels (about USD 1,390). This difference was due mainly to the Khmer households' higher average earnings from cassava production.

[13] See the asterisked footnote (**) in Table 4 for an explanation of how the household categories were defined

[14] Income inequality likewise existed among Dak Dam sample households in 2003: 17 households had annual incomes of less than 1 million riels, 23 households had annual incomes of from 1 million riels to 1.99 million riels, 14 had annual incomes of from 2 million riels to 2.99 million riels, and 11 had annual incomes of 3 million riels or more (McAndrew et al. 2003)

***Table 4:*** *Percent of average cash values*of household income in past year by type of household*, Dak Dam commune, 2012 ***

| | Very poor households | Poor house-holds | Above-poor households | Better-off households |
|---|---|---|---|---|
| Strategy | Percent | Percent | Percent | Percent |
| Upland crops (total) | 38.5 | 35.8 | 31.0 | 49.1 |
| Upland rice | (12.5) | (7.3) | (4.3) | (3.3) |
| Upland crops (other than rice) | (26.0) | (28.4) | (26.7) | (45.8) |
| Cassava | (13.9) | (18.3) | (16.2) | (38.5) |
| Cashew nut | (0) | (0.1) | (0.0) | (0) |
| Wet land (paddy) rice | 0 | 0 | 2.9 | 0 |
| Pigs raised | 3.2 | 5.9 | 5.5 | 7.7 |
| Chickens raised | 1.6 | 1.4 | 1.6 | 1.7 |
| Ducks raised | 0.1 | 0.2 | 0.4 | 0.1 |
| Food gathered from the forest | 5.2 | 4.3 | 2.5 | 1.2 |
| Other products gathered from the forest | 21.4 | 17.1 | 13.0 | 7.0 |
| Liquid resin | (0) | (0) | (0.0) | (0) |
| Animals hunted or trapped | 11.3 | 6.9 | 12.5 | 7.3 |
| Fish caught | 1.8 | 1.4 | 1.2 | 0.4 |
| Goods made and sold | 2.6 | 0.5 | 1.5 | 2.4 |
| Goods bought and sold | 1.2 | 0.4 | 2.6 | 4.4 |
| Wage work | 13.0 | 25.8 | 25.4 | 10.8 |
| Remittances from children and relatives not considered as household members | 0 | 0.3 | 0 | 8.0 |
| **Total percent** | 99.9 | 100.0 | 100.1 | 100.1 |
| **Total average cash value in riels** | 2,826,893 | 5,059,925 | 6,719,159 | 21,521,150 |
| | N=21 | N=34 | N=23 | N=7 |

*Cash values in riels. 4,000 riels equal one US dollar

*The World Bank estimates the 2011 poverty line for rural households in Cambodia at 4,422 riels per capita per day (World Bank 2013). Poor households in this table are those with per capita daily incomes below the poverty line of 4,422 riels per day, down to and including those with per capita daily incomes of 2,000 riels. Very poor households are those with per capita daily incomes of below 2,000 riels. Above-poor households are those with per capita daily incomes in the range from 4,422 riels to 8,499 riels per day. Better-off households are those with per capita daily incomes of 8,500 riels and above

All four household groups rely heavily on earnings from upland cultivation although their incomes from staple crops versus cash crops vary. Proportionally, the very poor households earn more from upland rice cultivation and less from cassava production than the other three groups. This suggests that the very poor are less integrated into the market economy than the other groups. Conversely, the better-off households earn more proportionally from cassava production and less from upland rice than the other three groups. Moreover, the absolute earnings of the better-off households from upland cultivation are striking in comparison with the other groups. This relates to upland farm size as well as to crops produced. On average,

in the 2011/2012 crop season, the better-off households cultivated 3.4 hectares of upland, the above-poor households cultivated 1.0 hectare of upland, the poor households cultivated 1.1 hectare of upland, and the very poor households cultivated 0.9 hectare of upland. Land concentration among the better-off households correlates to their higher earnings from cassava production and their fuller integration within the cash economy.

Somewhat surprisingly, the better-off households also earn more proportionally from pig-raising and chicken-raising than the other groups. Comparatively, the very poor households earn proportionally more than the other groups from gathering food and other products from the forest, while the better-off households earn less than the other groups from these pursuits. This underscores the importance of the forest as a safety net for the very poor and their acute vulnerability to forest dispossession. Of note, in Dak Dam commune the very poor household of Keng Klok and Tok An (Box 2) relies proportionally more on gathering forest food and other products than does the better-off household of Srem Poeun and Veang Nak (Box 1).

The poor and above-poor households earn about one-fourth of their total income from wage work, a much higher proportion than that earned by the very poor and better-off households from wage work. This suggests that the very poor are excluded from certain types of wage work while the better-off households with higher earnings from cash crops are less likely to engage in it. Better-off and above-poor households earn proportionally more from goods bought and sold than do poor and very poor households although the contributions to average incomes from this source are small. Only the better-off households earned much from remittances from migrant family members. This implies that the social networks of the other income groups are weak outside of their own local areas.

Household sizes and dependency ratios likewise have consequences for household livelihood security. The poor, and especially the very poor, have, on average, larger household sizes and higher dependency ratios than the other two groups. In the Dak Dam commune sample very poor households have, on average, 6.1 members and a dependency ratio of 54 percent, while poor households have, on average, 4.6 members and a dependency ratio of 35 percent. Comparatively, above-poor households have, on average, 3.2 members and a dependency ratio of 28 percent, while better-off households have, on average, 4.0 members and a dependency ratio of 33 percent. In Dak Dam commune the better-off household of Srem Poeun and Veang Nak (Box 1) has three members and a dependency rate of 33 percent, while the very poor household of Keng Klok and Tok An (Box 2) has six members and a dependency ratio of 67 percent.

## Srae Preah commune

In Srae Preah commune income disparities are striking between all four income groups (Table 5). The average incomes of better-off households are 65 percent higher than those of the above-poor households, while the average incomes of the above-poor households are 57 percent higher than those of the poor households, and the average incomes of the poor households are 122 percent higher than those of the very poor households.[15] Notably, the average yearly income of the 92 indigenous and mixed indigenous households sampled at 10,185,178 riels (about USD 2,546) was slightly higher than the yearly income of the 14 Khmer households sampled at 10,064,350 riels (about USD 2,516). Generally indigenous and mixed indigenous households in Srae Preah commune managed to resist dispossession by Khmer migrants.



***Table 5:*** *Percent of average cash values* of household income in past year, Srae Preah commune, by type of household**, 2012*

| | **Very poor households** | **Poor households** | **Above-poor households** | **Better-off households** |
|---|---|---|---|---|
| Strategy | Percent | Percent | Percent | Percent |
| Upland crops (total) | 34.0 | 40.3 | 34.4 | 32.6 |
| Upland rice | (4.3) | (4.2) | (3.2) | (1.3) |
| Upland crops (other than rice) | (29.7) | (36.1) | (31.2) | (31.3) |
| Cassava | (17.9) | (19.5) | (17.6) | (21.5) |
| Cashew nut | (6.3) | (10.1) | (7.4) | (5.6) |
| Wet land (paddy) rice | 17.9 | 15.2 | 13.1 | 19.5 |
| Pigs raised | 3.1 | 4.6 | 3.6 | 1.2 |
| Chickens raised | 1.6 | 2.2 | 1.2 | 0.5 |
| Ducks raised | 0.0 | 0.2 | 0.2 | 0.0 |
| Food gathered from the forest | 1.9 | 1.5 | 1.4 | 1.0 |
| Other products gathered from the forest | 24.0 | 17.5 | 22.9 | 25.0 |
| Liquid resin | (7.6) | (4.8) | (4.0) | (3.4) |
| Animals hunted or trapped | 7.1 | 5.2 | 11.2 | 6.1 |
| Fish caught | 4.5 | 2.7 | 2.1 | 2.4 |
| Goods made and sold | 0.0 | 0.5 | 0.3 | 0.2 |
| Goods bought and sold | 0.0 | 3.3 | 2.5 | 1.7 |
| Wage work | 5.9 | 6.8 | 6.9 | 9.7 |

[15] Income inequality likewise existed among Srae Preah sample households in 2003: nine households had annual incomes of less than 1 million riels, 35 households had annual incomes of from 1 million riels to 1.99 million riels, 18 had annual incomes of from 2 million riels to 2.99 million riels, and 12 had annual incomes of 3 million riels or more (McAndrew et al. 2003)

| | | | | |
|---|---|---|---|---|
| Remittances from children and relatives not considered as household members | 0.0 | 0.1 | 0.3 | 0.0 |
| Total percent | 100.0 | 100.1 | 100.1 | 99.9 |
| Total average cash value in riels | 3,040,529 | 6,750,875 | 10,570,290 | 17,405,052 |
| | N=12 | N=34 | N=34 | N=26 |

*Cash values in riels. 4,000 riels equal one US dollar

**See asterisked footnote (**) in Table 4 for an explanation of how the household groups were delineated

All four household groups rely on earnings from upland and wetland cultivation for about half of their proportional household incomes. However, within upland cultivation, household earnings from staple crops versus cash crops differ. Proportionally, the better-off and above-poor households earn less than the poor and very poor groups from upland rice. This again suggests that the poor and very poor groups are less integrated within the market economy. Meanwhile, better-off and above-poor households have higher absolute, if not proportional, earnings from cassava and cashew nuts than poor and very poor households. This relates to upland farm size as well as to crops grown. On average in the 2011/2012 crop season the better-off households cultivated 3.2 hectares of upland, the above-poor households cultivated 2 hectares of upland, the poor households cultivated 1.9 hectares of upland and the very poor households cultivated 1.3 hectares of upland. Land concentration among the better-off households relates to their higher absolute earnings from cash crop production and their greater integration within the cash economy.

Similarly, the absolute earnings from wetland rice cultivation fall steadily in value from the better-off to the very poor households, although the proportional earning shares do not. This likewise relates to wetland farm size. On average, in the 2011/2012 crop season, the better-off households cultivated 1.5 hectares of wetland, the above-poor households cultivated 1.0 hectare of wetland, the poor households cultivated 0.8 hectare of wetland, and the very poor households cultivated 0.4 hectare of wetland.

Not surprisingly, the very poor households earn proportionally more than the other groups from gathering food from the forest, and proportionally more than the poor and above-poor households (although not the better-off households) from gathering other products such as liquid resin from the forest. The very poor households likewise earn proportionally more than the other groups from fishing, and proportionally more than the poor and better-off households (although not the above-poor households) from hunting and trapping wildlife. This highlights the importance of forest resources in the livelihoods of the very poor and their vulnerability to forest dispossession. Notably, in Srae Preah commune the very poor household of Ngok Senh and Chet Heurt (Box 4) depends proportionally more on collecting forest food and other products than does the better-off household of Kreun Khan and Svay Sok (Box 3).

By contrast the very poor households earn proportionally less than the other three groups from wage work. Notably, the very poor households earn nothing from goods made and sold, or from goods bought and sold. This points to the exclusionary effects of the market economy with respect to the participation of the very poor in certain types of work and trade activities. Of note, none of the income groups earned significantly from remittances from migrant family workers. This suggests that the social networks of all four income groups are weak outside of their own local areas.

Household sizes and dependency ratios likewise have consequences for household livelihood security. The poor and very poor have, on average, larger household sizes and higher dependency ratios than the other two groups. In the Srae Preah commune sample, very poor households have, on average, 5.6 members and a dependency ratio of 46 percent, while poor households have, on average, 5.8 members and a dependency ratio of 41 percent. Comparatively, above-poor households have, on average, 4.7 members and a dependency ratio of 38 percent, while better-off households have, on average, 3.6 members and a dependency ratio of 31 percent. In Srae Preah commune the better-off household of Kreun Khan and Svay Sok (Box 3) has two members and a dependency ratio of 0, while the very poor household of Ngok Senh and Chet Heurt (Box 4) has seven members and a dependency ratio of 71 percent.

## Discussion

The expansion of the market economy contributed to land commodification, land concentration and social differentiation in both Dak Dam and Srae Preah communes. On average, the better-off households in both communes cultivated much larger upland parcels and had substantially higher earnings from cash crop production than did the other income groups. By comparison, the very poor households in both communes had the smallest upland farms and the lowest earnings from cash crop production. Similarly the better-off households in Srae Preah commune cultivated larger wetland areas and had higher earnings from paddy rice production than did the other groups. Meanwhile the very poor households in Srae Preah commune had the smallest wetland rice farms and the lowest earnings from paddy rice production. Notably, the very poor households earned proportionally more from gathering forest products and less from wage work than did most other income groups in the communes. This underscored the reliance of the very poor households on forest resources and their limited access to wage work. Not surprisingly, the very poor and the poor households in the two communes had, on average, larger household sizes and higher dependency ratios than did the above-poor and better-off households. In Dak Dam commune, although not in Srae Preah commune, Khmer households earned much more than indigenous and mixed indigenous households. This suggests that indigenous households in Dak Dam were more susceptible to dispossession from land and forest resources than indigenous households in Srae Preah.

## Land transactions in diverse income groups in Dak Dam and Srae Preah communes

Population increase and economic growth are major determinants of land use change which precipitate land markets and invariably give rise to land commodification and land concentration (Diepart and Dupuis 2014, Milne 2013, Taylor 2011). Notably, land transactions are driven by a synergy of factors that may be mostly endogenous or exogenous (Lambin et al. 2003). In Mondulkiri and other Northeast provinces, the land market is driven mainly by Khmer outsiders although it involves local agents and voluntary sales of indigenous insiders (Fox et al. 2008, McAndrew and Oeur 2009, Milne 2013, Thann et al. 2009). We consider here population growth and land transactions in the two communes from 2003 to 2012 and then proceed to examine land transactions in the five years prior to the surveys in the four income groups. We present findings first from each commune and then discuss comparative experiences.

### Dak Dam commune

The household population in Dak Dam commune rose by 46 percent from 257 to 376 households from 2003 to 2012, which increased pressure on land resources. In 2003 none of the Dak Dam sample households had sold land in the previous five years and only 5 percent had bought land. By contrast, in 2012, 13 percent of Dak Dam sample households had sold land in the previous five years and 15 percent had bought land. During the years from 2003 to 2012 a land market had begun to develop in Dak Dam commune. Moreover, in 2012, 64 percent of the sample households had reportedly cleared an average of 1.38 hectares for cultivation in the previous five years. The opening up of lands mainly for cassava cultivation spurred economic growth albeit at the expense of forest resources.

On average, in Dak Dam the better-off and above-poor households surveyed in 2012 had bought and sold more upland in the previous five years than had the poor and very poor households surveyed (Table 6). Not surprisingly there had been virtually no buying and selling of wetland in the previous five years among the sample households. Of note, very poor and poor households had cleared more forest land in the previous five years than had the above-poor and better-off households. Since the very poor and poor groups were minimally involved in the land sales, it appears that they had acted mainly in response to population pressure.

*Table 6: Average land transactions in the previous five years by type of household,* Dak Dam commune, 2012*

| | Very poor households | Poor house-holds | Above-poor households | Better-off households |
|---|---|---|---|---|
| Upland bought (hectares) | 0 | 0.2 | 0.3 | 2.3 |
| Upland sold (hectares) | 0 | 0.1 | 0.3 | 0.3 |
| Wetland (paddy rice land) bought (hectares) | 0 | 0 | 0.1 | 0 |
| Wetland (paddy rice land) sold (hectares) | 0 | 0 | 0 | 0 |
| Residential land bought (square meters) | 0 | 175 | 5 | 4,157 |
| Residential land sold (square meters) | 293 | 0 | 26 | 0 |
| Forest Land cleared (hectares) | 1.3 | 0.8 | 0.7 | 0.6 |
| | N=21 | N=34 | N=23 | N=7 |

* See asterisked footnote (**) in Table 4 for an explanation of how the household groups were delineated

## Srae Preah commune

The household population in Srae Preah commune similarly rose by 49 percent - from 289 to 430 households - from 2003 to 2012, which likewise had put pressure on land resources. Nonetheless, the percentage of Srae Preah sample households who had been involved in land sales in the previous five-year periods remained low, increasing from one per cent in 2003 (covering the period from 1998 to 2003) to five percent in 2012 (covering the period from 2007 to 2012). Rather remarkably, Srae Preah households were able to resist pressure to sell lands to Khmer in-migrants and land speculators. Indeed, with strong support from NGOs, three Srae Preah village communities - Gati, Pou Kong, and Ochra - had formed themselves into legal entities to attain communal land titles. Meanwhile the percentage of Srae Preah sample households who had been involved in buying land in previous five-year periods rose from 18 percent in 2003 to 22 percent in 2012. Perhaps more tellingly 58 percent of the sample households in 2012 had reportedly cleared an average of 1.37 hectares in the previous five years to expand their landholdings. Clearly, the expansion of cassava and cashew nut production, and the extension of wetland rice cultivation, propelled the clearing of large tracts of land in Srae Preah commune. While this promoted economic growth, it also intensified the threat to forest resources.

On average, in Srae Preah the better-off households interviewed in 2012 had bought and sold more upland, and bought more wetland, in the previous five years than had the above-poor, poor and very poor household groups interviewed. Even so, the average upland areas bought and sold, and the average wetland areas bought, were small (Table 7). All four income groups had bought residential land in the previous five years and, on average, the areas bought by the very poor group were the smallest. Of note, on average, the better-off and above-poor households had cleared more forest land in the previous five years than

had the poor and very poor households. Since all groups sold virtually none of their upland or wetland, it appears that the better-off and above-poor acted simply to increase their earnings from cash crops and paddy rice.

***Table 7:*** *Average land transactions in the previous five years by type of household,* Srae Preah commune, 2012*

| | Very poor households | Poor house-holds | Above-poor households | Better-off households |
|---|---|---|---|---|
| Upland bought (hectares) | 0.2 | 0.2 | 0 | 0.6 |
| Upland sold (hectares) | 0 | 0 | 0 | 0.1 |
| Wetland (paddy rice land) bought (hectares) | 0 | 0.1 | 0.1 | 0.2 |
| Wetland (paddy rice land) sold (hectares) | 0 | 0 | 0 | 0 |
| Residential land bought (square meters) | 92 | 354 | 114 | 196 |
| Residential land sold (square meters) | 0 | 34 | 0 | 35 |
| Forest Land cleared (hectares) | 0.4 | 0.6 | 0.8 | 1.1 |
| | N=12 | N=34 | N=34 | N=26 |

*See asterisked footnote (**) in Table 4 for an explanation of how the household groups were delineated

### Discussion

Population increase and the expansion of cash crop production spurred the development of land markets in both communes although somewhat more so in Dak Dam than in Srae Preah. In Srae Preah commune indigenous households were able to resist pressure to sell lands to Khmer in-migrants and land speculators. However, in Srae Ampil village indigenous households were less successful in stopping the Sovann Reachsei ELC from cutting down their resin trees. In both communes, better-off households had, on average, bought more upland in the previous five years than had the other income groups. This helps to explain the concentration of land resources among the more wealthy households. The expansion of cash crops had likewise spurred the clearing of large tracts of land in both communes, which had exacerbated the threat posed to forested areas and household livelihoods reliant on forest resources. Land markets in Mondulkiri have been particular robust along the national road and near market centers (McAndrew et al. 2003, Milne 2013). As land markets expand into more remote areas such as Dak Dam and Srae Preah communes, land transactions will undoubtedly increase.

## Poverty and inequality in Dak Dam and Srae Preah communes

In the introduction to this chapter we identified economic inequality as a consequence of market integration and posited that livelihood transitions in the two communes encompassed prosperity for some and impoverishment for others. Indeed, in Srae Preah commune,

economic growth has led to a decline in the number of sample households living in poverty, from 63 percent in 2003 to 43 percent in 2012. By contrast, economic growth in Dak Dam commune has not had the same mitigating effects on poverty, as the proportion of sample households living in poverty increased from 54 percent in 2003 to 65 percent in 2012. Poverty levels in 2012 in both communes were much higher than the poverty level of 24 percent calculated by the World Bank for rural households in Cambodia in 2011 (World Bank 2013). Gini coefficients, which measure levels of overall income inequality, were also high in both communes. In 2012 the Gini coefficient for the Dak Dam household sample was 0.43, while that for the Srae Preah household sample was 0.38, both much higher than the Gini coefficient of 0.28 estimated by the World Bank for Cambodia in 2011.[16]

Overall poverty decline in Srae Preah commune was indicated by the fact that proportionally higher numbers of Srae Preah households enjoyed a degree of prosperity in 2012 than they did in 2003. Conversely, overall poverty rise in Dak Dam commune indicated that proportionally higher numbers of Dak Dam households were impoverished in 2012 than they were in 2003. This may be explained partially by the ability of the Srae Preah households to exert their rights over land resources and to resist land sales to Khmer migrants. Households in Dak Dam were not as successful. At the same time, high levels of overall household income inequality in 2012 suggest that economic well-being and deprivation co-existed among households in both communes. This points to the exclusionary effects of the market integration and indicates that exit options are limited for many indigenous households leaving them vulnerable to marginalization and displacement (Vandergeest and Rigg 2012).

## CONCLUSION

We have used the concept of transition (Martens and Rotmans 2005) in this study as a heuristic to examine the interplay of livelihood and land use change in Dak Dam and Srae Preah communes. We have further argued that the rapid expansion of the market economy in these communes has resulted in dispossession from land and forest resources, a reliance on cash crops, land commodification, land concentration, social differentiation and economic inequality. We have likewise presented detailed findings and analysis to support this argument.

Between the years 2003 and 2012 Dak Dam and Srae Preah households experienced a transition in agricultural production as they moved from the cultivation of upland staple crops mainly for subsistence to the production of cash crops, specifically cassava and cashew nuts, for the market. Market integration generated economic growth, with mixed outcomes for poverty reduction, as well as high income inequality among sample households. This resulted in prosperity for some and impoverishment for others.

[16] Figures for 2003 are based on the poverty line for rural areas of 1,036 riels per capita per day set by the Ministry of Planning, Royal Government of Cambodia, and the United Nations World Food Programme (2003). Figures for 2011 are based on World Bank estimates of the poverty line for rural areas of 4,422 riels per capita per day and the Gini coefficient for Cambodia of 0.28 based on the Cambodia Socio-Economic Survey (CSES) 2011 (World Bank 2013)

The cultivation of cash crops in the two communes was accompanied by a shift away from swidden agriculture to the cultivation of crops on permanent farms. Establishing permanent farms helped to expand the number of hectares devoted to cash crops and to prevent encroachment on fallow lands. Even so, the clearing of new lands - which is a defining feature of swidden agriculture - persisted. Large tracts of land have been cleared in the past five years in Dak Dam and Srae Preah communes to expand the production of cassava. In Srae Preah commune, lands have also been cleared to extend paddy rice cultivation. The opening up of lands for cash crop production and paddy rice cultivation has spurred economic growth, but at the cost of exacerbating the threat posed to forested areas and household livelihoods reliant on forest resources.

By 2012 livelihood transitions had emerged in the local economies giving rise to substantial increases in average annual household incomes. This extraordinary growth resulted from increases in the cash values of household livelihood pursuits. It likewise reflected high inflation rates during the interim years. In Dak Dam commune growth was due principally to earnings derived from the cash crop production of cassava and from wage work principally in the form of agricultural labor. In Srae Preah commune growth was due primarily to earnings gained from cassava and cashew nut production, and less so from paddy rice cultivation. In both communes household income groups with lower dependency ratios had higher income earnings.

As income shares from the cultivation of crops increased in the two communes, income shares from forest products, hunting and trapping decreased. Specifically, household earnings from hunting and trapping in Dak Dam commune, and from liquid resin tapping in Srae Preah commune, declined sharply from 2003 to 2012. Nonetheless, in 2012, forest products, hunting and trapping still made up one-fourth of household incomes in Dak Dam and nearly one-third of household incomes in Srae Preah. Although forest resources no longer constituted the dominant share of household income that had been the case in 2003, a large majority of Dak Dam and Srae Preah households continued to rely on gathering forest food and other products and on the hunting and trapping of wildlife to supplement their household incomes and livelihoods. Access to and control over forest resources and the conservation of these resources remained as critical for household livelihood security in 2012 as they had been in 2003. Prior to the baseline study in 2003, anarchic and concession logging had posed the principal threats to land and forest resources in the two communes. Since 2003, ELCs, mine exploration and the illegal timber trade had become the major threats to indigenous access to natural resources in the communes.

Meanwhile the rapid adoption of cassava as a boom crop raised concerns of its own. Reliance on cassava production made indigenous households more vulnerable to the exigencies of the market economy. Critically, though perhaps less well understood, the pursuit of cassava cultivation had consequences for social differentiation. In both communes income earned from cassava cultivation was related to upland farm size. Better-off farmers cultivated larger

upland areas and earned more from cassava production than did other income groups. In the previous five years, better-off households had likewise augmented their holdings, buying up more upland than other income groups.

The accumulation of land in the hands of better-off households threatened to result in the dispossession of small farm holders potentially to the point of landlessness. While cassava production created opportunities for agricultural labor, very poor households in both communes earned proportionally less from wage work than did most other income groups. Moreover, the very poor households, like the other income groups, earned little or nothing from trading and migrant remittances. This revealed that livelihood opportunities and exit options for the very poor households remained limited. Loss of upland farms and access to forest resources would, no doubt, leave them further displaced and marginalized.

Polarization of households was more evident in Dak Dam than in Srae Preah. In Dak Dam, better-off households earned more, and very poor households earned less, on average, than respective income groups in Srae Preah. In 2012 the Gini coefficient was likewise higher among the Dak Dam sample households than it was among the Srae Preah sample households. Of note, in 2012 Khmer households in Dak Dam commune earned on average more than double that of indigenous and mixed indigenous households. This indicated that polarization in Dak Dam commune was associated in part with ethnicity. By comparison, average earnings of Khmer, indigenous and mixed indigenous households in Srae Preah commune were virtually equal. Indigenous and mixed indigenous households in Srae Preah commune generally managed to resist dispossession by Khmer migrants.

Overall, indigenous groups in Srae Preah commune had retained greater access to, and control over, their natural resources, and had achieved greater participation in the governance of these resources than had indigenous groups in Dak Dam commune. While land markets had begun to develop in both communes, land sales in the previous five years had been higher in Dak Dam than in Srae Preah. Notably, with strong support from NGOs, three Srae Preah village communities had taken steps to attain communal land titles. Importantly, the topography of Srae Preah commune, unlike that of Dak Dam commune, provided Srae Preah villagers with an opportunity to produce paddy rice. As a consequence Srae Preah households were less vulnerable to the exigencies of the cassava market and less reliant on the low returns and seasonality of agricultural labor than were Dak Dam households. The pathway pursued by the Bunong in Srae Preah commune, while fraught with threats posed by the rapid adoption of the cassava boom crop and the incursion of ELCs and mine development, translated into greater prosperity and less poverty for a larger proportion of households than the pathway taken by the Bunong in Dak Dam commune.

# RECOMMENDATIONS

Our study has considered livelihood and land use change in the broad context of agrarian transitions. This approach dismisses simplistic single-cause explanations in favor of those that integrate multiple causes and their complex interactions. This view likewise cautions against applying generalizations uncritically to local experience (De Koninck et al. 2012, Lambin et al. 2003, Martens and Rotmans 2005). Our research has shown that similar transition processes can have different livelihood outcomes for local communities, households and individuals. Rather than proposing a set of prescriptions to be rigorously enacted, the researchers present a few principles and lessons learned from the study to guide participation and policy implementation in the transition process.

A recent volume on land dilemmas in Southeast Asia cites the case of Cambodia to underscore the extent and rapidity of change in the region's land relations. The authors note the active involvement of the Cambodian government, private enterprise, NGOs and the World Bank in shaping the transition process. Importantly, they stress the human agency of the smallholders themselves: "Meanwhile, the smallholders throughout Cambodia were taking their own initiatives to consolidate their claims to land for livelihood security and also, in some cases, as the means to a decent income from new cash crops. Their goal was not only to defend their land against the state and corporations, but also to respond to the actions of kin and neighbors who were consolidating their own claims, and some of whom were accumulating land" (Hall et al. 2011). Advocates for indigenous people's rights must acknowledge the human agency and aspirations at work among the people they wish to support. Otherwise the natural resource projects they propagate may mirror the top-down projects they intend to replace.

This study has demonstrated that land constitutes a critical livelihood resource and that indigenous groups with access to land are better off than those without it. The authors have likewise argued that indigenous people's participation in land use governance is critical in ensuring livelihood security in the transition process. Efforts of indigenous groups to obtain the full benefits of communal land titles in the Srae Preah villages of Gati, Pou Kong and Ochra must be sustained and the government's resistance to communal land tenure overcome. Similarly, efforts of indigenous groups to acquire private land titles in other study villages of Srae Preah and Dak Dam communes must be supported. Security of land tenure is critical especially for vulnerable and marginalized groups who lack opportunities outside of agriculture. While remedial action pursued through communal land titling and private land titling counteract threats posed by corporate incursions such as ELCs and mine exploration, they nonetheless entail their own exclusionary dilemmas. Understanding the diverse implications that exclusion in land use schemes have for disparate stakeholders enables indigenous people, NGOs and policymakers to make better informed choices (Hall et al. 2011).

The Cambodian government's ratification and adoption of progressive legislation in recent years with respect to indigenous people's access to land and forest resources provides a legal framework for preventing the further impoverishment and marginalization of these

groups. These laws are a necessary first step towards recognizing indigenous people as full Cambodian citizens and accommodating their livelihood systems and aspirations into the national development agenda. Laws promulgating indigenous rights must be fully implemented. For the foreseeable future efforts to enhance indigenous access to land and forest resources will remain paramount as livelihood transitions continue to emerge from land use change. But, inevitably, populations will increase and access to land and forest resources will diminish further. Efforts to secure the access indigenous people have to resources should now be encompassed within a broader context that seeks to expand the options these people have and to reduce their current, almost total, reliance on agriculture and forests.



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# BIBLIOGRAPHY


Analyzing Development Issues (2010) *The Expansion of Mining Activities and Indigenous Peoples' Rights in Mondulkiri Province: Case Studies of Gati Village, Keo Seima District and Pou Rapeth Village, Pechreada District, Phnom Penh:* Cooperation Committee for Cambodia.

Asian Development Bank (2000) *Health and Education Needs of Ethnic Minorities in the Greater Mekong Sub-Region. Cambodia Country Report,* Manila: Asian Development Bank.

Backstrom, M., Ironside, J., Paterson, G., Padwe, J. and Baird, I. G. (2007) *Indigenous Traditional Legal Systems and Conflict Resolution in Ratanakiri and Mondulkiri Provinces, Cambodia.* Phnom Penh: United Nations Development Programme.

Beaumont, P. (2008) *Extractive Industry Mining Study, Social and Environmental Impacts, Ratanakiri & Mondulkiri,* Phnom Penh: Development and Partnership in Action.

Chheang, V. and Dulioust, J. (2012) *Rural – Rural Migrations in Cambodia Policy paper,* Supreme National Economic Council and Agence Francaise de Développement.

Cramb, R. A., Colfer, C. J. P., Dressler, W., Laungaramsri, P., Quang Trang, L., Mulyoutami, E., Peluso, N. L. and Wadley, R. L. (2009) Swidden Transformations and Rural Livelihoods in Southeast Asia. *Human Ecology, 37,* pp. 323-346.

De Koninck, R., Rigg, J. and Vandergeest, P. (2012) A Half Century of Agrarian Transformations in Southeast Asia, 1960-2010. in Rigg, J. and Vandergeest, P., (eds.) *Revisiting Rural Places: Pathways to Poverty and Prosperity in Southeast Asia,* Honolulu: University of Hawai'i Press. pp. 25-37.

Diepart, J.-C. and Dupuis, D. (2014) The peasants in turmoil: Khmer Rouge, state formation and the control of land in northwest Cambodia. *Journal of Peasant Studies, 41*(4), pp. 445-468.

Eggert, R. (2010) Mineral Exploration and Development: Risk and Reward. *International Conference on Mining: Staking a Claim for Cambodia,* 26-27 May 2010, Phnom Penh.

Ellis, F. (2000) *Livelihoods and Diversity in Developing Countries,* Oxford: Oxford University Press.

Evans T. D., O'Kelly H. J., Men S., Nut Meng H., Pet P., Sorn P., and Pollard E. H. B. (2013) Seima Protection Forest. in Sunderland T. C. H., Sayer J., and Minh-Ha H. (eds.) *Evidenced-based Conservation: Lessons from the Lower Mekong,* New York, Routledge, 157-186.

Evans T., Arpels, M.., and Clements T. (2012) Pilot REDD Activities in Cambodia are Expected to Improve Access to Forest Resource Use Rights and Land Tenure for Local Communities. in Naughton-Treves, L. and Day, C., (eds.) *Lessons about Land Tenure, Forest Governance and REDD+: Case Studies from Africa, Asia and Latin America,* Madison, Wisconsin: UW-Madison Land Tenure Center. pp. 73-82.

Evans, T. P., Hout, P., Phet, P. and Hang, M. (2003) *A Study of Resin-Tapping and Livelihoods in Southern Mondulkiri, Cambodia, with Implications for Conservation and Forest Management,* Phnom Penh: Wildlife Conservation Society.

Fox, J. M., McMahon, D., Poffenberger, M. and Vogler, J. (2008) *Land for My Grandchildren: Land-Use and Tenure Change In Ratanakiri: 1989-2007,* Community Forestry International (CFI) and the East West Center.

Guerin, M. (2007) Highlanders of Central Vietnam and Cambodia: Economic and Socio-Cultural Changes between 1975 and 2007. *Conference on Socio-Cultural issues of Champa 175 years after its Disappearance,* San Jose.

Hall, D., Hirsch, P. and Li, T. M., (eds.) (2011) *Powers of Exclusion: Land Dilemmas in Southeast Asia,* Honolulu: University of Hawai'i Press.

Hul, R. and Marks, S. (2011) B Kak Firm Seeks Bauxite in Mondulkiri. The *Cambodia Daily,* 4 August.

Javier, E. L. (1997) Rice ecosystems and varieties. in Nesbitt, H. J., (ed.) *Rice production in Cambodia,* Manila: Cambodian IRRI Australian Project. pp. 39-81.

Lambin, E. F., Geist, H. J. and Lepers, E. (2003) Dynamics of land-use and land-cover change in tropical regions. *Annual Review of Environment and Resources, 28,* pp. 205-241.

Li, T. M. (2012) Why So Fast? Rapid Class Differentiation in Upland Sulawesi. in Rigg, J. and Vandergeest, P., (eds.) *Revisiting Rural Places: Pathways to Poverty and Prosperity in Southeast Asia,* Honolulu: University of Hawai'i Press. pp. 193-210.

Martens, P. and Rotmans, J. (2005) Transitions in a Globalizing World. *Futures*, 37, pp. 1133-1144.

McAndrew, J., Mam, S., Hong, K. and Ly, B. (2003) *Indigenous Adaptation to a Decline in Natural Resources: The Experience of Two Phnong Communes in Northeast Cambodia,* Phnom Penh: CIDSE Cambodia.

McAndrew, J. and Oeur, I. (2009) Access to Natural Resources: Case Studies of Cambodian Hill Tribes. in Perera, J., (ed.) *Land and Cultural Survival:The Communal Land Rights of Indigenous Peoples in Asia,* Manila: Asian Development Bank. pp. 93-124.

McKenney, B., Yim, C., Prom, T. and Evans, T. (2004) *Focusing on Cambodia's High Value Forests: Livelihood and Management,* Phnom Penh: Cambodia Development Resource Institute and Wildlife Conservation Society.

Milne, S. (2013) Under the Leopard's Skin: Land Commodification and the Dilemmas of Indigenous Communal Title in Upland Cambodia. *Asia Pacific Viewpoint, 5,* pp. 323-339.

Ministry of Commerce (2011) Cassava Plans for Mondulkiri. in Phnom Penh: Ministry of Commerce, Trade Promotion Department.

Ministry of Agriculture Forestry and Fisheries (2008) *Book of Agricultural Statistic and Research Planning*. Ministry of Agriculture Forestry and Fisheries, Department of Planning and International Cooperation, Phnom Penh.

Ministry of Planning - Royal Government of Cambodia and the United Nations World Food Programme (2003) *Poverty and Vulnerability Analysis Mapping in Cambodia: Mapping Poverty, Malnutrition, Educational Need, and Vulnerability to National Disasters in Cambodia*. Phnom Penh: Ministry of Planning - Royal Government of Cambodia and the United Nations World Food Programme.

National Institute of Statistics (2009) Demographic Census 2008 (final results). Phnom Penh: Ministry of Planning - Royal Government of Cambodia.

So D., Hak S., Oeur I., and McAndrew J. (2012) Prosperity and Impoverishment: Bunong Livelihoods in Transition in Two Mondulkiri Communes. *Cambodia Development Review, 16,* (4) pp. 10-14.

Sopheap, U., Patanothai, A. and Aye, T. M. (2011) Farmers' Perceptions on Cassava Cultivation in Cambodia. *Khon Kaen Agricultural Journal, 39,* pp. 279-294.

Taylor, J. (2011) *Food Security, Climate Change and Natural Resources Management in Cambodia. A Overview of the Literature and Source Book*. Phnom Penh: Learning Institute and IDRC.

Thann, S., Hak, S., Oeur, I. and McAndrew, J. (2009) Negotiating Tenure Conflict in Indigenous Villages of Ratanakiri Province. in CBNRM Learning Institute, (ed.) *Emerging Trends, Challenges and Innovations: Community Based Natural Resource Management (CBNRM) in Cambodia,* Phnom Penh: CBNRM Learning Institute.

Vandergeest, P. and Rigg, J. (2012) The Restudy "Problem"and Agrarian Change: Revisiting Rural Places in Southeast Asia. in Rigg, J. and Vandergeest, P., (eds.) *Revisiting Rural Places: Pathways to Poverty and Prosperity in Southeast Asia,* Honolulu: University of Hawai'i Press. pp.1-24.

World Bank (2013) *Where Have All The Poor Gone? Cambodia Poverty Assessment 2013,* Washington, DC: Work Bank.

# CHAPTER 6

## Differentiation of swidden agriculture in Northeast Cambodia: Kavet swiddeners, the state and the markets in Kok Lak commune

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## ABSTRACT

Until recently, Kavet ethnic minority people traditionally practiced swidden agriculture and accessed natural resources in the uplands as an important, and unchallenged, part of their food system. This present study aims to trace the historical transformation of land use and tenure practices by Kavet communities in Kok Lak commune in the context of various state-driven and social-economic transformations. At commune level, we look at land use changes along with the migrations associated with these transformations. We also aim to understand how these changes have induced social differentiation between households as it relates to their entitlements, their production activities and their income structure.

We examine the transformation in land use prompted by a multiplicity of drivers (demographic, economic, political, institutional and cultural) and in land tenure regimes through a land control matrix that differentiates between two types of rights (the land rights of the users and the rights to manage those rights given to the users).

We discovered that the Kavet people have been resilient in protecting and promoting the core of their swidden territories and traditions; however, recent developments (including the establishment of the Virachey National Park (VNP) and market incentives) have considerably fragmented their land uses, cultural values and institutions. Through forced and free migration, some households have adopted new forms of agriculture (e.g. paddy, and annual and perennial non-rice crops) and converted their swidden land into cashew plantations, while others still rely solely on the practice of swidden agriculture as a lifestyle. By reviewing past transformations, by identifying the role swidden agriculture has had and the contribution it has made to the lives of the Kavet people, we recommend that efforts be made to conserve it in recognition of the pivotal role it plays in community development and to adopt better land use planning at local level. But proper consideration should also be given to the Kavet people who do not practice swidden agriculture.

**Key words:** *Swidden agriculture, indigenous people, Kavet, Protected Area management, co-management, land use change, migration*

# INTRODUCTION

Swidden agriculture has been a dynamic farming system for centuries in Southeast Asia where it is mainly practiced by ethnic minority groups (Fox et al. 2009). It comprises a temporally and spatially complex form of farming, typically represented in the landscape by a large number of distinct land use features, each of which may be in some kind of transition (Padoch et al. 2007). The capacity of swiddeners to integrate forest use into agricultural production relies on an intimate knowledge of the ecology of natural resources (Condominas 2009, Fox et al. 2008, Ironside and Baird 2003). However, swidden agriculture has not tended to find favor in Southeast Asia, where governments generally associate it with deforestation and degradation of soil and water resources (Ducourtieux 2006, Fox et al. 2009). Throughout history, state-driven projects have tried with varying degrees of success to integrate swiddeners with low-land paddy farmers (Baird 2009, Baird 2010, De Koninck 2006, Scott 2009).

Swidden systems have always been in flux but for the past 40 years the increased pace has resulted in transformations that have exerted profound and irreversible effects on the everyday lives of swiddeners (Fox et al. 2009, Fox et al. 2008). Swidden land has been replaced by protected forest (Ducourtieux et al. 2005, Fox et al. 2009) and extensive agriculture systems including annual and perennial crops, tree plantations, horticultural plants and livestock grazing (Schmidt-Vogt et al. 2009). These transformations have followed multiple pathways but are usually driven by a synergy between political-economic decisions at central state level (i.e. land reform, Protected Areas management, the granting of large-scale land concessions, and resettlement politics) and the social-economic contingency at the local level (i.e. cash crops, wage labor opportunities, niche markets, incidence of migration and new rural-urban relationships) (Fox et al. 2009).

In Cambodia, swidden agriculture is traditionally practiced by indigenous people (IPs) who represent approximately 1 to 2 percent of the total population[1] and are mainly located in the Northeastern provinces of Ratanakiri and Mondulkiri[2] (Mikkelsen 2014). Their livelihoods, culture and traditions are intimately linked to forest resources through swidden agriculture, the collection of timber and non-timber products and animal husbandry (Phath and Sovathana 2012).

Cambodian swiddeners integrate other forms of land use including perennial crops (mostly cashew) and permanent rice cultivation (Baird 2010). They accommodate a larger portfolio of livelihood activities articulated in a market economy (Cramb et al. 2009). Backstrom et al. (2007) and Fox et al. (2008) have shown that swiddeners have started to see more profitability coming from perennial crop plantations such as cashew. However, Fox et al.

[1] 200,000 to 400,000 indigenous people from 24 different groups (Mikkelsen 2014): Broa, Chhong, Jarai, Kachak, Kavet, Kel, Koang, Kouy, Kreung, Krol, Phnong, La'Eun, Lun, Mil, Por, Radei, Ro' Ang, Sa' Ouch, Sam Rei, Souy, Spong, Stieng, Thmoun, and Tampuan

[2] Among 13 provinces were IPs can be found, Ratanakiri is home to eight IP groups include the Broa, Jarai, Kavet, Kachak, Kreung, Lun, Phnong, and Tampuan (Phath 2012)

(2008) have also argued that swidden agriculture is still pivotal for some swiddeners to support their own food security and as part of their culture. It seems that the expansion of new market opportunities has initiated or reinforced new forms of disparities as they are manifested in different income generation strategies and structures.

A number of research projects focusing on the Kavet ethnic minority and their relations with the state and markets, have been conducted. Most notably, that of Ironside and Baird (2003) provides a fine-grained investigation into the history and land use practices of Kavet people in Kok Lak commune. Baird (2013), with an emphasis on the ethno-ecology of Kavet people in relation to their natural resources, adds valuable information about how Kavet people perceive the ecology of their resource system. Tol and Srey (2010) provide additional insights into the development of malva nut (*Sterculia lychnophora*) collection, management and market in the context of Protected Area co-management.

Adding to these previous studies, this research aims to trace the historical changes in land use and tenure practices by Kavet communities in Kok Lak commune in the context of various state- or market-driven transformations, for example warfare, post-war reconstruction, the establishment of Protected Area management, and the development of perennial crop plantations. At commune level, the study looks at land use changes alongside migrations associated with these transformations. We also aim to understand how these changes have induced social differentiation between households in terms of their entitlements, their production activities and their income structures. This study aims to support the co-management efforts made in the area since 2005 (BPAMP 2005). We want to provide evidence-based knowledge that can help Protected Area managers to take the current social-ecological transformations more into account.

# METHODOLOGY

## Analytical approach

We studied changes in the land use patterns in a systemic framework that articulates a multiplicity of drivers (demographic, economic, political, institutional and cultural) working at and across different scales. We first look at changes at the commune level. We describe the history that has differentiated land use and land tenure systems of the Kavet over the past 40 years and then examine transformations in land tenure regimes through the land rights control matrix that we adapt from Le Roy et al. (1996). The matrix differentiates between two types of rights; the land rights given to the resource users/appropriators[3] and the right to manage those rights given to the resource users/appropriators[4] (Le Roy et al. 1996).

[3] Access: right to enter a defined, physical area. Usufruct: right to harvest the product of a resource. Claim: right to regulate internal patterns of use or to transform the resource. Possession: right to exclude other people from using the resources. Ownership: right to use/keep land or resources at any time

[4] Public: when the rules are common to all and applied un-differentially. State: right to land/resources is sanctioned by [a representative of] the state. Co-Management: right to land/resources is co-decided by the state and community according to an agreement or based on a contract. Community: right to land/resources is decided by a community (unit of decision). Private: right to land /resources is managed by one individual/family

Against this background, we try to understand how evolution has worked at the household level, identifying the differentiation between households in relation to their land, labor and land use practices. This analysis leads us to establish a typology of household farming systems to examine income formation mechanisms and food security status.

## Study area

The research was conducted in Kok Lak commune, located in Veunsai district, Ratanakiri province, and adjacent to the border with Laos (Figure 1). The Virachey National Park, which is the biggest national park in Cambodia (3,380 $Km^2$), represents about 70 percent of the commune area. Kok Lak commune comprises 2,695 people (441 families) (NCDD 2012). Kok Lak was chosen as the study site in order to build on previous research efforts and because of the establishment of the associated Community Protected Area (CPA), which is a forestry co-management scheme established inside Virachey National Park.

The Kavet people have settled in four villages: Rak, La Lai, Trak and La Meuy. The last village is divided into two sub-groups, La Meuy O' and La Meuy Tonle. As Figure 1 shows, the villages are situated along the La Lai Stream in the lowland of the commune and are about 50 kilometers north of Banlung city, Ratanakiri provincial town.

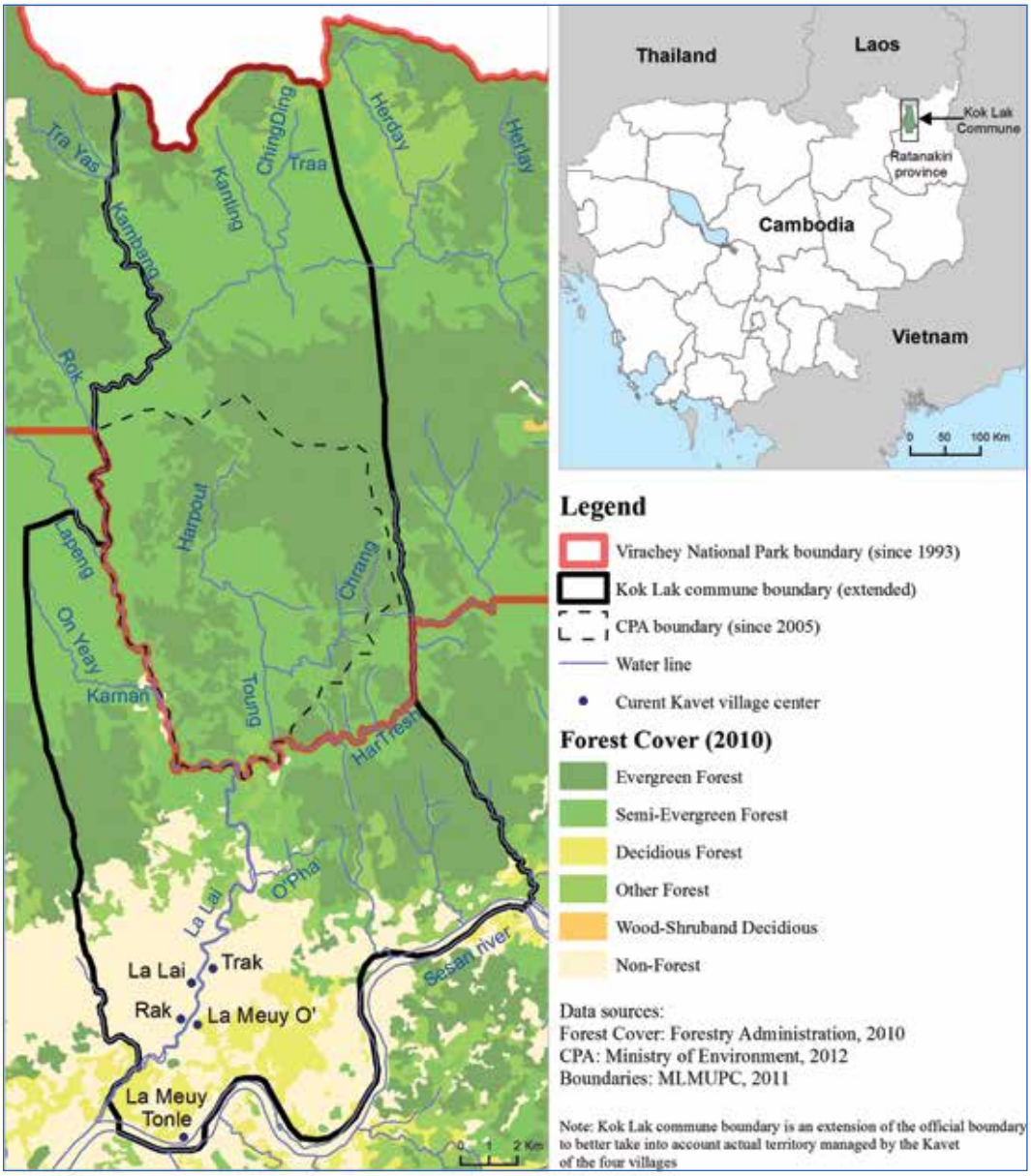


*Figure 1: Location of the Kok Lak commune.*

## Fieldwork and data collection

In addition to a diversity of secondary data the research is based on primary data collected in Kok Lak commune through different data collection methods. The fieldwork was conducted from 2012 to 2014.

In order to identify historical changes in land use patterns we conducted Participatory Rural Appraisals (PRAs) in all four villages of the commune. Aerial photos derived from Google Earth were used during focus group discussions (of which there were nine) to help participants to identify migration flows that have occurred over the recent past. The drivers and consequences

of these migrations were further discussed in relation to swidden agriculture systems and other land use patterns. A total of 128 people took part in these focus group discussions but only about 10 participants in each village actively responded including elders (traditional authority) and representatives of the Community Protected Area (CPA) committee.

We then combined this field dataset with secondary information found in Baird (2013) relating to the criteria for swidden agriculture adopted by the Kavet people, and made them spatially explicit using geo-referenced data. We intersected these different layers in a geographic information system to produce a land suitability map for swidden agriculture that represented the criteria defined by the Kavet people themselves. This suitability identification helps to contextualize and interpret their different migration movements.

Additional information about agriculture techniques, livelihood history, and land use and tenure changes was collected through in-depth interviews. Thirteen people were selected according to their livelihood activities or to their status: six farmers representing different farming practices, three village chiefs, one commune chief and three executive members of the Community Protected Area (CPA) committee.

Household interviews were conducted to understand the history of the families and their land use trajectories, as well as to gather a comprehensive characterization of their farming systems. Overall, we interviewed 42 families, selected randomly based on the Yamane Taro formula (Israel 1992)[5]. The sampling was facilitated by a database provided by the NGO Non-Timber Forest Products (NTFP). The first round of household surveys enabled us to elicit the main differentiation trends among households and identify a household typology (five types). We then selected two representative households of each type (n=10) to conduct a detailed survey on food security and income formation. These activities included swidden, rice cultivation, small-scale perennial crop plantation (principally cashew), livestock husbandry, the collection of malva nuts, and timber exploitation. We also included incomes derived from secondary but nevertheless important activities such as fishing, wage labor, handicrafts, the collection of non-timber forest products, and agriculture from home gardens. Data from both in-kind and in-cash gross income was also collected.

# THE KAVET SWIDDEN AGRICULTURE SYSTEM

## Land suitability for swidden agriculture

In order to understand the nature of land use change and the impacts these changes have had on local farming systems, we have tried to take a Kavet point of view and consider the rationality and practices of their swidden agricultural system as it was before the 1970s. Based on a triangulation between our primary datasets and secondary data found in Baird (2013) and the availability of geo-referenced data, we defined four ecological criteria that are important for Kavet in assessing the suitability of an area for swidden agriculture.

[5] $n=N/[1+N(e)^2]$ where n is the sample size, N is the total number of households (HHs) in the village and e is the level of accuracy (15 percent)

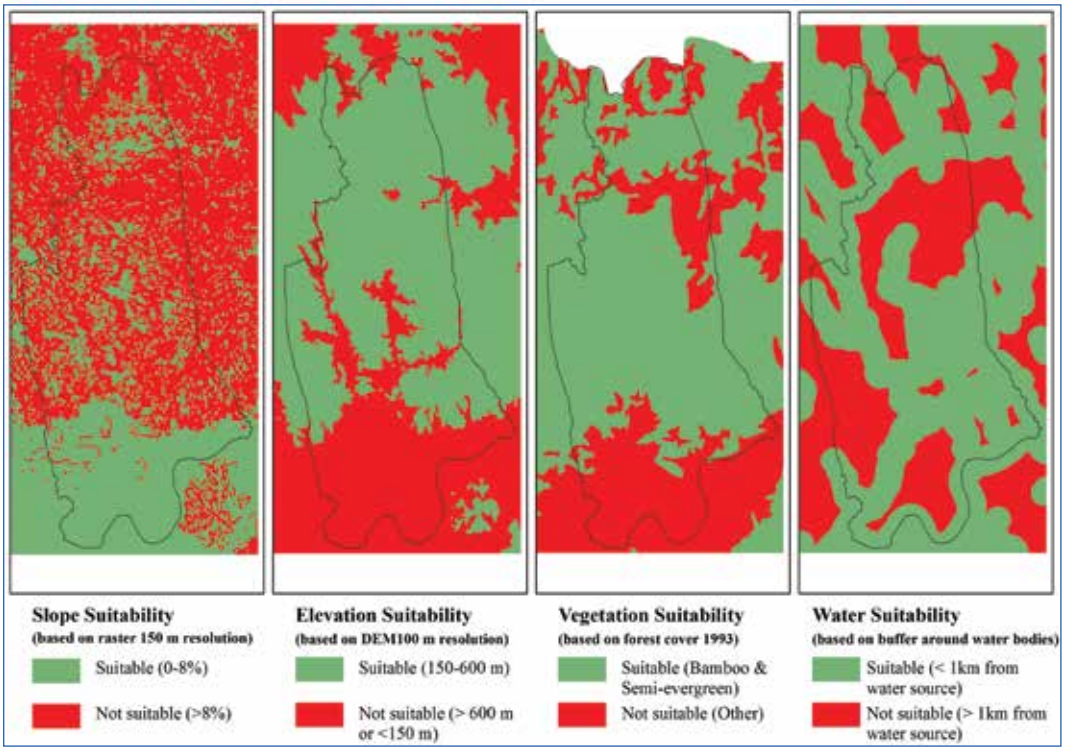


***Figure 2:*** *Suitability maps indicating key factors that influence the choice of swidden agriculture land by Kavet people, according to their ethno-ecological knowledge and preferences.*

The Kavet ecological classification system is essentially based on two general ecological terms: *bree* and *dak*. *Bree* is a condition of the land according to criteria such as soil, dominant species, and successional patterns in swidden agriculture. Among the 108 ecological classification categories of *bree* identified by Baird in 1999 (2013), the Kavet people prefer forest types *bree baw* and *bree lao* (two types of bamboo forest) and *bree lawng* (semi-evergreen forest) for swidden. *Dak* localities encompass rivers and streams with water levels up to the tops of their banks. *Dak* features are critical for swidden agriculture because they also provide drinking water and opportunities for fishing. Keeping both criteria in mind, we have used the best available data to establish two suitability maps: one relating to vegetation, the other to access to water (Figure 2). Two other criteria taken into account by Kavet communities to determine the suitability of the land for swidden agriculture are slope and the elevation (also shown in Figure 2). Specifically, the land must not be too steep (we have identified a threshold value of 8 percent slope based on data available) and, according to Baird (2013), swidden is typically practiced between 150 and 600 meters above sea level. Using the intersection of these four layers of information and subsequent multi-criteria analysis, we have established a map with five grades of suitability for swidden agriculture (Figure 3). The analysis reveals that areas that are highly suitable for swidden are located mostly (but not exclusively) inside the Virachey National Park. The area south of the commune, where villages are situated, is mostly unfavorable for swidden agriculture.

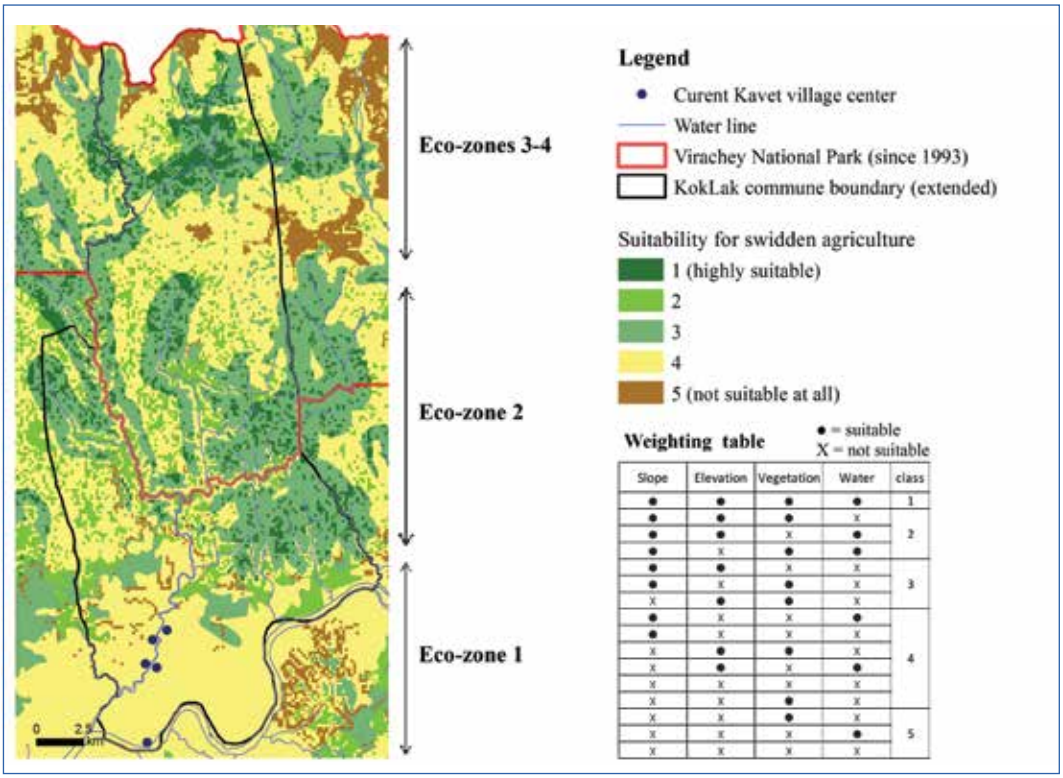


***Figure 3:*** *Overall suitability map for swidden agriculture land for the Kavet people, according to their ethno-ecological knowledge and preferences.*

Baird offers a nuanced description of ethno-ecological knowledge created by the Kavet in relation to forest resources and their swidden agriculture, and we used this classification to interpret the suitability map (Figure 3). Baird identifies four different ecological zones in which biological and plant-animal-human relationships are specific. The details of distinct successional patterns on fallow[6] are important in differentiating each zone.

Eco-zone 1 is a low and flat land with soil of a relatively low quality (sandy and gravelly). According to Baird, the succession patterns in this lowland area are remarkably different from those in the hilly areas that are just a few hundred meters higher (eco-zone 2). In the lowlands, *imperata* grass (*imperata cylindrica*) is the main species that becomes established during fallow periods when the land is not cultivated. The widespread practice by ethnic Lao people of setting dry season fires encourages fallow re-growth and many areas become climax[7] *imperata* grass savanna areas changing from the rich semi-evergreen forests that were historically found in the northern part of this eco-region (1). This considerably limits the restoration of fertility and thus the suitability for swidden agriculture (Baird 2013). Our surveys have confirmed that Kavet people are fully aware of this and do not consider this eco-zone (1) to be favorable for swidden agriculture. Eco-zone 2 is much more suitable for

[6] That is the colonization of fallow land by successive types of vegetation

[7] Climax vegetation is the vegetation that would flourish in an area, were growth to proceed undisturbed over a long period

swidden agriculture, especially where regrowth vegetation is bamboo or semi-evergreen forest (*bree lawng*) and close to streams. The successional patterns in zone 2 thus differ from those in zone 1. After two to three years of cultivation, the plot is left fallow. The pioneer[8] species is not *imperata cylindrica* but another herbaceous species, which is quickly followed by the appearance of bamboo, wild bananas or semi-evergreen, fast-growing trees (*bree lawng*). Forests regenerate quickly, and within a few years the canopy is 10 meters high. Fast-growing trees (*bree lawng* - semi-evergreen) are shaded out by other trees that can grow in the shade of the pioneer and then take over to colonize the area (sciophytes i.e. trees that can flourish at a lower light intensity such as *bree gra*, then *bree greung*). In the case of a bamboo forest, *bree baw* or *bree lao* becomes the mature forest type. Figure 3 shows that, currently, the Virachey National Park largely overlaps with this eco-zone. Little is known about the ecology of eco-zones 3 and 4. Baird (2013) mentions that successional patterns and pioneer species differ from those of zone 2. However, according to our swidden suitability classification, huge areas are potentially suitable for swidden agriculture in the north (where zones 3-4 are supposed to be located).



## The practices of swidden agriculture in the past

Traditionally, Kavet people have tended to cultivate swidden land for about two years on plots ranging from 1 to 3 hectares per household. In addition to the suitability criteria outlined earlier, the size and location of the plots are chosen according to the number of active people within each household.

In the Kavet language, a swidden cultivated plot is called a *meur*. During the first year of cultivation (*meur 1*), the Kavet practice multi-cropping within the full extent of the area. Baird (2013) identified 181 different crop types that are regularly cultivated, including 36 varieties of rice and 145 other varieties of annual and perennial crops. In the second year (*meur 2*), the number of cultivated species and the area size are reduced. Short-term rice and sesame seeds are the crops most commonly grown (Baird 2013).

The duration of the fallow period necessary for the restoration of fertility depends on a number of factors such as the type of forest, the successional patterns and the soil dynamics and natural fertility, but it tends to range from seven to 10 years. Fallow lands are not necessarily unproductive as people may continue to collect fruits and NTFPs from the plot they used for cultivation. Most NTFPs are actually collected on fallow land.

## Socio-spatial organization in the past

The village is the traditional socio-spatial unit in Kavet communities. Each is divided into sub-villages of 15-20 families, based on family ties (Ironside and Baird 2003). Each sub-village is usually divided into groups of families from the same lineage. A system of labor exchange exists between three to five families of the same group to manage the peak periods. Families

[8] Pioneer species are those that are the first to colonize ecosystems that have been disturbed. They start the ecological progression that eventually leads to a more biologically-diverse ecosystem

live in different houses within the same residential area located close to a stream and not too far from their swidden agriculture plots. In addition to the core settlement structure, a hut is built by each household directly on their swidden field to be used during the cultivation period.

When a *meur* is located too far from the village, the village settlement is repositioned to another location in a circular move that usually follows a river. These movements are limited to a territory that makes ecological and social sense to Kavet communities. Kavet do not move continually and should not be viewed as a nomadic population; they have a real sense of territorial belonging.

Before choosing and accessing a new plot (*meur*), the household's head informs the elders and then performs a ritual to ask the spirits with a test cutting. This ritual involves cutting a piece of tree from the plot that the family intends to cultivate and bringing it home. If the family members have pleasant dreams the following night, this is interpreted as a positive sign, and they will move to the plot. If they have nightmares, which happens rarely, this is a negative sign, and they will do another test cutting not too far from the plot previously tested.

The village leaders, chosen consensually by everyone in the community, are the major figures of authority and are advised by the elders. Respect for elders is fundamental in Kavet society. Conflicts are addressed by the village leader and elders acting as advisors. When a conflict is linked to spatial conflicts or social taboos, Kavet call it *huntre* (Baird 2008). An example might be an instance where swidden areas belonging to two different groups overlap.

## Land tenure arrangements in the past

The traditional land tenure system of the Kavet is based on common property and individual use rights for the plot under cultivation. Within village limits, land and resources are managed as communal property, and village leaders and elders are responsible for land management and allocation: they are the guardians of group harmony and ensure equitable land allocation between families. According to Ironside and Baird (2003), equality is a central concern in land allocation in Kavet society. There are no land transactions (sale or rent) for fear of spirit retaliation in the form of serious sickness or even death. Moreover, outsiders are not allowed to use village land.

On *meur* plots, individual households have possession rights (access, use, management and exclusion rights). That is to say that Kavet swiddeners possess the plot during the *meur* periods, but do not own the land. A land left fallow usually goes back to the collective domain, unless the family continues to use it to harvest fruit and produce from trees. Even so, the land is available for another family to start swidden when the level of fertility is sufficient.

Habitation is privately managed with exclusion rights. The villagers can access and exclude others from the parcel of land on which they have settled, but in the village area, household plots are determined by the village leader and elders. Customary law has traditionally prohibited the cutting of trees in the immediate vicinity of village habitation areas.

Spirit forests are important as the center within which spirits reside. The Kavet people believe that spirits live in large rocks, mountains, rivers, streams, trees and houses. These forests are strictly off-limits to avoid disturbing the spirits, and the cutting of trees is not allowed in accordance with customary belief (Ironside and Baird 2003). Burial forests are used only to bury the dead.

In other types of forest, free access and use is available to all villagers. There is no regulation in respect of the amount of resources collected, which can include bamboo, vine, rattan and wild vegetables. Hunting and fishing are also freely allowed. These forests are very important in providing food for the Kavet people, especially during shortages.

## DIFFERENTIATION OF LAND USE SYSTEMS IN A CONTEXT OF MULTIPLE MIGRATIONS

Migrations of Kavet people have occurred several times since 1970 in and around the Kok Lak commune in different waves, driven by different factors and under different circumstances (Figure 4). These migrations are critical in explaining how land use and land tenure systems have evolved and how this evolution has influenced household farming systems.

### 1970-1973: Indochinese war and the shifting grounds for swidden agriculture

Up to, and between 1970 and 1973, the Kavet people lived near the border with Laos in an area that was highly suitable for swidden agriculture. However, because the area was located on the Ho Chi Minh trail, the US bombing in the region forced a massive migration. Some groups also moved due to attacks from tigers that have been persistent threats. In relation to their original settlement areas, the Kavet people moved northward into Laos or southward either to Steung Treng province or close to the La Lai Stream. In these new locations (south of eco-zone 2, partly inside what is now the Virachey National Park), lands were still suitable for swidden (Figure 4). All of the Kavet people continued to practice swidden agriculture and their socio-spatial organization did not change.

### 1973-1975: Khmer Rouge control over swidden agriculture

Between 1973 and 1975, the groups living in Laos moved southward or further north to continue their swidden rotations. Meanwhile, the Khmer Rouge started to control the entire area and the Kavet living close to La Lai Stream areas were forced to move southward. In these places, the Kavet continued to practice swidden agriculture, but the land was less suitable

for this compared with their previous zones of occupation (north of eco-zone 1) (Figure 4). Access to land and forest resources was under the authority of the Khmer Rouge who controlled the allocation of swidden land to the Kavet.

## 1975-1979: Khmer Rouge and lowland rain-fed rice cultivation

In 1975, the Kavet living close to the La Lai Stream were forced by the Khmer Rouge to move to Norng Dan and Tapeang Veng. Kavet people staying near to the border with Laos were forced to move to the provinces of either Steung Treng or Kampong Thom (Figure 4). Even though the Kavet comprised a small population of people, and had no political connection with the Khmer Rouge, families were dislocated. In these new settlement areas, the Kavet were now engaged in lowland rain-fed paddy cultivation, which was a rather new agricultural experience for them (e.g. seedlings nursery, transplanting and water management). Chamcar crops (non-rice crops) including corn and sugar cane were also produced but on a smaller scale. All land and production were the property of the state. The Kavet were denied any access to forest areas, and the practice of swidden agriculture, along with the collection of NTFPs, was forbidden.

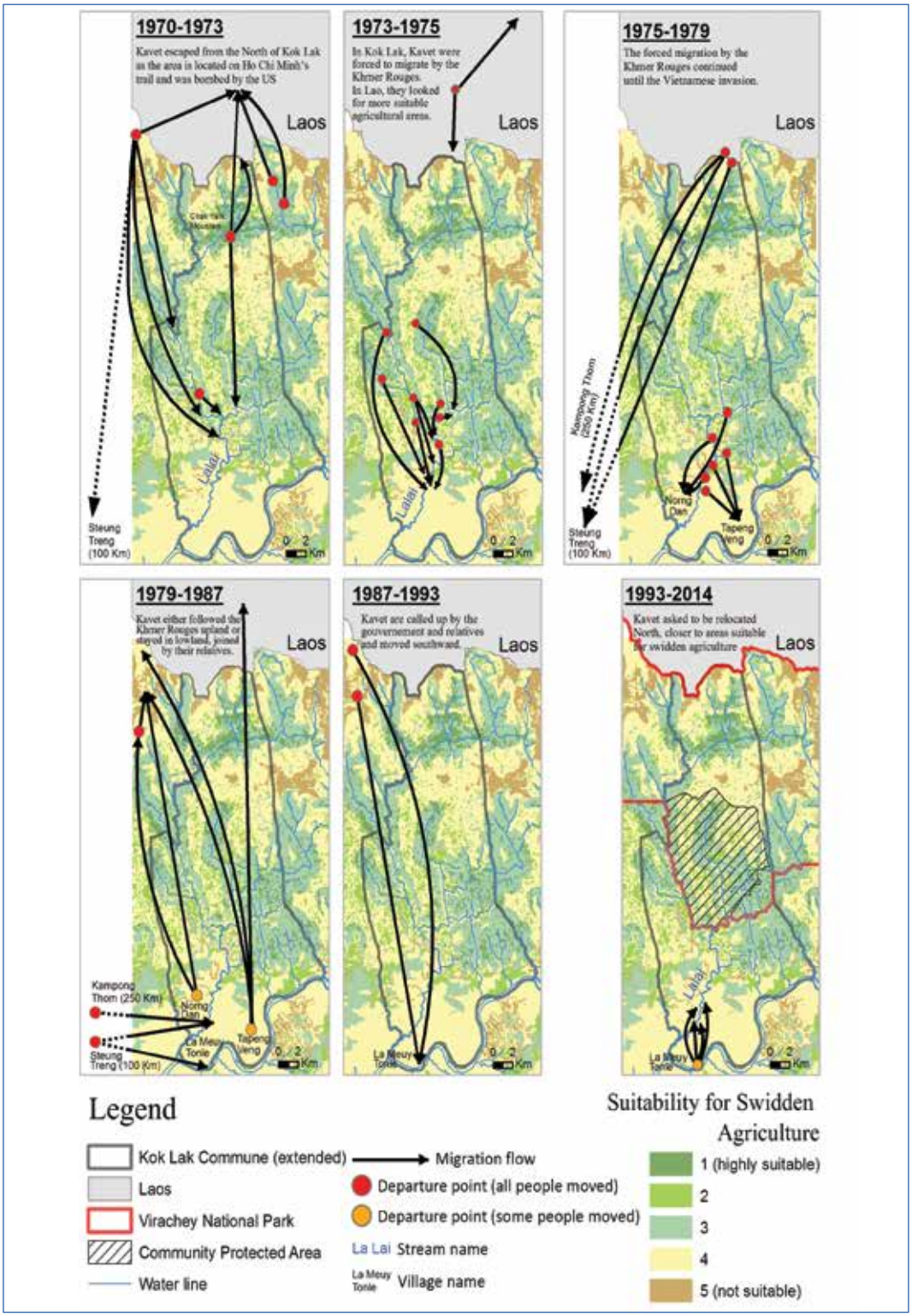


***Figure 4:*** *Migrations and swidden agriculture in the recent history of the Kavet*

## 1979-1987: Instability, division among Kavet and initial appropriation of paddies and rice cultivation equipment

After the Vietnamese invasion in 1979, the Khmer Rouge in Kok Lak commune escaped the invaders and government armies and moved to the north near to the border with Laos. A section of the Kavet people were persuaded by the Khmer Rouge to follow them, but this move was not driven by support for Khmer Rouge dissidence, but was rather motived by a desire to re-establish swidden agriculture in the north, which was very suitable for this purpose, and by the fear of being killed by the Vietnamese (Figure 4). However, confusion arose in that the Vietnamese army identified some Kavet as Khmer Rouge soldiers as they were sharing the same territory. The rampant conflict between the Khmer Rouge and the Vietnamese army meant that the entire area was unstable and the Kavet could not practice their swidden system to the full extent. They never stayed in one place for more than one cropping season and food insecurity became a serious issue.

Another group of Kavet stayed in the lowland area of Kok Lak commune along with some others who had moved to Steung Treng and Kampong Thom under the Khmer Rouge regime. At this time, all paddies and rice cultivation equipment that were collectivized during the Khmer Rouge regime were redistributed to individual families. The de-collectivization of land and agricultural equipment was carried out under the supervision of local authorities (village chief and elders) who until then had assumed the role of overseeing the allocation of land for swidden agriculture. Land area suitable for paddy is actually quite limited in the commune, and was distributed to individual families without clear rules. However, it seems that the labor capacity of the family was an important factor in decisions relating to land allocation. Even so, paddies were not available over large areas so the people who were the first to benefit from this rice land distribution received land with greater soil fertility and potential for intensification. Agricultural equipment as well as draught animals were redistributed to the individual households but quite a few were allocated on a 'first come, first served' basis to families who were engaged in rice cultivation.

At the same time, the return to swidden agriculture was limited by several factors. For a start, the region was still largely unstable as a result of persistent conflicts between government/ Vietnamese armies and the Khmer Rouge and so it was risky for the Kavet to venture into the forest. Families also needed family labor and resources for rice production, thus resources available for swidden plots had diminished. So people started to look for alternatives and turned to the cultivation of non-rice (chamcar) crops on upland plots located on the periphery of villages, beyond the residential area and home gardens. The crops grown were similar to those in the swidden plots (mostly vegetables for self-consumption) but they were cultivated on a permanent basis (not under a swidden system with fallow periods). Access to these chamcar lands – and to paddies - was managed by village leaders and elders under the close supervision of the Vietnamese as was the case in the rest of the country at that time. Each household was given a parcel of 1500 sq. meters. However, some families with low labor capacity received smaller land areas. Our interviews revealed that households experienced no restrictions or exclusions in terms of the allocation of these chamcar lands.

## 1987-1993: Deepening inequality in access to paddies

At the end of the 1980s the Vietnamese army left the area, and peace and stability were re-established. Donor-supported state projects (e.g. the UNDP Cambodia Reintegration and Rehabilitation (CARERE) project) arrived in Kok Lak with various development assistance services. These included rice cultivation equipment and draught animals for paddy farmers and the rehabilitation or construction of physical infrastructure (i.e. roads). NGOs also started to be involved in the area. With growing stability, security and the provision of social services, Kavet swiddeners moved back from their refuge near the border with Laos southward to the lowland areas where their fellows from the Kavet population of Kok Lak had concentrated (Figure 4). These migrations created a high demand for paddy land. But most of the lowland paddies with good soil quality and rice cultivation equipment and draught animal were already appropriated and distributed to those who had stayed behind during the Vietnamese period. The new migrants were therefore given paddy lands that were distributed by the Kavet traditional authorities but only on smaller plots with lower soil fertility. They benefited from the distribution of agricultural equipment and draught animals, but in smaller quantities. Our survey shows that the main reason for this return migration was not so much an interest in lowland rice cultivation but rather to practice swidden agriculture in the areas the Kavet people had used before the Khmer Rouge regime. The arrival of these new migrants in lowland rice cultivation areas marked a renewed movement to swidden agriculture north of villages in eco-zone 1 and further north into eco-zone 2 (Figure 3).

This difficulty in accessing paddies and rice cultivation equipment exacerbated the differentiation processes initiated earlier, and two main groups of farmers emerged. On the one hand, there were those who had become primarily lowland rice farmers (with a land area size that allowed them to be food secure) and who were settled and conducting agriculture in the lowland area (eco-zone 1). Swidden agriculture and chamcar remained an element of their livelihood diversification strategy but their interest was focused on permanent agriculture. They practiced swidden agriculture not too far from their villages in the north of eco-zone 1, in areas that were mostly unfavorable for swidden agriculture (see above). On the other hand, another group of households moved further north to conduct swidden agriculture in an area that was more suitable for swidden (eco-zone 2, along the La Lai Stream, which includes a large area inside the present-day Virachey National Park). They decided to move back to this swidden area because they had a rice land area size that was insufficient for them to be food secure and/or because they had a greater labor capacity that allowed them to engage in both lowland rice and swidden agriculture.

## 1993-2014: State denial of swidden agriculture and the emergence of cashew plantations

In the early 1990s, Kavet settlements remained adjacent to the Sesan River, but the people requested to be relocated further north, closer to lands that were more suitable for swidden agriculture. Even though the government and NGOs continued to encourage the Kavet to cultivate paddy and remain in the lowland area, the village settlements were relocated

north to their current location (Figure 4). This allowed them to return to swidden agriculture in areas that they had used for this purpose in the early 1970s. This move was managed under the authority of village leaders and elders in the same way as had been the case in previous settlements in 1987. Many families then returned to their swidden plots located along the La Lai Stream and some to areas to the very far north of the village.

Virachey National Park (VNP) was officially established as forest Protected Area in 1993 but its management did not come into effect until 1998 (Baird 2013) (Figure 4). The establishment of the VNP took place without consultation with the Kavet (Baird 2013) and swidden agriculture is strictly forbidden inside this area, although the park encroaches upon large areas of Kavet swidden land (north of eco-zone 1 and the full extent of eco-zone 2, Figures 3 and 4). However, the majority of people continued to conduct swidden agriculture. In 2005, the government established a Community Protected Area (CPA) consisting of several zones where rules and forest practices were declared in co-management with the Ministry of Environment. CPA rules are aligned with the mandate of Protected Areas, which forbids the practice of swidden agriculture. The enforcement of CPA regulations has put further pressure on the Kavet to cease swidden agriculture in the area. For lowland farmers mostly involved in permanent lowland agriculture, the decision has had little effect as their swidden plots are located outside of the Protected Area. In contrast, the establishment and enforcement of the CPA will have a particularly significant effect on those who have moved northwards and are more dependent on swidden agriculture for their food security.

In a parallel process, the development of family-scale cashew plantations will affect Kok Lak commune. Cashew plantations actually began in the late 1990s but were in full swing in Kok Lak from 2005 to 2010. In this period, the interest of Kavet people in income generation from cashew plantation increased and the conversion of swidden plots to perennial crop plantation became common practice. Cashew production is not a very time-consuming or input-intensive activity and the proximity of the large Vietnamese market means that the cultivation of cashew nuts will continue to be a widely adopted diversification strategy. The change has tended to start with lowland farmers who transform their swidden land (south of the present-day VNP) in areas where the successional patterns are not favorable for swidden agriculture (north of eco-zone 1) but also because these households have lost interest in this traditional practice. But the change to the cultivation of cashew nuts is also expected to be pursued by the upland famers currently involved in swidden agriculture in areas of eco-zone 2 located outside VNP. The push factor is related to the reduction in space that has resulted from the establishment of the Protected Area, which is forcing a reduction in fallow periods and is thus limiting soil fertility. The pull factor is the opportunity offered by the emerging market for cashews. The conversion of swidden plots into cashew plantations has been proceeding gradually alongside the continual practice of swidden agriculture, both inside and outside the VNP. However, the traditional leaders and elders in Kok Lak have decided to limit the area of cashew plantation, especially in areas adjacent to the VNP, in order to keep the lands available for swidden agriculture, which remains an important activity for many household farming systems.

The process involved in the acquisition of land to establish cashew plantations has been poorly regulated and has operated on a 'first come, first served' basis. As in the case of rice land appropriation, an important parameter that differentiates people in access to cashew land is the time when the conversion of swidden or forest into cashew plantation took place. Our interviews suggest that the availability of fallow land allows those who are the 'first comers' to acquire larger areas and land with a higher fertility value. The distances from the village settlement and accessibility by bicycle and motorbike to transport produce to market are important criteria in the choice of cashew plantation areas made by the 'first comers'.

## Land tenure changes

Collective ownership and community-based land tenure arrangements that were once the core institutions for governing the access to, use of, and control over land are evolving in two different ways with respect to economic development (Table 1). Factors affecting this evolution of tenure arrangements include a higher degree of commoditization, demographic or population increase, the policy for Protected Areas (PAs) and cultural influences from outside individuals and organizations.

For the past 40 years, and especially since the 1990s, the different forms of land tenure that have prevailed for swidden agriculture have evolved towards the individualization of private land property rights. This is a direct consequence of the demise of swidden agriculture resulting from higher commoditization of land and resources associated with the development of rice cultivation and cashew plantation. The privatization of land rights allows people to have a permanent claim on land and to be able to transfer land to the next generation or sell it in a market system. Privatization is also a self-driven process because the advance of private and permanent agriculture, combined with the establishment of large PAs, has considerably limited the area available for swidden, which includes the cultivated plot (*meur*) and a larger fallow area. Privatization of land reduces the availability and duration of the fallow period, which limits the development of swidden agriculture, thus creating the incentives for conversion and privatization. However, in remote areas, the practice of swidden agriculture has not disappeared along with *meur* and fallow land, and thus the community-based rules of access and use by Kavet still apply.

***Table 1:*** *The diversity of land tenure regimes in present day Kok Lak*

| | | Property rights given to the resource users/appropriators | | | | |
|---|---|---|---|---|---|---|
| | | **Access** | **Usufruct** | **Claim** | **Possession** | **Ownership** |
| **Management of the property right of the resource users/appropriators** | **Public** | | | | | |
| | **State** | Virachey Protected Area (outside CPA) | | | | |
| | **Co-Management** | | | Community Protected Area (CPA) | | |
| | **Community-Collectivity** | | Forest (spiritual - burial) | Fallow land still with trees in production | Swidden land (*meur*) in Kavet swidden agriculture (temporary) | |
| | | | Forest (other) (NTFPs, fishing, hunting) | | | |
| | **Private** | | | | Habitation in village | |
| | | | | | Rice land | |
| | | | | | Cashew land | |

Source: Authors, adapted from Le Roy et al.1996

Note: See footnotes 3 and 4 for an explanation of the specific terms used in this table

With the creation of the Virachey National Park the state has re-introduced certain forms of control over land rights. Protected Area management rules forbid swidden agriculture, so, instead of being allowed to practice swidden agriculture, the Kavet were consulted to establish a forest resources co-management scheme inside the Protected Area, which became the Community Protected Area (CPA). In this area (measuring 9,909 ha), the management of resources is jointly designed and enforced by the community and representatives of the Ministry of Environment. This co-management scheme has been put in place to regulate the access to, and use of forest resources for the Kavet. The practice of swidden agriculture is forbidden inside the CPA.

After several years, an area that was mostly used for swidden agriculture and managed under collective rules defined by Kavet communities has abruptly changed. The local institutions of the Kavet now have to play with different rules for land use relating to private claims and the alienation of land rights to state control. The Kavet were not necessarily prepared to engage with this legal pluralism and fragmented land tenure system. But they are now fully aware of the implications. They have not passively accepted these pressures and have mobilized to protect their livelihood assets and strategies. But they are also not resisting all new forms of agriculture such as cashew. They are adopting new practices and engaging with markets. But in many situations swidden is still important to their livelihood strategies, and they have consequently consistently requested to keep access to swidden agriculture land and to be able to rely on their own tenure system in some parts of the enclosed Virachey National Park, which they consider as the core of their homeland. We observed that the so-called CPA has not managed to address this legitimate claim in a very satisfactory way.

# DIFFERENTIATION OF HOUSEHOLD FARMING SYSTEMS IN KOK LAK

As a result of the complex transformation in land use systems, Kavet cropping systems are composite in that they consist of different crops and activities (swidden, paddy, cashew, NTFPs, and so on), which are managed under different land/resources tenure regimes. We indicated earlier the challenges of navigating in a context of institutional and legal pluralism, but the composite nature of cropping systems obliges swiddeners to navigate different cropping seasons which involve different calendars, different locations (sometimes far from each other), different peaks of labor, different technical itineraries, and so on. We suggest that not all households have been influenced by, or have contributed evenly to, these transformations and in our research study we were particularly interested in eliciting the different household trajectories.

## Differentiation drivers and trends

The year 1993, marking the establishment of the Virachey National Park, was pivotal in the differentiation of land use at commune and household levels. The ban on swidden agriculture in the Park has certainly forced the Kavet to revise their cropping activities, but we have also shown that new opportunities from the cashew market have created significant incentives to convert swidden into small-scale plantations.

The commune data on landholdings and land use practices at household level indeed reveals important differences between families established before or after 1993. The transformation of cropping practices obviously took place over a longer period of time, but 1993 is an important milestone.

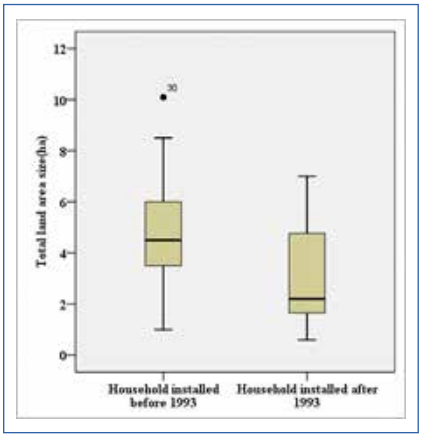


***Figure 5:*** *Total land area size between households in Kok Lak[9] (N=42)*


***Figure 6:*** *Distribution of mean land area size per land use item (N=42)*

[9] Box plot graph indicates the values of five descriptive statistics. The central value is the median. The lower and upper limits of the box are the first and third quartiles respectively. The inferior and superior limit equals the first quartile respectively minus and plus 1.5 x distance between 3rd and 1st quartile. All values outside this range are called singular values

The households established in Kok Lak before 1993 have a significantly larger landholding size (4.80 ha) than those installed after 1993 (3.17 ha) (Analysis of Variance (ANOVA): F=4.934, p=0.033) (Figure 5). When considering specific land use (Figure 6), there are also significant differences between households installed before and after 1993. The size of paddy is significantly different between both groups of households (1.21 and 0.85 ha, ANOVA F=3.332, p=0.0436), which suggests that the effect of unequal access to paddy, initiated in the 1980s, is still clearly visible today. The difference in landholding size for small-scale plantation is also significant between households installed before 1993 (1.62 ha) and those after (0.72 ha) (ANOVA; F=8.474, p=0.006). As for swidden, the differences are clear but are not statistically significant. Swidden is now forbidden for both groups of households and access to *meur* lasts for only two years before the plot returns to the common land pool. In this way, land accumulation is not possible. We also note a significant correlation between area size of total landholdings, small-scale plantations and paddy land area size (Figure 7), which suggests that both processes of land accumulation (rice and small-scale plantations) have benefited the same households.

| | Total land | Swidden | Mosaic swidden-plantation | Small scale plantation | Chamcar outside village | Paddy |
|---|---|---|---|---|---|---|
| Total | 1 | | | | | |
| Swidden | 0.588** | 1 | | | | |
| Mosaic swidden-plantation | 0.145 | -0.178 | 1 | | | |
| Small scale plantation | 0.715** | 0.123 | -0.089 | 1 | | |
| Chamcar outside village | 0.201 | -0.281 | -0.144 | 0.239 | 1 | |
| Paddy | 0.505** | -0.039 | -0.078 | 0.413* | 0.337* | 1 |

***Figure 7:*** *Pearson Correlation of land area size per type of land use*

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Our findings suggest that there are three distinct elements that explain this differentiation process.

1) In a context where land appropriation follows the rule 'first come, first served', it is clear that the households who were present and able to make a land claim when they had the opportunity to do so are at an advantage. These households received paddy land and were later occupying lowland swidden areas and were reactive in converting them to cashew plantation. This has particularly benefited those households who were well connected to past authority. In a context where the land is now privatized to a large extent, and where the possibilities of further expansion of the agricultural area are limited, these inequalities are now reproduced by inheritance.

2) Given that access to land was conducted through unpaid appropriation, the family labor capacity has been decisive in determining the area that could be accessed. The difference in active labor between households installed before 1993 and those installed after, is also statistically significant, 4.52 versus 2.81 people, respectively

(ANOVA F=10.617, p=0.002). Nowadays, the household labor capacity explains why some families continue to engage in swidden agriculture in areas located far from villages. Over the past 25 years the relationships of people to the land have completely changed. In this context the differentiation process at play is still profoundly marked by the demographic differentiation, which is indicated by the evolution of the dependency ratio of the households (number of non-active to active people) that evolves along its life cycle.

3) The age of the household also reveals important differences in respect of interest in swidden agriculture: Sixty-five percent of households installed before 1993 are still involved in some form of swidden agriculture whereas only 14 percent of households installed after 1993 practice this activity. Indeed, our interviews revealed that most young people (but not all) are less interested in swidden agriculture than are their elders. This interest in non-swidden forms of agriculture or even in non-farm activities is another important element influencing current land use practices, and this also explains the interest younger households have in permanent agriculture (paddy and small-scale plantations).

## Differentiation and typology of farming systems in Kok Lak

Before the 1970s Kavet families were living mostly on swidden agriculture in large forest territories. They enjoyed considerable freedom to practice their swidden agriculture and to interact with outsiders through various timber and NTFP trade activities.

Over the past 40 years, we suggest that various drivers of differentiation have been at play that have profoundly transformed the swidden system practiced by the Kavet. These include the appropriation and integration of paddy in their cropping systems, the dramatic reduction of areas where swidden is allowed due to Protected Areas regulations, and later the conversion of swidden and/or appropriation of forest into small-scale perennial crop plantations. We identify three very distinct trajectories of evolution reflecting different degrees to which the swidden system has been transformed. The different types are positioned on a gradient that indicates the relative importance of swidden agriculture in the current farming systems of the people concerned (Figure 8). The distribution of mean land area size per type of land use is presented in Figure 9.

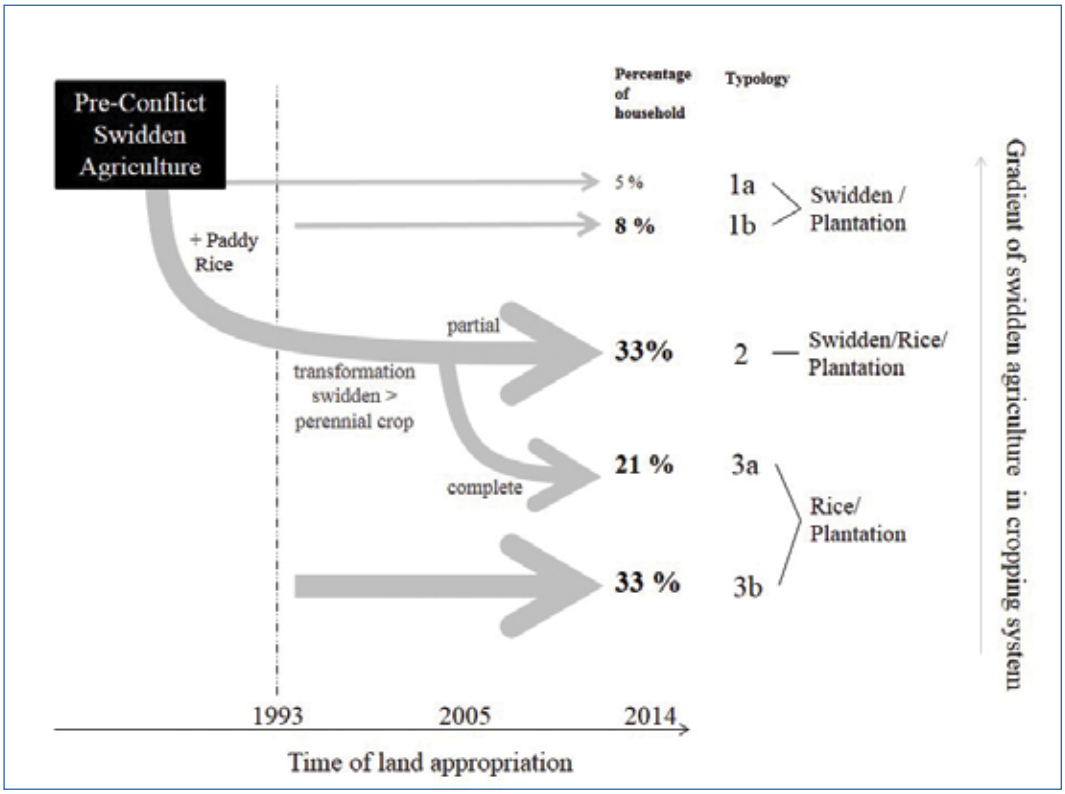


***Figure 8:*** *Differentiation and typology of farming systems in Kok Lak*

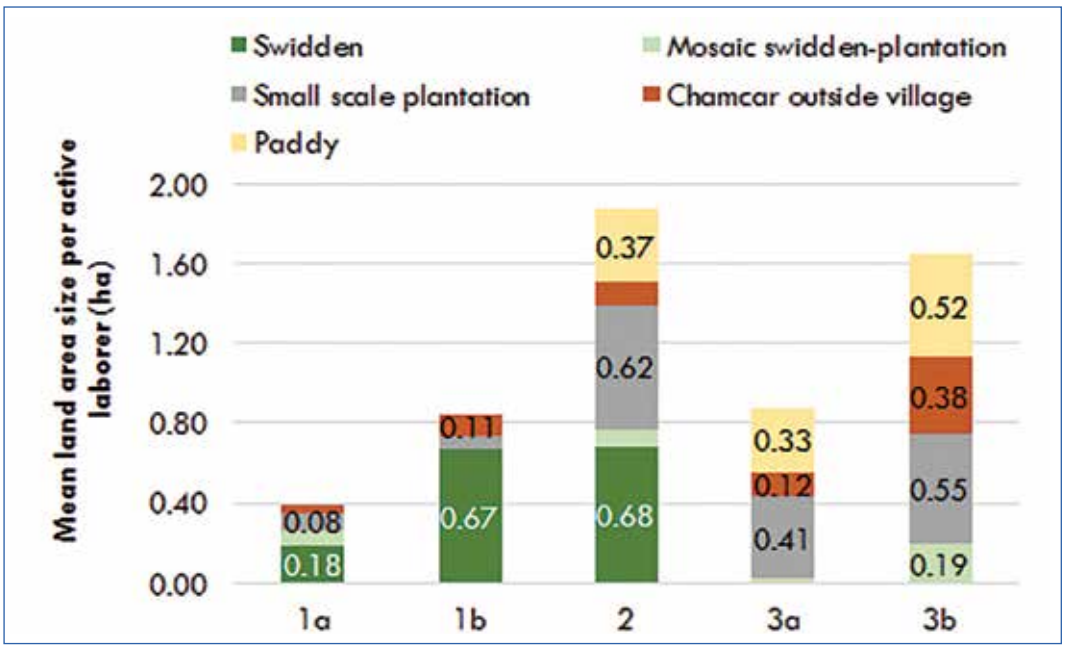


***Figure 9:*** *Land area size per active laborer (per type of land use)*

## Type 1 - Swiddeners

Type 1 consists of households who never received paddy land because they were not present when the distribution of paddy land and agricultural equipment took place at the end of 1980s/early 1990s (type 1a, 5 percent of the sample) or because they were too young to benefit from it as an individual household (type 1b, 8 percent of the sample). In total, they represent 13 percent of our sample. They have lived a swidden lifestyle in the uplands since the end of the war and the socio-political instability of the 1980s, and are still mostly relying on swidden agriculture and forest common pool resources as a main source of livelihood. Given the constraints on swidden agriculture, they are being persuaded to convert swidden plots into cashew income and secure land for their next generation. But this transformation is very gradual given the time needed before these plantations become productive. But most of their landholding still consists of plots with swidden agriculture (Figure 9).

Type 1a households have relatively smaller landholdings per active laborer (mean=0.39 ha; min=0.28 ha; max=0.50 ha) as a result of low labor capacity combined with the fact that more resources are allocated to the collection of forest common pool resources (including fishing). Household groups under type 1b are younger, with higher labor capacity, and are mostly living on swidden land adjacent to the CPA with a larger land area size per active laborer (mean=0.894 ha; min=0.61 ha, max=1.26 ha) (Figure 9). The food security of types 1a and 1b has greatly suffered from recent changes in land use and the limitation of swidden grounds. Forty percent are said to be food secure through their own food production, but they are highly dependent on the collection of Common Pool Resources (CPRs) and on market-based activities such as selling malva nuts to make ends meet.

The detailed case study on income reveals that forest-related activities represent an important share of the total gross income (estimated at USD 1,645 annually: 53 percent in-kind and 47 percent in-cash). Income from swidden agriculture represents 34 percent of this total income. The weakness of this income is compensated for by the collection of malva nuts from the CPA (35 percent) and by a diversity of other activities (fishing, handicrafts, NTFPs and chamcar) which, when accumulated, represent 18 percent and are therefore certainly not negligible.

Omitting these households from land and agricultural equipment distribution associated with the establishment of the Protected Area has rendered them quite poor and vulnerable. Future perspectives for households of type 1 (1a and 1b) are somewhat limited and depend greatly on the future management of the CPA and how the question of swidden agriculture will be addressed. For these households, there is a crucial need for swidden agriculture to be allowed, while inclusive access of these households to the CPA is maintained.

## Type 2 - Composite swiddeners

Households of type 2 are composite swiddeners in that they have a diversified portfolio of activities and income opportunities. They are all households installed before 1993 (with the exception of one household that was integrated within the group) and represent 33 percent of

households in our sample (Figure 8). They have confronted all the different forms of change in land use systems, which they have somehow managed to incorporate. They are all involved in swidden agriculture but also have paddy land. They have converted a part of their swidden land into cashew production. Their interest in, and attachment to, swidden agriculture, associated with a significant labor capacity, allow them to conduct agricultural activities in the lowland (rice and small-scale plantations) along with swidden agriculture in the upper north in an area adjacent to the CPA.

Households in this type have the largest landholdings in the commune as well as the largest landholdings per active laborer (mean=1.87 ha; min=0.57 ha; max=5.05 ha) (Figure 9). Sixty five percent of households in this type declare themselves to be food secure. Our datasets and observations suggest that swidden agriculture buffers households with smaller landholdings in the lowland area (paddy or small-scale plantation) from the risk of food insecurity.

Type 2 households have the highest annual income among all the three types (USD 2,398 per year). Their labor capacity allows them to engage in different activities and to diversify their income. However, swidden agriculture and collection-sale of malva nuts remain the most significant in the income structure (representing 16 and 22 percent, respectively, of total gross income).

Access to a diversity of land use opportunities is an asset to households in type 2 and the future prospects for this group are better than they are for households in type 1. However, the continued reliance on swidden agriculture and the importance it has for the poorest of this group reinforce the need to reconsider the place, role and recognition that is presently given to it.

### Type 3 - Lowland rice growers

Unlike type 2, households in type 3 have totally transformed their swidden land into cashew plantations (type 3a, 21 percent of the sample) or have never engaged in swidden (type 3b, 33 percent of the sample) (Figure 8). The reason why type 3a households have abandoned swidden is related to the continued pressure exerted on swidden, and the resulting exiguity of fallow land and a marked preference for lowland, permanent agriculture. For type 3b households the reason for not engaging in swidden is related to low labor capacity (2.4 laborers per household on average) that prevents them from working simultaneously in lowland rice cultivation and on plantations.

Type 3b households are younger and were installed after 1993: they have mostly inherited rice land from their parents and/or have had the capacity to mobilize resources to materialize their claim to small-scale plantations and to access chamcar land outside of the village, despite a lower labor capacity.

These observations translate into mean land area sizes per active laborer. The type 3a household land-holding size per active laborer is 0.87 ha (min=0.4 ha; max=1.75), while

the area size for 3b type households is 1.64 ha (min=0.3 ha; max=4 ha). The average income appears to be lower for households of type 3a (USD 1,031/year) than of type 3b (USD 1,537/year). Types 3a and 3b mainly earn their income from paddy and malva nuts. 3b households also gain from other income-generating activities such as wage labor - related or not to migration or to more illicit activities including illegal logging, which we were not able to assess accurately.

The future prospects for these households lie essentially in their capacity to reinforce their lowland agricultural systems. The possibility to expand cultivated areas is limited so the improvement needs to come from existing land resources. The challenge will be even more difficult to overcome in the future when all of the private landholdings of these households are divided through inheritance. Improving the productivity of small-scale plantations via intercropping of an annual crop is a first possibility. Systems of rice intensification that do not demand substantial inputs should be recommended to increase yield. This can be promoted through the adoption of integrated multi-purpose farming (MPF) systems that include aquaculture and livestock production.

## CONCLUSION AND RECOMMENDATIONS

Over the course of the past 40 years, forced and free migration has reshaped the swidden landscapes of the Kavet people. Irrespective of the nature of the forces that drive these migrations, we have identified a consistent trend on the part of the Kavet to move back to the core of their swidden territories. This trend is an expression of the Kavet communities' determination to practice swidden agriculture despite a changing environment.

With the establishment of the Virachey National Park (VNP) in 1993, the state has become an important actor presiding over Kavet destiny. VNP overlaps large areas of the swidden grounds formerly used by the Kavet. The ban on swidden agriculture within the Park has considerably reduced the availability of land for fallow, thus putting the swidden system of the Kavet in jeopardy.

In a parallel process, the development of permanent lowland agriculture has given important incentives to some Kavet people to quit swidden agriculture and to stabilize their agricultural activities in lowland areas. However, a significant number have remained composite swiddeners in that they practice both swidden agriculture and paddy cultivation. The development of cashew production through small-scale plantations at household level will create further incentives for the Kavet people to transform part of their swidden land into permanent perennial crop plantation.

The swidden territories of the Kavet are now much more fragmented and present a mosaic of different land use and land tenure regimes. At the center lies a contradiction between, first, those agricultural systems that represent a permanent claim over private land, and that allow for commodification and accumulation (rice and small-scale plantation), and, second, those agricultural systems that represent an impermanent claim over land by local institutions,

that prevent any forms of accumulation (swidden agriculture). At the household level, the farming systems that result from these transformations are hybrid and consist of an association of different land use practices such as paddy rice, swidden, and small-scale perennial crop plantations. These still rely on forest common pool resources and fisheries activities. People are not resisting nor fully embracing these new forms of agriculture. Instead, they are using them according to their own interests and asset base to create a diversified livelihood.

Among the different trajectories of evolution we have identified is the undeniable interest in non-swidden agriculture and non-farm activities on the part of younger households. However, despite the strong push and pull away from swidden agriculture, we have shown that swidden still plays a vital role in the Kavet communities of Kok Lak commune. It is practiced by nearly half (46 percent) for whom it represents a significant part of their income and is an important element in supporting household food security.

This chapter has shown a misfit between the land use changes that have affected farming systems, and the institutional instruments put in place to frame these transformations. A co-management scheme between the Kavet people and the state has been established to devolve part of the management of forest resources to the local community in an attempt to reduce poverty and to promote inclusive development. But swidden agriculture is not playing any role in this scheme despite its importance to their sense of identity and their way of living.

In this context, we keenly recommend that all relevant stakeholders (farmers, swiddeners, commune and traditional village authorities, representatives of the CPA and the Ministry of Environment) become engaged in a more detailed land use inventory and planning exercise where central questions about land availability and use, as well as the requirements of future generations, can be articulated and the diversity of interests and needs within the communities, consequently recognized. The recognition of the role swidden agriculture plays in the community, and a focus on integrating it into on-going conservation efforts, is particularly important.

The Cambodian legal framework offers a good basis to conduct land use planning at village and commune level with the participation of all relevant actors. This planning needs to widen its scope so that it is not restricted to CPA management. For instance, the demarcation of a community development zone, as set out in the Law on Protected Areas, could be used to open up a larger space for swidden agriculture.

In a wider perspective such land use planning should serve as a forum in which the Kavet are able to critically review past transformations of their land use systems and project themselves into the future with both forward planning and directed activities that balance the needs of their entire population.

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# BIBLIOGRAPHY


Backstrom, M., Ironside, J., Paterson, G., Padwe, J. and Baird, I. (2007) *Indigenous Traditional Legal Systems and Conflict Resolution in Ratanakiri and Mondulkiri Provinces, Cambodia*. Phnom Penh: United Nations Development Programme.

Baird, I. (2008) The Case of the Brao: Revisiting Physical Borders, Ethnic Identities and Spatial and Social Organisation in the Hinterlands of Southern Laos and Northeastern Cambodia, *Études thématiques, 18,* pp. 596-620.

Baird, I. (2009) Controlling the margins: Nature conservation and state power in northeastern Cambodia. in Bourdier, F., (ed.) *Development and Dominion: Indigenous Peoples of Cambodia, Vietnam and Laos,* Bangkok: White Lotus Press. pp. 215-248.

Baird, I. (2013) The Ethnoecology of the Kavet Peoples in Northeast Cambodia. in Poffenberger, M., (ed.) *Cambodia's Contested Forest Domain: The Role of Community Forestry in the New Millennium,* Manila: Ateneo De Manila University Press. pp. 155-186.

Baird, I. (2010) Making spaces: The ethnic Brao people and the international border between Laos and Cambodia. *Geoforum, 41,* pp. 271-281.

BPAMP (2005) *Participatory development of management plans for Protected Areas in Cambodia, Biodiversity and Protected Areas Management Project* Phnom Penh: Ministry of Environment.

Condominas, G. (2009) Anthropological Reflections on Swidden Change in Southeast Asia. *Human Ecology, 37,* pp. 265-267.

Cramb, R. A., Colfer, C. J. P., Dressler, W., Laungaramsri, P., Quang Trang, L., Mulyoutami, E., Peluso, N. L. and Wadley, R. L. (2009) Swidden Transformations and Rural Livelihoods in Southeast Asia. *Human Ecology, 37,* pp. 323-346.

De Koninck, R. (2006) On the Geopolitics of Land Colonization: Order and Disorder on the Frontiers of Vietnam and Indonesia. in Dufumier, M., (ed.) *The Agriculture in Southeast Asia: An Update,* Paris-Aix: EDISUD. pp. 33-59.

Ducourtieux, O. (2006) Is the diversity of shifting cultivation held in high enough esteem in Lao PDR? in Dufumier, M., (ed.) The Agriculture in Southeast Asia: An Update, MOUSSONS 9-10. pp. 61-86.

Ducourtieux, O., Laffort, J.-R. and Sacklokham, S. (2005) Land Policy and Farming Practices in Laos. *Development and Change, 36*(3), pp. 499-526.

Fox, J. M., Fujita, Y., Ngidang, D., Peluso, N., Potter, L., Sakuntaladewi, N., Sturgeon, J. and Thomas, D. (2009) Policies, Political-Economy, and Swidden in Southeast Asia. *Human Ecology, 37,* pp. 305-322.

Fox, J. M., McMahon, D., Poffenberger, M. and Vogler, J. (2008) *Land for My Grandchildren: Land-Use and Tenure Change In Ratanakiri: 1989-2007,* Community Forestry International (CFI) and the East West Center.

Ironside, J. and Baird, I. (2003) *Wilderness and Cultural Landscape: Settlement, Agriculture, and Land and Resource Tenure in and adjacent to Virachey National Park, Northeast Cambodia.* Banlung: Ministry of Environment, Department of Nature Conservation and Protection.

Israel, G. D. (1992) *Determining Sample Size.* Factsheet PEOD-6, University of Florida.

Le Roy, E., Karsenty, A. and Bertrand, A. (1996) *La sécurisation foncière en Afrique. Pour une gestion viable des ressources renouvelables,* Paris: Karthala.

Mikkelsen, C., ed. (2014) *The indigenous world 2014,* Copenhagen International Work Group for Indigenous Affairs (IWGIA).

NCDD (2012) *Commune Database Online,* Available at: http://www.ncdd.gov.kh

Padoch, C., Coffey, K., Mertz, O., Leisz, S. J., Fox, J. M. and Wadley, R. L. (2007) The Demise of Swidden in Southeast Asia? Local Realities and Regional Ambiguities. *Danish Journal of Geography, 107*(1), pp. 29-41.

Phath, M. and Sovathana, S. (2012) *Country Technical Notes on Indigenous Peoples' Issues. Kingdom of Cambodia.* Phnom Penh: IFAD Cambodia.

Schmidt-Vogt, D., Leisz, S. J., Mertz, O., Heinimann, A., Thiha, T., Messerli, P., Epprecht, M., Pham, V. C., Vu, K. C., Hardiono, M. and Truong, M. D. (2009) An Assessment of Trends in the Extent of Swidden in Southeast Asia. *Human Ecology, 37,* pp. 269-280.

Scott, J. C. (2009) *The Art of Not Being Governed. An Anarchist History of Upland Southeast Asia, Yale Agrarian Studies Series,* New Haven & London: Yale University Press.

Tol, S. and Srey, M. (2010) Malva nuts and co-management: can the poor benefit? in Frieson, K., (ed.) *Social Landscapes and Rural Livelihods. Cambodian Communities in Transition,* Phnom Penh: The Learning Institute.


# Section D

## Environmental change in fishing communities

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## CHAPTER 7

Pathways of change in a coastal resource system: study from Kampong Trach district, Kampot province

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Environmental change and Community Fisheries: Widening the scope of fisheries management to provide better support for vulnerable Cambodians

# CHAPTER 7

## Pathways of change in a coastal resource system: Study from Kampong Trach district, Kampot province

VOE Pisidh, TOUCH Panha and Jean-Christophe DIEPART



## ABSTRACT

Over the past several years, Cambodia's coastal resources system has undergone considerable transformation. The causes have included uncontrolled fishing activities, tourism development, salt and shrimp farming, sand mining, and trade, to name just the most significant. Against this background, this study analyzes pathways of change over the past 15 years in coastal resource systems in two neighboring communities in the Kampong Trach district of Kampot province. The analysis proceeds on two different levels. We first look at change in respect of the cross-scale multiple drivers in the resource system at village level and its effects on the social and ecological components of the marine, intertidal and agricultural areas of the coastal zone. Then, at household level, we examine the diversity of adaptation measures adopted to deal with these changes, and evaluate their impacts on livelihoods.

We argue that the degradation of fisheries resources in marine and intertidal zones results from drivers that originate outside and inside the communities, but mostly stems from problems of governance. Despite tangible improvements in rain-fed rice yield, the development of the farming sector is constrained by limited capacity to diversify and intensify production. The adaptation paths to this resources degradation squeeze are multiple.

The few households who can afford to enhance or intensify their farming and fishing efforts usually manage to improve their food security status. But in a majority of cases, the adaptation works through a move away from the land and the sea, either through self-employed non-farm and non-fishing activities (local business associated with cross-border trade with Vietnam) or through wage labor. Self-employed activities and demand more capital but represent the main path of improvement in these communities. Wage labor - particularly associated with migration - has become widespread but its potential to improve food security is very limited. Accessing credit and going into debt is another significant way in which people have attempted to adapt either to address chronic food insecurity or to maintain the same level of productivity.

The increase of mobility is a central element in adaptation strategy adopted by many who have been affected. This includes: mobility of labor (non-farm, wage and migration); the mobility of capital (e.g. conversion from marine zone fishing to trade); and mobility of landownership (occurring through market-based land concentration). However, we suggest that these processes of adaptation have actually reinforced the wealth disparity that exists between households. It has particularly exacerbated the vulnerability of those who are most dependent on small-scale fisheries.

**Key words:** *coastal area, fisheries management, small-scale fisheries, livelihood, social mobility*

## INTRODUCTION

In the coastal regions of Cambodia, the majority of households rely on fishing activities for their livelihoods. However, some are employed in farming, self-employed non-farm and wage labor activities, while others have migrated to find jobs and remittance money for their family (Marschke 2012). In the coastal province of Kampot most households are engaged in rice farming (Rizvi and Singer 2011). But for coastal people who depend on coastal aquatic resources, opportunities have emerged from both social and ecosystem (and species) diversity that have provided households with a wide range of resources. These have enabled them to cope or adapt under changing and often highly uncertain social, economic and environmental conditions. Livelihood diversification is essential for developing sustainable livelihood strategies and thus constitutes a crucial element in individual and community well-being (Brugère et al. 2008, Campbell et al. 2005).

Cambodia's coastal resources have changed over the past several years under the influence of several factors. These have included uncontrolled post-war resource exploitation, lack of coordinated management in trans-boundary water resources, degradation of the mangrove ecosystem and seagrass beds associated with development of salt farms and fish farming, and the rapid economic development driven by, for instance, tourism (Campbell et al. 2005, Marschke 2012).

This study analyzes pathways of change in coastal resource systems in two communities. The analysis proceeds on two levels. We look first at change and the associated cross-scale multiple drivers in the resource system at village level, along with the effects these drivers have had on the social and ecological components of the marine, intertidal and agricultural areas of the coastal zone. A central hypothesis is that the changes in the resource system have induced differential transformations in the production processes at the household level. Secondly, we examine these household level transformations for different types of household production systems. We look at the diversity of adaptation measures taken to deal with these changes and assess their impacts on livelihoods.

# ENVIRONMENTAL CHANGE IN COASTAL CAMBODIA



Although in the UN classifications Cambodia is still a 'least developed' country, it is, nevertheless, resource rich. However, after 20 years of war (1970-1990) and recent post-conflict exploitation, all resources, including coastal fisheries in Cambodia, have suffered sharp declines. Forests have traditionally seen the most serious decrease but other resources such as inland fisheries and mangrove-based harvesting have also been heavily depleted (Le Billon 2000, Un and So 2009). Other resources, such as offshore oil and gas, must also be taken into account as moves to extract those continue to develop (Cock 2010). A strong reduction has now been registered in catch per unit effort (CPUE) of fisheries resources, while the use of different fishing gears is reported to have significantly increased. The decline of resources and the subsequent impact of this on communities differ from one specific area to another (So and Touch 2011). For example, degradation of fish stocks in the Gulf of Thailand is caused primarily by the destructive fishing practices of both inshore coastal fishers and foreign over-fishing, or from illegal operations in offshore areas (NACA 2004). In the Memorandum of Understanding (MoU) between the Kieng Giang province of Vietnam and Kampot province in Cambodia (2008), the use of illegal fishing gear by both Cambodian and Vietnamese fishers in trans-boundary areas was highlighted as a matter of concern to be curtailed. The increased number of fishing boats and the use of modern fishing equipment is diminishing resources and habitats. This directly leads to habitat degradation and a decline in local fish stocks. There is also a concern about current rates of shoreline and offshore island tourism development. This development lacks transparent and accountable environmental and impact assessment processes and there is a general lack of local public input that would help in understanding and controlling it (Ouk et al. 2012).

Additional factors that challenge sustainable coastal resource management in Cambodia include a lack of coordinated management in trans-boundary waters and fishing disputes with Vietnam and Thailand. Furthermore, a lack of community-level awareness about law enforcement, in conjunction with the long-term sustainable use of resources, is still limited as local people concentrate on securing direct, short-term benefits.

Within Cambodia, all the living resources in the marine zone are under the direct management of the Fisheries Administration. Marine resources are ruled by the new Fisheries Law, which came into force in 2006 (Royal Government of Cambodia 2006). Cambodian fisheries, in both marine and coastal waters, are governed through the process of establishing Community Fisheries (CFis) of which, by 2013, 360 had been registered throughout the country. These arrangements represent attempts by the central government to decentralize fisheries management, conservation and enforcement efforts to a more local level. However, this system remains highly centralized and suffers from a number of governance shortcomings. For example, enforcement of rules and regulations associated with Community Fisheries is not effective due to the weak capacity and cross-level corruption of authorities that is evident in both Keng Kiang and Kampot.

Mangroves are trees and shrubs found in intertidal zones of coastal areas that have adapted to living in saline water, either continually or during high tides (Duke 1992). The importance and quality of the various goods and services provided by mangroves varies depending on location (Ewel et al. 1998). However, they do provide many critical ecosystem services to support coastal livelihoods. They play a key role in stabilizing land, cycling nutrients, processing pollutants, supporting nursery habitats for marine organisms and providing fuel wood, timber and fisheries resources. Moreover, they serve as key fish nursery grounds and thus link seagrass beds with associated coral reefs (Orth et al. 2006, Food and Agricultural Organization 2005, Mumby et al. 2004). Destruction of mangroves can thus interrupt these links, damage biodiversity and thus lower the productivity in reef and seagrass biomes (Alongi 2002). Rizvi and Singer 2011 also describe declines in fish stock due to increased fishing activity and the loss of mangrove forest. Documenting an impact assessment survey carried out in the context of the Rural Development Program in Kampot, supported by GTZ (the German agency for technical cooperation), Degens and Choun (2007) have shown that when mangrove forests are kept intact or regrown through community mobilization, ecosystem services are maintained and there is an increase in fisheries and other aquatic animal (OAA) resources.

Mangrove areas worldwide have become degraded and their conversion to other uses is widespread. These other uses have included the development of aquaculture, agriculture and the establishment of salt farms (Farnsworth and Ellison 1997). Among four municipalities and provinces where mangrove forests have traditionally existed, those in Kampot and Sihanoukville have been destroyed (MOE and DANIDA 2002). Mangrove forests are being cleared illegally for use as firewood, for the production of charcoal, to create saltpans, as part of land reclamation activity and to promote intensive shrimp aquaculture, among other activities (Johnsen and Munford 2012). Even when mangrove forests are theoretically protected by the Fisheries Administration (FiA) and Ministry of Environment (MOE), efforts to prevent illegal cutting are often ineffective (IUCN 2013, Johnsen and Munford 2012).

Seagrass meadows are also a key part of the intertidal zone where they are closely linked to mangrove forests, and those in Kampot are the largest in Southeast Asia (Kirkman and Kirkman 2002). Seagrass habitats play a critical role in supporting fisheries, in preventing erosion, providing storm protection, conserving biodiversity and in sequestering atmospheric carbon. They are important nursery and feeding grounds for many species of fish, including endangered species such as dugongs and seahorses. Seagrass meadows have been destroyed or extensively degraded as a result of unsustainable inshore fishing practices (Unsworth 2014, Unsworth and Cullen 2010).

In Kampot province salt farms are commonly found along the coast, although most are located close to paddy fields with the result that salt water leaks into these fields damaging the crop. The extensive degradation of coastal natural resources, including the loss of valuable forests, wildlife, fisheries resources, mangroves, coral reefs, and seagrasses, has led to an overall worsening of coastal social-economic conditions (Monyneath 2000).

# METHODOLOGY

## Analytical framework

Coastal environmental systems are among the most biologically productive social-ecological systems in the world (Turner et al. 1999). They have important ecosystem functions and provide important services for people who depend on them. For instance, mangroves, seagrass beds and coastal marshes provide habitat for juvenile fishes (ecosystem function), which can ultimately contribute to commercial and recreational fish landings (ecosystem service). They also have a role in wave attenuation (ecosystem function), which may protect coastal property from storm surge (ecosystem service) (Granek et al. 2010). Unfortunately, recent evidence shows that many human activities have severely diminished coastal ecosystem integrity and consequently the well-being of the people who depend on them. The coastal system is subject to different drivers of change that can be natural or human-generated and can directly or indirectly cause a change in the ecosystem's structure-function relationships (Newkirk 1996). These drivers or change agents, individually or acting together, can profoundly influence the overall state and productivity of the ecosystem (e.g. the fish yield) (Mumby et al. 2004). In this study we examined changes in the coastal social-ecological system in three subtype areas; inland areas (land-based areas influenced by sea water - e.g. rice farming and residential areas), intertidal areas (areas where fresh water and saltwater mix), and marine (inshore/offshore) fisheries systems (deeper zones where local people interact through fishing activities).

Directly connected to previous analyses on change in social-ecological systems, this research considered the effects that changes in the coastal system have had on the ability of households and communities to achieve food security. Impacts can be two-fold: they either create new opportunities (a higher quantity and/or improved diversity of natural products) or they can negatively affect the security of local livelihoods by degrading the essential natural-resource base. These effects and impacts are diverse and the research team examined this diversity closely, basing their study on several key aspects: the variation of change and impacts from one place to another and within communities, and the different responses made by households to deal with these changes and impacts. We then analyzed these differences as they were manifested in different income generation strategies determined by individual household assets and entitlements. This process is called social-economic differentiation (Bernstein 2010), and leads to a new distribution of resources and activities within communities, new social relations in production activities and different income formation mechanisms that result in an increasing wealth gap between households. To elicit the diversity of change at household level, we first established a typology based on the nature of household members' production activities (farming, fishing, self-employed or wage off-farm activities) and the way these activities were combined within the household production system. We then identified different paths of adaptation prevailing in both coastal communities that were the focus of the study, and examined their relevance to the different types of production system. This facilitated an assessment of the efficiency of these adaptation paths in supporting household well-being.

## Study area

Cambodia's coastline stretches for 435 kilometres and covers an area of approximately 18,000 km$^2$ (Rizvi and Singer 2011). The coastline area comprises four municipalities and the provinces of Kampot, Kep, Preah Sihanouk and Koh Kong, which have a combined population of well over 1 million people (National Institute of Statistics 2013). The topography of the coastal area includes mountains, plateau, plain, coastal zone, seaside and gulf, and it is connected closely to other ecosystems including those associated with beaches, forest and coastal strand vegetation, and mangroves (including a *Melaleuca* dominated swamp forest). There are also estuarine ecosystems, seagrass meadows, coral reefs and a gently sloping, relatively shallow seabed. One of the four coastal provinces, Kampot is located in Southwest Cambodia and has a total coastline spanning about 73 kilometers, stretching from the border of Hatieng district, Vietnam, to Koh Ses, Prey Nup district, Preah Sihanouk province (Rizvi and Singer 2011).

This research was conducted in two villages, Kaoh Kruesna (10o27'50 N, 104o 26' 09 E and elevation 3m) and Lok (10o26'50 N, 104o26'25 and elevation 6m) in the Kampong Trach district of Kampot province. Both villages are coastal and lie near the border with Ha Tien, Vietnam. The research study identified three zones of resource change, farming, intertidal and marine (Figures 1 and 2). The farming zone of both villages is dominated by wet rice agriculture, yam production and dry season crops (Figure 2). Livestock constitute a further focus. The intertidal zone contains mangroves and seagrass beds, and a small fraction of this has been established two Community Fishery areas (one Community Fishery in each village) and is used by fishers from both villages (Figure 1). The marine zone (also referred to as 'offshore') embraces fishing areas beyond the intertidal zone.

The villages have different demographic and social-economic profiles. As of 2012 (NCDD 2012), the total population was 1,242 people (233 households) and 2,949 people (637 households) in Kaoh Kruesna and Lork, respectively, with population density much higher in Lork than in Kaoh Kruesna (632 and 333 people per square kilometer, respectively). As a further comparison, Kaoh Kruesna households rely more than their Lork counterparts on a combination of farming and fishing, but, proportionally, Kaoh Kruesna villagers are more dependent on fisheries than their fellows from Lork village. Within its commune, Lork village is a relatively important trade center with a much more dense settlement structure. Most households rely on agricultural and off-farm activities but some households located closer to the reef also depend on fishing activities.

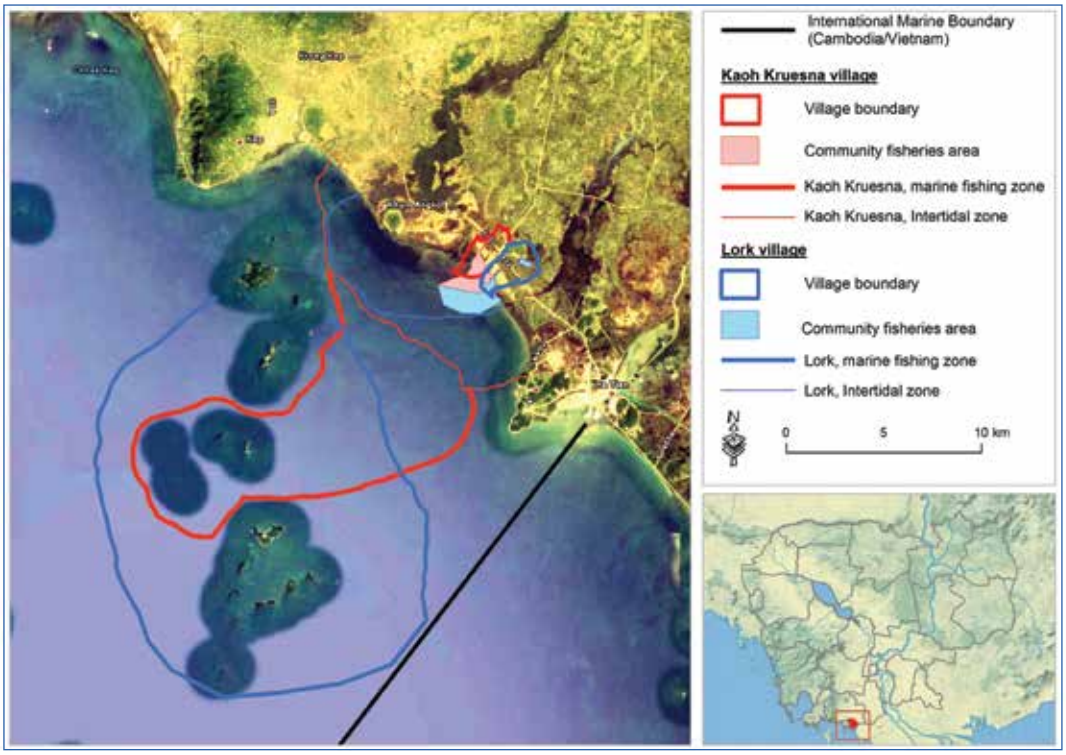



***Figure 1:*** *Fishing zones of the two villages*

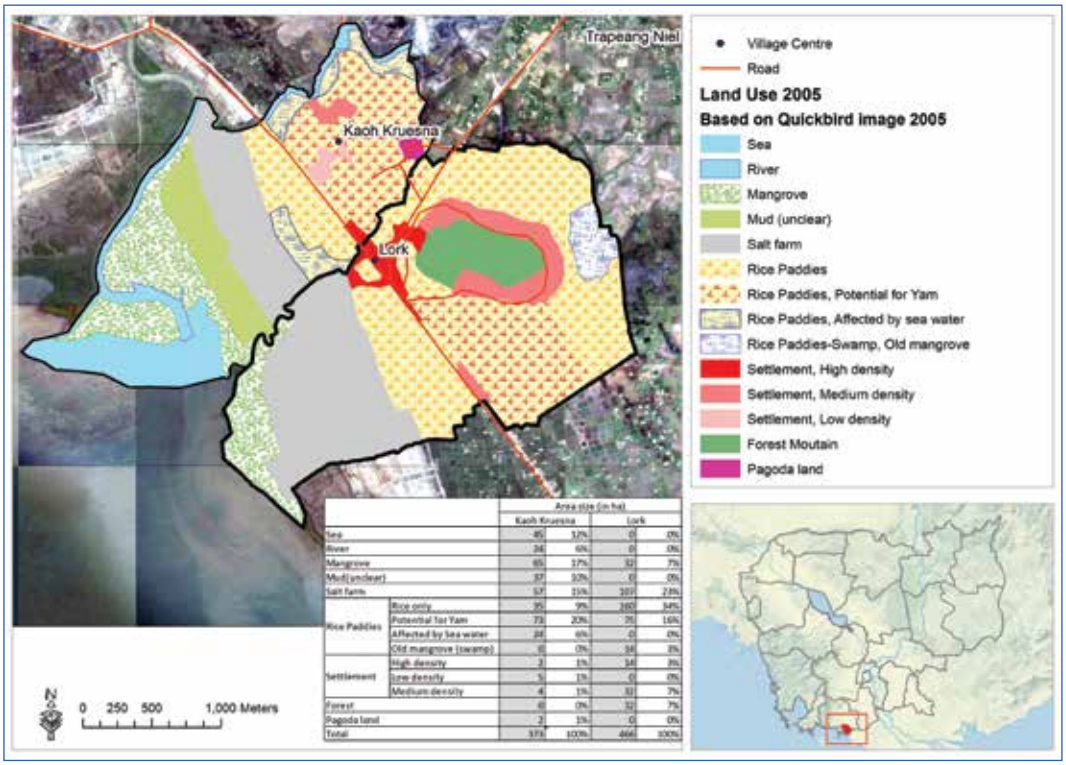



***Figure 2:*** *Study area and land use in Kaoh Kruesna and Lork*

## Fieldwork and data collection

Commune level data was gathered using Participatory Rural Assessment (PRA) tools, and qualitative data gained from discussions with members of each community. The selection of participants for the PRA (n=12) was based on the activity in which they were engaged (farming, fishing activities or both). A checklist was used to guide questions about the change in resource use. An additional discussion elicited details of change in the period from 1993-2004, which was when Community Fisheries (CFis) were established for both villages. The second part of the discussion covered the period after CFis were established (2004-2012). Semi-structured interviews were used to further explore the changing history of household (HH) resource use. The HHs interviewed (n=101, 42 in Kaoh Kruesna and 59 in Lork) were selected randomly based on the Yamane Taro formula (Israel 1992).

To analyze the change in resource use at the commune level, we identified drivers of change in the three zones (farming, intertidal and marine) over the period 1993-2012. The analysis used both commune data and relevant literature. A 2005 aerial photo acquired on the Google Earth server was used to identify land use and cover changes (LUCC) in the community. These include the loss of mangrove forest area, expansion of salt farms, and damage to rice cultivation areas caused by high tides and storm surge. This helped to identify changes in the physical environment linked with local social-economic impacts. The second data analysis looked at the impact the change in resource availability had exerted on livelihoods.

# THE EVOLUTIONARY PROCESS OF RESOURCE CHANGE OVER THE PAST 15 YEARS

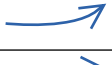
## Evolution in the farming zone

Rice cropping and small-scale livestock reemerged in the 1980s after the war and political instability that prevailed in the area between 1970 and 1979.

From 2005 to 2013, rain-fed rice yield increased from 0.8 tonnes per hectare to 2 tonnes per hectare [CDB online and commune statistics] as a result of several factors that are best understood together (Table 1). The post-war demographic increase (natural increase and in-migration) has put pressure on land resources in a context where agrarian expansion into upland forest has been impossible and where a lack of irrigation has prevented the intensification of production. Soil salinization resulting from rainy season storm surge and saltwater intrusion into rice fields has complicated the problem of land availability (Figure 2). A rapid process of landholding fragmentation has resulted in a decreasing land area size per family. In this context, the need to boost rice production for increased food demand has been met through a combination of new farming technologies (e.g. increased use of fertilizers and pesticides) and, above all, through the intensification of labor. This process of intensification has been driven primarily by households. Dry season agricultural diversification into yam production has occurred where water has been available and where the land has not been affected by saltwater intrusion. But overall, the possibility to further intensify and diversify

the agricultural production is now limited from an institutional point of view because farmers receive little support from the Provincial Department of Agriculture to improve technical itineraries, support agricultural innovation and facilitate access to market.

**Table 1:** *Resource change in the farming zone during the past 15 years*

| Elements of the resource system | Type of change/ evolution | Village | Nature of the change/process |
|---|---|---|---|
| Population |  | Kaoh Kruesna and Lork | Population increase (birthrate and immigration) |
| Soil salinization |  | Lork | Not affected by salinization |
| |  | Kaoh Kruesna | Tidal surge and salt intrusion |
| Water for agriculture |  | Kaoh Kruesna and Lork | Reliance on rainfall (no irrigation) |
| Land transfer |  | Kaoh Kruesna and Lork | Land was sold to new migrant families while land market prices increased<br><br>New families - land formerly used for cultivation was converted to settlement land |
| Labor (farming) |  | Kaoh Kruesna and Lork | Most people try to find new off-farm jobs<br><br>Youth (young generation) have lost interest in farming |
| Capital (technology and credit) |  | Kaoh Kruesna and Lork | New technology (new seeds and handy trucks) introduced for cultivation<br><br>Increased use of chemical fertilizers and pesticides<br><br>New opportunities for investing in farming: farmers have taken loans from microfinance institutions instead of borrowing from middle-men |
| Cash crop cultivation |  | Lork | Where water is available people grow some cash crops such as yam, corn, watermelons and cucumbers in rice fields after rice harvesting |
| |  | Kaoh Kruesna | Where water is available, people grow some dry season cash crops after rice harvesting, especially yams |
| Family gardening |  | Kaoh Kruesna and Lork | Small home gardens remain important for home consumption and for sharing with neighbors |

## Evolution in the intertidal zone

The intertidal zone is located close to inland communities (Figure 1). It consists of three sub- zones, reef, mangroves and seagrass. The intertidal zone provides a critical habitat for other aquatic animals (OAAs) which are key elements of local diets. Some households close to the area glean OAAs by going out on rowing boats using traps, and hand collecting during low tides. Crabs are the most popular species of OAA. The fishermen who glean these resources lack the necessary capital to purchase boat engines and fishing equipment (Gillett 2004). This zone has undergone significant changes in resource availability and governance. During the period from 1993 to 2004, fish and OAA resources declined due to widespread mangrove clearing for building materials and firewood, conversion to salt pans, aquaculture, and existing salt farm expansion. Beyond the mangrove forests, seagrass beds were destroyed by outsiders using large trawlers. Throughout this time, given the scope of change and actors involved, the local authorities were relatively powerless to control illegal fishing or to ensure conservation in the intertidal zone.

Starting in 2004, a Community Fishery (CFi) was established in the intertidal area in each village to protect the mangrove forest and to improve fisheries practices in the area (the Community Fisheries areas are shown in Figure 1). The initiative was first supported by the GTZ Rural Development Program (Kampong Thom-Kampot) to boost the extent of the mangrove forest area and to enhance seagrass bed conservation (Degens and Choun 2007). Regulations were also designed to enforce or implement some form of sustainable resource co-management in partnership with the Fisheries Administration (FiA). Mangroves were replanted, local authorities and management committees were supported along with FiA staff to patrol the area (Table 2). The impact assessment made by Degens and Choun (2007) indicates the success of these efforts in terms of governance, as well as fish diversity and productivity.

But there is a strong contrast in the way the CFis have developed in each village. In Lork, the CFi is less functional as people are much more engaged in farming and cross-border trade and are consequently not as dependent on intertidal fishing as their Kaoh Kruesna counterparts. Their CFi is neglected as a result. In Kaoh Kruesna the higher dependence of the population on fisheries resources creates more incentive and better control of resources in the CFi areas.

However, the withdrawal of the GTZ efforts in supporting the Community Fisheries schemes has revealed the weakness of the CFis that were put in place. Without the back-up provided by GTZ, the Community Fisheries scheme has had very limited capacity to generate revenue that could have financed the patrolling of the area or supported management operations. This lack of resources and the impact of illegal fishing form the narrative that local authorities and CFi committees continually use to explain their lack of active implementation of the CFi management plans and rules with local fishers and CFi members. So in the context of dynamic transformations in the economy and resource systems, Community Fisheries are not currently functioning as a comprehensive and adequate solution to the many challenges

facing fisheries management. Another important issue is scale. The intertidal area where the Community Fisheries regulations are actually applied is rather small in comparison with the total intertidal area used by fisher folk (Figure 1). These CFi restrictions are thus easily circumvented by local fishers who simply operate in the areas outside of that designated as 'Community Fisheries' where a more business-as-usual attitude prevails.

After 2011, given that the CFi institutions were unable to properly manage and protect fisheries resources, the resources in the intertidal zone underwent further degradation. To adapt to this degradation, a number of fishermen (at least those who could afford it) decided to upgrade their boat engines (to small-scale motorboats greater than 10HP (horsepower)) and relocate their fishing efforts offshore where they were able to target crab as the main species around offshore islands (Figure 1). These new fishing grounds are much larger than those in the intertidal zone, so the competition between fishermen is lessened.

***Table 2:*** *Resource change in the intertidal zone during the past 15 years*

| Elements of the resources system | Type of change/ evolution | Village | Nature of the change/process |
|---|---|---|---|
| Pollution |  | Kaoh Kruesna and Lork | There is continued but low impact on fishery resources and mangroves in the intertidal areas |
| Aquaculture development projects |  | Kaoh Kruesna and Lork | Large shrimp farms were initiated before 2005 - expanding into the mangrove area - but they were cancelled after the creation of the CFis |
| Law enforcement |  | Kaoh Kruesna and Lork | Despite the period when the CFis were active (2004-2011), there was weak law enforcement which has led to massive and illegal over-extraction of resources (destruction of mangrove forest, land development, and so on) |
| Salt farms |  | Kaoh Kruesna and Lork | Some altered mangrove forest areas were converted to salt farms |
| Number of large-sized fishing vessels (10- 30HP) |  | Kaoh Kruesna and Lork | In 2008 poles were placed in the CFi area to prevent trawling boats from crossing the CFi boundary |
| Number of medium-sized fishing vessels (<10 HP) |  | Kaoh Kruesna and Lork | People move in or out depending on whether or not they have sufficient labor to fish in the marine zone |
| Rowing boats |  | Kaoh Kruesna and Lork | Fishermen using rowing boats move to the marine fishing zone and opt for small-scale motorboats for crab fishing around off-shore islands |
| Fishing tools |  | Kaoh Kruesna and Lork | CFi regulations restrict the use of fishing gear, types and net mesh sizes. But there has been no major change in the type of fishing tools used<br><br>What has changed is the number of tools used per fisherman |

## Evolution in the marine zone

The marine fishing zones of Kaoh Kruesna and Lork villages are located in trans-boundary waters between Kampot province (Cambodia) and Kie Giang province (Vietnam). Some of this zone is used by fishers from both Cambodia and Vietnam as the marine boundaries remain contested and thus ignored and there are no clearly defined fishing areas (Anonymous 2008).

Most fishers in this zone use either medium- or large-scale fishing gear. Some fishers use (large-scale) trawlers for multi-species fishing, whereas medium-scale fishers use traps for crab. But the resources in this zone have declined since 1993 when Cambodia adopted a free market approach to natural resource management. The decline of resources is due to increasing numbers of fishing boats from inside and outside the provincial Cambodian community (Vietnamese fishers) because this zone lacks clear and enforced boundaries (Table 3).

***Table 3:*** *Resource change in the marine zone in the past 15 years*

| Elements of the resources system | Type of change/ evolution | Village | Nature of the change/process |
|---|---|---|---|
| Law enforcement | → | Kaoh Kruesna and Lork | Weak law enforcement due to major uncertainties revolving around internal water management |
| Number of large fishing vessels (10-30 HP) | → | Kaoh Kruesna and Lork | Intense competition with Vietnamese and Thai large fishing vessels with the result that some people have decided to just abandon fishing in the marine zone |
| Number of medium-sized fishing vessels (<10 HP) | → | Kaoh Kruesna | Purchasing for a new family to start a new fishing enterprise after marriage<br><br>Moved from the intertidal zone for intensive fishing |
| | → | Lork | Not active in fishing because they are engaged in farming and other jobs |

Communities stated that over the past 15 years many fishers from Vietnam had entered the Cambodia fishery zone. In 2004 51 illegal Vietnamese fishers were arrested off Kampot. At that time, the resources in the marine zone were continually extracted by modern and illegal fishing gear that negatively affected legal trawling activity from both internal and external communities, and this had a severe impact on coastal resources (Table 3). With little or no effective state enforcement of the Fisheries Law in the coastal zone, the degradation of marine resources continues (Department of Fisheries 2005). Implementation and enforcement of the Fisheries Law remains poor also because the political will to act against illegal Thai and Vietnamese fishing is lacking. The decline of resources in the marine zone over the past 15 years is indicated by a drop in the number of fishing boats, especially larger-scale vessels from Lork village. The study revealed that some fishers had sold their boats because they could no longer make any money (Table 3). The fish catch per unit effort declined anyway and

some types of fishing gears were further restricted in the new fishing regulations released in 2006 (Em 2007). This limited their ability to increase their catch, while the fish stock continued to decline and outsiders continued to fish with even more efficient fishing gear.

As a result of this decline, our study revealed that 10 large-scale fishing boats had been withdrawn from fishing activity. The numbers of medium-scale fishing boats that were active had slightly increased since some fishers had moved from the intertidal zone for fishing. But most of them were targeting crab as the main species around offshore islands (Figure 1), especially fishers from Kaoh Kruesna village. They could also benefit from fishing in the marine zone because of the lower competition from the decline in large-scale fishing capacity among fishers in Lork village. An additional MoU in 2008 was established to enhance fishery resources management in the trans-boundary waters between Cambodia and Vietnam. However, marine resources remain under threat from illegal fishing and coral harvest conducted by both community outsiders (including illegal Vietnamese fishers) and Cambodians due to weak patrolling and law enforcement on both sides.



# TRAJECTORIES OF CHANGE AT HOUSEHOLD LEVEL

## Household typology and food security

In order to capture the diversity of production activities at household level, we established a typology based on different production activities in which households are engaged. We considered three elements that established differences among households in the way their production system was functioning: involvement in farming; in fishing; and in self-employed non-farm activities. This led us to classify the households into six types, each offering a specific association of production activities. For instance: type 1 includes households who combine farming and fishing along with self-employed non-farm activities; type 2 are those who fish, farm but are not involved in self-employed non-farm activities; type 3 farm and are involved in self-employed non-farm activities but do not fish; type 4 are exclusively farmers; type 5 fish and are involved in self-employed non-farm activities; and type 6 are exclusively farmers. This typology is illustrated in Figure 3.

| Involved in farming | Land | | | | Landless | |
|---|---|---|---|---|---|---|
| Involved in fishing | Fishing | | No fishing | | Fishing | |
| Involvement in self-employed non-farm activities | Yes | No | Yes | No | Yes | No |
| Typology | 1 | 2 | 3 | 4 | 5 | 6 |
| Proportion in sample | 7% | 11% | 36% | 18% | 11% | 17% |

***Figure 3:*** *Household typology*

Most of the households combine several activities but few have a fully diversified livelihood portfolio. Only 7 percent of the total sample were involved in a fully diversified scheme (type 1, farming, fishing and self-employed activities). This suggests that access to livelihood diversification is fragmented; people are restricted in their choice to diversify livelihoods because this depends on their labor capacity, their access to land and networks, and the skills and history of their family (Campbell et al. 2005).

The distribution of the different types of production system in each of the communities reveals important differences between both villages (Figure 4). To add clarity to these differences, we assessed the household food security status as the capacity of the household to ensure sufficient food consumption throughout the year:

- Food secure (level 1): households are secure with natural resources (farming and/or fishing). Households in this category might be involved in off-farm activities as well
- Food secure (level 2): households are not food secure with natural resources (farming and/or fishing) to which they have access, but have access to enough off-farm resources to be food secure
- Food insecure: this category comprises household who are not food secure – neither from natural resources nor off-farm income, combined.

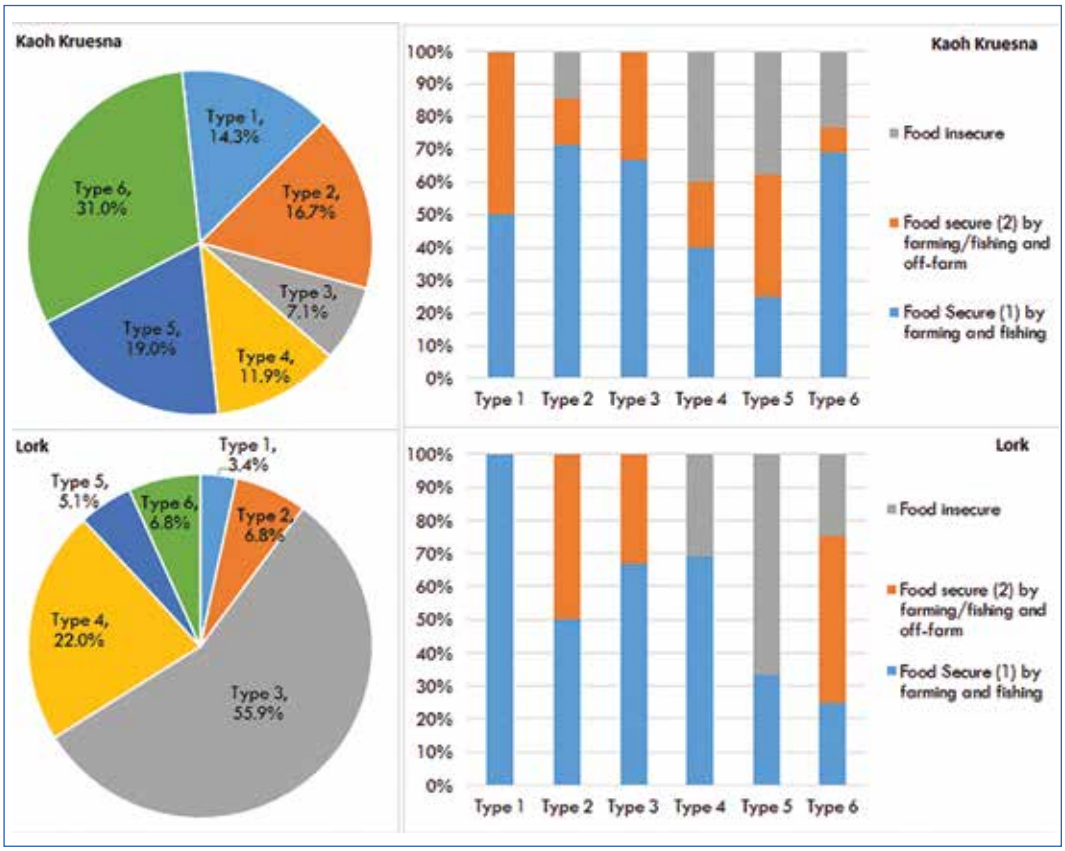



***Figure 4:*** *Typology and food security status of households in Lork and Kaoh Kruesna*

Households in Kaoh Kruesna comprise a more diversified distribution of livelihood types but with a much higher percentage of landless fishers (31 percent). In Kaoh Kruesna, households involved solely in subsistence farming are the most insecure. This shows that a combination of natural resources and income from off-farm employment (self-employed or wage labor) offers the most food secure strategy to households. But we do see that 70 percent of households in Kaoh Kruesna who are involved solely in fishing are able to be food secure (type 6) as they have invested in fishing technology, capacity and in their Community Fishery to be effective in conservation and management.

In Lork, the incidence of landlessness is limited as most households (88.1 percent) have an agricultural land holding. Only 22 percent of households are engaged in fishing (types 1, 2, 5 and 6) (7 percent marine and 15 percent intertidal including 2 percent in both). In general, households in Lork rely more on cropping and self-employed non-farm/farm labor (type 3). A significant 64 percent of household are engaged in self-employed non-farm activities, mostly related to trade as Lork village center is a trading crossroad for the commune (Figure 2). In terms of food security, fishing households with no access to land (types 5 and 6) or engaged only in farming activities (type 4) are the most food insecure (Figure 4).

In order to cope with food insecurity, households have adopted a range of different responses, which were reflected in the household survey. Borrowing money is the first way in which respondents endeavor to cope, and borrowing food is the second.

## Trends in adaptation to social-ecological changes

Social-ecological changes at play in the study area are quite similar in both communities: these include the degradation in fisheries resources/decline in fish catch per unit effort in an institutional context of weak governance (in both marine and intertidal zones) and the decline in the extent of farmland per household that takes place in a context where intensification and diversification in cropping systems is quite limited. At household level, we have identified three paths that households adopt most actively to adapt to these changes.

### Enhancing farming or fishing activities

The first way households adapt to these changes is by investing further in activities related to the existing resource base (farming, intertidal and marine fishing). We have measured this intensification in terms of an increase in fishing or farming equipment and fish catch or rice yield per household. As indicated in Figures 5, 6 and 7, only a very limited proportion of households have opted for enhancing farming or fishing activities. In Kaoh Kruesna, 7, 12 and 4.9 percent of households have enhanced their marine zone fishing, intertidal fishing and farming activities, respectively, and 0 (zero), 3 and 13.8 percent in Lork.

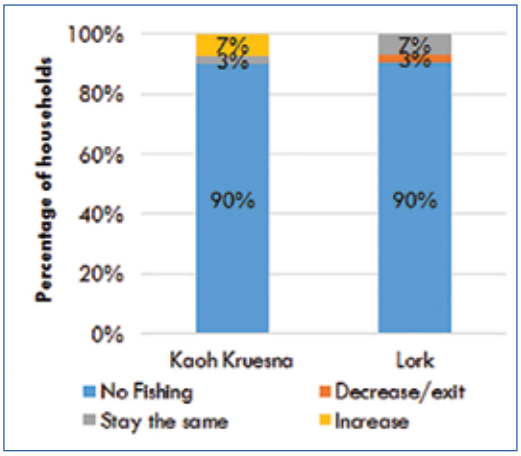



***Figure 5:*** *Evolution of fishing efforts in the marine zone over the past 15 years*

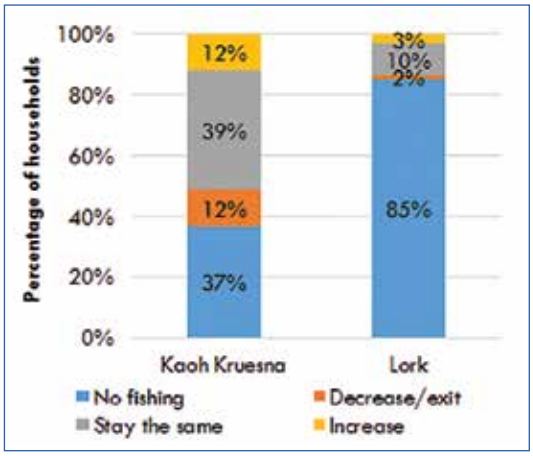



***Figure 6:*** *Evolution of fishing efforts in the intertidal zone over the past 15 years*

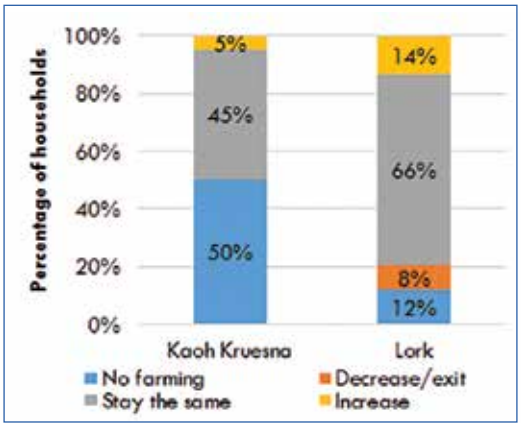



***Figure 7:*** *Evolution of farming activities over the past 15 years*

A similar proportion of households are involved in marine fishing in both village (10 percent) but in Kaoh Kruesna only, some of them have increased their fishing efforts in the marine zone (7 percent). These are the households who have upgraded their rowing boats to small-scale motorboats to quit fishing activities in the intertidal zone to engage in crab fishing around offshore islands (Case study 1). In Lork, 7 percent have maintained their fishing efforts in the deep-sea marine zone.

**Case study 1: Moving from the intertidal zone into the marine zone to catch crab**

Mr. Houn Soun, who is 30 years old, is a medium-scale fisher from in Lork village. In the past, he used a rowing boat for catching crab in the intertidal zone close to his village. On average he could catch 10 kg a day. Later, crab yield dropped, a decline which he understood to be the result of the destruction of mangrove forest and the increase in the number of fishers. In 2010, he purchased a new fishing vessel and switched to the marine zone because it was easier for him to catch crab here than in the intertidal zone.

As far as intertidal zone fishing is concerned, the trend is slightly different. In Kaoh Kruesna, some households (12 percent) have intensified their fishing efforts, thereby putting more pressure on resources. Others (in the same proportion) have decreased their efforts or re-located them to the marine zone. A typical example is described in Case study 1. In the majority of cases, however, households have not changed the intensity of their fishing efforts. In Lork, a small number of households have increased fishing efforts in the intertidal zone, mostly through a shift from the marine zone. Most households fishing in the intertidal zone have maintained their efforts.

In the farming sector, given the difficulty of intensifying or diversifying agricultural production, the proportion of households who have invested in the enhancement of their agricultural production is limited, and is even lower in Kaoh Kruesna (5 percent) than it is in Lork (14 percent) where the agriculture-enhancing process has gained pace through land purchase and intensification of production to increase rice yield. In five cases, an enhancement of agriculture activities had been achieved by households who had abandoned fishing in the marine zone and been able to invest in land with the capital coming from the sale of their boats.

## Moving away from both the land and the sea

A more important trend in adaptation to the changes in the resource system is the choice by some households to engage more in off-farm work. Two trends must be clearly differentiated here: the investment in self-employed non-farm activities and the increase in wage labor sometimes associated with migration (Figures 8, 9 and 10).

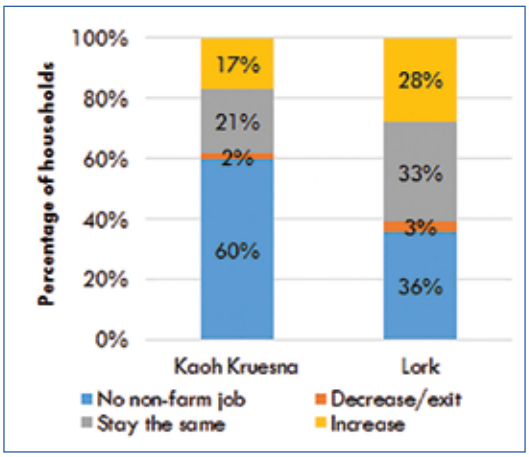



***Figure 8:*** *Evolution of self-employed non-farm activities over the past 15 years*

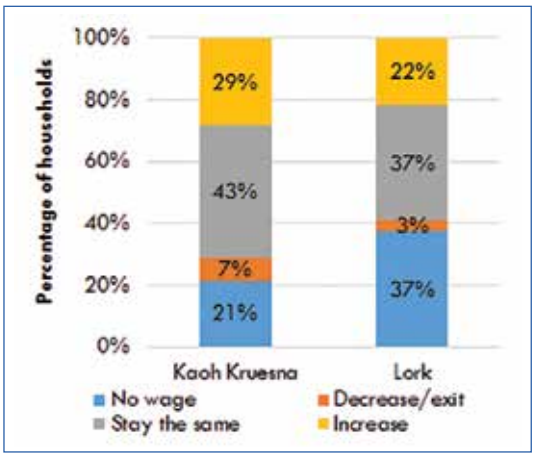



***Figure 9:*** *Evolution of local wage labor activities over the past 15 years*

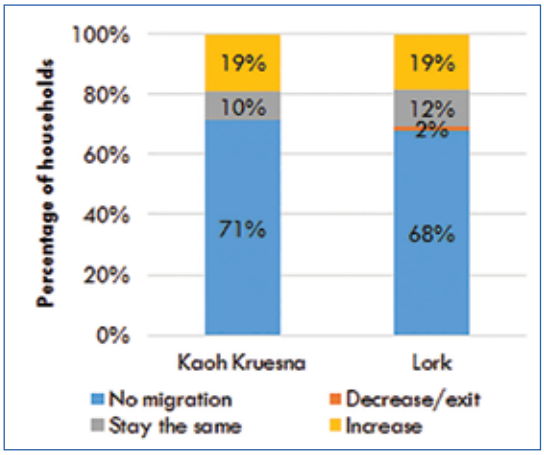



***Figure 10:*** *Evolution of migration-related wage labor activities over the past 15 years*

Self-employed non-farm or non-fishing activities (typically relating to business/trade) are clearly on the rise. The trend is less significant in Kaoh Kruesna (17 percent) than it is in Lork (28 percent) and the underlying reason for these differences is that Lork is a trade center with many more opportunities than Kaoh Kruesna. The most profitable trade activities involve exchanges with Vietnamese traders (import/export) and we also noted many small-scale businesses linked to fishing (fish processing and transport, the sale of fishing equipment, and so on).

Interestingly, we observed that the intensification of self-employed off-farm activities and the enhancement of land-based or fishing activities are processes that are almost mutually exclusive. Only 2 percent of the whole sample had been engaged in both processes.

Both require resources that only a few people can afford. Actually, the process through which the development of self-employed off-farm activities happens involves a reallocation of resources (labor and capital) away from fishing into trade. It builds on networks that have already been established with local traders and fishers. In both villages, households involved in these types of self-employed trade-related activities tend to have abandoned fishing in the marine zone for reasons explained earlier (an example also appears in Case study 2 below). This reallocation of resources requires a lot of upfront investment capital and leads to profitable trading activities. So this path of action was more successful for those households who had a higher endowment in fishing equipment and boats.

Another significant trend is the increase in wage labor activities (local or migration-related) usually in the non-farm and non-fishing sectors. Even though this trend marks a move away from land and natural resources, it does not engage the famers in re-investing or re-allocating the related equipment. The driving element is quite different as migration is more of a coping mechanism resulting from a low capacity to deal with change. To some extent, it even implies a process of de-capitalization (selling fishing equipment).

**Case study 2: Abandoning large-scale fishing**

Mr Dearv Sungheng, who is 52 years old, is a large-scale fisher from Lork village. He has been fishing for 30 years. In the past, he could secure a high income from his fishing activities, catching from 30 to 40 kg/day using traditional fishing gear. Recently he decided to abandon fishing because he could no longer benefit from this activity because of the decline in the fish catch that he associated with the presence of Vietnamese fishers in the Cambodian marine fishing zone. He argues that marine zone fishers use hi-tech and illegal fishing gear against which it is difficult to compete and that there is limited patrolling and law enforcement from relevant authorities. Another fisher living in Lork village, who requested to remain anonymous, told us that Mr. Deary Sunheang decided to abandon fishing because he had to pay too much money in 'unofficial payments' to authorities to be allowed to fish.



## Going into debt

A significant aspect of the current transformation in these coastal social-ecological systems is the increase in credit uptake. The survey indicated that a substantial 47 percent of households in Kaoh Kruesna and 74 percent in Lork accessed credit through either formal or informal institutions (or a mixture of both) and most of them had an outstanding debt. Credit took place through seasonal (cyclic) movement of borrowing and reimbursing, which mirrors the rhythm in the lives of a large majority of households in the two villages.

In addition to short-term borrowing at high interest rates to tackle food insecurity, credit is also use for productive investment mainly for farming (purchase of inputs such as fertilizers, seeds, and so on) and fishing (purchase of nets and traps, maintenance of boats and suchlike).

Fishing activities account for a large proportion of credit accessed in Kaoh Kruesna because this village relies heavily on fishing. The money is used for vessels or gear. On average, each household borrows USD 453, annually, for fishing and USD 125 for farming equipment and inputs. In Lork, households borrow money to support both farming and fishing activity. On average each household borrows USD 250, annually, to invest in fishing and USD 127 for farming.
Our results showed that, in addition to a high reliance on credit, going into debt has actually increased (31 percent of households in Kaoh Kruesna and 17 percent in Lork (Figure 11)). The main reason for this trend is the decline in the productivity of resources: households have to invest more in production inputs to maintain the same level of productivity or fish catch. Thus, when interest rates are high and the fishing season is poor, this adaptation has the potential to cripple them.

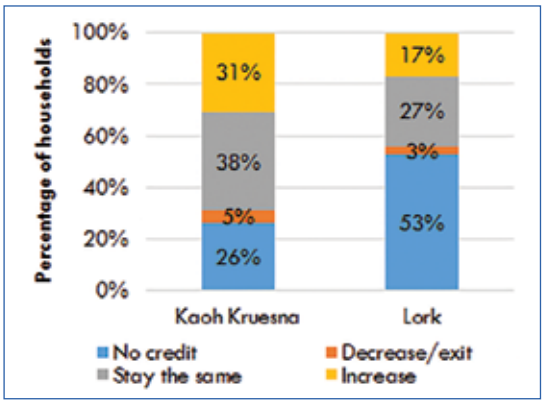



***Figure 11:*** *Evolution of credit uptake over the past 15 years*

## Adaptation and livelihood changes

As a further point of investigation, we looked at the adaptive measures different types of households had adopted, and assessed how these had contributed (or not) to improving the food security situation of each. Figures 12 and 13 indicate how the food security status of households has changed over the past 15 years for the six different types.

In Kaoh Kruesna, 29 percent have improved their food security situation, 50 percent have maintained a status quo while, for 21 percent, the situation has worsened. In Lork, these percentages are 39 (more food secure), 47 (the same) and 14 (less food secure). Types 1 and 3 are mostly improving their situation (above the average in both villages) whereas, for types 5 and 6, the situation has worsened (below the average in both villages).

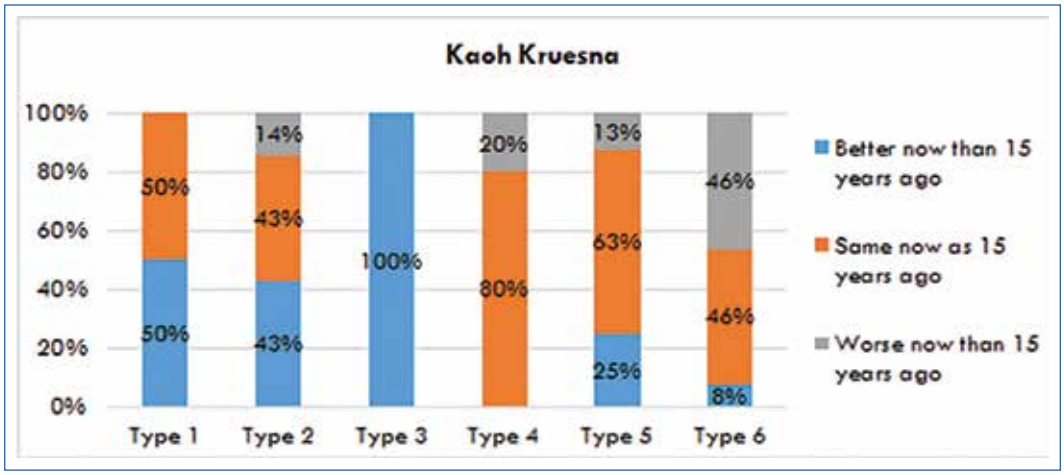



***Figure 12:*** *Evolution of food security status over the past 15 years for the six different types of household in Kaoh Kruesna*

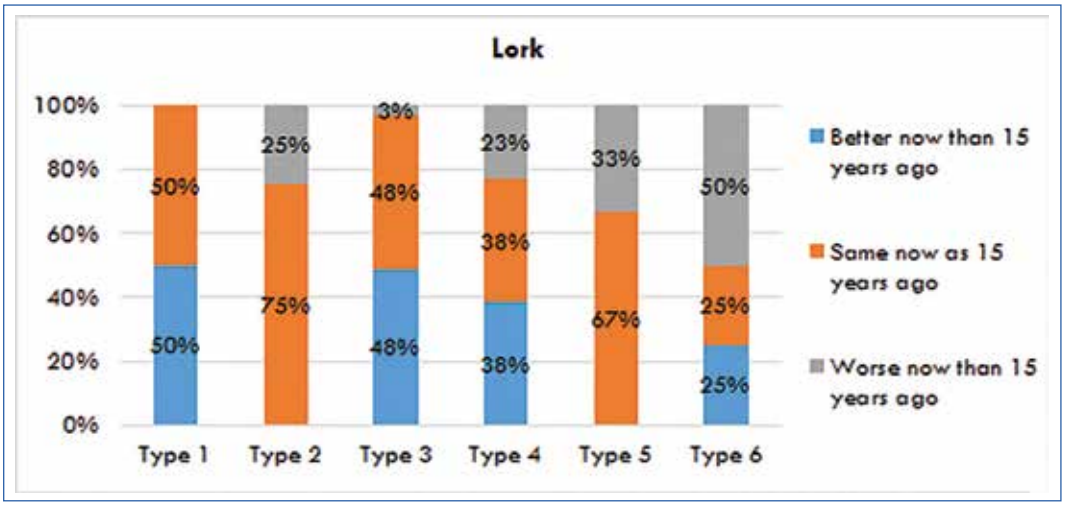



***Figure 13:*** *Evolution of food security status over the past 15 years for the six different types of households in Lork*

The mobility of households - overall and within each type - is highly significant. However, we suggest that there are three main trends underlying these movements:

- A relatively higher proportion of households in types 5 and 6 are suffering from a worsening food security status, and those are the households who rely most on fishing. This is a consequence of degradation in the fisheries resources system. They are clearly the most vulnerable section of the population in our study area and those who are most in need of support;
- As indicated above, a very small number of households had been able to enhance their existing land and natural resource activities. The other most successful measures to improve livelihood and food security status involved self-employed off-farm activity related to trade and business. But those with the capacity to make these non-farm investments were already among the families who were better off.
- The effect of wage labor on the overall food security status of the households is very limited. It works more as a coping mechanism and, alone, does not offer a solid path out of poverty.

## CONCLUSION

The livelihoods options in these Cambodian coastal communities, and indeed in other resource dependent communities around the world, are now directly determined or affected by the interaction between the condition of the natural resource stock and the mobility into and out of other livelihood options such as wage or in-kind labor, entrepreneurship or cross border trade. These shifts are a direct result of the proliferation of close global-local links as products (or impacts) of globalization.

In our study area, this increased interest in off-farm and off-fishing labor opportunities results from a mix of push and pull factors. The push factors relate to the degradation of fisheries resources and the decline in fish catch available to individual fishers. This results mostly from weakness in the institutions responsible for governing the management of natural resources and is primarily manifested in ineffective control of illegal and over-fishing in the marine area and ineffective community-based fisheries management. The pull factors relate to the increase in opportunity for trade and business activities with Vietnam.

Increasing mobility is a central element in adaptation strategy and is manifested through mobility away from the resources. This includes mobility of labor (to non-farm, wage and migration related activity), the mobility of capital (de-capitalization from fishing and reinvestment in self-employed small trade activity), and mobility of landownership (occurring through market-based land concentration). This study from coastal Cambodia shows how livelihood improvement is related to the proximity of people to business or wage labor opportunities, or to trade with Vietnam. This increasing mobility has been sparked by the implementation of the economic and rural development policies of the government and its supporters whose aim is to produce more resource product (such as rice, fish and crops) with fewer producers.

However, the processes of adaptation in these communities have actually reinforced the wealth disparity between households. The increased mobility of labor through local and migration-related trade has reinforced the vulnerability of some households.

In this context, what could be done as we move forward? As an overall principle, we recommend a reinforcement of the activities and assets that are rooted in the people's own resource systems. There are several paths through which this can be achieved. Given the key importance of land in buffering the degradation of fisheries resources, we recommend consolidating farming systems with small-scale and affordable irrigation systems, selecting the varieties of rice that are best adapted to the specific conditions of soils in coastal areas, and promoting the diversification of cropping systems by supporting production but also by enhancing fair access to inputs and markets. On the fisheries side, local communities need to be politically enabled and supported with both human and financial resources to undertake strong conservation and management. The intertidal fishing zone is an essential resource for the poorest. This strengthening of both conservation and management can be done through a revised CFi structure, or by the people themselves through deliberative and collective action, so that fishing at any scale can be maintained as part of a viable livelihood portfolio. For small-scale coastal fishing in Cambodia to be sustainable, and for the related communities to be food secure, a combination of individual and household investments is also required. The challenges that face the marine zone are largely beyond the control of local communities but a more strict implementation of the MoU between Kampot and Kie Giang in trans-boundary water management, particularly as it relates to fishing in Cambodian waters, would reduce illegal fishing and local corruption that tend to exclude fisherfolk from their own resource systems.

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# BIBLIOGRAPHY


Alongi, D. M. (2002) Present state and future of the world's mangrove forest. *Environmental Conservation, 29*(3), pp. 331-349.

Anonymous (2008) *Memorandum of Agreement on the Policy and framework for cooperation in management of coastal ecosystems and natural reosurces between the provinces of Kien Giang (Vietna) and Kampot (Cambodia).*

Bernstein, H. (2010) *Class Dynamics of Agrarian Change: Writing a 'Little Book on a Big Idea'*. Agrarian Studies Colloquium. New Haven.

Brugère, C., Holvoet, K. and Allison, E. H. (2008) *Livelihood diversification in coastal and inland fishing communities: misconceptions, evidence and implications for fisheries management., Sustainable Fisheries Livelihoods Programme Working Paper* Rome: FAO/DFID.

Campbell, J., Townsley, P., Whittingham, E., Ward, A., Sem, V., Sim, B., Heng, P., Em, D., Nut, L., Phork, P., Chhun, S., Chap, S., King, S., Iem, M., So, S. and Nith, C. (2005) *Understanding the factors that support or inhibit livelihood diversifcation in coastal Cambodia*. Phnom Penh: IMM LTD, Fisheroes Administration, CBNRM Learning Institute and FAO.

Cock, A. (2010) Anticipating an Oil Boom: The 'Resource Curse' Thesis in the Play of Cambodian Politics. *Pacific Affairs, 83*(3), pp. 525-546.

Degens, P. and Choun, D. (2007) *Impact Assessment of the NRM component. GTZ Rural Development Program Kampot/Kampong Thom*. Phnom Penh.

Department Fisheries (2005) *Annual Fisheries Statistics of Cambodia in 2004*. Phnom Penh: Ministry of Agriculture, Foresty and Fisheries.

Duke, N. C. (1992) Mangrove Floristics and Biogeography. in Robertson, A. I. and Alongi, D. M., (eds.) *Tropical Mangrove Ecosystem,* Washington D.C.: American Geophysical Union. pp. 63-100.

Em, P. (2007) *Marine Fisheries Resource Management Potential for Mackerel Fisheries of Cambodia*. Unpublished Research Report, The United University, Reykjavik, Iceland.

Ewel, K. C., Twilley, R. R. and Ong, J. E. (1998) Different kinds of mangrove forests provide different goods and services. *Global Ecology and Biogeography, 7*(1), pp. 83-94.

Farnsworth, E. J. and Ellison, A. M. (1997) The global conservation status of mangroves. *AMBIO, 26*(6), pp. 328-334.

Food and Agricultural Organization (2005) *Global Frest Resources Assessment: thematic study of mangroves in Cambodia,* Roma: Forest Service Division, FAO.

Gillett, R. (2004) *The marine fisheries of Cambodia*. FAO/FishCode Review - FCR04 Phnom Penh.

Granek, E. F., Polasky, S., Kappel, C. V., Reed, D. J., Stoms, D. M., Koch, E. W. and Wolanski, E. (2010) Ecosystem Services as a Common Language for Coastal Ecosystem-Based Management. *Conservation Biology, 24*(1), pp. 207-2016.

Israel, G. D. (1992) *Determining Sample Size*. Fact Sheet PEOD-6: University of Florida.

IUCN (2013) *Building Resilince to Climate Chamge Impacts; Coastal Southeast Asia, Kampot Province*. Kampot: IUCN.

Johnsen, S. and Munford, G. (2012) *Country Environment Profile: Royal Kingdom of Cambodia*. Phnom Penh: European Union.

Kirkman, H. and Kirkman, J. A. (2002) The Management of Seagrasses in Southeast Asia. *Bulletin of Marine Science, 71*(3), pp. 1379-1390.

Le Billon, P. (2000) The Political Ecology of Transition in Cambodia 1989-1999: War, Peace and Forest Exploitation. *Development and Change, 31,* pp. 785-805.

Marschke, M. (2012) *Life, Fish and Mangroves. Resource governance in coastal Cambodia,* Ottawa: University of Ottawa Press.

MoE and DANIDA (2002) *Physical Framework Plan Koh Kong Province*. Phnom Penh.

Monyneath, V. (2000) The Status of Cambdodia's Coastal and Marine Environment: "Emerging Policies and Management Strategies" in Paper Presented to the International Symposium on Protection and Management of Coastal Marine Ecosystem.

Mumby, P. J., Edwards, A. J., Arias-Gonzalez, J. E., Lindeman, K. C. and Blackwell, P. G. (2004) Mangroves enhance the biomass of coral reef fish communities in the Caribbean. *Nature, 427*(6974), pp. 533-536.

NACA (2004) *STREAM: Support to Regional Aquatic Resources Management System Requirement Report*. Phnom Penh: Fisheries Department.

National Institute of Statistics (2013) *Cambodia Inter-Censal Population Survey 2013,* Phnom Penh: Ministry of Planning.

NCDD (2012) *Commune Database Online*. Available at: http://www.ncdd.gov.kh

Newkirk, G. (1996) Sustainable coastal production systems: a model for integrating aquaculture and fisheries under community management. *Ocean & coastal management, 32*(2), pp. 69-83.

Orth, R. J., Carruthers, T. J. B., Dennison, W. C., Duarte, C. M., Fourquean, J. W., Heck, K. L. and Hughes, A. R. (2006) A global crisis for seagrass ecosystems. *BioScience, 56*(12), pp. 987-996.

Ouk, V., Prak, V. and Rafae, B. (2012) *Coastal Fisheries Management in Cambodia, with Case Study in Preah Sihanouk Province*. Quezon City: Partnerships in Environmental Management for the Seas of East Asia (PEMSEA).

Rizvi, A. R. and Singer, U. (2011) *Coastal Situational Analysis*. Gland: IUCN.

Royal Government of Cambodia (2006) *Law of Fisheries, NS/RKM/0406/011*.

So, N. and Touch, B. (2011) *Fishery Resources in Cambodia: Implications for Food Security,* Phnom Penh: Inland Fisheries Research and Development Institute (IFReDI).

Turner, R. K., Adger, N. W., Crooks, S., Lorenzoni, I. and Ledoux, L. (1999) Sustainable coastal resources management: principles and practices. *Natural Resources Forum, 23,* pp. 275-286.

Un, K. and So, S. (2009) Politics of Natural Resource Use in Cambodia. *Asian Affairs: An American Review, 36*(3), pp. 123-138.

Unsworth, R. K. (2014) Seagrass meadows in a globally changing environement. *Marine Pollution Bulletin, 83,* pp. 383-386.

Unsworth, R. K. and Cullen, L. C. (2010) Recognising the necessity for Indo-Pacifi seagrass conservation. *Conservation Letters, 3*(2), pp. 63-73.

# CHAPTER 8

## Environmental change and rural livelihoods in coastal Cambodia: Understanding and enhancing adaptive capacities in Peam Krasaop Wildlife Sanctuary, Koh Kong province

KIM Nong, KIM Sarin and Katelyn Rae PERFITT



## ABSTRACT

The Participatory Management Mangrove Resources and Participatory Management Coastal Resources (PMMR/PMCR) initiatives, funded by the International Development Research Centre, have been on-going in the Peam Krasaop Wildlife Sanctuary (PKWS) region of Koh Kong province since the mid-1990s. The current research seeks to understand how coastal communities living within PWKS are being affected by climate and environmental changes including tidal surge, change in water availability, storm events, and the decline in fishery resources. The villages of Koh Sralao (KSL), Peam Krasaop (PK), and Toul Korki (TKK) were selected as the research focus in order to identify and analyze the impacts of climate change on the food security of the people living there, to understand how the natural resources upon which they depend are changing, and to learn about the ways in which livelihoods are being affected by these changes. This project investigates the adaptive responses used by the resource users, and further suggests how these changes, or adaptation measures, are incorporated into the design and implementation of any adaptive co-management institutions to better address key issues of ensuring food security, sustainable land use change, and equitable water management within the variable context of climate change. The research team has continued its use of both qualitative and quantitative research methods, and has infused participatory action research methods into that portfolio. This research ultimately informs an adaptive co-management approach to resource management between a variety of relevant stakeholders in PKWS.

**Key words:** *natural resource conservation; water resources; climate change; fisheries; environmental protection; participatory action research; rural livelihoods; livelihood diversification*

# INTRODUCTION

## The PMMR/PMCR research experience in perspective

This project aims to build upon previous work of the Participatory Management Mangrove Resources and Participatory Management Coastal Resources (PMMR/PMCR) initiatives, funded by the IDRC, which have been on-going in the Peam Krasaop Wildlife Sanctuary (PKWS) region of Koh Kong province since the mid-1990s. The overview of the background, objectives and methods, and lessons learned from previous work are described in the paper entitled Adaptive Co-Management: Lessons from Coastal Cambodia, which appeared in the *Canadian Journal of Development Studies* (Marschke and Kim 2003) and in a synthesis book entitled *Learning for Change: Ten years of experience on community-based coastal resource management and livelihood improvements in Koh Kong, Cambodia* (Kim et al. 2008).

This current work aims to investigate how climate change, as perceived by a diversity of stakeholders, is influencing the livelihoods of people living in PKWS and what adaptive responses the resources users have adopted. It further suggests how these changes, or adaptation measures, have been incorporated into the design and implementation of any adaptive co-management institutions to better address key issues relating to food security, sustainable land use change, and equitable water management within the variable context of climate change.

Adaptive co-management is a fusion of adaptive management and co-management (Armitage et al. 2009). Adaptive co-management is ultimately a learning partnership (adaptation as learning). It is the trial of adaptive processes in natural resource planning and in the management characteristics of adaptive management, combined with the bottom-up participation focus of co-management. It is also a learning partnership between the state, resource users and all the actors that mediate the relationships between both.

There is a wealth of knowledge and opportunity to be found in the history of PKWS community-based work, which incorporates not only climate but also other drivers of social and ecological change for the communities of this coastal system. Key questions concern the overall extent of vulnerability and the impact climate change has exerted on the PKWS, in tandem with other drivers of environmental change.

## Cambodia and climate change

Cambodia has been identified as one of the areas in Southeast Asia most vulnerable to ongoing and future impacts of climate change. Moreover, the Economy and Environment Program for Southeast Asia showed that almost the entire country of Cambodia was vulnerable due to a *relatively low adaptive capacity*. This means that the country lacks the assets, resources and skills to cope with, and then thrive from, change (Yusuf and Francisco 2009).

In the province of Koh Kong, climate change has caused irregular rainfall patterns, heavy rains and storms. These weather events have presented challenges to villagers in their activities to generate income, often rendering them unable to fish or grow crops (Leang 2012). Sea level rise has caused saltwater intrusion into the rice paddies and crop fields, reducing or destroying yields, thereby contributing to food insecurity.

Future impacts of climate and related environmental change include more or earlier floods, earlier and more prolonged drought, a heightened uncertainty of rainfall patterns, and the social and ecological impacts of altered Mekong hydrological flows (Arias et al. 2012, Arias et al. 2013).



## Objectives

The research team involved in the PMMR/PMCR initiative is based within the General Department of Administration for Nature Conservation and Protection at the Ministry of Environment. Project leaders have endeavored to understand the experiences of the communities in PKWS, to build adaptive capacity to climate change and thereby to improve food security. The project is funded by Canada's International Development Research Centre (IDRC), and has been conducted under the technical coordination, and in collaboration with, the Learning Institute (LI). The intention of the project was to explore: 1) how environmental change affects people's livelihoods in the coastal area of PKWS; 2) how people in the coastal communities of PKWS use their past experiences and local institutions in natural resource co-management to improve their adaptation to climate change and to enhance food security; and 3) how current government policy on climate change and Protected Areas reflects and addresses the changing environment and livelihoods of people living in coastal communities.

The study takes into account local knowledge and the actions taken by local communities and other stakeholders to increase their knowledge and capacity to build resilience to climate change and to enhance their livelihoods (Brugère et al. 2008). In addition, it supports the development of strategies and actions to identify the processes, plans and policies that contribute to adaptive and resilient livelihoods and natural resource management in coastal communities.

# METHODOLOGY

## Study area

Three villages, Koh Sralao (KSL), Peam Krasaop (PK) and Toul Korki (TKK), were selected as the focus for research activity. The aim was to identify and analyze the impacts of climate change on the food security of the people living there, to understand how the natural resources upon which they depend are changing, and to learn about the ways in which livelihoods are being affected by these changes (Figure 1).

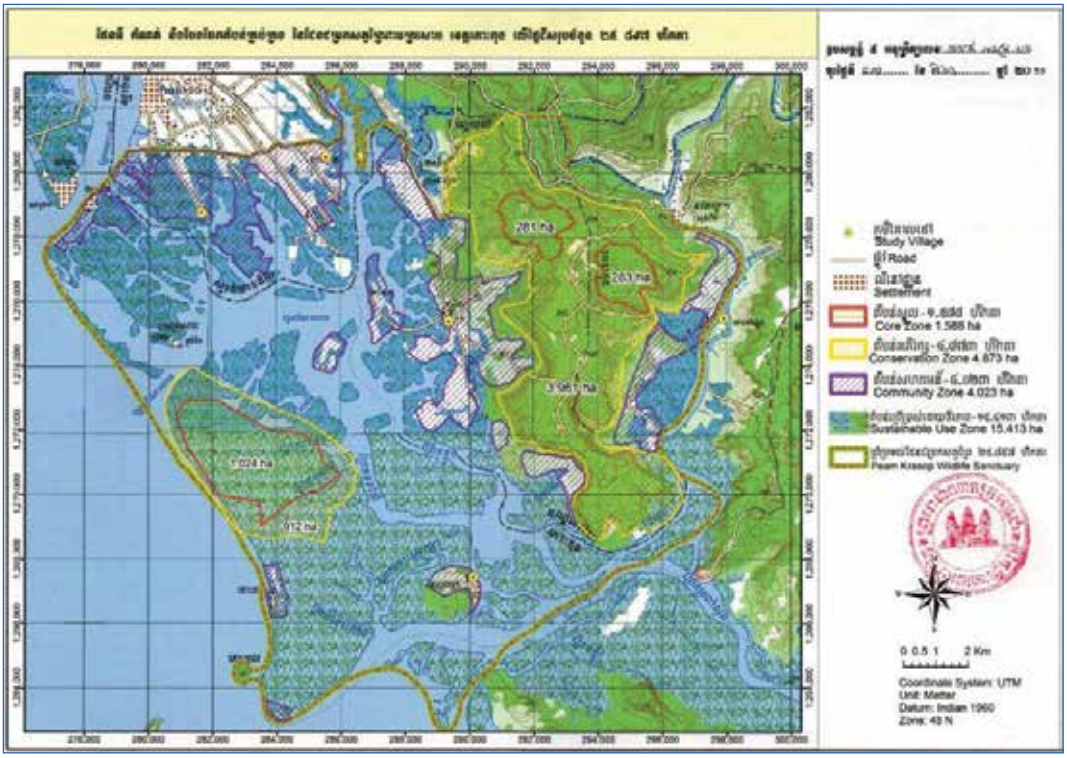



***Figure 1:*** *Map of the study area*

Koh Kong province is located in Southwest Cambodia and borders the provinces of Pursat in the north, Kampong Speu in the east, Sihanoukville in the south, and the Gulf of Thailand in the west. The provincial town of Koh Kong is located about 350 kilometers from Phnom Penh.

Peam Krasaop Wildlife Sanctuary has a total area of 25,897 hectares. It is divided into four zones that include: the 1,588 hectares of the core zone; 4,873 hectares of the conservation zone; 15,413 hectares of the sustainable use zone; and 4,023 hectares of the community zone (An et al. 2009, IUCN 2009, Royal Government of Cambodia 2011). PK, TKK and KSL - three of the six communes in Koh Kong province - are located completely within PKWS with a total population of 35,896 of whom 15,082 are women (National Institute of Statistics 2009).

PKWS is part of the Greater Cardamom Mountains ecosystem which is rich in forests and river channels that link the uplands to the coast. With wetlands accounting for three-quarters of the area, and the remainder being uplands, PKWS is the intersection of saltwater and fresh water runoff from the mountains creating an intertidal system dominated by mangroves. These features make it unique in Cambodia (Kim et al. 2008). The mangrove ecosystem provides abundant varieties of aquatic species such as fish, shrimps, prawns, oysters, lobsters, and so on, and it attracts many birds in search of food and habitat. PKWS is mountainous and contains mixed forests, high wildlife diversity and many sources of fresh water.

The interaction between these uplands with fresh water sources and the coast creates rich biodiversity and attracts people to the area for livelihood opportunities (Marschke 2012). People are highly dependent on natural resources for fishing, farming and other activities.

## The Participatory Action Research approach

The research was designed as a Participatory Action Research (PAR) project based on dialogues between people living in the PKWS and the researchers-facilitators from the MOE.

PAR engages researchers and villagers in the integration of three key elements: participation (life in society and democracy); action (engagement with experience and history); and research (soundness in thought and the growth of knowledge) (Chevalier and Buckles 2013). PAR seeks to understand the world by trying to change it, collaboratively and reflectively. The concept is one of 'learning by doing' in which learning is perceived as experiential and reflective, and is followed by change and more learning (Sy et al. 2005 ).

The PAR process in this research took place in four interactive phases each involving specific activities and approaches as sketched in Figure 2.

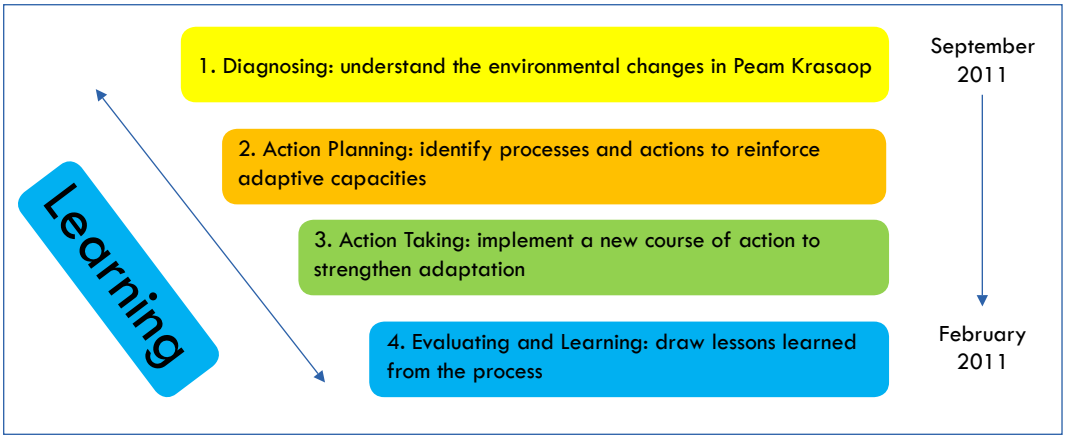



***Figure 2:*** *The Participatory Action Research process*

### Diagnosis: To better understand the nature of the environmental change and its influence on livelihoods

We analyzed environmental change in the study area using a multi-scale/multi-level framework (see Chapter 1 of this volume). We did not isolate climate change as a single influencing factor but we addressed it in association with other drivers (economic, institutional, cultural and demographic). Since climate change usually takes place over long periods of time, the challenge for the researchers was to build the analysis on the actual experiences of people and with what they knew about climate change. This included knowledge about storm and rainfall patterns and changes in the characteristics and dynamics of the local ecological system.

We then looked at how environmental change had influenced the livelihoods of people. To do this, we looked at the effect it had exerted on livelihoods through its impact on food security (accessibility and availability) and the processes through which people were coping in the short term and adapting in the longer run. During the diagnosis phase, the team spent time working with villagers in the target areas and with other relevant stakeholders using several Participatory Rural Appraisal (PRA) methods to better understand the importance, the structure/function, and change in the resource systems. These PRA tools included historical timelines, participatory mapping, seasonal calendars, ten seed ranking and field observations.

### Household surveys

In order to collect a diversity of views on how households are affected by, and respond to, environmental changes, a structured household survey was conducted to gather information at family level in the three target villages. Fifteen percent of the village population was randomly selected, with a total of 126 households surveyed (44 families from KSL, 46 from PK and the other 36 from TKK), out of a total of 779 households. Each survey took 30 to 45 minutes per household to complete.

### Community mobilization and research in action

In addition to the specific research activities, the PAR process engaged the communities in a variety of events organized in the context of this project including training workshops and study tours. A diversity of actors was associated with these activities: the relevant technical institutions in Koh Kong province (i.e. the Department of Environment, Department of Agriculture, Department of Fisheries, Department of Women's Affairs, Department of Tourism, and the Department of Planning); PKWS authorities; provincial/district/commune/village authorities; and other non-state actors (NGOs and universities).

### Action planning: Identifying processes and actions to reinforce adaptive capacity

The key issues affecting livelihoods, linked to environmental change, were mapped and shared with local stakeholders in a community forum. Of particular interest was a consideration of what activities the villagers had conducted to build adaptation to environmental/climate related changes for their specific livelihoods at the village level. The key guiding questions aimed to discover what people think about the change in their livelihoods, what measures had been developed to address these changes, and what could be done to further strengthen their adaptive capacity.

We used problem and solution ranking with the villagers to highlight specific ideas for small-scale projects that could be implemented to build adaptive capacity. Data was analyzed in a participatory manner in order to identify ways to develop concrete actions at local level.

To organize the consultation process at the local level, to discuss the results of the household surveys, and to identify the community-level action projects, the MoE research team collaborated with the provincial MOE to invite representatives from relevant local governmental agencies. Participants included representatives from the commune council (two people), the village chief (one person), and people from villager households (three people) active in community-based natural resource management.



### Actions : Implementing a new course to strengthen adaptation

The implementation and monitoring of the activities on the ground were carried out by villagers themselves with approval from each commune council chief. To ensure transparency and accountability, the MOE research team supported the process throughout the different phases with continual analyses and reflections with participants and technical departments at the sub-national level.

### Evaluation and learning: Drawing lessons from the process

The project evaluation was organized in two steps. First, local villagers or village representatives held an evaluation meeting at the commune level facilitated by each chief of commune council (from PK, KSL and TKK), the provincial environmental facilitator, and the field research team leader. This meeting provided a space to discuss the strengths and weaknesses of community project activities and to gather lessons learned from the project planning and implementation. Second, an evaluation was carried out at the provincial level through a workshop for all relevant stakeholders from the first workshop who shared their experiences with the provincial line departments for learning and future support.

## Environmental and livelihoods change in Peam Krasaop Wildlife Sanctuary: A diagnosis

In this section, we first describe the nature and extent of natural resource dependence of the three villages, followed by the types of environmental change that have affected them over the past four to five years. We then look at climate-driven change but enlarge the scope to other anthropogenic drivers. We next examine food security and the ways in which people are coping with chronic and periodic episodes of this. Lastly, we look at several adaptation mechanisms at the household and institutional levels. These include livelihood diversification strategies for the former, and the fostering of cross-level co-management for the latter.

### Dependency of livelihoods on natural resources

Livelihoods in PKWS vary due to geography and the different natural resources available from location to location. In KSL, PK, and TKK, 84 percent, 89 percent and 10 percent of household, respectively, are in one way or another dependent on natural resources to generate an income. Resource-dependent activities include fishing in mangroves and along the beach, rice farming, and raising livestock. These activities vary depending on the knowledge, skills, experience and gender roles in each family (Kim et al. 2008).

However, even if the majority of income is generated from natural resources, activities not directly dependent on natural resources are significant. In KSL, PK and TKK, 27, 25 and 22 percent, respectively, of the households' primary occupations encompass non-farm activities, wage-labor, or migration-dependent work.

### *Koh Sralao village*

KSL is located on a small island surrounded by mangrove estuaries about 2 kilometers from open sea. There is limited land suitable for agriculture, so only a small percentage of households grow supplementary crops and fruit trees (20 percent of households surveyed). Subsistence and market activities in KSL typically include selling of foodstuffs, with a small subset of households offering tailoring services. Laborers either stay in the village (often working as fishing laborers), or they work outside, often in Phnom Penh or Thailand. Both local and migrant laborers tend to be young adults.

Fishing activities in KSL typically require fishing equipment such as crab traps, gill nets to catch *clupea* fish, crab nets, and fishing lines to catch snapper fish. Other activities and gear include mangrove snail catching, shrimp catching using spears and flashlights, and other fish traps. Conch shells are used to catch squid (Figure 3).

*Trap for catching muddy and swimming crabs* | *Squid trap made of conch shells* | *A group of women catch mangrove snails*

***Figure 3:*** *Important livelihood occupations in the study areas*

### *Peam Krasaop village*

PK was formed in 2004 after the old location of the PK commune was affected by landslides and sea-level rise. In the past, upwards of 70 percent of people living in PK made their living through fishing (Marschke 2012). In the new settlement, PK villagers are still quite dependent on natural resources, including fishing. However, most fishers seek supplemental income from other jobs in order to secure their livelihoods. Since PK village is located near the provincial town of Koh Kong, PK residents are now able to take advantage of opportunities in eco-tourism, providing services to national and international tourists. They also have increased opportunities for wage labor. Additional income generating activities include motor-taxi driving, green mussel farming, selling food to tourists, and so on. Unlike KSL, only about 5 percent of people in PK have access to agricultural land, thus farming is not a significant livelihood option.

### *Tuol Korki village*

TKK is located on a mountain slope and borders the sea. The upper part is surrounded by mountains and the lower part is covered by mangroves. There are three water bodies flowing from the uplands through the village before discharging into the mangrove area of PKWS. Due to favorable agro-ecological conditions for agriculture, people take advantage of the surrounding nature all year round. Farming activities are much more important here than they are in the other two villages. According to our survey about 80 percent of households have agricultural land with access to an average of 2.8 hectares for each household on which people are engaged in rice and chamcar (non-rice) farming. Other activities include the collection of non-timber forest products (NTFPs), mangrove fishing, and farming on both the slope and the piedmont. Moreover, since the village is now connected to Koh Kong town by road, there are more chances to develop livelihoods, especially related to eco-tourism and the transportation of agri-products. As in the other villages, wage labor within and outside of the village is undertaken for additional household income.

## Livelihood challenges

When questioned about the biggest challenge to their livelihoods, villagers most commonly cited the decline in fishery resources, the limitation or instability of household income, and the lack of available farmland (Table 1).

***Table 1:*** *The biggest livelihood challenges facing coastal villagers*

| | **KSL** (%) | **PK** (%) | **TKK** (%) |
|---|---|---|---|
| Decline in fishery resources | 20.5 | 45.7 | 25.0 |
| Unstable income | 38.6 | 23.9 | 13.9 |
| Low income | 20.5 | 23.9 | 11.1 |
| Availability of land | 15.9 | 0.0 | 30.6 |
| Other | 4.5 | 6.5 | 19.4 |
| Total | 100 | 100 | 100 |

## Food security versus food insecurity

To assess overall household food security, respondents were asked whether they had enough to eat throughout the year from their own production (availability) or from other income sources (accessibility), what period of the year they were most food insecure and how they coped with food insecurity. Because food insecurity is largely a poverty issue in Cambodia (Ratner 2011), these issues immediately relate to a livelihood analysis. But they also contribute to a more general discussion on the coping/adaptive mechanisms households employ to address their food vulnerability (Figure 4).

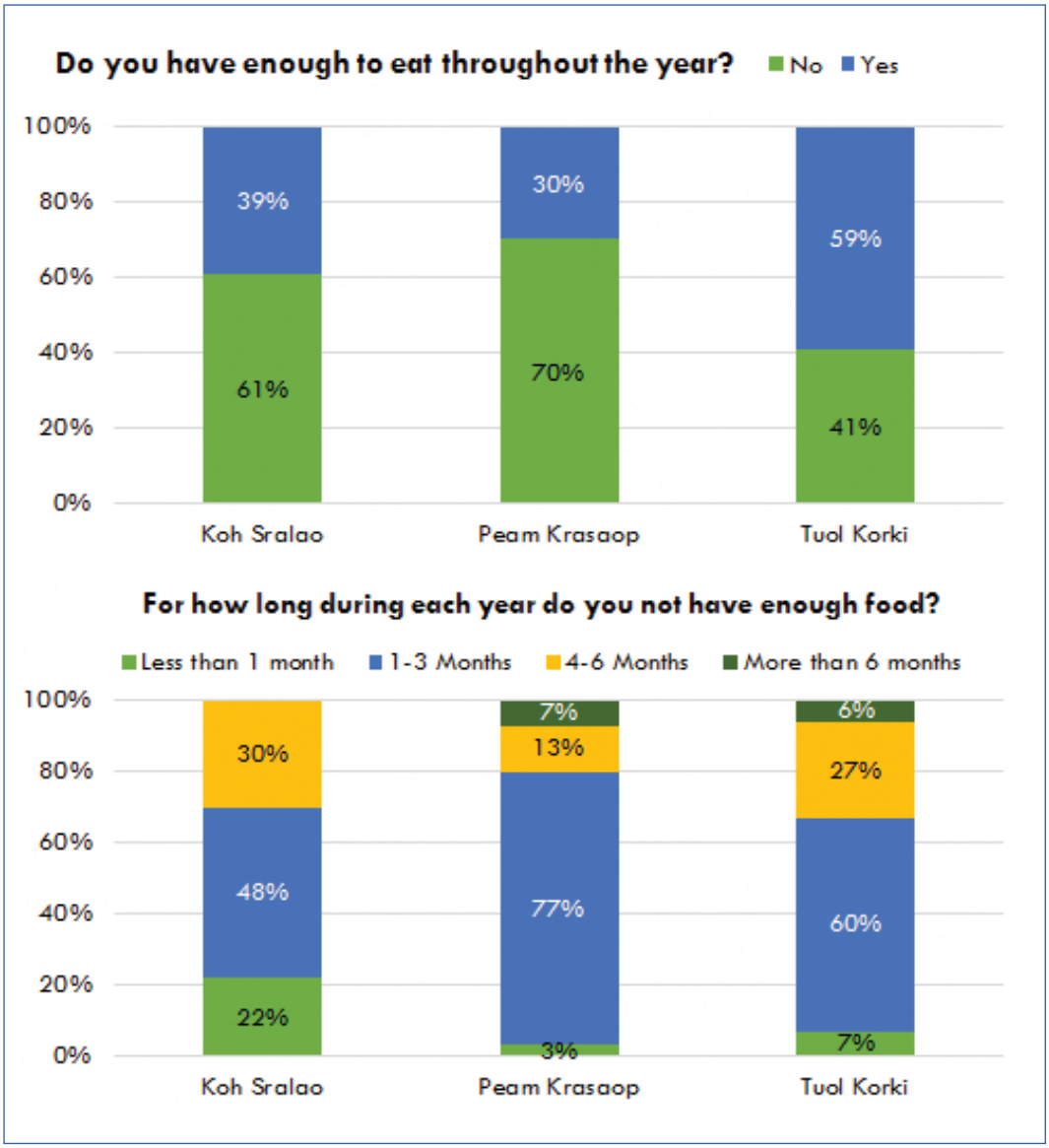



***Figure 4:*** *Overview of food security status in the three villages*

PK had the highest level of food insecurity with 70 percent of respondents noting this as a problem, especially during the rainy season. Over 70 percent of these households were insecure for one to three months, with smaller groups of people stating that they were insecure for less than a month, for four to six months, or for more than six months. In KSL, 61 percent of respondents were insecure during the year, and particularly tended to be so during the rainy season. About half of the respondents were food secure for one to three months, and smaller groups of respondents were food insecure for four to six months or for less than one month. In KSL, no respondents were food insecure for more than six months of the year. TKK had the lowest level of food insecurity of the three villages, with just over 40 percent of respondents experiencing this, and mainly during the rainy season. About half of these households were food insecure for one to three months, with a smaller number noting

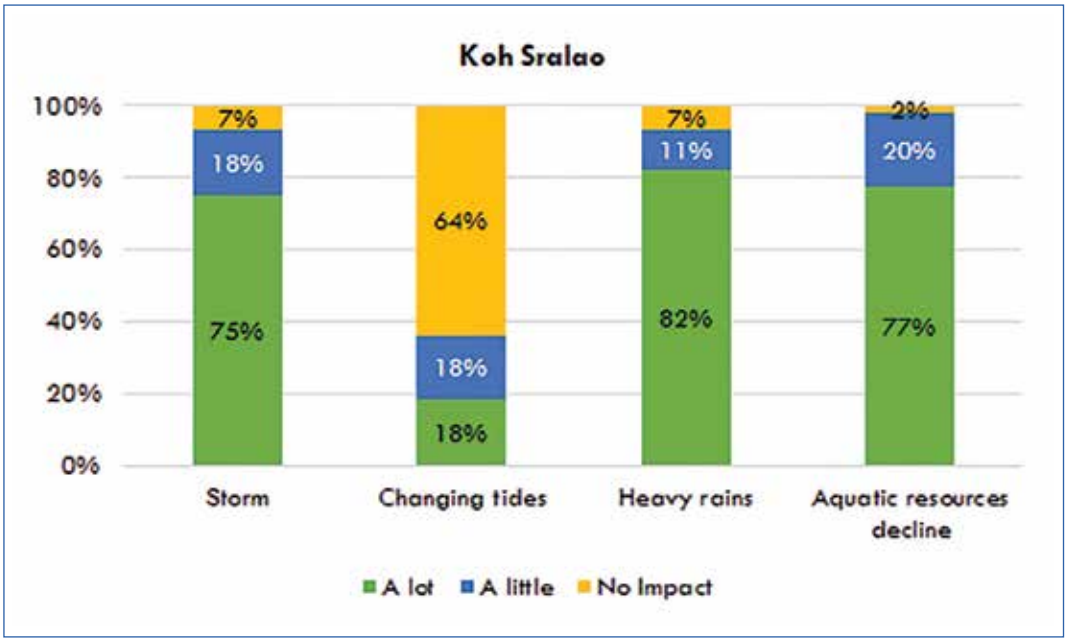
food insecurity for four to six months. Relatively few respondents experienced food insecurity for less than one month or for more than six months.

It seems clear that food insecurity is widespread and that it is a serious issue within PKWS. TKK is overall more food secure than the other two villages because it benefits from a larger land-based farming sector which provides a buffer against food insecurity. This observation confirms that fishers, as net buyers of food, are very vulnerable to increasing agricultural prices (Chan 2008).

## Environmental change in Peam Krasaop Wildlife Sanctuary

Our survey investigated four major environmental challenges in PKWS: tidal surge; change in water availability; storm events; and the decline in fishery resources. Both positive and negative impacts resulting from environmental change were initially considered, but the survey shows that most respondents associated negative effects with these changes (79, 87 and 77 percent in KSL, PK and TKK, respectively). The few respondents who did find positive impacts from these environmental events suggested that these related to increased amounts of rainwater (used for drinking) and increased numbers of crabs and octopus in warmer water.

During the household survey, each household was invited to say how much these changes affected their livelihood (a lot, a little, or no impact) (Figure 5). The comparison between the effects of these different types of environmental changes is meaningful:



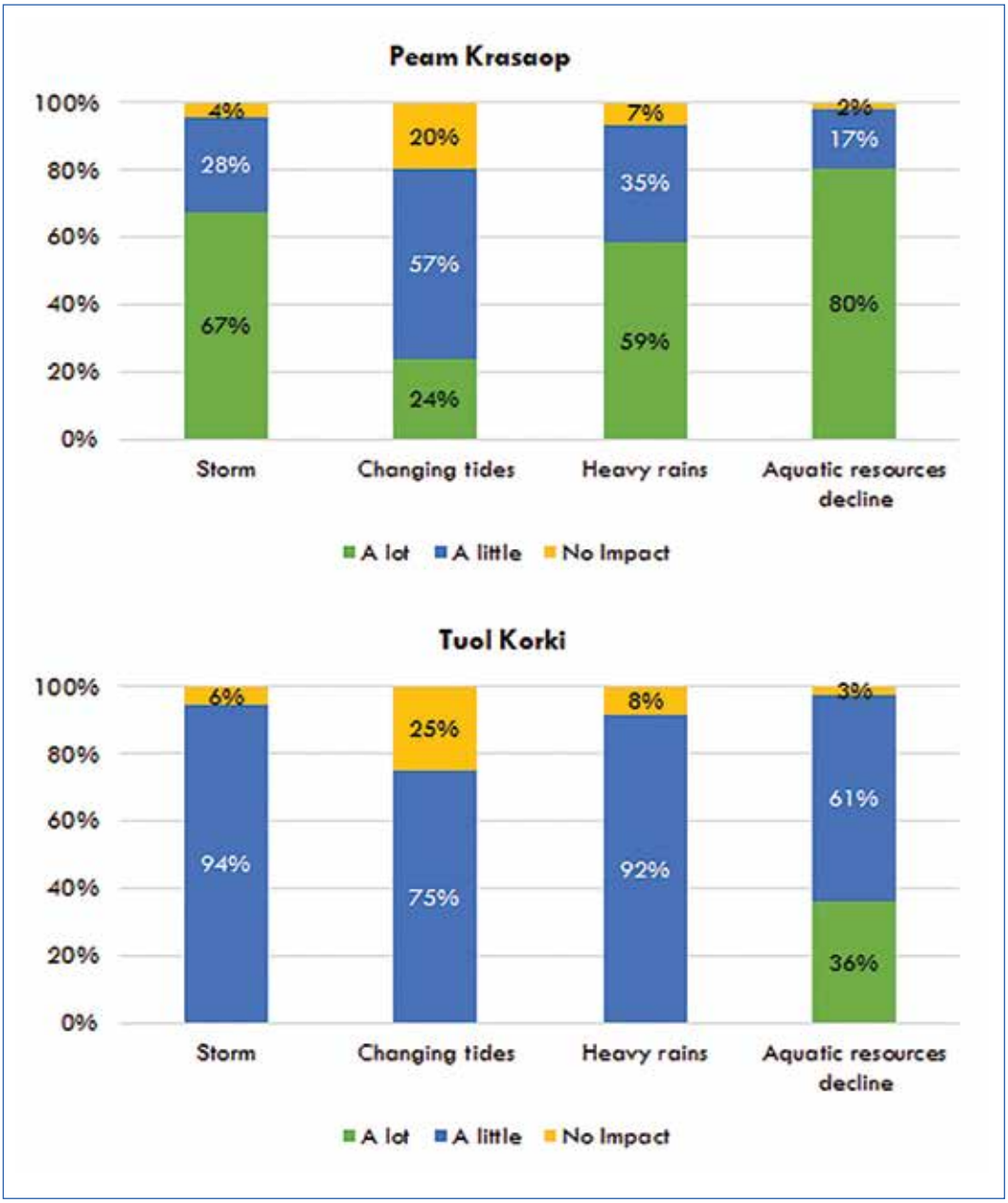



***Figure 5:*** *Level of impacts of environmental changes on livelihoods*

## Storms

Storms occur frequently, accompanied by heavy rains. Observations by the villagers over the last several years suggest that strong storms have taken place, but so far they have not caused any serious damage. However, storms prevent fishers from fishing, hindering their efforts to generate income. If storms are continuous for more than five days, families, especially the poor, face food insecurity. Many of the respondents in PK and KSL found that storms affect their livelihoods a lot, while in TKK, storms affect the livelihoods of most respondents only in a small way. Of the respondents who noted that storms affected their livelihoods in some way, 67 percent relied on fishing as their main source of income. In the three focus villages, seven respondents noted that storms did not affect their livelihood. Only one of those households relied on fishing activities for their main source of livelihood. The other respondents who had the same perception did not rely solely on fishing, but also undertook farming, government work, and other income generating activities.

## Changing tides

For a majority of respondents in KSL, changing tides had no impact on livelihoods: just a small portion reported a moderate or significant impact. In PK and TKK many respondents found that changing tides affected their livelihoods a little. In PK and KSL, around 10 percent found that these significantly affected livelihood activities. Of the households who noted that changing tides do have an impact on household income, over half relied either on crab trapping, gill nets, or on other kinds of fishing as their primary or secondary source of income. A smaller portion of households that were affected farmed rice as a primary source of income. The close proximity to extensive mangrove ecosystems could explain why residents of KSL are less affected by changing tides than those of the other two villages, as the mangroves might act as a buffer against changing tides for people living there.

## Changes in water availability

Observations from villagers suggest that rainfall patterns have become more seasonally irregular. In PKWS rainfall actually increased in 2011; the region experienced 10 months of rain. The increased rainfall has had a negative impact on local livelihoods since heavy rains prevent fishers from fishing. In addition, with heavy rain, fishing in shallow areas is not as effective as the rains bring fresh water from rivers and canals, changing the salinity of the water, forcing sea fish to move further offshore (Figure 6). Irregular rainfall makes rice farming and the cultivation of other crops more difficult for farmers, while livestock face an increased risk of drowning and a higher incidence of disease.

Nearly all respondents surveyed (95 percent) noted that heavy rains affected their livelihoods. Half of the total respondents felt that heavy rains have a strong impact on their livelihood, while the rest noted a small impact. In PK, most households responded that heavy rains affected their livelihood a lot or a little. In TKK nearly all respondents noted that heavy rains affected their livelihoods a little. In KSL most respondents noted that heavy rains affected them a lot.


***Figure 6:*** *Fresh water run-off into intertidal area*

## Tidal surge

Local people know all about the natural seasonal variations in sea levels. When high tides (usually between November and February) combine with low pressure and strong winds, a tidal surge can occur. People have experienced this phenomenon in past years and have built a dike to prevent floods. The problem is that these surges are now becoming more intense than before and the infrastructure no longer offers adequate protection. On 25th December, 2011, sea water surged by approximately 0.6 meters, which caused flooding in houses in across PKWS (Figure 7).

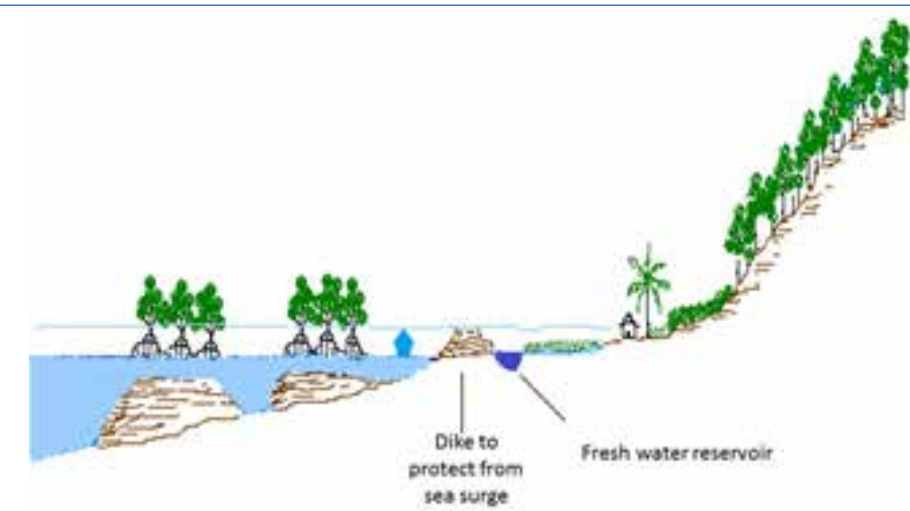


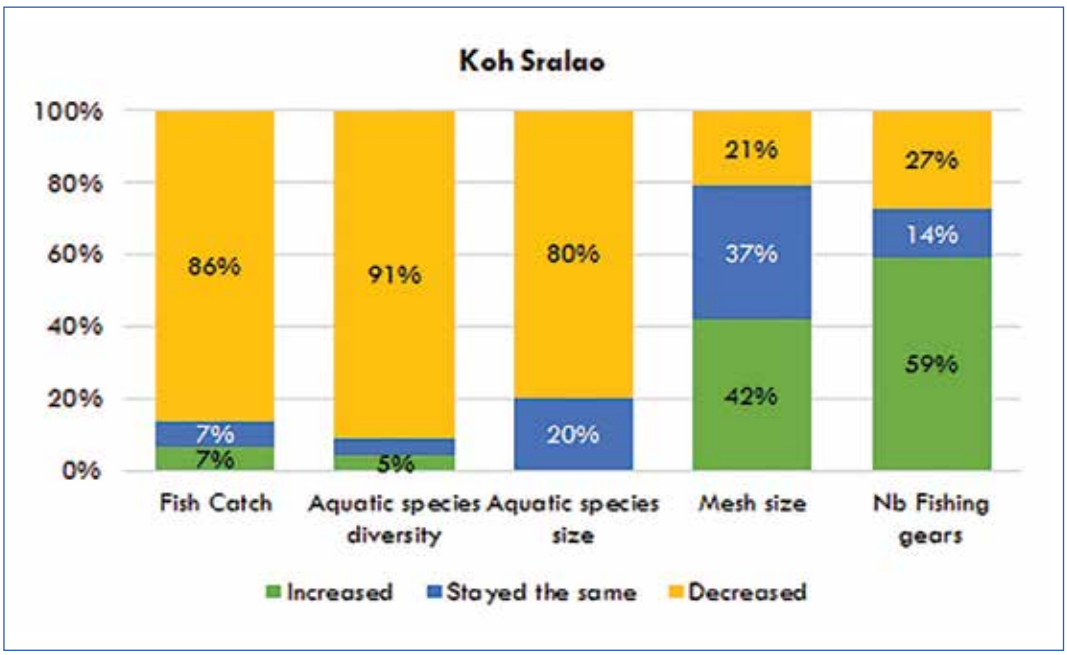

***Figure 7:*** *Tidal surge in Peam Krasaop Wildlife Sanctuary*

This tidal surge exerted negative impacts on the livelihoods of people. These included environmental damage, the destruction of agricultural products (rice and other crops), the killing of livestock (chickens and ducks), and damage to soil due to saltwater infiltration. (Figure 8).

***Figure 8:*** *The harmful effects of high sea levels (tidal surge) at PK on 25th December, 2011*

## Fishery resources decline

Ninety-nine percent of all respondents said declines in fish and other aquatic animals (OAA) had an impact on their livelihoods. Of these respondents, half said declines in fish numbers affected them a lot. Eighty-eight percent of these households rely on fishing activities as their main or secondary source of income. Of the households who noted that declines in fish stocks affected their livelihood in a small way, 17 percent reported that fishing activities were their main source of income; of the others, the activities that contributed more significantly to household income were rice farming and other activities that were not related to fishing. In KSL and PK, depleted stocks of aquatic fish affected livelihoods of most respondents a lot. In TKK, the impact was mixed; it either affected respondents only a little or a lot (Figure 5).



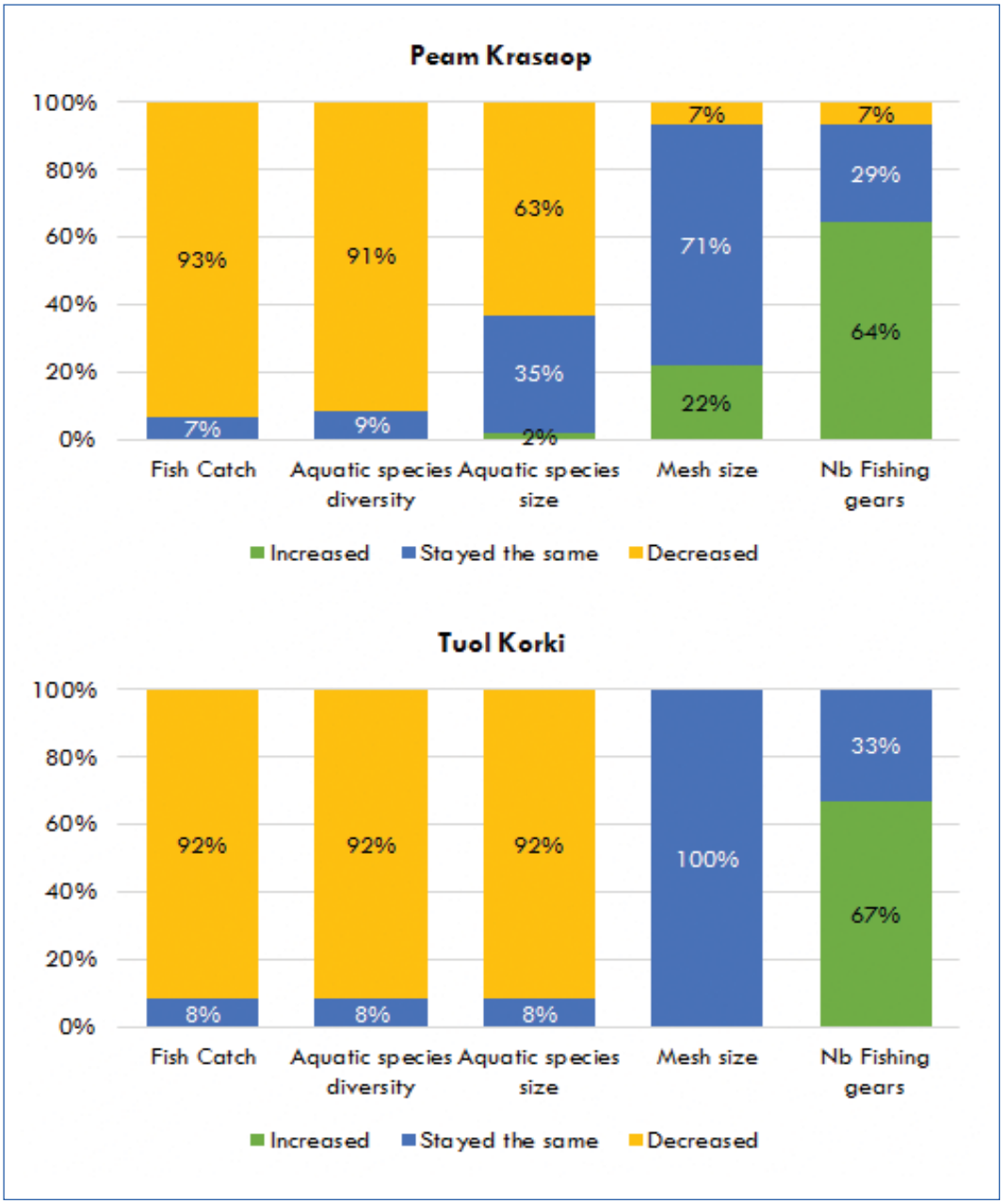



***Figure 9:*** *Trends in fishery resources management*

A majority in all villages surveyed said that fish and other aquatic animal resources are declining in three ways: in terms of total fish catch; in the diversity of aquatic species; and in fish size (Figure 9). For those who agreed that there was an overall decline, catch size and species diversity were said to be most certainly declining. A small number of respondents thought species size might have remained the same.

Fisheries law and community by-laws have specified that the mesh size of crab traps should increase from 5 cm to 6 cm, and that mesh size of fishing nets should be more than 10 cm. In

practice, however, local fishers find these laws hard to follow. Observations suggest that the local fishers tend to use mesh sizes of 3 cm to 3.5 cm for crab traps, and mesh sizes from 8 cm to 10 cm for fishing nets to enable them to catch more fish.

The results of the survey suggest that mesh sizes seem to have stayed the same, with all respondents in TKK affirming this. Most respondents in PK also said that their mesh sizes had remained constant, with several noting a mesh size increase. In KSL a majority of respondents said that their mesh size either stayed the same or increased, with a small number noting a mesh size decrease. The discrepancy between observations by research staff and responses from surveys could be that the survey questions were unclear. Respondents who noted a mesh size increase may have been referring to an increased amount of gear used during harvest. A majority of respondents had increased the amount of gear used in fishing. This was especially true in PK and TKK. In all of the villages some respondents were using the same amount of gear. Only in KSL did a considerable number of respondents note that the amount of gear they used had decreased.

A correlation between climate change and the state of fishery resources is difficult to draw but from our investigation there seems little evidence that climate change is actually affecting the productivity of fisheries resources. Longer-term research is needed on the relationship between climate and environmental change impacts and the resulting fish diversity, productivity and yield.

### What environmental changes really matter?

The majority of natural resource and ecological changes in PKWS are a direct result of human activities. The most significant issues result in a decline in fish stocks. This decline, which has also reduced fish catch over the past five years, has occurred for a number of reasons, but is primarily due to the continual use of illegal fishing gear such as coastal seine, motor push nets, and bottom trawls. A lack of effective management from all levels of governance in coastal Cambodia has led to overfishing and environmental degradation.

That said, climate change is manifest, and the people have been experiencing its affects. Factors such as saltwater intrusion from higher tidal surges have reduced the yields of fish and rice from coastal ponds and paddies. Heavy rains allow for fresh water to flow into the sea, reducing salinity, forcing sea fish into deeper waters or increasing mortality of sessile organisms such as snails and oysters. The impacts these climate-driven changes have had on local livelihoods are significant. But we suggest that climate change actually adds more risks and uncertainty to livelihoods that are already being affected by a decline in fisheries resources, which we see as a mostly institutional problem.

## Adaptation to environmental changes

Different agendas are at play when it comes to environmental change adaptation. We differentiate between households and multi-level institutional networks both of which serve to shape collective adaptive mechanisms. This network includes village representatives,

Protected Area staff, and those from the private sector. At household level, given the temporal diversity in responses to environmental change, it is useful to differentiate between the short-term coping mechanisms and longer-term adaptive strategies.

## Household coping mechanisms to enhance food security

In order to cope with food insecurity, households have adopted a range of different responses, which were reflected in the household survey: a change of diet; cutting down on portion sizes; reducing the number of meals; borrowing food; borrowing money; selling assets; consuming wild food; sending household members to other households to eat; and out-migration of some household members.

Borrowing money is the first way that respondents deal with food insecurity and borrowing food is the second (Figure 10).

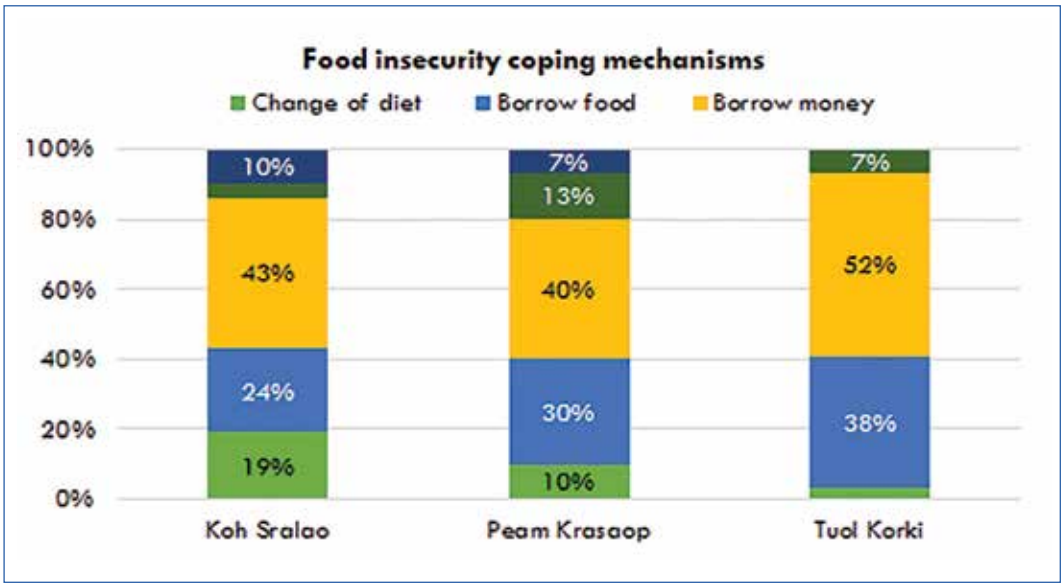



***Figure 10:*** *Food insecurity coping mechanisms*

Indeed, the results suggest that going into debt is a primary coping mechanism at the household level (Figure 11), and that both the access to, and use of, credit are strikingly important. The survey indicated that a substantial 97 percent of the respondents accessed credit through either formal or informal institutions (or a mixture of both) and most of the respondents had an outstanding debt. Credit took place through seasonal (cyclic) movement of borrowing and reimbursing, which mirrors the rhythm in the lives of a large majority of households in the three villages.

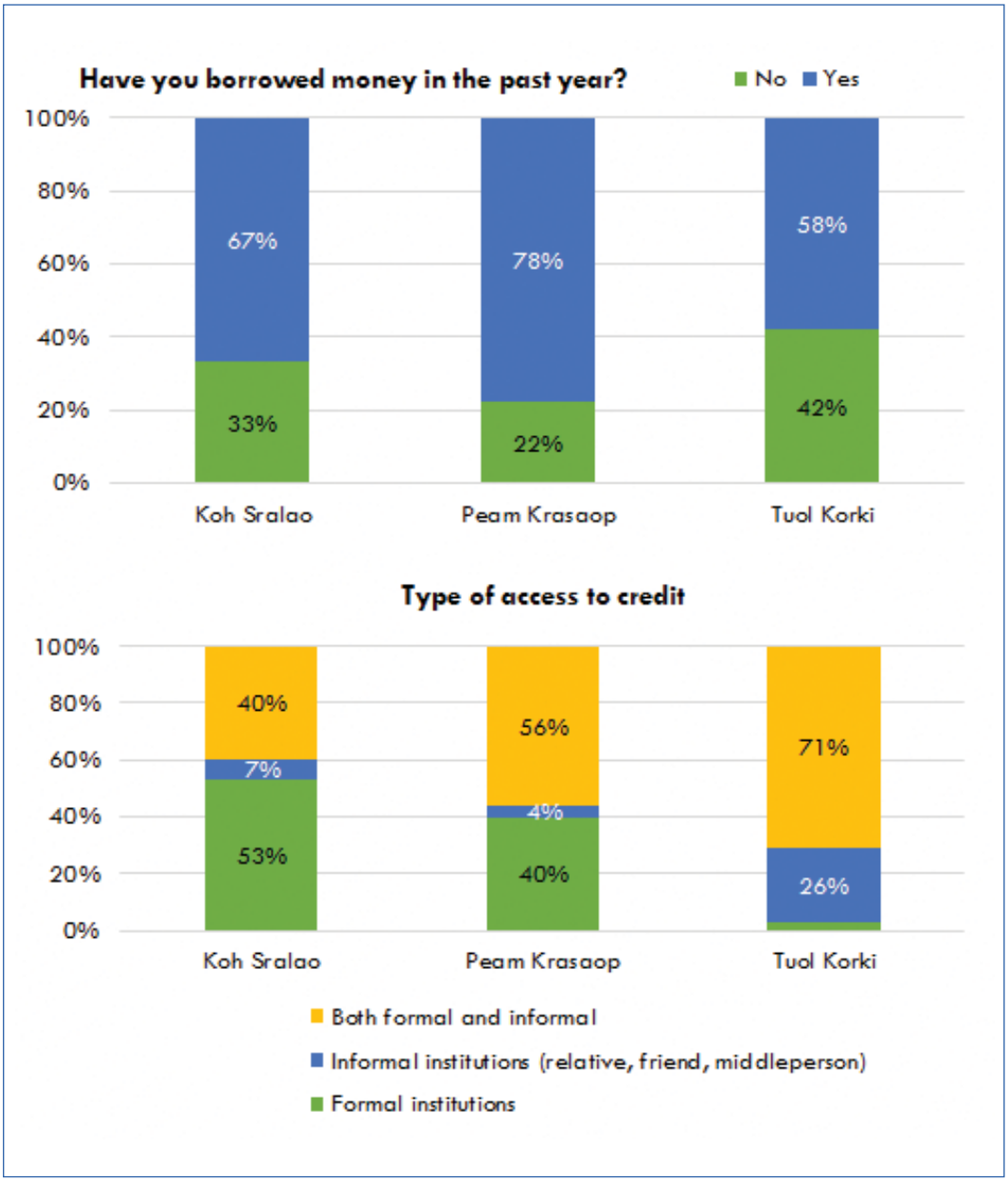



***Figure 11:*** *Reliance on and type of access to credit in the three villages*

In PKWS, informal credit lenders - fish buyers or rich people in their village - were the most important source of loans and almost all small-scale fishers access credit from these people. These credit lenders create personal agreements based on relationships in the community. They also offer more flexibility for the borrower allowing payback to be either in cash or in-kind (a portion of their catch) and a flexible pay-back time. In addition, they are more understanding than the large banks when the fish catch is poor.

Thus, access to credit is clearly important, and the survey also indicated how vulnerable the fisheries sector is and how much debt needs to be taken on at the beginning of a fishing season. Times when the interest rates are high and the fishing season poor have the potential to cripple fishers.

## Livelihood diversification strategies at the household level

Earlier analysis suggested that each family gets involved with more than one occupation; labor diversification seems the norm in PKWS. This is illustrated by the case of Mr. VENG Samsak who is currently working as a government official. In his spare time, he works on his farm, and his wife runs a small business at home while his son works on a transportation boat. The household survey and the community pilot project show that local communities will expand their livelihood activities in order to cope with, and adapt to, climate and environmental change. The field survey and interviews with local communities, reveal that fishing on its own does not generate enough stable income to support local livelihoods. Eco-tourism development, wage labor and other alternative livelihood activities are thus helping to diversify income generation activities and to improve livelihoods long-term in PKWS.

We wanted to investigate how, and to what extent, livelihood diversification was actually being employed as an adaptive strategy to address environmental change and in particular how it could address the decline in fishery resources. Based on the household survey dataset, we classified livelihoods in the three villages into five main categories: fishing (with gill nets and traps, aquaculture and trade); farming (rice, home gardening and livestock); local wage labor (in/out of the fisheries sector); non-farm (self-employed or salaried jobs); and migration-related jobs. We opted for this classification to identify the dependency of households on natural resources; the households practicing either fishing or farming are called resources-dependent.

The dataset allows for a more detailed scrutiny of diversification pathways by taking into account the secondary and tertiary activities of the households. By also considering these different occupations and their importance, we determine how households actually combine several types of activities to make their living. In so doing, we pinpoint pathways of livelihood diversification. We have identified six basic types of occupational structure at household level which we can view on a continuum of resource dependency:

1. Households who are involved in either fishing or farming and do not practice any other activities. These households are obviously resources dependent and we see them as specialized or households that cannot access other opportunities;
2. Households whose livelihood is entirely dependent on natural resources but where both fishing and farming activities take place;
3. Multi-active households involved in several occupations (resources-dependent or not) but whose livelihoods primarily depend on fishing or farming activities;

4. Multi-active households involved in several occupations (mainly resources-dependent) but who are also involved in migration. This implies a clear move away from the family and the resources;
5. Multi-active households involved in several occupations (resources-dependent or not) but whose livelihoods primarily depend on off/non-farm activities;
6. Households whose livelihoods are entirely dependent on off/non-farm activities.

Figure 12 shows the distribution of households in each village according to this typology of livelihood diversification strategies.

Gradient of Resource Dependency

| | 1. Specialized in fishing or farming | 2. Multi-activity: fishing with farming | 3. Multi-activity: mainly resources dependent activities | 4. Multi-activity: mainly resources dependent activities + migration | 5. Multi-activity mainly dependent on off and non farm activities | 6. Entirely dependent on off and non farm activities |
|---|---|---|---|---|---|---|
| Koh Sralao | 25 % | 14 % | 25 % | 11 % | 14 % | 11 % |
| Peam Krosoap | 17 % | 9 % | 46 % | 4 % | 9 % | 15 % |
| Tuol Kiri | 8 % | 36 % | 28 % | 11 % | 17 % | 0 % |

***Figure 12:*** *Frequency distribution of households livelihood diversification pathways*

From Figure 12, three important deductions can be made:

- The number of households whose livelihoods depend mainly on or entirely on off-farm (wage) and non-farm occupations is significant (17 to 25 percent). In all three villages, the number of households with at least one member involved in job migration is not negligible (4 to 11 percent). Focus group discussion shows that this move away from resources is the result of the decline in fisheries resources. It is a tactical choice that is promoted by the weakness of resources management rather than a strategic departure out of the resources.
- The portfolio of activities at household level offers an argument that households are very reactive to change in the resources system. Indeed, the household is the key agency that manages livelihood diversification resources as an adaptive strategy to reduce vulnerability and possibly to cope with environmental change.
- The diversification pathways followed by the household are multiple and they engage different types of relationships with the natural resources. This multiplicity depends on the wealth, the types of resources that are accessible, the demographic structure of the household, and the skills and opportunities people can grasp through various social-economic networks. In turn, the diversity is likely to influence the rationality and incentives of households to engage in community-based natural resources management as a collaborative process. Understanding the multiplicity of relationships to resources is also important in efforts to support the collaborative management of resources.

## Institutional management of environmental changes

Natural Protected Areas within Cambodia were designated by Royal Decree, dated 1st November, 1993, under the protection and management of the Ministry of Environment. During 20 years of experience in managing Protected Areas, the Ministry of Environment has learned that the participation of the local community living in or near to these areas is crucial for the sustainable management of Protected Area resources (Kim et al. 2008). The Law on Protected Areas was adopted by the National Assembly on 27th December, 2007, and signed by King Norodom Sihamoni on 15th February, 2008. This has since supported and encouraged local communities and indigenous people to participate in the management of natural resources under the guidelines and with facilitation from the General Department for Nature Conservation and Protection of the MOE. Fostering a policy of diverse participation from all stakeholders is the appropriate strategy for improving the sustainable integration of the conservation and development of Protected Areas. This is necessary simply because there are so many Cambodians living in or near to all Protected Areas, the majority of whom earn their livelihoods directly from these natural resources.

This is the context in which the PMMR project was initiated. The focus was on mangroves and sources of fish, which are directly related to people's livelihood security. Compared with 10 years ago, mangrove resources have significantly increased. People in PKWS have set up Natural Protection Communities that have stopped the production of charcoal made from mangroves. In addition, villagers are encouraged to protect and replant more mangroves.

Since 2012, within PKWS, six Community Protected Areas (CPAs) have been established under the MOE, covering eight villages with 1,542 families and managing 14,138 hectares of land and water. CPAs are natural resources schemes co-managed between MOE and a club of authorized users represented by a committee. Authorized users are entitled to use and manage natural resources in accordance with their requirements and with the management plans they have submitted. In addition to benefits derived from using natural resources for their livelihoods, the villagers in PKWS have developed and delivered eco-tourist services. This provides additional employment to enhance their incomes.

The management of CPAs is under the jurisdiction of the MOE, with the participation of relevant institutions such as local authorities, provincial departments and civil organizations as partners. CPAs within PKWS are developed with financial and technical assistance from a number of national and international projects and organizations, including PMCR-IDRC, CZM-DANIDA (the Danish International Development Assistance project to support Coastal Zone Management), small-scale UNDP, International Union for Conservation of Nature (IUCN) and the Wildlife Conservation Organization. Furthermore, with the involvement of local authorities and of institutions at provincial level, and with their assistance, coordination efforts and intervention in conflict resolution, CPAs have made remarkable progress. A crucial element of this success has been the involvement of all actors in the co-management scheme.

Based on long experience in the area and on interviews with relevant agency personnel, the research team has formed the opinion that the lack of cooperation with internal and external agencies hinders effective adaptive interventions. This is partly due to a lack of resources (i.e. people, materials and budgets) and as a result, it is impossible for these external agencies to identify problems, and still less to achieve a resolution in a timely fashion. Therefore, additional and well-placed technical assistance, relevant materials and an adequate budget are needed. These would facilitate better cross-scale and cross-agency cooperation to address the key constraints that hamper effective adaptation to climate change, sustainable natural resources development and food security.



# TOWARDS IMPROVING ADAPTIVE CO-MANAGEMENT: LESSONS LEARNED FROM COMMUNITY ACTION PROJECTS

## Identification and implementation of adaptive strategies through community actions

During the preparation and implementation of the small-scale pilot projects, an emphasis was placed on key areas such as objectives, activities, the people responsible, monitoring and evaluation mechanisms, and expected results. These were deemed crucial elements in the ability of the CPA committees to function adequately. Table 2 outlines pilot projects conducted.

***Table 2:*** *Project selection in each village*

| KSL CPA | PK CPA | TKK CPA |
|---|---|---|
| • Fixing tourist kiosks/harbor<br>• Renovating a community center<br>• Fixing walking boards in the north areas of the village | • Renovating tourist parking lots with soil<br>• Re-planting about 3 hectares of mangroves at Prek-Bei | • Experimenting with different varieties of rice seeds<br>• Raising more chickens<br>• Improving home gardening |

In their choice of pilot project activities, both PK and KSL had selected similar activities for improving infrastructure, ecotourism services, and the rehabilitation of natural resources. These communities are located in an area of mangrove forest where livelihoods depend almost completely on mangrove resources, including fishing and tourism. Local people have clearly grasped the fact that fish production has declined and that they need alternative livelihoods to improve their income. In the past, mangrove resource conservation and protection were their main focus (Kim et al. 2008). Now that the condition of the mangrove forest has improved they want to use it to improve their livelihoods through increased eco-tourism. The identification of activities that support the development of eco-tourism facilities corresponds to previous experiences and attempts to boost this economic sector (Kim et al. 2008). Responsibility for the development of infrastructure for community-based eco-tourism (Figure 13) rests with the CPA management committees. On behalf of the resources users, the CPA management committees take responsibility for designing the infrastructure, managing the budget and monitoring the construction work. The whole process was carefully steered by the action-research facilitators.

*Tourist harbor at Koh Sralao*

*Soil being used to renovate the parking lots for tourist vehicles in Peam Krasaop*

*Mangrove replanting in Prek Bei*

***Figure 13:*** *Implementing community action projects*

The TKK CPA is situated on the mainland and most people's livelihoods depend on farming. Farmers in TKK explained to the research facilitator team the problems they have with rice production, namely frequent weather variations leading to both lack and excess of water over limited periods of time, thus negatively affecting the yield. Through the network established by the project, a research facilitator contacted a Cambodian NGO involved in famer-led agricultural innovation. CEDAC (Centre d'Etude et de Développement Agricole Cambodgien) has been conducting field experiments in Kampong Chhnang to test rice varieties resistant to problems that are similar to those occurring in Koh Kong. The research facilitator purchased an assortment of seeds and brought them to TKK to be tested. Subsequently, 30 households were selected for pilot activities to test five varieties of rice seeds. These included the varieties *Phka Rormiet, Sen Pidaor, Phka Malis, Phka Khnei* and *Raing Chey*. In addition, some households volunteered to carry out chicken-raising activities and home gardening. The participatory evaluation of farmers who conducted the experiment on the five varieties of rice ranked *Raing Chey* in first place, *Phka Romduol* in second, *Phka Khnei* in third, and *Phka Rormiet* in fourth. *Sen Pidaor* had no ranking because this variety has very low growth rate when broadcast. After the rice seeds were selected, and the experimentation on chicken-raising and home gardening had taken place, the project team organized sessions to disseminate the results to villages in the target communes. Farmers directly involved in the experiments were required to present their results to other farmers in order to share their experience and raise awareness about the selection of high-yield rice seeds (Figure 14).

*Classification of the results of the rice seed experiment*

*Dissemination of the results of the pilot project implemented in Tuol Korki village*

*Dissemination of the results of the pilot project implemented in Ta Chat village*

***Figure 14:*** *Evaluation of community project implementation*

Through the dissemination of the results, other households have become interested in increasing agricultural production through both livestock-raising and crop cultivation. Due to the location of TKK Community Protected Area there is good potential for the expansion of agriculture to meet the high market demand for rice, livestock and natural vegetables in Koh Kong province and to supply tourists whose numbers continuously increase. On the other hand, fishing, which is a supplementary occupation of the people in TKK, has dramatically decreased. These factors have prompted people in TKK to change rice seeds, to raise chickens and to grow vegetables to increase the household income and to promote food security.

The concrete experiences drawn from the community in terms of an increase in food security suggest only limited achievements. This is because this pilot project was conducted over only a short period and with limited funds. Therefore, more experiments are needed to reach a firm conclusion. However, the pilot project undertaking is a starting point in affecting behavioral changes among the villagers and in enabling them to identify appropriate actions for enhancing climate adaptive livelihoods.

All in all, through the research study outcomes and implementation of the pilot projects in the three villages, the CPAs and the stakeholders involved were able to realize a strategic action plan for adaptation to climate change which can be implemented now but which can be adapted to ensure future food security. In addition, each group of actors can safeguard food security by building adaptive capacity in the face of changing coastal conditions. These new measures must enhance comprehension of the issues to enable those affected to better describe and debate the factors and opportunities which can allow them to change their habits, and take precautions against future social or ecological impacts and changes to their resource systems.

## Environmental change policies in action: A discussion

Cambodia signed the Convention on Climate Change in 1997 three years after the establishment of the MOE. In 2006, the government officially approved the national program for adaptation to climate change (Royal Government of Cambodia 2006). In 2009, the government created the Department of Climate Change within the MOE to coordinate activity - in Cambodia and internationally - and to communicate plans with relevant individuals and organizations. In addition, the government established the National Council for Green Development which was officially inaugurated on 19th March, 2013. This development was an appropriate strategy for mitigation and adaptation to climate change. Furthermore, the government's National Committee for Disaster Management was created to respond to disaster situations. In PKWS there are a number of projects and organizations that support the various policies related to climate/environmental change. These include the Greater Mekong Sub-region Biodiversity Conservation Corridors Project sponsored by the Asian Development Bank (ADB), the Coastal Adaptation and Resilience Planning Component (CARP) and the International Union for Conservation of Nature (IUCN).

The development of macro-level policies and master plans for adaptation, or to raise awareness among local level actors on the effects of climate change, were the preliminary steps made by government agencies and donor communities. However, an examination of the actual activities of these agencies at the local level with respect to developing effective adaptive climate change policies shows that there are still gaps. Indeed, most relevant technical institutions in local areas do not have specific plans to conduct field interventions to reinforce adaptation.

However, too narrow a focus on climate change diverts attention away from the complexities of resources systems and their management. The degradation of the coastal natural resources system, and in particular the decline in fish stocks, is largely due to deficiencies in resources tenure and management. So we need to think beyond climate and accept the fact that coastal households and their communities need to adapt to multi-driver/multi-scale environmental changes.

In this perspective, stakeholders are required to be clearly aware of the issues that are the result of environmental change and have full capacity to develop strategies so that they can overcome both the political and physical obstacles created. In addition, the relevant technical agencies in local areas need to consult, and engage in collective cooperation with, local communities in order to enhance adaptation to changes in resources systems. Ideally these action plans should come from across sectors and levels of governance. They need to have explicit learning components built into their planning and implementation regimes (Vernooy 2010). Furthermore, key stakeholders or their representatives should be involved at the beginning, and, working together, they should start with problem and potential solution identification, moving into design, and planning and implementation stages. All stakeholders could also commit to developing `foresight scenario narratives' (Foran et al. 2013). In other words, they could imagine what circumstances the future might present and devise action plans to ameliorate the negative consequences. There are some key objectives to consider in these types local planning exercises. They should:

- Promote capacity building for climate adaptation that relates to fostering sustainable local livelihood activities
- Encourage local communities, relevant stakeholders and households to work and study with each other
- Build water storage facilities to store sufficient fresh water for later use
- Build strong salt water protection embankments and promote agro-forestry systems
- Increase tree planting especially mangroves
- Prepare and improve eco-tourism areas to attract tourists
- Increase family-scale aquaculture
- Promote education on sanitation and health including forming saving groups so that people help one another financially.

In addition, innovative approaches to resource conservation and the creation of effective development and climate change research must also be included. Developing adaptive strategies for climate change in order to ensure food security is not the responsibility of any one particular institution. It requires collective action. Climate change and the resulting impacts on livelihoods are complex and will require collaboration among all the relevant government agencies and civil society organizations. However, a focal person or agency could act as facilitator. For example, in Protected Areas, the environmental ranger is a focal point and plays an important role in helping local communities who live in these. This broad and inclusive participation requires funds, time and human resources to build the abilities of stakeholders to use the resources sustainably in order to meet their development priorities. Leadership is key, and people who show leadership skills, and those who can teach or facilitate collaborative learning, should be given the responsibilities and resources to promote adaptive capacity regardless of political affiliations. Also it must be very clear what capacity is being built, how, for whom, and when will it be needed. It needs to be determined from the start who will benefit from this and who will not. Problems arise when people who feel they should benefit, and who were entitled to participate, end up being excluded from the process, the results (benefits), or both. Legitimate representation within an equitable, effective and transparent process of deliberation and decision-making for any and all climate adaptation projects should be fully supported by all government ministries and their provincial line departments.

## CONCLUSION

Climate change is manifest and experienced by people living in PKWS by way of saltwater intrusion, tidal surge, fresh water flowing into the sea, storms, and a decline in fisheries resources. The impacts of these climate-driven changes are significant for local livelihoods. However, livelihoods are mostly affected by the decline in fisheries resources, a problem associated with overall degradation of fish habitats that is the result of uncontrolled over-fishing and inadequate resources management. We suggest that too narrow a focus on climate change diverts attention away from the complexities of resources systems and their management. Rather, we see climate change as adding more risks, uncertainty, and perhaps some opportunities to local livelihoods. Thinking beyond climate change has led us to address coastal households' and communities' adaptation in the framework of multi-driver and multi-scale environmental changes.

Most of the people living in coastal areas still depend relatively heavily on fishing, other aquatic resources, and rice. But the considerable changes in ecosystems and natural resources (discussed above) have affected food security and the livelihoods of resource users. Villagers have developed a number of different response mechanisms. At household level, the capacity to address changes in natural resources availability depends on the economic/financial capacity of the family and we suggest that adaptive responses by the household to environmental changes are actually reinforcing processes of social differentiation between households. To establish food security in the short run, those with the least capacity are falling into debt and are consequently engaging household resources and labor in a reimbursement cycle. In other words, the most disadvantaged people are regularly fighting to pay debts, a situation from

which they rarely emerge. In contrast, people who are better off can internalize short-term shocks with their own resources. In the longer run, economic diversification is the key to solving problems presented by the degradation of natural resources. In PKWS, this diversification usually implies a move away from the resources but we suggest that economic diversification is more a tactical choice promoted by the weakness of resources management rather than an explicit strategic rupture with the natural resources. But, for an increasing number of families, wage labor associated with migration becomes a central element in the household production systems; it promotes marginalization, a process that might be reinforced in the future if degradation of the resource base persists.

The participatory action research process gave the resources users and local authorities an opportunity to express views and ideas related to the problems occurring in their area. They received information and knowledge through training sessions, workshops, study tours, and through the practical implementation of the pilot projects. Using the knowledge and experience gained, the communities set in motion strategic activities for environmental change adaptation at community level to ensure current and future food security. Communities situated on islands or near to coastal areas decided to enhance their adaptive capacity by improving services and infrastructures for eco-tourism. At the same time, they tended to increase mangrove planting particularly in the areas that can provide multiple benefits for community development and can also serve tourism. It became clear that the communities located on the mainland needed to increase agricultural labor and nurture the implementation of the household agricultural system to ensure food security.

Pilot project implementation in this study was conducted for only 18 months so definitive conclusions about climate adaptability are limited. But the research process did contribute to changing the behaviors of the local community to enable them to improve the management of natural resources in order to improve livelihoods. This is a vital element of effective adaptation to climate change and in combating food insecurity.

Achieving these goals requires effective participation and support from all relevant stakeholders to develop policies and appropriate technical skills. These include building or reinforcing the adaptive mechanisms of pre-existing governance institutions pertaining to local communities (resources users and local authorities). It also requires an accurate data recording and management system to follow up and monitor changes in resource stocks. This is vital in providing up-to-date, relevant information so that better adaptive environmental and natural resource strategies can be designed and implemented. These strategies should go beyond a narrow focus on climate change to help to foster policy and management processes which assist the development of livelihoods and communities that have greater, overall, resilience.

Formal investigations of the impacts of climate change and the associated adaptive capacities are relatively new undertakings for local communities and officials in Cambodia. There is a need to strengthen broad levels of awareness about climate and environmental change. There is also a need to design more inclusive and effective (directed) training approaches and to develop more participatory monitoring programs to deliver the most relevant and

applicable information. In addition, this local push/pull for diversification ties in with the broader national (and Mekong regional) level economic agendas from both central government policies and practices and from the social and economic impacts that will result from increasing ASEAN trade integration. We can already see the impacts of local-global (or at least ASEAN-level) interactions at work in this project - for example in the widespread desire to participate in linking PKWS (Cambodia) with the eco-tourism business - and the significance of these factors will only increase in the years ahead.



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# BIBLIOGRAPHY


An, D., Kong, K., Hout, P. and Mather, R. (2009) *An Integrated Assessment for Preliminary Zoning of Peam Krasaop Wildlife Sanctuary, Southwestern Cambodia*. Gland and Phnom Penh: IUCN.

Arias, M. E., Cochrane, T. A. and Elliot, V. (2013) Modelling future changes of habitat and fauna in the Tonle Sap wetland of the Mekong. *Environmental Conservation, 41*(2), pp. 165–175.

Arias, M. E., Cochrane, T. A., Piman, T., Kummub, M., Caruso, B. S. and Killeen, T. J. (2012) Quantifying changes in flooding and habitats in the Tonle Sap Lake (Cambodia) caused by water infrastructure development and climate change in the Mekong Basin. *Journal of Environmental Management, 112,* pp. 53-66.

Armitage, D. R., Plummer, R., Berkes, F., Arthur, R. I., Charles, A. T., Davidson-Hunt, I. J. and Diduck, A. P. (2009) Adaptive co-management for social-ecological complexity. *Frontiers in Ecology and the Environment, 7*(2), pp. 95-102.

Brugère, C., Holvoet, K. and Allison, E. H. (2008) *Livelihood diversification in coastal and inland fishing communities: misconceptions, evidence and implications for fisheries management, Sustainable Fisheries Livelihoods Programme Working Paper* Rome: FAO/DFID.

Chan, S. (2008) *Impact of High Food Prices in Cambodia. Policy Brief,* Phnom Penh: Cambodia Development Resource Institute.

Chevalier, J. M. and Buckles, D. J. (2013) *Handbook for Participatory Action Research, Planning ad Evaluation*. SAS Dialogue Ottawa.

Foran, T., Ward, J., Kemp-Benedict, E. J. and Smajgl, A. (2013) Developing detailed foresight narratives: a participatory technique from the Mekong region. *Ecology and Society, 18*(4), 6.

IUCN (2009) *Zoning Proposal for Peam Krasaop Wildlife Sanctuary Koh Kong Province, Cambodia*. Briefing Note: IUCN.

Kim, N., Marschke, M., Taylor, J., Frieson, K., Carson, T. and Newkirk, G., eds. (2008) *Learning for Change: Ten years of experience on community based coastal resource management and livelihood improvement in Koh Kong, Cambodia,* Phnom Penh: The Learning Institute.

Leang, P. (2012) *Fishery Communities in Koh Kong are being affected by climate change,* Available at: http://www.iucn.org/about/union/secretariat/offices/asia/asia_where_work/cambodia/?10505/Fishery-Communities-in-Koh-Kong-are-being-affected-by-climate-change.

Marschke, M. (2012) *Life, Fish and Mangroves. Resource governance in coastal Cambodia,* Ottawa: University of Ottawa Press.

Marschke, M. and Kim, N. (2003) Adaptive Co-Management: Lessons from Coastal Cambodia. *Canadian Journal of Development Studies, 24*(3), pp. 369-383.

National Institute of Statistics (2009) Demographic Census 2008 (final results). Phnom Penh: Ministry of Planning.

Ratner, B. D. (2011) *Natural Resource Governance and Food Security in Cambodia*. Policy Discussion Note: Cambodian Development Resource Institute (CDRI), Council for Agricultural and Rural Development (CARD) and International Food Policy Research Institute (IFPRI).

Royal Government of Cambodia (2006) *National Adaptation Programme of Action to Climate Change (NAPA)*.

Royal Government of Cambodia (2011) *Sub-decree No 179*.

Sy, R., Phan, K. and Kim, S. (2005 ) Ken, S. R., Carson, T., Riebe, K., Cox, S. and von Kaschke, E., (eds.) *The Development of Community-Based Natural Resources Management (CBNRM) in Cambodia:Selected Papers on Concepts and Experiences,* Phnom Penh: CBNRM Learning Institute. pp. 195-208.

Vernooy, R. (2010) *Collaborative Learning in Practice: Examples from Natural Resource Management in Asia,* Cambridge University Press India [online].

Yusuf, A. A. and Francisco, H. (2009) *Climate Change Vulnerability Mapping for Southeast Asia,* Singapore: IDRC, SIDA and EEPSA.

# CHAPTER 9

## Environmental change and Community Fisheries: Widening the scope of fisheries management to provide better support for vulnerable Cambodians

LY Vuthy and HENG Kong



## ABSTRACT

Cambodia's fisheries play a significant role in employment, fiscal revenue, income and food. Climate change is already having an impact on the levels of fish stock and the species composition of catches, and this is affecting the fisherfolk who depend on them. But this is only part of the picture. Changes in precipitation patterns and the attendant climate events - particularly severe storms, floods and droughts - are damaging livelihoods, increasing food insecurity and driving impoverished rural communities into poverty. Community Fisheries, an initiative overseen by the Fisheries Administration, have been established to give communities who rely on fishing the rights to, and responsibilities for, specific fishing areas. Introduced by legislation in 2005, Community Fisheries were at that stage envisaged as having a wider role than just fishing within the communities they served: their mandate was to improve the standard of living of their members in a more general sense, and to contribute to poverty reduction. This research examines the strategies that fishing communities have adopted in the face of extreme weather events - with a particular focus on floods - and the extent to which Community Fisheries have fulfilled their wider role in helping members in need. It then makes recommendations for the future. Concentrating on fishing communities in three provinces - Kratie, Takeo and Siem Reap - the project identifies a typology of the people involved, ways in which they were being affected by extreme weather events - particularly in terms of livelihoods and food security status - and the strategies they were adopting to cope. The results revealed a mixed picture in the effects these climate-induced disasters were having on people and the coping strategies they were adopting. Community Fisheries were, however, involved neither in helping people to prepare for disasters, nor in assisting their recovery. The project suggests a new approach to the role - legal and practical - of Community Fisheries to promote and widen the help they provide to members, and to enable them to more closely match the mandate that was envisaged at their establishment some ten years ago.

**Key words:** *community fisheries, natural disasters*

# INTRODUCTION

At all levels of social organization, climate change has become a key concern. In many ways these concerns, or interpretations of severity and impact of climate change, right or wrong, now influence the daily lives of people, and, in turn, shape the policy responses of authority and governments around the world (O'Brien et al. 2007).

Evidence that has been gathered about the impact of climate change on the fisheries sector, both marine and freshwater, suggest that the changes in precipitation patterns that are forecast will affect seasonal flood patterns in Cambodia and in other tropical flood-pulse driven, aquatic-terrestrial systems (Baran et al. 2007, Halls 2009). Any changes to these seasonal inter-annual flood patterns will, in turn, affect the extent of inundation in flooded forests and on floodplains and the resulting productivity of the fishery activity that depends upon them (Bayley 1995, Welcomme et al. 2010). Changes in the extent and duration of floods will also affect the species composition of the catch and increase or decrease the availability of different species to different consumers. Increased rainfall in some areas could increase production from aquaculture. Droughts in other areas could decrease productivity. The effects of climate change will not only threaten the fisheries sector but also other aspects of the livelihoods of people living in a fishing community, including their links to assets, and processes such as land management and food production. Climate change, nested within the wider context of social ecological systems change, will increase uncertainty for producers in these already risk-prone livelihoods that are based on natural resources (Badjeck et al. 2010, Daw et al. 2009).

Cambodia's fisheries play a significant role in employment, fiscal revenue, income and food. They are a rich natural heritage contributing to foreign exchange and economic growth for the country. The fisheries sector contributes 8-12 percent of Cambodia's GDP (FAO 2011, Fisheries Administration 2010b, Hortle et al. 2004), and it is estimated that in Cambodia 10.5 percent of full time employment and 34 percent of part-time workers are involved in the fisheries sector (fishing, processing and selling fish products) (Fisheries Administration 2010c). Consequently, fisheries are important in securing livelihoods for a large percentage of the rural population of Cambodia.

In terms of food security, the importance of fisheries is even more profound. Fish provide food for more than 13 million people and are the most important source of animal protein for human consumption in Cambodia. On average fish make up more than 80 percent of the animal protein consumed in the country and, according to Ahmed (1998), they constitute as much as 90 percent in specific fishing-dependent provinces. Overall, fish consumption is estimated to be around 52.4 kg/person/year (Hortle, K.G. 2007) - a figure that is many times greater than the global average, reflecting its particular importance to the diet and culture of this country (Hortle 2007, Lieng and Van Zalinge 2001). Therefore, any changes that have adverse effects on the fisheries sector will threaten millions of people whose livelihoods and diet directly or indirectly depend upon it.

Climate change research programs have tended to concentrate on the physical science, such as changes in temperature, ultraviolet light (UV), and rainfall; they have not reflected changes in social behaviors including local community perceptions, reactions and how the people affected now value their natural resources. In particular, the perceptions of the local people of the effect climate change will have on their own food security and on their livelihoods have not been clearly assessed. Where local perceptions and understanding of climate change impacts have been assessed and documented (CCCN 2014, Geres 2009), they have not been formally integrated into any Community Fisheries (CFi) or commune council planning process. At present, the government still acquires climate and adaptation information primarily from sources such as the International Panel on Climate Change (IPCC), the World Bank (Pilot Project for Climate Resilience, Project Phases 1 and 2), and the UNDP's Cambodian Climate Change Alliance (CCCA). But these tend to have a more general, or 'Western-focused' approach. So what are the specific key factors that would strengthen the adaptive capacity of local Cambodian communities and what adaptation strategies should they take in order to achieve food security and livelihoods that provide a reliable income? How are these issues related to the mandate of Community Fisheries? Does the current legal framework enable Community Fisheries to improve food and livelihood security in the context of social-ecological change? If so what recommendations should be made and how should these best be applied to management actions as part of the on-going efforts of the government and its donors to improve the governability and resilience of rural agro-aquatic food systems in Cambodia?

This research starts to answer some of these profound questions by providing a basic understanding of the relationships between livelihood diversity, local coping strategies in the face of natural disasters, and the institutional flexibility of the Community Fisheries. It looks at the capacity of Community Fisheries to respond to crises such as increased food insecurity or to the general negative impact environmental change is having on rural livelihoods. Using a mixed-methods approach with Participatory Rural Appraisal (PRA) tools, this research recommends transforming Community Fisheries to provide realistic rural resource management and to be more effective as forums for cross-level policy and management interventions. In addition, it identifies a need for Community Fisheries to ensure just decision-making about resources in the face of current complex social, political and environmental changes.

## THE LEGAL CONTEXT OF COMMUNITY FISHERIES: ARE THEY MANDATED TO RESPOND TO CHANGE?

This section outlines the history and current legal context of Community Fisheries. The aim is to begin to look for possible institutional entry points in order to build the capacity that will enable them to address the complex environment changes that their members now face. Indeed, more than ever, it is recognized that Community Fisheries need a proper legal mandate - supported by effective adaptive capacity - to respond in a timely fashion to social-ecological drivers of change of which climate change is only one of many that are currently affecting Cambodia's inland fisheries.

To look first at the anticipated role of Community Fisheries, under Chapter 11 (Article 59) of the Fishery Law it states that `all Cambodian citizens have the rights to form Community Fisheries in their own areas on a voluntary basis to take part in the sustainable management, conservation, development and use of fishery resources'. Community Fisheries in the Cambodian context are thus seen as a fisheries co-management arrangement between the government and the local community in which the government intends broad citizen participation with active support from development partners. However, the intended outcomes have still not been fully realized. Therefore, to look for the best ways forward, we first explore how the emergent Community Fisheries fit within the wider social-political context of rural Cambodia and if they are able to deal with a new environment that comprises agents of complex change. We also examine their impacts and the increased uncertainty under which the fishing communities operate.

Community Fisheries can trace their origins primarily back to 2005 when a Royal Decree (*Nor Sor/Ror Kor Tor/0505/240*) was issued for their establishment. Article 2 of the Decree states that 'Community Fisheries shall have by-laws, internal regulations, management plans, maps of their community fishing areas and agreements recognized by the competent authorities'. The second part of Article 3 states that 'rules and legislative procedures for establishing and managing Community Fisheries shall be determined by Sub-Decree'. This Sub Decree (*No: 25 Or Nor Kror. Bor Kor*) followed in 2007, and consists of 10 Chapters with 33 Articles covering the set-up and running of a CFi anywhere in Cambodia.

As Chapter 1, Article 1 of the 2007 Sub Decree reads, 'The scope and goal of this Sub-Decree is the determination of the rules and legislative procedures for establishing and managing Community Fisheries throughout the Kingdom of Cambodia'. While the fifth and final objective under Article 2 states that the aim is to 'improve the standard of living of Khmer citizens in order to contribute to poverty reduction'. This final objective indicates that a wider social function was intended for this fisheries arrangement, beyond simple fisheries management. In reality, however, this intention has yet to be realized in that fish-dependent communities still have some of the highest levels of poverty in the country (Kurien and Khim 2012).

To look further at the governance and organizational arrangements that were intended to manage Community Fisheries, Article 6 states that 'the Fisheries Administration and local authorities or commune/sangkat councils shall cooperate together to establish Community Fisheries'. Thus, it was envisaged that it would be through the local electoral processes that people/fisherfolk would participate in the running of these organizations.

This project looks, therefore, at the extent to which these initial aspirations have been met, and identifies recommendations for the future.

# RESEARCH METHODOLOGY

## Conceptual framework

Food systems are complex and are adaptive on a social-ecological basis (Foran et al. 2014). Like economies, cities and immune systems, they are characterized by uncertainty and surprise and are thus unpredictable over long timeframes. They tend to become more unpredictable and less amenable to management as a result of increased environmental change (Reilly and Willenbockel 2010, Wheeler and von Braun 2013). Food systems at household level within local communities comprise farm and non-farm activities, as well as fishing, which contribute income and support food security. Each household can use their capital inputs including labor, skill, and production assets, to derive income and food security from the farm, non-farm and natural resources to which they have access. Each household's food security needs are different and the level and resilience of their food security depend on their production system or their social-economic and power status within their village or commune. Hence, it is hypothesized that a household's food security is closely related to the diversity of the production systems available to its members. Thus, the more social-economic ability the household has, the more food that family is able to secure.

For this study we made a link between climate change and natural disasters, given that more frequent and severe weather events - and thus natural disasters - are expected as a result of climate change. Different types of natural disasters are observed and discussed in this study, namely flood, drought and heavy storms, and these natural disasters result in negative impacts on assets, livelihoods and food security. The level of impact depends on the severity and context of each incident as it interacts with the coping ability or adaptive capacity of each household. The direct use of this adaptive capacity to both reduce physical risk and overcome socio-political disadvantages increases the resilience of households (Allen and Holling 2010). It is helpful, therefore, to analyze the possible roles and influence of the government's Community Fisheries system for increasing resilience both at household and at the wider village/commune (community) level (Berkes and Ross 2013, Davidson 2013).

To do this, we identified the production system status of each household to see how each derives food security. Then, we analyzed the impact climate change had exerted on their food security status and livelihoods.

## Research sites

Figure 1 below presents the research study sites. Seven Community Fisheries in seven communes in three provinces were selected, representing typical inland fisheries. The provinces included Kratie, Takeo and Siem Reap. Kratie is representative of the Upper Mekong region, Takeo the Lower Mekong delta, and Siem Reap the Tonle Sap region. The Tonle Sap and Mekong regions together form the main freshwater systems of Cambodia: the annual fish production from these areas constitutes 72.7 percent of the total national fish production (Fisheries Administration 2010a). These regions have, however, different characteristics in terms of

fisheries ecology, biology and biodiversity and each consequently perceives and experiences the impacts of climate change differently.

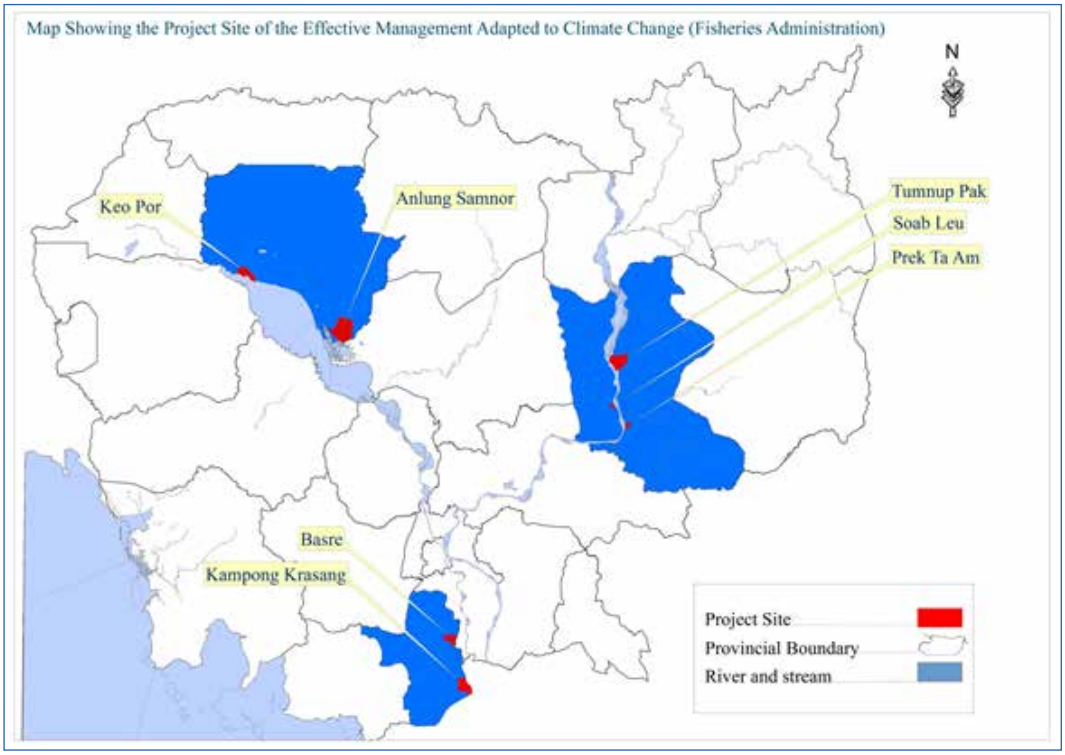


***Figure 1:*** *Map of the research sites*

*Source:* Authors

## Data collection

Both qualitative and quantitative data collection methods were used. The qualitative methods included stakeholder consultations at different levels including provincial and commune. At the provincial level, workshops were conducted in each of the selected provinces - Kratie, Siem Reap and Takeo – and participants came from relevant institutions and organizations. Key questions were used to guide group discussions, and information from these workshops formed the basis for the selection of communes for the study sites. It was also used to formulate the checklist and participatory rural appraisal (PRA) tools for further consultation at commune level. At the commune level, seven commune consultation workshops were conducted with relevant representatives including commune heads, members of commune councils, commune police, village heads, representatives from relevant NGOs, members of Community Fisheries and fisheries officers. PRA tools were used to gather information related to agriculture, natural resources, occupational calendars, food insecurity coping strategies, and the impacts of - and responses to - natural disasters.

Quantitative methods included a household survey administered to a random selection of 20 families in each of seven Community Fisheries using a questionnaire that focused on aspects drawn from the commune consultation.

## Analytical framework

The analytical framework for this study classified households according to their social-economic characteristics and household production systems. This classification enabled comparisons to be made among different groups of households in terms of the effects of natural disasters on their social-economic and food security status. Household production systems reflected the social-economic capacity of households in selected Community Fisheries, and indicated how capable they were in establishing secure livelihoods and in generating income. Indicators were used to determine: (1) the number of man-months households spent in different occupations; (2) the land crop area and land crop area per active laborer; (3) the current value of assets; (4) production; and (5) the annual household income. Based on these indicators, a household typology was computed using hierarchical cluster analysis.

The food security situation of households in this study relates to food sources, food shortages, and food security calendars. The food security calendar shows the periods of household food security or food insecurity. This analysis focused on food shortage coping strategies of the household.

The impact of natural disasters on households was compared among different groups of households. Three types of extreme climate event were observed (1) flooding, (2) drought, and (3) storms, although a particular focus was placed on flood.

# RESULTS

## Household typology

The diversity of the production systems of households in rural areas, or their social-economic status, reflects the diversity of livelihood and income generation opportunities to which they have access. Most rural households depend for their livelihoods and food security on farming and non-farming activities, as well as the collection and direct use of different natural resources. Our findings showed the diversity of assets and strategies that households throughout the study areas need in order to cope with flooding. None of the coping strategies involved assistance from the local Community Fisheries, and these organisations did not appear to play much of a role in any disaster mitigation or assistance planning.

The household production systems encompassed land, labor, production assets, occupations, and income formation processes. In the Community Fisheries areas covered by this project, these differ from household to household depending on the relationship between assets, entitlements (rights) and capacity (opportunities to use).

Based on social-economic status, study results suggested that households in the selected Community Fisheries could be classified into three groups: (1) Landless or near-landless fishing households; (2) Land-poor agro-fishing households; and (3) Land-abundant households. The percentage of land distribution among the groups varied from region to region. However, in general, the majority of households in the three regions were land-poor, and, therefore, fell into the second grouping (Figure 2).

The data relating to the different groups appears in Tables 1 to 5 in the Annexes to this chapter.

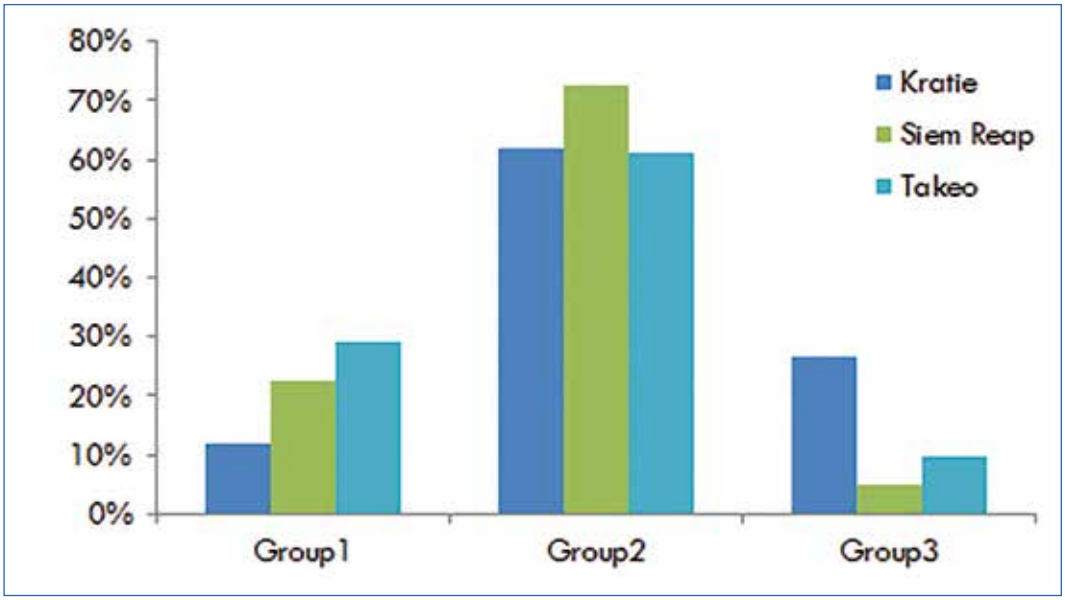


***Figure 2:*** *Percentage distribution of household typologies by region*

## Landless or near-landless fishing households

The group of households classified as landless or near-landless each have, on average, 0.12 hectares of land, or 0.04 hectares per active laborer. To compensate for the lack of land, these households tend to engage in fishing activities and the collection of other common pool resources because these supplemental resources can be freely gleaned. This group of households considers fisheries and other aquatic resources central to their food security strategies.

In terms of labor intensification, households in this group mainly focus on fishing and collecting other aquatic animals (OAA). For example, on average, each household spends 11.5 man-months fishing and five man-months collecting other aquatic resources each year. Although they are landless or near-landless, some households have the opportunity to conduct cropping activities on their homestead land. They occasionally devote available labor and time to non-farm, self-employed or salaried employment. On average households in this group spend 3.5 man-months in cropping, 2.2 man-months in non-farm self-employed activities and 2.4 man-months in salaried employment. The diversification into wage labor is a strategy designed to boost weak incomes.

In terms of production assets, households in this group invest more of their capital in boats and fishing equipment and less in agricultural implements than is the case with the other groups. In general they value boat and fishing equipment higher than the other groups. They have a fish catch significantly higher than the other households, and derive a significant part of their total income from other aquatic resources.



### Land-poor agro-fishing households

The second group represents the majority of rural households in all study areas, with a 65 to 75 percent share (Figure 2). The households in this group have small agricultural land holdings, with, on average, 0.7 hectares of land, which is not enough to secure the livelihoods of all family members. Nevertheless, our study showed that they spend most of their labor on agricultural activities (12.1 man-months per year).

Although fishing is not a full-time activity, households in this group consider fishing to be an important source of livelihood. The amount of time and household labor each household allocates to fishing is seven man-months per year. This implies that farming is the main source of livelihoods and fishing is secondary. These households derive a higher percentage of their income from farming and fishing than from other activities.

Apart from agriculture and fishing activities, households in this group also depend on a diversity of activities including gathering other aquatic resources, animal raising, non-farm self-employment and wage labor. This livelihood diversification has to be understood as a strategy to compensate for weak agricultural income resulting from small agricultural land areas and little agricultural equipment.

### Land-abundant households

Group three households account for only a minor percentage in all study areas - less than 30 percent (Figure 2). The households in this group have large agricultural land areas, owning an average of almost 4 hectares per household, or more than 1 hectare per active laborer. In terms of labour intensification, households in this group concentrate on agricultural activities, each spending, on average, 18 man-months per year on this. Consistent with time spent on agriculture, they have higher investments in the associated equipment than they do in other activities and these amounts are also higher than they are for other household groups.

The households in this group are dependent on, and specialize in, agriculture. They also diversify their labor, but this diversification has to be understood as a strategy to maximize the use of labor available within the family. Their income is significantly higher than those of groups1 and 2 and is primarily generated from agriculture and animal-raising activities. Livelihoods of this group of households are more lucrative than those of groups 1 and 2.

## Food security

Food security is a key issue in the areas covered by this project, and is linked to rural poverty. Rice and fish are the main sources of food with most households depending on their own capacity to produce these and to gather other products to meet their own food needs (Buntong and Pang 2010).

The results of this study show that more than 80 percent of households sampled depend on their own sources of rice and that landless households are rice insufficient and need to buy from the local market. The sample households revealed that, in 2012, households in groups 1 and 2 faced food insecurity, although households in group 3 were in a better position.

It is clear that the issue of food insecurity cannot be dealt with by the existing Community Fisheries mechanism. When there is a food emergency, households who face serious food shortages receive food aid only from the Cambodian Red Cross or NGOs, and normally the amount of food received is very limited. The Community Fisheries are not involved in this process. Indeed, Community Fisheries currently lack mechanisms for providing direct assistance and have limited external funding support to offer to local people.

When faced with food insecurity and to combat hunger, fishing/farming households apply their own food coping strategies and these differ. These strategies include buying inexpensive food, borrowing money or rice from neighbours or local money-lenders, consuming rice seed, reducing food consumption, or selling animals. It was generally observed that, among these coping strategies, buying inexpensive food was the most popular strategy as it was easy to do (Figure 3). This implies that, in order to eat, households are forced to buy less expensive food regardless of the quality and safety of that food, and this consequently adds to rural malnutrition and health problems.

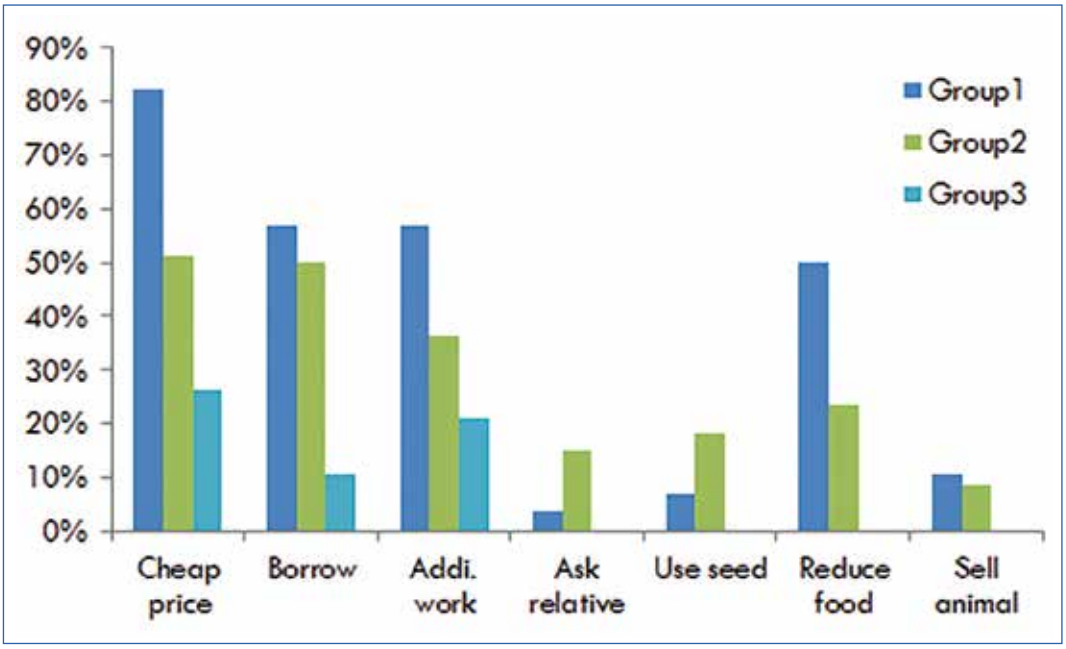


***Figure 3:*** *Percentage distribution of food security coping strategies*

## Impact of climate-driven flooding

### Description of the study area affected by climate change

Climate change has occurred in all parts of the study area. Local people realize that the climate has changed through the occurrence of more severe floods and drought cycles, heavier storms, and altered rainfall patterns. Floods are the most serious of these natural disasters as they destroy infrastructure, houses and crops, and disrupt people's daily activities. The meteorological record over the past three decades shows that all three regions of the study area experience similar natural disasters. Looked at individually, Kratie province is an upland area, but most people reside along the Mekong River and are therefore vulnerable to the Mekong floods. The province has experienced severe flooding several times in the last three decades - 1984, 1986, 2000 and 2011. Siem Reap province is the most vulnerable because the area is located in the floodplain and is subject to two sources of flooding; upland mountainous and overflow from the Mekong River. Although Takeo province is less vulnerable to flood because the area is almost completely separated from the Mekong River, people living there have still been affected.

### Impact of flooding and local responses

Table 3 (see annex) shows the percentage of households affected by flood in 2011. The highest was among group 3 households, who particularly experienced the destruction of rice production. But they were not the most vulnerable because they had alternative sources of income to compensate for this loss. Group 1 households experienced the highest impact on their fishing activities during the heavy floods because these were accompanied by severe

storms during which no fishing could take place. This implied that households in group1, who depend on fishing activities, were the most vulnerable to flooding because their household livelihoods and food security depended mainly on their ability to fish.

The survey did, however, discover short-term coping solutions that were commonly adopted by people when they faced abnormal flood. These included 'moving to a safer place' which occurred when the whole village, including all of its structures, were completely flooded. In some areas, local authorities had built a 'safe place' to accommodate the local people for short periods when there was flooding. But in others there were no such places and people simply moved out of their houses to stay temporarily on the national highway.

In addition, fishing and collecting common pool resources (CPRs) from areas near to houses during heavy floods, were important activities for households in groups1 and 2, especially those located in floating villages or if the village was completely flooded. This was because during severe storms and heavy floods they could not travel far.

Table 5 (see annex) presents the mean values of coping methods to the floods in 2011. Households in group 3 spent longer in the `safe place' than households in groups 1 and 2 because many in those latter groups live in the floating houses. Households in group 3 spent more on building additional floors, but households in the other two groups did this only when their lower house floor was flooded. The preparation of food for long-term use was also a coping strategy adopted to varying extents: group 1 had less ability than the other groups to buy and prepare food for long-term use.

As in the case of food security, the Community Fisheries were not involved in the process of adaptation. They lack mechanisms for direct assistance and have limited external funding support to offer local people when they are in need. When they are affected by climate-induced disasters, even if they are members of a CFi, fishing-farming households use their own coping or adapting strategies.

## DISCUSSION

The relationship between weather events, climate change, the resulting food insecurity and the responses to these issues, is complex. It perhaps gives rise to `wicked' problems that defy definitive or precise solutions (Jentoft and Chuenpagdee 2009, Rittel and Webber 1973). From this study we see how the diversity of coping strategies is based on land, wealth and household assets, and clearly allows for more or less food security in times of severe weather or climate events such as flood. However, in their assigned role to help people in need to cope with adversity, the Community Fisheries do not currently acknowledge and build on this diversity and are consequently not yet acting as effective resource management bodies.

As additional challenges, long-term changes in water regimes, including flood preparedness, mitigation measures and supply-side managed irrigation schemes, reduce connectivity and serve to undermine the resilience of social-ecological systems (SES). In turn, these create complex institutional challenges for multi-level and inter/intra agency responses (Lebel et

al. 2009). Extreme weather and natural disasters, resulting from the long-term effects of climate change, economic and social crises, demographic shifts and resulting migrations, are forcing governments to review their policies and management strategies to determine how they will (re)combine natural and human resources into strategies that lead to more resilient communities (Rijke et al. 2012). So, from the literature and media, we see that in Cambodia the climate change discourse is also multi-dimensional with many state and non-state actors involved in its definition (of impacts), mitigation and adaption. This involves taking into consideration a diversity of agendas, power sources and funding (Koch et al. 2007). Fishing is often only one of many livelihood activities that the residents of these communes actually undertake and so the Community Fisheries mandate should acknowledge and embrace the needs and impacts of these. The aquatic-terrestrial system (the agro-fishing floodplain SES) must be the focus of a broader co-management in these areas rather than focusing just on fish and fishing.

Overall, a strengthening of commune level management and collective action around fisheries conservation, with support from commune councils, might, in turn, help to coordinate local Community Fisheries to address wider issues including their own financial sustainability. Only with increased, and more accountable, financial and decision making autonomy would Community Fisheries be able to address a broader rural development mandate. This would mean a real commitment to good (transparent and accountable) governance methods and procedures.

The impact of different timings and types (or origins) of flooding (as an acute form of natural disaster) in Cambodia has rendered all three study areas food insecure for significant parts of the year. Flood affects the household production unit in a number of ways, from destroying crops and even infrastructure, to damaging animal and human health, which, particularly in the case of the latter, reduces their capacity for work. The highly diverse nature of these impacts is captured in the study typology of coping strategies. The land abundant households (group 3), who were engaged in `enlarged reproduction', cope in additional and perhaps more effective ways. There is wider engagement in social coping actions but also the adoption of more diverse agro-ecological and fishing strategies. The Community Fisheries have no institutional or practical ways of recognizing this or of building on it for a) more sustainable fisheries resource management, or b) to aid in developing disaster (flood) management/ relief planning. The diversity of impacts and implications climate change (floods) exerts on food security is also reflected in differences revealed in the three study areas. For different reasons all areas are food-insecure for different periods of the year. But so far, the Community Fisheries have not been able to adequately acknowledge and respond to these differences other than to link climate change to possible changes in fisheries yield, composition and the availability of certain favored Khmer species.

Under the current law there is no legal mandate for Community Fisheries to address these wider issues that have such an impact on rural communities. The Fishery Law and Sub-Decree on Community Fisheries need to be improved to permit the Community Fisheries to be able to address these additional drivers of social-ecological change in a timely, inclusive and effective manner. Climate change - in conjunction with other drivers - creates additional

and non-trivial levels of uncertainty which these laws do not currently take into account. The current legal-cultural context also lacks an updated funding mechanism for rural citizens to actively plan, change and adapt their Community Fisheries, and CFi members need to 1) use their local knowledge and tacit rules to adapt and manage their fisheries in times of high uncertainty, and 2) find innovative ways to build-in the necessary institutional flexibility to quickly address wider issues and effectively assemble the capacity to take necessary actions. We have argued in this chapter that Community Fisheries themselves currently lack adequate, sustained funding, and this severely hinders the ability of the Fisheries Administration to address complex fisheries management and enforcement requirements, let alone to deal with any wider social and ecological changes, impacts and consequences such as increased food insecurity and persistent rural malnutrition.

The serious social, ecological and economic changes in Cambodia will profoundly affect all fisheries, and there is a need now for the government, through its Fisheries Administration, to develop more strategies and legal instruments to promote adaptation. This project, which reviewed the Community Fisheries legislation and combined it with a detailed, three-site, household-level analysis of the impact of flooding on food security, supports this view. It revealed a clear disjunction between the mandate, the actions of Community Fisheries, and the diversity of strategies households were using to cope with extreme weather events: people in rural communities are employing strategies far beyond the mandate of current Community Fisheries legislation. There is, too, a need to recognise that responses to climate challenges create the conditions for an inequitable distribution of risks, gains and losses. Thus, ideally, state-community processes should recognize this and ensure that responses are inclusive, and that members of Community Fisheries are involved. In their study, Lebel et al. (2011) focused on assistance to Thai communities following the flooding they experienced in 2011. Their remarks relating to state responsiveness are, however, just as relevant in the Cambodian context, and particularly to the role Community Fisheries could play:

"*Our analysis identifies several gaps which need to be overcome if vulnerability is to be reduced. Possible responses are to expand public participation in managing risks, build adaptive capacities at multiple levels and link them, integrate flood disaster management and climate change adaptation into development planning and prioritize risk reduction for socially vulnerable groups.*"

## CONCLUSION

Climate change presents both challenges and opportunities, and these need to be recognized. Community Fisheries can be a vital element in promoting a broader improvement of dialogue and processes to establish an ecosystem-based management approach not just to fisheries but also to the management and use of all rural resources. Community Fisheries need more empowerment and the capacity to be financially sustainable. In the long-term, they can act as a forum for learning and knowledge exchange about different issues relating to the fishery sector, such as processing, marketing, species conservation and fishing rights. They could serve as a part of a truly de-concentrated network of fisheries management centres characterized by a diversity of links with vertical and horizontal actors, including the

Fisheries Administration as the central authority. The Community Fishery system needs to be part of a wider group of `knowledge communities' not centred in specific disciplines or with a sector focus, but perhaps including a network of `knowledge-based actors' who could propose a common set of protocols and analyses for assessing knowledge creation (Hulme and Toye 2006). This trans-disciplinary approach to solving complex issues such as poverty or community resilience would represent a consensus among community members on the related aims, conceptual framework and methods.

Local knowledge and its use for resource management would include knowledge about individual fish species – which would help individual fisherfolk in conserving their stocks - as well as the wider, and more general, issues of habitat conservation and watershed management that could be achieved through a diversity of interrelated management institutions, working within and between governance levels (Olsson and Folke 2001).

Simultaneous, cross-level monitoring, which would consider a range of indicators and would incorporate a diversity of state and non-state management responses, could work towards building resilience. Ways could be sought for Community Fisheries to assume a role here, particularly assisting in the development of local capacities so that people were better able to adapt to the different impacts of environmental change (O'Brien et al. 2007). There is a need to assist *existing* local capacity to be more proactively adaptive. Help should not just be reactive - responding to immediate catastrophe - or solely limited to building the capacity of government staff. Neither should it simply alter landscapes or infrastructure. Instead, there is a need to think ahead and plan beyond the usual vulnerability-poverty links, to help all actors to learn to adapt, if necessary facilitating fundamental transitions to new and possibly challenging types of livelihoods. Initiating or navigating complex change starts with bringing these diverse actors together to both acknowledge and incorporate their knowledge and worldviews into some form of deliberative institutional design process.

Cambodian state institutions require increased flexibility and inclusiveness in both the institutional design process and the implementation of any adaptation and management regimes. This requires *all* actors and stakeholders to support the creation of adaptive capacity (a capacity to act adaptively in uncertain conditions), and to foster both institutional learning and institutional memory (Olsson and Folke 2001) for building resilient SES.

The most recent international mechanism that could contribute to improving Community Fisheries management in Cambodia is the Global Voluntary Guidelines for Sustainable Small Scale Fisheries, accepted in June 2014. This can be accessed at: http://www.fao.org/fishery/ssf/guidelines/en. These guidelines spell out a clear rights-based approach to implementing sustainable small-scale fisheries, and discussions on the effective implementation of these guidelines are taking place (Jentoft 2014).

The government, via the Fisheries Administration through its Community Fisheries Development Department and the Technical Working Group-Fisheries, is committed to harmonizing the outcomes of policy deliberations (governance) and any proposed management actions for Community Fisheries. This determination is manifested in the government's revised 10-year

strategic planning framework, which echoes the new global guidelines. These guidelines have the endorsement of the world's small-scale fisher organizations and the focus now is on their implementation (Jentoft 2014). For this country, the hope is that this new global initiative will promote sustainable development of its small-scale fisheries for wider social and ecological benefits: Cambodia will need to account for its involvement in meaningful and valid livelihoods with real commitments to justice and poverty reduction for all of its fisherfolk. In this way, political and managerial reforms to the Community Fishery system in Cambodia may well find a positive way forward using global guidelines to enhance its capacity across the board, and to play a much more significant role in the general wellbeing, safety and security of the country's most vulnerable people.

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# BIBLIOGRAPHY


Ahmed, M. (1998) *Socioeconomic Assessment of Freshwater Capture Fisheries of Cambodia - Report on a Household Survey*. Phnom Penh: Mekong River Commission.

Allen, C. R. and Holling, C. S. (2010) Novelty, Adaptive Capacity, and Resilience. *Ecology and Society, 15*(3).

Badjeck, M. C., Allison, E. H., Halls, A. S. and Dulvy, N. K. (2010) Impacts of climate variability and change on fishery-based livelihoods. *Marine Policy, 34*(3), pp. 375-383.

Baran, E., Jantunen, T. and Chong, C. K. (2007) *Values of inland fisheries in the Mekong River Basin,* Phnom Penh: WorldFish Center.

Bayley, P. B. (1995) Understanding large river: floodplain ecosystems. *BioScience, 45*(3), pp. 153-158.

Berkes, F. and Ross, H. (2013) Community Resilience: Toward an Integrated Approach. *Society & Natural Resources: An International Journal, 26*(1), pp. 5-20.

Buntong, B. and Pang, S. (2010) *The Current Status of Integrated Strategies for the Sustainability of Food Security and Food Safety in Cambodia. Integrated Technology for Food Security and Food Safety, .* Bangkok: Kasetsart University.

CCCN (2014) *Many Factors in an Uncertain Future Situating Climate Change in Cambodia.* Phnom Penh Cambodia: CCCN.

Davidson, D. J. (2013) We Still Have a Long Way to Go, and a Short Time to Get There: A Response to Fikret Berkes and Helen Ross. *Society & Natural Resources: An International Journal, 26*(1), pp. 21-24.

Daw, T., Adger, N. W., Brown, K. and Badjeck, M. C. (2009) Climate change and capture fisheries: potential impacts, adaptation and mitigation. *Climate change implications for fisheries and aquaculture.*

FAO (2011) *National Fisheries Sector Overview,* Available: ftp://ftp.fao.org/fi/document/fcp/en/FI_CP_KH.pdf [Accessed May 05 2014].

Fisheries Administration (2010a) Annual Overview Report on the Status of Fisheries 2010. Phnom Penh: MAFF.

Fisheries Administration (2010b) The Strategic Planning Framework for Fisheries: 2010-2019 (SPF). Phnom Penh: MAFF.

Fisheries Administration (2010c) The Strategic Planning Framework for Fisheries: 2010-2019 (SPF). Volume 2-background information. Phnom Penh: MAFF.

Foran, T., Butler, J. R., Williams, L. J., Wanjura, W. J., Hall, A., Carter, L. and Carberry, P. S. (2014) Taking Complexity in Food Systems Seriously: An Interdisciplinary Analysis. *World Development, 61*(85-101).

Geres (2009) *Public perceptions of Climate Change in Cambodia*. Phnom Penh: DanChruch Aid.

Halls, A. (2009) Addressing fisheries in the Climate Change and Adaptation Initiative. *Catch and Culture, 15*(1), pp. 12-15.

Hortle, K. G. (2007) *Consumption and the yield of fish and other aquatic animals from the Lower Mekong Basin, MRC technical paper 16*.

Hortle, K. G., Lieng, S. and Valbo-Jorgensen, J. (2004) *An Introduction to Cambodia's Inland Fisheries, Mekong Development Series, No. 4,* Phnom Penh: Mekong River Commission.

Hulme, D. and Toye, J. (2006) The case for cross-disciplinary social science research on poverty, inequality and well-being. *Journal of Development Studies, 42*(7), pp. 1085-1107.

IFReDI (2012) *Food and nutrition security vulnerability to mainstream hydropower dam development in Cambodia, Synthesis report of the FiA/Danida/WWF/Oxfam project "Food and nutrition security vulnerability to mainstream hydropower dam development in Cambodia"*. Phnom Penh: Inland Fisheries Research and Development Institute, Fisheries Administration.

Jentoft, S. (2014) Walking the talk: implementing the international voluntary guidelines for securing sustainable small-scale fisheries. *Maritime Studies, 13*(1).

Jentoft, S. and Chuenpagdee, R. (2009) Fisheries and coastal governance as wicked problems. *Marine Policy, 33,* pp. 553-560.

Koch, I. C., Vogel, C. and Patel, Z. (2007) Institutional dynamics and climate change adaptation in South Africa. *Mitigation and Adaptation Strategies for Global Change, 12*(8), pp. 1323-1339.

Kurien, J. and Khim, K. (2012) *A Community Future*. Samudra Report No. 63.

Lebel, L., Foran, T., Garden, P. and Manuta, B. J. (2009) Adaptation to climate change and social justice: challenges for flood and disaster management in Thailand. in Ludwig, F., Kabat, P., van Schaik, H. and van der Valk, M., (eds.) *Climate change adaptation in the water sector*, London: Earthscan. pp. 125-141.

Lebel, L., Manuta, B. J. and Garden, P. (2011) Institutional traps and vulnerability to changes in climate and flood regimes in Thailand. *Regional Environmental Change, 11*(1), pp. 45-58.

Lieng, S. and Van Zalinge, N. (2001) *Fish Yield Estimation in the Floodplains of the Tonle Sap Great Lake and River Cambodia, Cambodia Fisheries Technical paper Series Volume III,* Phnom Penh: IFReDI.

O'Brien, K., Eriksen, S., Nygaard, L. P. and Schjolden, A. N. E. (2007) Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy, 7*(1), pp. 73-88.

Olsson, P. and Folke, C. (2001) Local ecological knowledge and institutional dynamics for ecosystem management: a study of Lake Racken watershed, Sweden. *Ecosystems, 4*(2), pp. 85-104.

Reilly, M. and Willenbockel, D. (2010) Managing uncertainty: a review of food system scenario analysis and modelling *Philosophical Transactions of the Royal Society B: Biological Sciences, 365*(1554), pp. 3049-3060.

Rijke, J., Brown, R., Zevenbergen, C., Ashley, R., Farrelly, M., Morison, P. and van Herk, S. (2012) Fit-for-purpose governance: a framework to make adaptive governance operational. *Environmental science & policy, 22,* pp. 73-84.

Rittel, H. and Webber, M. (1973) Dilemmas in a general theory of planning. *Policy Sciences, 4,* pp. 155-169.

Welcomme, R. L., Cowx, I. G., Coates, D., Béné, C., Funge-Smith, S., Halls, A. and Lorenzen, K. (2010) Inland capture fisheries. *Philosophical Transactions of the Royal Society B: Biological Sciences, 365*(1554), pp. 2881-2896.

Wheeler, T. and von Braun, J. (2013) Climate change impacts on global food security. *Science, 341*(6145), pp. 508-513.

# ANNEXES

***Table 1:*** *Household production system typology and value of key indicators*

| Key Indicators | Group 1: Landless or near-landless fishing households | Group 2: Land- poor agro-fishing households | Group 3: Land-abundant households |
|---|---|---|---|
| **1. Land crop area and land area per active laborer** | | | |
| Land crop area (ha.) | 0.12 | 0.70 | 3.93 |
| Land area per active labor (ha.) | 0.04 | 0.26 | 1.46 |
| **2. Laborers and average man-months in income and production** | | | |
| Number of dependent people | 2.35 | 2.07 | 1.82 |
| No. of active laborers | 2.92 | 3.30 | 3.27 |
| No. man-months in fishing | 11.54 | 7.00 | 3.18 |
| No. man-months in collecting Common Pool Resources (CPR) | 5.07 | 0.15 | 0.55 |
| No. man-months in fish processing | 0.00 | 0.14 | 0.50 |
| No.man-months in cropping | 3.50 | 12.10 | 18.05 |
| No. man-months in animal raising | 0.00 | 2.21 | 1.64 |
| No. man-months in non-farm self-employment | 2.21 | 2.59 | 5.73 |
| No. man-months in salaried employment | 2.39 | 5.74 | 3.82 |
| No. man-months in wage labor | 11.00 | 6.00 | 2.68 |
| **3. Current value of production and transportation assets** | | | |
| Current value of agricultural equipment (USD) | 16.70 | 544.7 | 2,416.03 |
| Current value of transport equipment (USD) | 280.82 | 495.56 | 551.55 |
| Current value of fishing gear (USD) | 52.07 | 21.58 | 39.92 |
| **4. Average annual aquatic resource production collected per household** | | | |
| Annual fish catch (Kg.) | 622.50 | 316.33 | 214.32 |
| Annual OAA catch (Kg.) | 349.29 | 17.07 | 85.91 |
| Annual vegetable collection | 99.68 | 19.87 | 0.32 |
| Annual firewood collection | 18.61 | 6.80 | 0.36 |
| **5. Average annual income from various sources (Riel)** | | | |
| Income from fishing | 1,652,857 | 1,142,808 | 682,727 |
| Income from CPR collection | 480,982 | 227,187 | 395,682 |
| Income from fish processing | 50,857 | 197,406 | 800,227 |
| Income from cropping | 141,429 | 3,002,254 | 6,656,968 |
| Income from animal raising | 42,071 | 533,989 | 811,136 |

| | | | |
|---|---|---|---|
| Income from non-farm self-employment | 189,286 | 660,659 | 136,364 |
| Income from salaries | 428,571 | 774,395 | 430,909 |
| Income from wage labour | 1,107,500 | 932,280 | 530,455 |
| **Total** | 4,093,553 | 6,449,599 | 10,444,468 |



***Table 2:*** *Percentages relating to food security*

| | Sufficient | Minor food shortage | Serious Food Shortage |
|---|---|---|---|
| Group1 | 25 | 46 | 29 |
| Group 2 | 33 | 37 | 29 |
| Group 3 | 78 | 22 | |

***Table 3:*** *Percentage occurrence in respect of the impact of flood in 2011*

| Type of Impact | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| Human Injury or Illness | 50 | 34 | 37 |
| Animal death | 0 | 7 | 11 |
| Poultry death | 32 | 35 | 47 |
| House destruction | 39 | 9 | 16 |
| Asset destruction | 46 | 21 | 16 |
| Rice destruction | 11 | 35 | 53 |
| Other crop destruction | 18 | 26 | 16 |
| Fishing disturbance | 57 | 33 | 32 |
| Other occupation disturbance | 29 | 24 | 16 |
| Children disturbed in attending school | 39 | 31 | 32 |
| Water sanitation problems | 11 | 15 | 11 |

***Table 4:*** *Percentages relating to solutions to the flood in 2011*

| Type of Solution | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| Move to safe place | 7 | 21 | 16 |
| Build additional floor | 25 | 28 | 5 |
| Migrate to work | 4 | 7 | 0 |
| Do additional fishing | 39 | 34 | 26 |
| Collect additional CPRs | 32 | 13 | 5 |
| Prepare food for long-term use | 32 | 33 | 42 |
| Maintain healthy environment | 29 | 37 | 42 |
| Consume less to keep for next day | 57 | 53 | 26 |

***Table 5:*** *Mean values of solutions to the flood in 2011*

| Type of Solution | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| Move to safe place (day) | 35 | 35 | 50 |
| Build additional floor (Riel) | 55,714 | 173,846 | 200,000 |
| Migrate to work (days) | 30 | 93 | |

# CHAPTER 10

## Learning towards resilience

Ronald W. JONES and Jean-Christophe DIEPART

This book has outlined eight case studies that show the diversity of profound changes as well as continuities occurring in Cambodian social-ecological systems (SES). These cases encompass different social and ecological processes and have illustrated the influence and consequences of the power-wielding instruments of governance and economics within contexts of dynamic and unpredictable system change.

These transformations are the result of both developments within contemporary Cambodian society and politics, and of external pressures occurring across multiple scales such as regional Mekong development, the progression of the Association of Southeast Asian Nations (ASEAN) and changes in the nature of global-local links. These interacting dynamics have resulted in the relative success or failure of local communities to make more effective decisions at different levels of governance. At the same time, this context of change has affected their ability to move the wider SES itself towards a more sustainable livelihood-climate-food nexus or state (Baird et al. 2014).

An underlying cross-cutting question in this project has related to how resilience has been manifested and built within the people themselves, and in the contexts on which the case studies have focused. We have interpreted resilience as a capacity that includes knowledge, skills and assets, and that allows systems to persist and change simultaneously. One key mechanism that supports resilience is an engagement in diverse forums of social learning to ultimately influence pathways of system self-organization (Rodela 2013, Rodela 2014). Indeed, a key function of this project focused on learning; for the communities and their supporting multi-level institutions and, just as importantly, for the Learning Institute itself.

## TRANSFORMATIONS AND CHANGES

The cases reveal the flexibility and capacity of resource-dependent communities to integrate and manage the multiple changes that affect them. Our studies show that they have also increasingly been able to voice their concerns and demand rights to foster processes of self-organization. This has been evident in the different pathways of development and change that have come to light in our studies. These have suggested that a primary form of food security adaptation - in response to social-ecological changes - has taken place through increased mobility and a move away from the natural resources-base systems: this has included mobility of labor as people have sought wage-earning opportunities; mobility of people through job-related and permanent migrations; mobility of capital and investment away from land and natural resources management to urban-based options; and mobility

of land ownership indicated by a higher degree of land transactions and land concentration among the wealthy and powerful.

The institutional analysis from this project shows that government policies for rural development are purposely promoting this rural mobility and are pushing for the shift of labor from working the land and natural resources to secondary and tertiary employment sectors. But these sectors and the necessary urban social facilities and services are not yet at the point where they can absorb the surplus migrant labor force in a just and decent fashion. In addition, this increased focus on mobility and the associated adaptation for the people involved, has reinforced the social differentiation between households and has exacerbated the polarization between labor and capital in the countryside. An increasing proportion of the rural population has consequently been marginalized. Our cases suggest that the de-agrarianization policies that are currently being promoted in Cambodia do not help to build rural resilience. Indeed, the high incidence of rural poverty, seasonal food insecurity and strong cultural and economic dependence on natural resources require labor to remain embedded and productive in the countryside. These policies fail to take this into account.

## CONTINUITIES AND UNRESOLVED CHALLENGES

Despite profound transformations in the social-ecological systems and related adaptation measures taken by the people, these studies emphasize the continuity in some economic and political forces acting across both biophysical scales and levels of governance. In the current context of rural Cambodia, our studies highlighted the difficulties faced by resource-dependent communities in fostering resilience when they are embedded in a powerful neo-liberal development agenda.

Discussions of resilience to change in Cambodia tend to focus on 'natural disasters' or 'climate change' and suggest that adaptation is needed to maintain the *status quo* or to prevent further economic loss. Continual local community participation in programs dealing with adaptation to climate change and greater food security, as advocated by the government and international organizations, can have the opposite result: following options promoted by the state and external donors can eliminate the incorporation of the communities' own local or traditional knowledge. These externally-imposed mechanisms can thus fail to take into account resilience measures that have been locally developed, are locally appropriate and that take local concerns, culture and social norms into account. The resulting social-ecological systems can be less, rather than more, resilient as a result.

The case studies show that shortcomings in natural resource management in Cambodia are primarily failures of governance. There are significant misfits between state policies and management interventions, and the governance interactions among very diverse sets of local actors need substantial attention if they are to be effective (Kooiman and Bavinck 2005). This institutional misfit creates the power-political space for elite capture of resources and processes and thus can result in decision-making processes that are ineffective, or that play to vested interests, while the social, economic and political isolation of marginalized groups in rural Cambodia is exacerbated.

# THE WAY FORWARD

> *"To embed practice of adaptive governance, a research and policy development challenge is to develop principles and procedures of collaborative management, policy, and program delivery that are consistent with theory and available practice, but suitable for incorporation into agency operating procedures. This would enhance the justification of and capacity for what are often novel policy styles within the culture and operations of the state: formalizing the informal* (Wyborn and Dovers 2014)."

These eight case studies clearly show that addressing the challenges faced by Cambodian policy makers, resource managers and communities will require the understanding and adoption of analytical tools and processes which explicitly recognize the unpredictable nature of working within social-ecological systems that are diverse and complex. The rapid pace and profound extent of alterations and degradation within the natural systems in the Mekong region will require all organizations to take a fundamental look at how and why they apply social and natural science tools. They need a better understanding of the key norms, rules and values that drive resource management, and, ultimately, the condition of those resources (Ostrom and Basurto 2011).

This project confirms the need to create collaborative institutional space in order to develop much more effective co-management regimes with a higher capacity or willingness to experiment. An over-reliance on top-down command and control methods for regulatory compliance requires reconsideration and `hard science' is needed to inform management decisions. The design and implementation of co-management systems and the accompanying shifts towards adaptive co-management - with its emphasis on social learning and proactive policy experiments – is a further step. The progression then towards some form of adaptive governance requires much more equal relationships between the state, as organized under the government, and the diverse people and the roles they play within natural resource systems found across Cambodia. All stakeholders have the right and responsibility to engage collaboratively in taking action (Wyborn 2015).

Resilient food systems are diverse and should be strongly rooted in place and in an 'agri' culture (Barthel et al. 2013) with secure land rights (Diepart and Sem 2015) and access to locally developed and managed markets.

The contemporary dilemmas in natural resources management are characterized as 'wicked problems' in that they have no *one* definitive solution, and no end point: the need is to constantly learn about, and adapt to them. This requires creative thinking and adaptive decision-making and management. In many cases the focal point for adaptation is the household, its assets and capacities, and their interactions within wider communities of livelihoods and authority. Institutional innovations and approaches to create adaptive governance are deliberative actions of debate and knowledge co-production. Actors need to pursue innovative

expressions of principles, inclusion and adaptation within broader social contexts of coping with multiples stressors. Here, multiple actors, including representatives from the state, engage in knowledge co-production to supplement science and thereby to foster a more inclusive and relevant policy process.

## THE LEARNING INSTITUTE ROLE

If this project was about social learning at the community level, it was also about learning at the organizational level. For the Learning Institute, the question now is how to be part of this process. The Learning Institute can help to bridge the gap between science/knowledge and policy for decision makers. It can act as an organization that helps to increase understanding about how both social and transformative learning processes can be applied in order to identify, understand and guide solutions to key natural resource issues. The Learning Institute is well-placed within a growing network of NGOs working in Cambodia and in the Lower Mekong Basin to build civil society awareness, along with links between knowledge and action.

Learning for resilience is learning from the experience of change and it often involves hands-on, learning-by-doing activity. This supports the development of new skills and innovative approaches. This will require the Learning Institute to work across bio-physical scales and governance levels and to acknowledge the impact power and politics have on research and the use of its products. The Learning Institute can serve as a place where young Cambodian researchers gain valuable first-hand experience and develop skills such as critical thinking and the ability to conduct institutional analysis for the entire research process. This could prepare them for future careers in research.

The following proposals are put forward for consideration by the Learning Institute in enabling it to move forward in engaging in innovative research activities in the field of environmental change.

### Identify and analyze issues, adaptations and innovations

Building on the projects featured in this book, and on a body of knowledge accumulated over more than 10 years, the Learning Institute could now further study the underlying causes of vulnerability that affect resource-dependent communities across Cambodia. The studies included in this book outline the diversity of cross-scale drivers that affect individuals and households, up to larger communities. These key forces are shown to have a significant impact on economic assets and decision-making processes.

Many of the resource governance problems outlined in this book pertain to institutional or legal pluralism in natural resource management or to related social-ecological contexts that require people to adapt to different forms and rates of environmental change. There are multiples rule-sets in play. They stem from different state and/or non-state actors vying for political or economic influence over resource extraction, or simply from the state's desire to retain control of rural populations via their access to crucial resources. This often results in

institutional discrepancies and thus confusion and inaction, and sometimes conflict. There is a hierarchy of different levels of power and influences relating to decision-making as it pertains to natural resource management in Cambodia, with most vested within cross-level government authority and a related tendency for the leading party to wield the most influence. The Learning Institute must become an active player in helping not only to build research capacity but also to use the information generated to affect change. The Learning Institute can identify existing capacities in groups or communities and meld those within a process or forum that promotes knowledge co-production (Wyborn 2015). This relates not only to technical but also to institutional innovation that allows multiple actors to deliberate then form legitimate rules for managing resources and also to advocate for change.

## Create a collaborative forum

As its name suggests, the Learning Institute must work to create a forum for learning to navigate change through the complexity of SES change and its associated consequences. This must start with comprehensive and critical reviews of relevant resource management theories such as those related to adaptive management, interactive governance, and resilience. From the very beginning, research design must be inclusive, involving people at grassroots level as collective actors of rural development. The resource-users themselves must be involved as it is only through a comprehensive and inclusive process that the diverse sets of tacit or experiential local knowledge can be included in the design and implementation of salient research, and in the ultimate production of legitimate results that can be used for further learning or for guidance in the policy arena.

## Facilitate effective social learning to foster adaptation/transformation

Forums or platforms for social learning comprise a key component in the development of effective adaptive co-management approaches. That is, learning by a relevant group of stakeholders or individuals within a social or collective process. The Learning Institute should continue to build social learning platforms or adapt their current research and information dissemination processes to include the ideas and challenges stemming from local cultures. It should also focus on how the use of power throughout Cambodian history has shaped the current power structures and hierarchies. History matters. It has shaped the current actors, agendas and interests that currently have the greatest impact on Cambodian natural resources and food systems.

It is essential to allow local people (as resource-users and stewards) to have some control over the choices they make relating to both the production and consumption of food. This starts with actively bringing small-scale agro-ecological landholdings into the wider discussion relating to the move from productionist-oriented food security towards one based on rights and responsibilities and the notion of 'food sovereignty' (Altieri et al. 2012). Food sovereignty is a rights-based approach in which the local producers and distributers have direct input and influence on how their food systems are designed and run, and how benefits are distributed through linked communities (Patel 2009).

The lessons from this study also underline the importance for the Learning Institute, its partners and participating actors to be aware of, and to create, feedback loops in terms of important information and resources. The long-term adaptive co-management of Cambodian natural resources depends on engaging these critical feedback systems. These could support management, as well as facilitating interaction between wider social-political governance organizations and individuals. All relevant actors are encouraged to engage in trial-and-error learning, and, where possible, to implement experimental policies and strategies at an early stage. In this way lessons can be learned at a relatively low cost and with limited consequences while providing participants with vital and practical learning, and opportunities for critical reflection.

# BIBLIOGRAPHY


Altieri, M. A., Funes-Monzote, F. R. and Petersen, P. (2012) Agro-ecologically efficient agricultural systems for smallholder farmers: contributions to food sovereignty. *Agronomy for Sustainable Development, 32*(1), pp. 1-13.

Baird, J., Plummer, R., Haug, C. and Huitema, D. (2014) Learning effects of interactive decision-making processes for climate change adaptation. *Global Environmental Change, 27*, pp. 51-63.

Barthel, S., Crumley, C. and Svedin, U. (2013) Bio-cultural refugia—Safeguarding diversity of practices for food security and biodiversity. *Global Environmental Change, 23*(5), pp. 1142-1152.

Diepart, J.-C. and Sem, T. (2015) *Cambodian Peasants and the Formalization of Land Rights: Historical Overview and Current Issues (forthcoming), Etudes et documents du GRAESE No ../2015,* Gembloux: Groupe de Recherches Asie de l'Est et du Sud Est.

Kooiman, J. and Bavinck, M. (2005) The governance Perspective. in Kooiman, J., Jentoft, S., Pullin, R. and Bavinck., M., (eds.) *Fish for Life: Interactive Governance for Fisheries,* Amstrerdam: Amsterdam University Press. pp. 11-24.

Ostrom, E. and Basurto, X. (2011) Crafting analytical tools to study institutional change. *Journal of Institutional Economics, 7*(3), pp. 317-343.

Patel, R. (2009) Special section: Food sovereignty. *Journal of Peasant Studies, 36*(3), pp. 663-706.

Rodela, R. (2013) The social learning discourse: trends, themes and interdisciplinary influences in current research. *Environmental science & policy, 25,* pp. 157-166.

Rodela, R. (2014) Social Learning, Natural Resource Management, and Participatory Activities: A reflection on construct development and testing. *Wageningen Journal of Life Sciences, 69,* pp. 15-22.

Wyborn, C. (2015) Co-productive governance: A relational framework for adaptive governance. *Global Environmental Change, 30,* pp. 56-67.

Wyborn, C. and Dovers, S. (2014) Prescribing adaptiveness in agencies of the state. *Global Environmental Change, 24,* pp. 5-7.

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John is a consultant of the Analyzing Development Issues Centre (ADIC). Since 1995, he has conducted development research and assisted in rural livelihood programs in Cambodia, principally with the Cambodia Development Resource Institute (CDRI), International Cooperation for Development and Solidarity (CIDSE), Cooperation Committee for Cambodia (CCC) and ADIC. From 1970 to 1992, he was engaged in similar work in the Philippines. He has a Doctorate in Political and Social Cultural Sciences from the University of Amsterdam, the Netherlands, and a Master of Arts, majoring in Anthropology, from the Ateneo de Manila University, Philippines. His professional and research interests include social and cultural change, indigenous and marginalized people, local impacts of the market economy, Participatory Action Research (PAR), localized religion and urbanization. He is a contributor to the Leaning Institute's Volume II Emerging Trends, Challenges and Innovations (2009) and Engaging for the Environment (2012).

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IL has been the Executive Director of the Analyzing Development Issues Centre (ADIC) since 2011 dedicated to promoting critical thinking and analysis with local communities through policy research and Participatory Action Research (PAR), mainly on land and natural resource governance in the Tonle Sap provinces and in Northeast Cambodia. This work carries on from previous experience since 1999 when he worked for the Analyzing Development Issues (ADI) project of the Cooperation Committee for Cambodia (CCC), but the target group then was Cambodian staff of NGOs in Cambodia. Il worked for five years with Partnership for Development in Kampuchea (PADEK) managing a rural development program. He graduated as a Master of Science in Public Policy and Human Development, specializing in Sustainable Development, in the Netherlands; and obtained a Master's degree in Business Administration in Cambodia. His professional and research interests are focused on community mobilization for collective action on land and natural resource challenges.

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Katelyn's interest in climate change and natural resource management led her to work with the Participatory Management of Coastal Resources (PMCR) research team in the winter of 2012. A recent graduate of International Development Studies and Geography from the University of Ottawa, in Canada's national capital, she worked with the research team for several months to develop, administer, and analyze the household survey described in Chapter 8 of this book. Katelyn's experience in Cambodia inspired her to return to academia. Shortly after returning to Canada from her time abroad, she began studying at Dalhousie University in Halifax, Nova Scotia, towards a Master's degree in Resource and Environmental Management. Her studies centered on conservation system design and ArcGIS, and community-based forms of natural resource management. Katelyn is also deeply invested in work related to environmental and climate justice. She enjoys her role as an organizer around different issues in the communities where she lives, and the time she spends doing environmental education volunteer work.

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Dane So has been a Development Researcher and Data Analyst for local and international organizations since 2002. From 2011, he has been a Program Associate with Analyzing Development Issues Centre (ADIC), providing capacity building in critical thinking, and research methods and statistics through Participatory Action Research (PAR). He has also been involved in policy research focusing on natural resource governance with indigenous communities, land use change and food security, migration, the experiences of older people and HIV/AIDS in the Northeast of Cambodia and in the Tonle Sap community. He was a Senior Researcher and Trainer with the Analyzing Development Issues (ADI) project conducted under the NGO, Cooperation Committee for Cambodia (CCC) from 2009-2011, and conducted a poverty and social impact assessment with the Asian Development Bank from 2009-2014. This involved a livelihood program focusing on micro and small enterprise development for the rural poor in Cambodia. He was a Data and Research Short-Term Consultant with the World Bank from 2012-2013, contributing to the project on Cambodian Poverty Assessment, and on Data Management in connection with a Cambodia Socio-Economic Survey. He holds a Bachelor of Arts degree

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Jan has a PhD in Journalism from City University, London, and a Master's degree (with Distinction) in International Communications from the University of Leeds in the UK. She is a professionally qualified journalist, PR practitioner, marketer and researcher. Jan gained her communications and research experience first in the UK working for publishing houses, universities and FTSE 100 companies. She has post-doc experience as research assistant to Professor Howard Tumber, Director of Research for the Graduate School of Journalism at City University in London, and has been a lecturer in the theory and practice of journalism for Master's degree students at the University of Cardiff in Wales. For the past

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Rithy is a Project Officer at the Learning Institute. He is a Master's student at the Royal University of Agriculture, Phnom Penh, majoring in Natural Resource Management. His work experience is related to research, capacity building/training, community organizing and workshop facilitation, especially dealing with indigenous and rural people. His research interest is focused on the areas of land use change, water management, food security and climate change.

This publication emerged from four years of sustained research by partners in the Food Security, Climate Change and Natural Resources Management in Cambodia research program. In implementing this major program, the Learning Insti tute received financial support from the International Development Research Centre (IDRC) of Canada and acted as a grant-making organization for partners.

This book summarizes lessons learned from rural communities about ways they have tried to build resilience in the face of changes that have affected their social-ecological systems. The research program consists of a diversity of projects spanning the country and focusing on a wide variety of themes and issues. Each project addresses specific dimensions of the nexus of 'climate change-food security-natural resources management' but they are integrated under one common research framework.

Full details of this publications can be found with the following website

**www.learninginstitute.org**

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