

Mainstreaming of Climate Change Adaptation into the Sub-National Development Planning in Cambodia



Cambodia Climate Change Alliance (CCCA)

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Abbreviations and Acronyms

AFD	Agence Française de Développement
CARDI	Cambodian Agricultural Research and Development Institute
CARP	Coastal Adaptation and Resilience Planning Component
CBNRM	Community Based Natural Resource Management
CC	Climate Change
CCCA	Cambodia Climate Change Alliance
CCD	Climate Change Department
CCU	Coastal Coordination Unit
CDP	Commune Development Plan
CSO	Civil Society Organisation
DANIDA	Danish International Development Assistance
DOA	Department of Agriculture
DRR	Disaster Risk Reduction
EIA	Environmental impacts assessment
EU	European Union
FFS	Farmer Field Schools
FiA	Fisheries Administration
FO	Farmer Organisation
FWUC	Farmers Water Users Community
GIS	Geographic information system
HH	Household
IDRC	International Development Research Centre
IPM	Integrated Pest Management
KAP-study study	Understanding Public Perception of Climate Change in Cambodia
LT	Long Term (rice variety)
MAFF	Ministry of Agriculture, Forestry and Fisheries
MoE	Ministry of Environment
Mol	Ministry of Interior
MoP	Ministry of Planning
MoU	Memorandum of Understanding
MoWRAM	Ministry of Water Resources and Meteorology
MT	Medium Term (rice variety)
NAPA	National Adaptation Programme of Actions to Climate Change
NCCC	National Climate Change Committee
NCDD	National Committee for Sub-National Democratic Development
NGO	Non-Governmental Organisation

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PDA	Provincial Directorates of Agriculture
PWG	Provincial Working Group
RGC	Royal Government of Cambodia
SCW	Save Cambodia's Wildlife
SLR	Sea Level Rise
ST	Short Term (rice variety)
ToT	Training of Trainers
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
VRA	Vulnerability Reduction Assessment

Executive Summary

The Royal Government of Cambodia (RGC) has identified the coastal zone as a focal point in Cambodia's work to adapt to existing and coming impacts of climate change. The coastal zone is threatened by severe impacts of climate change such as storms, surges, sealevel rise and seawater intrusion. Most of the people living in this area are very dependent on ecosystems because they support themselves mainly through agriculture (mostly paddy cultivation) and fisheries (mostly small-scale).

With financial support from the international donor community, Cambodia Climate Change Alliance (CCCA) is implementing the Coastal Adaptation and Resilience Planning Component (CARP) with the objective of building coastal zone adaptation capacity at national and provincial level. The CARP is being implemented in eight target communities in the provinces of Koh Kong and Sihanoukville by UNEP-DHI Centre for Water and Environment in cooperation with the Ministry of Environment.

The overall purpose of this report is to provide a blueprint for how climate change could be mainstreamed into sub-national development planning in Cambodia. To illustrate this, the report summarises a number of assessments and studies, which were carried out under the CARP in 2012-13. They draw lessons learnt from CARP implementation and suggest appropriate interventions in order to strengthen the adaptation capacity and response to the projected impacts of climate change in the coastal zone. The findings of the reports and the processes followed to obtain them could serve as examples or be replicated elsewhere in Cambodia, as well as in other countries.

Main climate change predictions for the coastal zone are:

- A sea level rise of 18 to 56 cm by the 2090s.
- An increase in rainfall along the coast by 2 to 6% by 2050.
- An increase in mean annual temperatures by 0.3 to 0.6 °C by 2025, by 0.7 to 2.7 °C by the 2060s and by 1.4 to 4.3 °C by the 2090s.

The CARP's target communities have already experienced climate related changes such as:

- Increase in coastal storms and intensified storms during the wet season
- Drought in the dry season
- Seawater intrusion
- Decrease in marine life
- Livestock health problems due to intensified heat

- Ecosystems contribute less to food security
- Decrease in soil fertility
- Well water/ground water no longer drinkable

An assessment of current coping strategies in the CARP's target communities in relation to flooding, drought and other extreme events shows that their pursuit is hindered by low technical capacity and limited institutional support, with the result that none of the strategies work at their full potential.

A lack of an organised system of dissemination of information about weather hazards is identified as a key problem in ensuring the effectiveness of coping strategies.

Recommendations are provided regarding how such an information system could be developed, and what type of information it should be based upon. Data collected in the target communities shows that villagers' perception of (the causes of) climate change contradicts the technical definitions of climate change, which could hamper project implementation. It is suggested to change the perception through awareness-raising activities.

An assessment of the vulnerability of existing agricultural practices in the target communities shows that a number of threats are either directly climate-related or will interact with climate-related threats. Examples include sea level rise (in some places interacting with land subsidence) affecting cultivation, flood exposure, drainage and coast erosion; sea water intrusion affecting water availability for cultivation and other purposes; increased frequency of storms affecting cultivation, fisheries and coast erosion; and degrading soil quality, which affects cultivation. Drought is a minor concern today (unlike in the rest of the country) but can escalate if the weather gets more irregular, in which case the area will be particularly vulnerable (due to lack of local experience). Between them, these threats will negatively affect the prospects for sustainable livelihoods.

Potential pilot projects and demonstration activities for further consideration are:

- Formation/consolidation of farmer and fishery communities and technical support directly to farmer households.
- Tree-planting schemes to break the wind, a feasibility assessment of a compartmentalization of the polder to confine exposure to sea water intrusion and systematic monitoring of salinity and land subsidence.
- Implementation of a major agricultural programme that could serve as a "controlled laboratory" for identification of appropriate seeds and cultivation practices.
- Support to appropriate use of fertilizer and pesticides and promotion of better seeds, particularly high-yield short-term rice varieties.
- Support to dissemination and promotion of recent positive experiences with two crops per year and to appropriate land use and soil management.
- Support to various supplementary livelihoods.

An assessment of community vulnerability and risks from the impacts of climate change in the target communities provides further evidence of the inadequacy of existing coping strategies.

PeamKrasaob, Koh Kong Province: The risk scenario in terms of loss of fishing opportunities is assessed to be in the high category towards the year 2100. PeamKrasaob mostly consists of water and mangrove forests and fisheries is a very important source of income for the people. Climate Change (and particularly SLR) is likely to cause significant losses of the habitats (the mangrove forests in particular) that provide shelter and food for fish. Such developments are likely to negatively alter the distribution and productivity of the fishing, and thus impact local livelihoods. There is also the risk that sea water inundation, if not contained by protective dykes, will make all normal cultivation activities impossible.

TuolKokir, Koh Kong Province: The risk scenario of loss of crops in the wet season is assessed to be in the extreme category towards the year 2100. In TuolKokir, the most important source of income is rice (over half of household income is from crops). Climate change is likely to cause loss of farm land, deteriorating soil and water quality, and increase the probability of flooding.

Prey Nob, Sihanoukville Province: The possibility of loss of crop (rice) in the wet season is assessed as extreme going towards 2100. In Prey Nob, crops remain the single most important source of income for households. As in TuolKokir, climate change will cause the loss of farming land and cause the degradation of soil and water quality. Flooding will also become more likely.

Although the target communities have made commendable efforts to counter the effects of climate change and variability, the adaptation capacity to future climate change is inadequate. Outside assistance (from local as well as national authorities) is therefore necessary.

Proposed demonstration activities regarding livelihood adaptation are:

- Integrated Farming Training Programme for agricultural/fisheries extension staff and households/families in adaptation strategies and integrated farming in 7-8 target communes.
- Community Forestry projects in cooperation with the Forestry Administration, where possibilities exist at TuolKokir. This might include livestock grazing rights for livestock in forest areas as well as tree nurseries.
- A Community Fisheries project at PeamKrasaob in cooperation with the Fisheries Administration, especially in terms of strengthening regulatory measures and their enforcement.
- Reinforcement of community dyke maintenance, drainage and irrigation systems management in cooperation with MoWRAM – for Prey Nob and TuolKokir.

- Promotion and increased availability of shorter duration seeds for crops, particularly for wet-season paddy, thus, possibly enabling harvest before onset of heavy flooding and sea water surges at all five communes.
- Promotion of increased livestock keeping at five communes - by using a revolving scheme for improved breeds – tested successfully in Cambodia, Laos and elsewhere.

An analysis of economic and social costs & benefits of the shortlisted interventions shows that they are all profitable in economic terms for both the CARP and the participating households. They are also in line with the expressed priorities of community representatives and builds on their present coping strategies. There are, therefore, limited social costs but rather benefits associated with them.

Consultations were undertaken in May-August 2012 with sub-national authorities in Koh Kong and Sihanoukville, the Prey Nob Water User Community and stakeholders in Phnom Penh in order to assess the capacity of government bodies to implement demonstration activities and identify training needs. Several capacity gaps were indicated; but also some “low-hanging fruit” available for visible improvement at a small cost (if any).

Based on the consultations, the following capacity-building activities have been proposed to add value and contribute to dissemination and consolidation of initiatives under the CARP:

- Inter-disciplinary CC training at province and district level.
- Support to dissemination of existing data; guidance on improved monitoring (of rainfall, salinity, land subsidence, cultivation practices etc.); promotion of the use of maps, and better accessibility of existing maps, as well as guidance on the use of satellite data and imagery, including resources readily available from the Internet.
- Capacity-building in soil quality analysis and soil management.
- A bridging programme, possibly involving exchange visits by farmers and salinity control operators with peers in the Cuu Long (Mekong) Delta in Vietnam where a substantial experience has been achieved within cultivation in areas exposed to sea water intrusion.
- A “Climate Change Atlas” for the coastal zone, including mapping of present (normal and extreme) rainfall and sea level, and flood risk.
- A national MSc-level education in environmental management (including the climate perspective).
- Formation of a national professional organisation in support of networking and knowledge-sharing among practitioners.
- Publication of policy briefs/case studies, including success stories.
- Support to national networking about drought preparedness and drought mitigation.

It has also been proposed to carry out training-of-trainers activities and pilot education and awareness-building sessions in both provinces for Provincial Working Group members, commune/village representatives and members of Farmer Water User Committees with the aims of increasing awareness and understanding of CC-related challenges and adaptation options, and improving technical skills.

As part of the selection process, the proposed demonstration activities were presented in September-December 2012 to the technical working groups and the commune councils at a series of workshops in Koh Kong and Sihanoukville. Feedback was received through these consultations regarding their ranking. Based on this, additional work was conducted to formulate the six demonstration activities into concrete projects including budget and implementation plans.

The successful implementation will depend on the smooth cooperation between the CARP, MoE and other RGC institutions – notably institutions under MAFF, including the Provincial Departments of Agriculture, Fisheries and PDWRAM. There may be some functional capacity limitations within the mentioned institutions. The timely consultation and negotiation of roles and responsibilities in regard to implementation is therefore of the utmost importance.

Most activities are to be implemented during 2013 but it will be necessary to have follow-up activities during 2014-15. However, the CARP component is due to close by end of 1st quarter 2014, thereby allowing only one main growing season (the wet season 2013) for the implementation. This is not an ideal situation as all demonstration activities would benefit from the component's presence in terms of follow-up and consolidation of results and outcomes.

1. Introduction

1.1 The purpose of the report

The Royal Government of Cambodia (RGC) has identified the coastal zone as a focal point in Cambodia's work to adapt to existing and coming impacts of climate change. The coastal zone is threatened by severe impacts of climate change such as storms, surges, sea level rise and seawater intrusion. Large parts of the coastal zone are at low elevations and are thus particularly vulnerable to the impacts of climate change. Most of the people living in the coastal zone are very dependent on ecosystems because they support themselves mainly through agriculture (mostly paddy cultivation) and fisheries (mostly small-scale).

With financial support from DANIDA, the EU, Sweden and UNDP the Cambodia Climate Change Alliance (CCCCA) is implementing the Coastal Adaptation and Resilience Planning Component (CARP). The objectives of the CARP are to build coastal zone adaptation capacity at national and provincial level and develop adaptation plans through a practical learning-by-doing capacity building exercise involving all stakeholders. The adaptation plans will then be translated into practical demonstration adaptation measures to be implemented in vulnerable communities in selected agricultural and mangrove areas.

The CARP is being implemented by the UNEP-DHI Centre for Water and Environment in cooperation with Ministry of Environment in eight target communities in the districts of Mondul Seima and Prey Nob in the provinces of Koh Kong and Sihanoukville. The selection of these two provinces was endorsed by the stakeholders present at the national consultation workshop on 16 March 2010.

The overall purpose of this report is to provide a blueprint for how climate change could be mainstreamed into sub-national development planning in Cambodia. To illustrate this, the report summarises a number of assessments and studies, which were conducted under the CARP in 2012:

1. *"Assessment of Coping Strategies in the Coastal Zone of Cambodia"*. This report provides inputs to the CARP baseline by assessing public perceptions of climate change in the coastal zone, the information being provided to the population in the coastal zone on climate change and weather hazards as well as the coping strategies employed by the target populations.
2. *"Vulnerability of Existing Agricultural Practices"*. This report provides inputs to the adaptation planning process by assessing the vulnerability of existing agricultural practices in relation to the impacts of climate change in the CARP's two target provinces of Koh Kong and Sihanoukville and proposes a number of pilot projects and demonstration activities that could be undertaken to improve these practices.

3. *“Assessment of Community Vulnerability and Risks from Climate Change in the Coastal Zone of Cambodia”*. This report provides further input to the adaptation planning process by assessing the overall vulnerability of and risks to the livelihoods of CARP’s target communities in relation to current climatic conditions and projected trends and listing a number of interventions that could be undertaken to secure them. Some of these interventions are proposed for further evaluation, consultation and economic analysis.
4. *“Analysis of Costs & Benefits of Modifying Agricultural Practices for Climate Change at the Coast”*. This report analyses the economic and social costs and benefits of the shortlisted interventions which are less vulnerable to the impacts of climate change.
5. *“Implementation Capacity of Demonstration Activities”*. This report provides an assessment of the capacity of government bodies to implement demonstration activities under the CARP component, together with suggestions on capacity-building activities.
6. *“Support to CC Education, Awareness-Building and FWUC Strengthening”*. This report provides suggestions on climate-related education and awareness-building activities that could be undertaken at the province and commune levels and within Farmer Water User Committees (FWUCs).
7. *“Detailed Implementation Plan for Demonstration Activities at the Coast”*. This report contains implementation plans for six prioritized demonstration activities to be implemented in CARP’s target communities.

The reports draw lessons learnt from CARP implementation and suggest appropriate interventions, based on extensive documentation and comprehensive analyses, in order to strengthen the adaptation capacity of the target communities and the response of government bodies to the projected impacts of climate change in the coastal zone. The reports are products of extensive consultations with the target communities and government authorities through on-site visits, group discussions and seminars and workshops at both national and local level. Combined the findings of the reports and the processes followed to obtain them could serve as examples or be replicated elsewhere in Cambodia, as well as in other countries.

The following sections include presentations of the specific characteristics of the coastal zone, the current climatic conditions and projected trends as well as the institutional and policy framework for CARP. A brief description of the eight target communities is also included.

1.2 The Coastal Zone

The coastal zone consists of four provinces (Kampot, Koh Kong, Sihanoukville and Kep). The total area covered by these provinces is approximately 17,237 km². The coastal shoreline is 435 km, and runs along the Gulf of Thailand. It has one deep seaport, located at Sihanoukville, which is one of the main economic centres of Cambodia. The climate of the

coastal zone is defined as tropic monsoon with an annual rainfall between 2,000 and 4,000 mm (the highest in the country).

The coastal zone has substantial sources of freshwater, from streams, rivers and lakes that exist in the area. However, during the rainy season, rivers, streams and lakes flood due to the heavy rainfall, resulting in destruction of crops in low lying areas. In the dry season, the downstream rivers get mixed with the seawater, making the water unsuitable for irrigation purposes. Observations indicate that the seawater can reach up to 10 km inland along rivers and canals.

Most of the coastal zone is covered by forest. Koh Kong province has the highest forest cover rate (83% or 1,002,721 ha), followed by Sihanoukville Province (54% or 81,539 ha) and Kampot province (48% or 224,730 ha). Kep province has the lowest forest cover rate (21% or 3,733 ha). From 1993 to 2005, the overall forest cover rate in the coastal zone decreased from 84% to 71% - mainly due to agricultural production.

In 2005, 55,419 ha along the coastline were covered with mangrove forests. The mangrove forests with their ecosystems are essential for the coastal zone for two reasons. Firstly, they have a vital role in the survival of numerous fish species and other marine organisms. Secondly, they act as a buffer against tropical storms, storm surges and rises in the sea level, thereby protecting the land from erosion and inundation. Despite their vital importance, studies estimate that a decline of 25% of the mangrove forests took place between 1993 and 2005. This is mainly due to the illegal use of mangroves for firewood and charcoal production. Other causes include clearing of forests for land reclamation and the establishment of salt pans and intensive shrimp aquaculture.

The coastal zone has large areas of seagrasses. Eight different species of sea grass can be found. The sea grass functions as habitat for juvenile fish, thereby serving as the nursing ground for many different species of fish including crustaceans and invertebrates. The sea grass is under pressure from degradation of water quality due to logging, sand mining and coastal reclamation activities. Destructive fishing practices also have a negative impact.

1.3 Climate change in Cambodia

Although not as highly exposed to the effects of climate change as other countries in the region, e.g. Vietnam and the Philippines, Cambodia is rated as one of the most vulnerable countries in the world to climate change (9th rank World Risk Index 2011 Vulnerability ranking catastrophes and natural disasters, 6th rank Maplecroft Climate Change Vulnerability Index 2012). Its vulnerability is due to a poor level of infrastructure, a very low level of capacity in adapting to climate change effects and the fact that a big part of the population earns its livelihood from agriculture in remote areas.

Livelihoods in Cambodia are heavily dependent on the rainy season from May to October and the seasonal flooding of the Mekong River and the Tonle Sap Lake, which has become increasingly unreliable in its coming and intensity in recent years.

The coastal zone is one of the most vulnerable areas to climate change in the country. Climate change can encompass seasonal variability as well as inter-annual variability, which are manifested in extreme weather occurrences, such as storms, cyclones, flooding, heat waves, etc. Below, only changes in average conditions are highlighted. The main climate change predictions are:

Sea Level Rise

The coastal zone will be subject to an expected rise in sea level (SLR) of 0.18 to 0.56 m by the 2090s. This will be exacerbated by tidal variation, which can be up to 0.7 m per day; while waves of 4-5 m height are known at sea during storms.

This combined with a decline in mangrove forests, and an increase in the frequency and intensity of storms and storm surges, will lead to more coastal inundation. This will have dramatic effects for the local communities. One consequence will be the salinization of the surface and the groundwater. The salinization will have a severe impact on the fertility of the areas used for farming, and on the freshwater based ecosystems. This will pose a threat to food security and livelihoods because most agriculture in the coastal zone is concentrated on these flood-prone low-lying coastal areas. The infrastructure in the coastal zone will also come under pressure, which can lead to an increased vulnerability over time and loss in income from tourism.

Increase in rainfall

Rainfall along the coast is expected to increase by 2 to 6% by 2050 – lowland areas are likely to experience a greater increase in rainfall than areas at higher elevations - and a consequential increase in frequency and intensity of flooding events due to more frequent episodes of heavy rainfall.

Flooding, heavy rainfall and storms destroy property and productive assets, such as crops and livestock. Flooding will often lead to poor water supply and unsanitary/unhygienic conditions, causing serious health issues and potential disease outbreaks. An increased frequency of storms will also affect cultivation, fisheries and coastal erosion.

Increase in temperature

The mean annual temperatures are expected to increase by 0.3 to 0.6 °C by 2025, by 0.7 to 2.7 °C by the 2060s and by 1.4 to 4.3 °C by the 2090s. This is likely to increase evapo-

transpiration and thereby increase the risk of periodic droughts. It is also predicted that there will be an increase in hot days and nights.

Droughts or heat waves will ultimately cause problems regarding feeding/watering livestock, watering crops and drinking water scarcity. All such issues have a detrimental effect on the overall health of people. An increase in temperature or occurrences in heat waves will also reduce the ability of people to work due to heat stress. Although drought may be a minor concern today (unlike in the rest of the country), this scenario may escalate if the weather gets more irregular, in which case the area will be particularly vulnerable (due to lack of experience).

1.4 Institutional framework

In order to be able to adapt to the impacts of climate change, a certain institutional capacity is required. This capacity includes not only coping strategies enacted by villagers in local communities, but also adaptation strategies that are integrated at all levels in the country.

The National Climate Change Committee (NCCC), which was established in April 2006 as an inter-ministerial mechanism, has a mandate to prepare, coordinate and monitor the implementation of policies, strategies, legal instruments, plans and programmes in relation to climate change. Prime Minister Hun Sen acts as the honorary chairman of NCCC; a fact that testifies to its political leverage. The NCCC is composed of officials from 19 Ministries and government agencies.

The following three ministries also have main responsibilities related to climate change, natural resources and coastal ecosystem management and development:

- Ministry of Environment (MoE) was established in 1993 and is responsible for environmental protection and natural resources management in the country. The MoE is also responsible for Climate Change coordination, and the Climate Change Department in the MoE functions as the secretariat for the NCCC. In relation to the coastal zone, the MoE has a mandate to coordinate environmental management and development activities according to a decision letter signed by the Prime Minister.
- Ministry of Agriculture, Forestry and Fisheries (MAFF) has a mandate to manage all activities related to fisheries, including artisanal fisheries, mangroves, sea grass and industrial fisheries. In practice, the MAFF has the responsibility for day-to-day management of most of the coastal resources, without the general coordinating mandate for overall environmental management.
- Ministry of Water Resources and Meteorology (MoWRAM) has the responsibility to manage all activities related to water and meteorology development and preventing natural disasters. The MoWRAM has signed a Memorandum of Understanding (MoU)

regarding the sharing of responsibility for the Prey Nob polder management with the Sihanoukville Provincial Authority and the local Farmer Water Users Community.

1.5 Policy framework

The National Adaptation Programme for Action to Climate Change (NAPA) acts as the political framework for NCCC. The NAPA was developed in order to prioritize adaptation needs in the country, and to create synergies with other environmental and development programmes. It identified the following objectives:

- Establish an understanding of the main characteristics of climate hazards in Cambodia
- Establish an understanding of coping mechanisms at the grassroots level
- Establish an overview of existing programmes and institutional arrangements for addressing climate hazards and climate change
- Identify and prioritize adaptation activities

Besides the NAPA, a national strategic action plan for climate change is under preparation by MoE. The Provincial Environmental Management Plan covering 2011-2015 is under finalization but has not yet been approved. However, it is expected that it will have climate change as an integrated theme, and serve as a policy framework for climate change adaptation strategies.

1.6 Target communities

The assessments of coping strategies and community vulnerability and risks have been carried out in two pre-selected target areas:

- MondolSeima District, Koh Kong Province
- Prey Nob District, Sihanouk Province

As stated in the CARP: “The Prey Nob and MondolSeima districts were selected as pilot districts during consultations between the MoE, provincial and district authorities from the coast, the CCD and the national and international consultants. Their selection was based on the fact that both areas border the shoreline and largely consist of low-lying land, and consequently are highly vulnerable to SLR, storm surges, saltwater intrusion and tropical storms.”

The following eight communes in the two districts were selected as target communities:

- PeamKrasaob and TuolKokirCommunes, MondolSeima District, Koh Kong Province
- TuekThla, TuekL’ak, Sameakki, TuolToteung, OuOknha Heng and Prey Nob Communes, Prey Nob District, Sihanoukville Province

The selection of these communities was based on the fact that they border the shoreline and largely consist of low-lying land, and consequently are highly vulnerable to sea level rise, storm surges, saltwater intrusion and tropical storms. The overwhelming source of livelihoods for all six target communities in Prey Nob is crop production – mostly paddy. All other sources together contribute 25% or less. The main source of livelihood for the PeamKrasaob Commune is fisheries. Tourism, however, is gaining increasing importance (up to 25% of total household income with 10% from tourist boats and 15% from selling operations). In TuolKokir Commune, the main source of income is crop production (50% of average household income from crop production, 30% from livestock and fishing, and 10% from wages).

MondolSeima District, Koh Kong Province

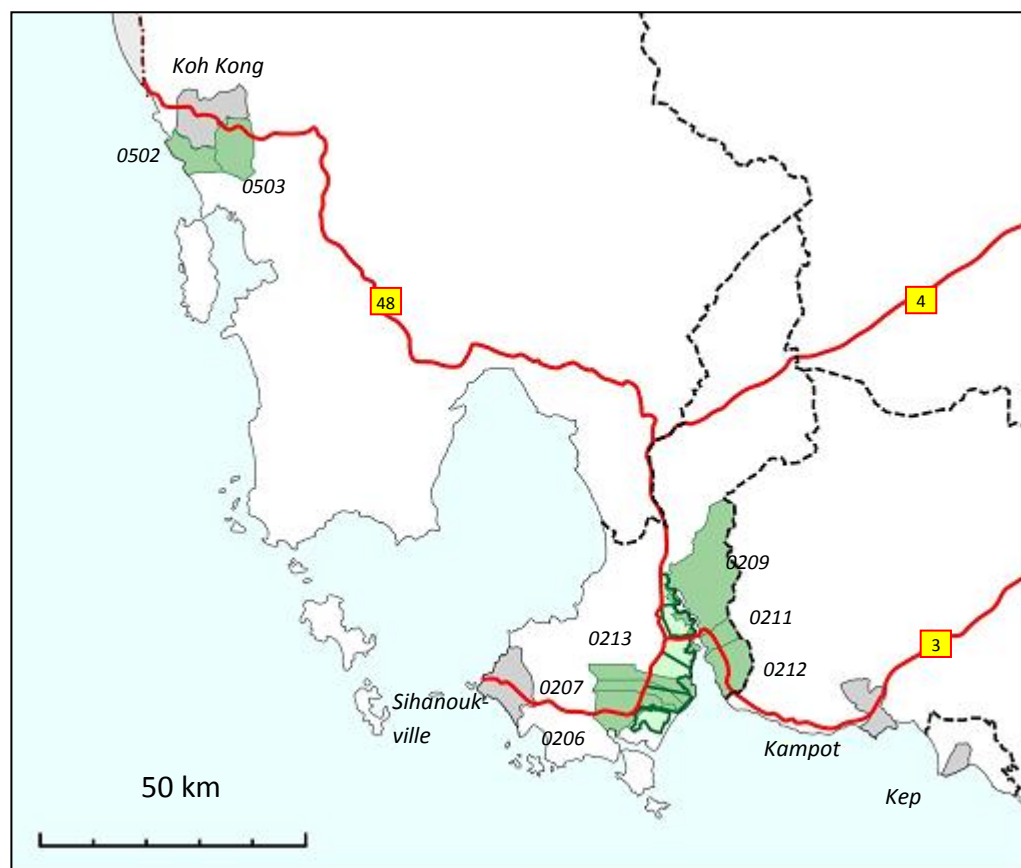
According to the most recent information regarding communities in MondolSeima, the number of families is 1,883, with a total population of 9,152 residents. Almost 95% of all villagers living in PeamKrasaob rely on fishing for their livelihoods. Following the efforts by the government to stop mangrove destruction in the sanctuary, many of the local people changed occupations to chicken and duck raising, harvesting crabs and snails, fishing, small-scale business, hunting, small speed boat operation, repairing boat and fishing gear, thatch weaving, fish processing, and repairing houses.

Prey Nob District, Sihanouk Province

Prey Nob district consists of 18,444 households with 93,141 people. This district is located in a particularly low-lying area with a total of 10,000 ha used for rice production, and protected by a dyke system. This dyke system was rehabilitated over a four-year period with funds from the French Development Agency, Agence Française de Développement (AFD).

See “Assessment of Community Vulnerability and Risks from Climate Change in the Coastal Zone of Cambodia”, October 2012, for more detailed livelihood profiles of the target communities.

Map of the CARP's target communes



- Communes:
- 0502: PeamKrasaob Commune, MondolSeima District
 - 0503: TuolKokir Commune, MondolSeima District
 - 0206: OuOknha Heng Commune, Prey Nob District
 - 0207: Prey Nob Commune, Prey Nob District
 - 0209: Sameakki Commune, Prey Nob District
 - 0211: TuekL'ak Commune, Prey Nob District
 - 0212: TuekThla Commune, Prey Nob District
 - 0213: TuolTotueng Commune, Prey Nob District

Map compiled from different sources.

Administrative borders, commune codes and English spelling of names are from NIS (March 2012).

2. Assessment of Coping Strategies in the Coastal Zone

This chapter is a summary of an assessment of current coping strategies in the Coastal Adaptation and Resilience Planning Component's (CARP) target communities in relation to flooding, drought and extreme events, which was carried out in 2012.

The objectives of the assessment have been formulated as Objective 2.2 in the CARP. The assessment was to a large extent based on existing literature. However, field research was also conducted in order to present site-specific data on selected variables. Since 2009, a number of climate change studies have been carried out in Cambodia. Data obtained through this research was used extensively in combination with the collected site-specific data. The Adaptation Knowledge Platform conducted a similar study in 2010 in the two target communities (Prey Nob and MondolSeima)¹.

The full assessment - "Assessment of Coping Strategies in the Coastal Zone of Cambodia", October 2012 - can be downloaded on the CARP website (www.czmcam.org).

2.1 Coping strategies in Koh Kong and Sihanoukville

Koh Kong –PeamKrasaob&TuolKokir Communes

The communities in PeamKrasaob and TuolKokir have experienced environmental changes over time such as:

- Increase in coastal storms
- Drought
- Seawater intrusion
- Decrease in marine life
- Well water/ground water no longer drinkable

Among other things these changes mean larger expenditures for drinking water for the villagers, and less money available for expanding livelihoods. Livelihoods have moved from farming to marine collection, increasing the pressure on the aquatic natural resources, which has also resulted in increased expenses for fishing gear.

In PeamKrasaob Commune, the villagers' perception of the changes to the eco-systems is that they have experienced a decline in marine life and that the law prohibiting fishing by "outsiders" is not being enforced, causing an unsustainable pressure on the marine life. Sand dredging is also mentioned as a cause. The villagers feel that an improvement has

¹ See the assessment report from October 2012 for a clarification of terms and data collection methods used and for a summary of the research from The Adaptation Knowledge Platform.

occurred in the enforcement of protecting the mangrove forests. However, the negative effect of this is that they cannot hunt monkeys, thus losing a source of food security. Because the village of PeamKrasoab was relocated from an island to the mainland, the villagers now have the possibility of backyard farming which enables them to grow fruits and vegetables. But absence of fresh water limits productivity.

A very positive change for the villagers is the expansion of eco-tourism. Due to an increased awareness of the possibilities in tourism, the villagers have organised themselves in a way so that tourism is now an alternative source of income, whereas before they had to migrate in order to find alternative sources of income.

The villagers have a number of coping strategies in case of different weather hazards. They have started to build lower houses, which are less prone to damage when storms occur. For the same reason, trees have been planted to protect the houses, and also a cooling effect during the increasing numbers of very warm days. Additionally, dykes have been built to protect the village against floods. However, the dykes are not high enough to protect against more severe flooding.

Drought: The community council has the following focus areas: (1) To ensure water sources for the community by building basins to store drinking water, (2) prepare medicine for the community both for humans and animals, (3) prepare water sources, and (4) ensure preparedness in the case of forest fire. The community committee is fully aware of the risk of sickness among animals during a drought, and has methods for ensuring that if an animal gets sick, then it is burned immediately in order to prevent the spread of the disease. The community committee has a budget to be used in the case of a drought which includes buying medicine and trees to plant. For this budget the community committee has applied for funding from the district authorities. According to the community committee, these actions have resulted in the planting of 160 Ha of trees, less than 50 % of animals dying during a drought and the building of one community well.

Seawater intrusion/flooding: The community committee has had a 5 km saltwater protection dyke built, based on community funding and contribution in kind from villagers. Furthermore, the community committee is advising households to build small hills for the animals to seek shelter. Boats are also being prepared to store villagers' belongings. The community committee is also advising villagers of the importance of cleaning their houses during and after seawater flooding has occurred. It further provides financial support to villagers to repair damaged houses.

Storms and lightning: The community committee has limited coping strategies for storms and lightning. In 2011, 38 houses and 14,000 m² of mangrove forests were destroyed, 2 fishing boats sank and forest fires occurred in about 30 places. The community committee advises villagers to listen to radio and TV to get updates on weather hazards. When a storm hits the community, villagers are advised to move to a shelter. According to the community

committee, no fishermen now go out fishing at the sea during storms as a result of this information-sharing, 90 % of households are now listening to radio or TV and 10 % of the households have bought lightning protection devices.

The Tuol Kokir commune is located further inland than Peam Krasaob, and the villagers in Tachat Village experience a severe decline in their access to fresh water, due to the drying out of fresh water sources on a yearly basis. This decline has a number of consequences. According to the villagers, the aquatic life in the fresh water sources has dramatically decreased. The water cycle has shortened the fresh water period as a result of more frequent droughts. The villagers perceive the decrease in fresh water as a consequence of deforestation in the area near the lake and fresh water streams. For Tachat Village the mangrove forest has been subjected to mass deforestation due to forest concessions being granted to companies. The villagers have, however, themselves taken part in deforestation of the mangrove forests, as part of their production of charcoal. Furthermore, the villagers use the slash and burn technique in order to create land for agriculture.

In order to cope with more frequent weather hazards, Tachat Village has, with financial support through microfinance loans, built artificial ponds to secure water for crops and animals during droughts. In case of soil erosion during the wet season the villagers, due to training in agriculture technology, have started to use chemical fertilizers and pesticides in order to boost crop production. The villagers have also started to fish in order to make up for the shortfall in food.

Drought: The community committee rehabilitates the channel system to protect the drinking water sources and makes sure that fences are being built around the ponds.

Seawater intrusion: In severe cases, villagers are being evacuated to a shelter. The committee ensures both prior to, during and after the evacuation that the seawater dyke protection system is working. If it has been damaged, they ensure that the system is repaired.

Storms and lightning: A priority for the community committee is to get the villagers to stay updated on the storm by TV and radio and make sure that they are ready to be evacuated to shelter. The committee has raised awareness on the importance not to cutting down the trees around the villages, as it protects the households against the storm. In the case of lightning some of the villagers have bought lightning protection gear.

Severe rainfall: The community committee defines severe rainfall as a period of 2 months continuous rain. For the villagers it damages the agricultural production by increasing pest attacks on the crops. The community committee contacts the district agriculture officer as soon as they identify a problem with pest on the crops. According to the community committee, the focus on pest on the crops and mechanisms in place to fight it has ensured that 70% of the crops have survived.

Sihanoukville – Prey Nob & OuOknha Heng Communes

As in Koh Kong, the communes of Prey Nob and OuOknha Heng have experienced a number of environmental changes over time, some of which are:

- Extended wet season
- Intensified storms during the wet season
- Livestock health problems due to intensified heat
- Ecosystem contribute less to food security
- Decrease in soil fertility

As a consequence of these impacts, farmers have been forced to increase the use of pesticides, herbicides and chemical fertilizers. Another change is that farmers have been forced to change to other natural resources for extraction.

The pressure on marine fish continues at an unsustainable rate. The lake has also come under increased pressure from a growing number of households trying to substitute their losses by fishing in the lake. An added consequence is that there is now less solidarity in the commune due to increased competition for resources. None of the villagers have participated in any development activities in the area.

The village BoekKrang in Prey Nob Commune has a number of different coping strategies in place. In case of flooding, which happens 2 to 3 times per year, the villagers open gates in the dykes in order to lower the level of the flooding. This, however, has a negative impact on the water volume for agriculture. The villagers are aware of the health risks involved with a flooding. Thus, after flooding, the villagers make sure to clean the surroundings immediately. None of these strategies are seen by the villagers as sustainable coping strategies, and they still encounter a loss when flooding occurs.

Storms: As in PeamKrasaob, information is given to villagers to stay updated by radio and TV, and not to go out fishing at the sea during severe storms. Prior to a storm, some villagers place wood sticks in the rice field to support the rice from breaking.

Seawater intrusion: The coping strategies are similar to those of PeamKrasaob. Building dykes to protect against the seawater is a central strategy in the communities, but also to prepare boats for evacuation of villagers and their belongings.

Conclusion on data from Koh Kong

In the target communities in Koh Kong, the villagers perceive a clear tendency to a change in the weather patterns which will result in more frequent weather hazards. The community committee in PeamKrasaob seems to have a more detailed perception of climate change and awareness of how the community committee can support the villagers in implementing the existing coping strategies. The community committee in TuolKokir has actively engaged with the provincial agriculture officer, who provided advice in the community's fight against

the outbreak of pests on crops, with a positive result. In general, from the commune councils and down there is an awareness of the importance of information sharing.

Conclusion on data in Sihanoukville

Compared to Koh Kong the target communities in Sihanoukville are supported by a stronger adaptation mechanism with the extensive water gate system built by ADF. However, this water gate system needs to be further developed. The collected data reflected a lower awareness of the term climate change, both compared to the data from Koh Kong, and also in relation to the nationwide KAP-study (see full assessment report, chapter 1). The level of information sharing is low, and it seems that the level is even lower than in PeamKrasaob.

2.3 Assessment of the coping strategies

A general problem with the coping strategies in both target areas (provinces) is that they seem to lack a long-term perspective. They seem to focus on keeping the status quo rather than on improving the livelihoods in the longer term. Furthermore, some of the coping strategies put further pressure on the ecosystem due to their short-term perspective, thus worsening the situation in the longer term. An example is when villagers change their occupation from farmers to fishermen as a result of change of weather patterns they put further pressure on this resource, as has been experienced in Prey Nob. Thus, an emphasis should be put on awareness-raising to stress the interconnection between coping strategies to climate change and other development issues.

The identification of a safe place ensures the immediate safety of the villagers. Naturally, the optimal strategy would be for villagers to be able to secure their houses in a way so they can stay in them during storms and other weather hazards. The safe place coping strategy should be developed both in relation to the physical surroundings of the safe place, and the coordination of transporting villagers to the safe place, and also an information system informing villagers to prepare to evacuate.

Building and maintaining dyke systems, while not able to fully prevent flooding and seawater intrusion, are still regarded as an important coping strategy by the villagers. The technical level of these dyke systems seems to be primitive. There seems to be no development of the dykes. The communities instead try to repair them to the same technical level prior to their damage. Thus, this coping strategy should be improved at a technical level. Such an improvement is closely linked to the available financial resources. Hence, funds need to be secured for this improvement to happen. Furthermore, the technical capacity of developing these dyke systems needs to be established at an institutional level.

A problem for farmers is that their rice crops break during storms. Some use wooden sticks to support the rice from breaking. Despite its primitive nature this coping strategy seems to be effective and is widely used by the farmers in the target communities. The use of

chemicals against pest on crops due to heavy rain seems to be quite effective, e.g. in TuolKokir where the commune committee used chemicals to save 70 % of the rice crops attacked by pest from being destroyed. This depends on two factors: 1) Knowledge of how to use the chemicals in the most effective way and 2) the availability of the chemicals.

The coping strategies described above are in use in both target communities. However, it seems that the community in PeamKrasaob is better organised than the others.

The general knowledge of climate change seems to be stronger in PeamKrasaob than in the other communes. Sameakki commune is the only commune where climate change has been integrated in the CDP and a committee on disaster preparedness and rescue has been established. However, besides locating a safe place, which has also been done in the other communes, this committee seems to be limited in its output.

Based on the water gate system that has been rehabilitated, it can be concluded that Prey Nob is supported by stronger adaptation capacities compared to MondolSeima. It should of course be taken into account that the water gate system does not fully prevent water flowing over the dykes. However, it is still an adaptation capacity that supports the villagers in Prey Nob, even though the water gate system needs to be further developed. The risk is to develop an adaptation mechanism, which makes the target communities think that it will solve all the problems related to weather hazards. This can lead to target communities becoming passive in relation to further developing their own coping strategies.

Another issue is that there is no institutional capacity to support the communities. Most of the capacities that are in place are mostly based on the development of the infrastructure like the water gate system in Prey Nob. However, more capacity on technical knowledge needs to be established such as training provincial resource persons, who are able to support the communities in case of more complex impacts of weather hazards.

The earlier mentioned level of organisation at the commune councils and community committee level is an essential factor. One example is the development and maintenance of the dyke systems in the target communities. It is important that it is well defined whose responsibility it is to develop and to maintain the different dyke systems and water gate systems. When this has been done, the next step is to ensure that the knowledge and resources are available to the stakeholders. At the moment, the responsibility of maintaining the dyke system is placed with the community committees, but they do not have the capacity to repair the system in a way that ensures against being flooded continuously. This raises the question whether the community committees have the right organisational level to maintain the dyke systems.

In relation to the CARP and its objective, it should be regarded as a problem that there is no general structure to support the coping strategies at an individual and community level. Thus, before developing a technical capacity in the target communities, it is recommended

that a clear emphasis be given to developing the organisational capacity at the community level.

Information

The key problem in both target areas is that there is no system in place for sharing relevant information between relevant stakeholders. A coping strategy needs to be based on an informed background both prior to, during and after a weather hazard.

The data from the questionnaire provides a clear understanding of from which sources the respondents receive their information regarding weather hazards. Radio and television are by far the two main sources. Additionally, the respondents receive information from their neighbors and local authorities, but to a limited extent. Only very few of the respondents have received information about weather hazards from the national authorities. For the commune councils the sources of information are much the same as for the villagers. None of them have a coordinated system of information with the national or provincial authorities. However, the commune councils of TuekThla and TuekL'ak have previously received information from the MoWRAM and provincial authorities prior to a weather hazard. Furthermore, in TuekThla, the community committee has informed district authorities about the impacts of a storm. It is, however, unclear how the authorities used this information.

As part of the ongoing work on developing more qualified weather forecasts and weather hazard prediction, the two media radio and TV should be given a key role in informing the target communities prior to a weather hazard. In case of extreme weather hazards, this information is recommended to come directly from the relevant authorities. This could be done in a number of ways. One way would be for the authorities to have a contact person within the commune councils, which they could contact by phone, and inform on a predicted weather hazard. This contact person would be responsible for sharing this information with the community committee, which then could initiate relevant actions.

After a weather hazard has occurred it is important that relevant information is passed from the villagers to the authorities, which can be used to make an assessment of the damage and economic loss. This data could serve as a baseline for a number of indicators in relation to weather hazards, e.g. frequency, impact, and level of success by adaptation capacity and certain coping strategies, and thus provide essential inputs for future research.

Perception

Villagers perceive climate change and its impacts in relation to the local environment. They do not have the understanding of climate change in a global context. This poses a risk for the implementation of not only climate change projects but also other development projects. This must be dealt with by ensuring that beneficiaries have a clear understanding of the objectives of the project prior to implementation. An example is the issue of sand

extraction, which many of the villagers in Koh Kong mentioned as a cause of climate change impacts which it is not. It is recommended that awareness-building materials be developed based on two formats, (1) a coping strategy catalogue listing existing coping strategies in the target communities, (2) posters illustrating these coping strategies. This material should be divided into the time categories of prior to, during and after.

3. Vulnerability of Existing Agricultural Practices

This chapter is a summary of an assessment of the vulnerability of existing agricultural practices in the CARP's target communities conducted in May and June 2012.

The assessment is related to Outcome 2 of the CARP: "Increased resilience of coastal communities and coastal ecosystem buffers to climate change and improved livelihoods". Specifically, it is related to Output 2.4: "A review analysis of the vulnerability of existing agricultural practices to the impacts of climate variability and climate change".

The work included a series of consultations with government bodies, farmers, fishermen and others in the provinces of Koh Kong and Sihanoukville.

The full assessment – "Vulnerability of Existing Agricultural Practices", July 2012 – can be downloaded on the CARP website (www.czmcam.org).

3.1 Resource-based livelihoods

Target communities in Koh Kong

Cultivation: In PeamKrasaob, farmers mostly cultivate MT, but ST is becoming more common. The yield is 2 t/ha (one crop per year), achieved without use of fertilizer. Seeds are retained from year to year. In TuolKokir, the paddy area is evenly divided between LT and MT varieties. ST rice is being tested (on 2 ha in 2012, sown directly in mid-April/late May). More than 10 rice varieties are grown in this commune; but knowledge about the soil quality is inadequate for selecting the best one from case to case. The cultivation season started early in 2012, due to early rain. The yield is 1.5 t/ha on the average, with one crop per year. Seeds are retained from year to year, except ST, which is bought from relatives in other districts or provinces.

Fisheries: The majority of villagers in PeamKrasaob are fishing; less are paddy farmers. In TuolKokir, villagers are fishing and cultivating. Most fishing is from small boats (that can only operate in fair weather), using traditional (and sustainable) technology. The larger boats that operate in the area are from Thailand. These use modern technology. The yield is steady, although the number of fishing days is affected by more frequent storms. In the floating villages, fisheries are the predominant livelihood. The advantage of living in a floating village is that less fuel is needed. Some households have two homes - one floating and one on dry land.

Issues

- *Sea Water Intrusion* is a major concern, seriously affecting cultivation, livestock and household supplies.
- *Agricultural runoff* (polluted by fertilizers and pesticides) can damage the mangroves habitats and ecosystems. This is a potential risk that can be activated in connection with otherwise desirable developments, such as introduction of high-yield rice varieties and crop diversification.
- *Soil degradation* in the areas behind the mangroves appears to be escalating. The degradation is caused by sea water intrusion, probably combined with water logging due to poor drainage. Imperfect operation and maintenance of dykes and gates can be a part of the cause-effect relationships.

Target communities in Sihanoukville

Cultivation:One rainfed crop of rice is grown per year. Yields are below the district average of 1.8 t/ha and well below the province average of 2.2 t/ha (which is in turn below the national wet season average of 2.3 t/ha). The yield is a bit better in parts of the polders, and in Sameakki, which are less exposed to sea water intrusion. Seeds are retained from year to year. A distinction is made between three types, named after the colour of the grains: Red and white (for eating) and brown (for sweets). These are rotated year by year. Many farmers sow the rice directly. As compared with transplanted rice, this can shorten the cultivation period by around a week time (a priority in this area), but the sensitivity to drought (if any) early in the cultivation cycle becomes higher (less of a concern in this area). Also, the yield will be somewhat less. Some supplementary crops are grown for household consumption and (sometimes) for sale, for example winter melon and cucumber. Maize and long beans could be grown if more water is available. Livestock includes buffaloes, cows, pigs, chicken and ducks.

Aquaculture:Aquaculture is practiced to a minor extent only (202 households in the whole district). The reason why it is not more common is that capital and operating costs are high as compared with the income. Also, technical skills are limited.

Issues

- *Small yields* and small land holdings.
- *Sea water intrusion*, gradually declining from south towards north.
- *Storms damaging the crops* (particularly the MT crops, while ST crops are already harvested, and LT crops are somewhat more robust). This occurs almost every year from mid-October and through December.
- *Soil degradation* caused by inorganic fertilizers.
- *Inappropriate use of pesticides* (partly due to lack of instructions from the manufacturers), causing fish deaths and (sometimes) human sickness as well as, presumably, unnecessary environmental pollution.

The Prey Nob Polders

General:The polders cover parts of OuOknha Heng, Prey Nob and TuolTotueng Communes, as well as parts of several other communes in Prey Nob District. This is the only irrigated area in Sihanoukville Province (and still predominantly rain-fed). A limited volume of water can be retained in a number of small ponds, and in canals within the area. The system consists of 6 polders, sharing 90 km of dykes, 125 km of canals and 36 auto sluice gates. Between them they cover an area of 10,500 ha. The system is threatened by sea water intrusion due to its low elevation. The two northernmost polders (no. 5 and 6) suffer critically from rain-generated floods, due to low drainage capacity. The elevation of the area is just around annual mean sea level. The water management is a delicate balance between keeping the sea water out (when the sea level is high) and disposal of the surface runoff by gravity flow (when the sea level is low).

Tourism:The polders are listed in the Total Road and Tourist Atlas (Gascuel, September 2009). They have a good location, next to National Road 4 and not far from Sihanoukville.

Cultivation:The polders provide 10,500 ha of paddy fields. One rainfed crop is grown per year, mostly MT, but also some ST. Yields can be up to 3 t/ha for fields far from the sea. Seeds are retained from year to year. Land holdings are small - mostly less than 1 ha. Most farmers own their own land.

Management:The outer dyke (and the main defense against sea water intrusion) is managed by MOWRAM. Other structures (canals and gates) are managed by a polder water user community (FWUC). The FWUC serves more than 6,000 households (some 15,600 persons) in 43 villages in 11 communes. It employs 6 persons at the centre and 43 in the villages. Farmers pay 12.50 USD per ha per year to the FWUC for operation and maintenance.

Issues

- *Land subsidence* is a major concern, given the low elevation of the area relative to the sea. Parts of the area subsided by 5-7 cm/year from 2001 to 2007. The main dyke has subsided by 0.8 m at places, and its crest level is now around the annual high sea level.
- *Storm water drainage* is needed for cultivation, for example during rice harvest. Once the area has subsided a bit more than today, drainage will require pumping of large volumes (although against a low pressure head). This is technically straightforward, but the construction and operation costs are a matter of concern as compared with the achievable economic benefits.
- *Storm water disposal* is affecting adjacent lands (north and east of the polders) during heavy rain, when the flood gates of the polders are opened. This is possibly amplified by small, private polders outside the area, but no clear information is available.

- *Weather irregularities* cause flooding or sea water intrusion. In late September 2011 there was 140 mm rain in 12 hours. Storm surges occur occasionally, typically in late September/early October.
- *Small land holdings and small yields* make it difficult for the households to make ends meet.
- *Lack of data and information, and access to existing data and information* are serious constraints. Knowledge is needed (about for example normal and extreme rainfall, normal and extreme sea level, sunlight radiation, and time and space distribution of sea water intrusion) for appropriate choices related to selection of rice varieties and cultivation modalities. Without such knowledge, innovation becomes a search in the dark for small-scale farmers with no capacity for uncertainties and risks. Some farmers try to learn (and import seeds) from families and friends elsewhere in Cambodia, where conditions are quite different.

3.2 Vulnerability assessment

Most households in the target areas have cultivation and/or fisheries as the predominant livelihood. As illustrated below, those households are vulnerable today, and will become even more so under the impact of climate change.

Present and imminent vulnerabilities

Paddy cultivation: Across the present study area, both in Sihanoukville and in Koh Kong, yields are low (2 t/ha or less), and land holdings small (mostly 1 ha per household or less). Apart from various specific threats, the paddy cultivation is adversely affected by low-quality ST and MT seeds, and lack of fertilizer, or less appropriate use of fertilizer.

The Prey Nob polders: A major concern is the declining margin between the land level (within in the polders, affected by land subsidence) and the sea level (outside the polders, affected by sea level rise). This margin decides to which extent drainage can proceed by gravity flow, as it is the case today. The monthly average sea level has a seasonal variation with amplitude of around 30 cm, lowest in June-August and highest in November-February. Today, drainage can take place by gravity flow in part of the time but not all the time, indicating a land elevation within the interval of the sea level variation. As the sea level rises and the land level decreases, this interval will diminish and eventually disappear. All evidence indicates that this is going to happen but it is uncertain how fast. At the stage where it is no longer practical that drainage takes place by gravity, there are several options:

- Shifting to salt-resistant production systems: Prawn farming, and/or cattle grazing on salt marshes.
- Restoring/heightening the dykes and providing drainage by pumping.
- Increasing the land elevation by reclamation (land fill).

All these options are technically feasible. For example, land reclamation for industrial developments has been made and is being planned at many places along the coast. From an economic point of view, however, there is no scope for using the area for paddy cultivation, because the economic benefits would be less than the costs.

3.3A look into the future

Paddy cultivation

In her paper 'Paddy cultivation - 20 years from now', Van Ngo (April 2010) considers the future of the main traditional livelihood. She observes that many countries see their agricultural sectors lagging behind industries and services in terms of technology and revenue. This means that there is less revenue to share than it is the case within industry and the service sector. Of course there is no rule saying that each sector should generate an equal value - in terms of money - per employee. (Rather, in an economic perspective, the sectors should contribute to the best of their potential, and in a social perspective, food is important in its own right). On the other hand, the imbalance seems consistent with the fact that paddy cultivation can be a hard way to earn a living. In a strongly generalised way, a simple distinction can be made between three stages of the paddy cultivation sector, as described below:

Today

Traditional production units are household-based and small. Some household members may seek a living off the farm, and bring back cash. A few cows and buffaloes can make a visible difference to the household economy, and so can a bit of seasonal fishing. Paddy cultivation is labour intensive, but typically the peak demands of labour, for transplanting and harvesting, are extreme, short and synchronised. If the cultivation is rain-fed, without reliable access to irrigation water, it becomes vulnerable to weather irregularities. In some places, the yield is low (but the quality can be high). Access to markets can be impeded by a variety of physical and structural (market-related) constraints. Irrigated paddy cultivation is (and will remain) the predominant off-stream water use.

A transition process

The process of structural change is important, because it will affect many households over a time span of decades. The agricultural sector will diversify, and the thrust of its development may occur for production systems other than rice. Food production will increase, but the process will see a big loss of employment in traditional paddy cultivation. The production unit - the farm size - will increase, driven by new technology that requires less labour but more capital, combined with a need of higher production efficiencies - more output and higher value per unit of input. Labour-intensive production systems - such as the System of Rice Intensification (SRI) - will be marginal.

The changes are driven by a combination of circumstances. Lower trade barriers will increase the exposure to competitive pressure, reflecting comparative advantages and disadvantages, as well as exposure to global price fluctuations - a tendency that will interact, in an unpredictable way, with escalating weather irregularities caused by a global climate change. New lifestyles will affect the demand of many commodities, including food (and energy) - for example if people consume more meat. A new demand of biofuel is a distinct possibility.

The recent tendency of large-scale international acquisition of agricultural land (and water) will affect the availability of production factors and have an explicit purpose of increasing the supply of food and other agricultural products - although perhaps in distant countries. The use of pesticides (and fertilizers) will escalate, partly necessitated by the diversification. Pesticides can end up in the environment and can contaminate edible fish and water used for drinking.

Higher revenue per ha will make agricultural lands an investment object - a bit like it occurred during the green revolution, and as it is clearly seen when an area is supplied with irrigation infrastructure. In addition, small-scale land owners risk losing their land in connection with irregular weather or in case of social shocks, such as illness in the family.

The future

Rice will remain the favoured staple food. Revenues of the agricultural sector will increase, but a large part of the value will be generated by crops other than rice, as well as meat, and, quite likely, biofuel. Less labour-intensive production systems will prevail. The technological development will proceed in the direction of further diversification and continued efficiency improvements, covering primary production, livestock and processing.

Lower trade barriers will increase the exposure to price fluctuations. Also, there will be a much higher exposure to competition, which will benefit the more efficient production systems at the cost of less efficient ones.

Policy implications

Between them, the various challenges clearly indicate a need for change. Below are listed some policy implications, in random order:

- *Efficiency improvement* is a general aim, considering the need to improve the income of the farmers, in an increasingly competitive environment, while, at the same time, producing more food with less water. This comprises the water efficiency - ton per m³ of water output - as well as the economic efficiency - value generated per m³ of water.
- Another important aim is *livelihood generation*, expectedly mainly outside the farms, but preferably including rural livelihoods, in order to reduce the rate of (an unavoidable

and possibly eventually beneficial) urban migration. Towns must grow, and will, but best at a rate that allows for facilities, infrastructure and services to grow accordingly.

- A *value chain perspective* can support generation of revenue and livelihoods, for example by encouragement of agro-processing, including innovative products, and partly undertaken de-centrally by small and medium enterprises.
- *Branding* of products and related marketing can, sometimes, add attractive value at a moderate cost.
- Gentle, pro-poor *market regulation* can be applied in support of shifting to new products (perhaps biofuel), and in support of a common national aim of affordable food prices while at the same time maintaining an income of the farmers that at least exceeds their production cost. A high predictability will support the intended outcome and reduce the risk of adverse effects.
- *Credit*, including (but not limited to) micro-credit, is a general precondition for investment and innovation. Some kind of risk insurance can make it possible for the farmers to keep their land in case of emergencies.
- *Water uses must be regulated*. There is a particular scope for strict regulation of new, water-dependent industries, because these can adapt more easily than existing ones with older technology - and sometimes even saving water, energy and money at the same time. The regulation must cover both surface water and groundwater.
- *Disaster preparedness* (for floods, drought and pests) must be in place.
- *Organisation of farmers* (like in water user groups) can facilitate efficiency improvements, other kinds of technological development, and access to markets.
- *Soil management* will become more important (and the benefits more visible) when water is sparse and in connection with diversifying the cultivation on lands that are not well suited crops other than rice.
- *Use of pesticides* must be kept at acceptable levels, supported by education and awareness campaigns and supportive extension and weather forecast services.
- *Continued research* is required, including international networking, knowledge-sharing and active collaboration. Results must be made available to the end users by pilot and demonstration activities, well functional extension services, and networking among farmers - possibly across borders.

Agricultural development must be cautious and gradual. There is always a risk of unforeseen adverse side effects when implementing new technologies, and even when implementing existing and well proven technologies in new places. If everyone grew water melons the market would fail.

The future of the Prey Nob polders

The sustainable development of this area is a particular challenge. Some aspects are summarized below:

Development characteristics of the Prey Nob polders	
Strengths	Residents/land owners well organised Good management by the FWUC Low drought exposure as compared with inland areas (adding to the food security value of the area)
Weaknesses	Low yields Small land holdings Low elevation (close to mean sea level), impeding drainage Inadequate height of outer dyke
Opportunities	Potential for salt-resilient (low-medium value) production systems; and for land use for (high-value) purposes other than cultivation Good location (next to National Road 4)
Threats	Sea level rise and continued land subsidence; adding to the flood risk and salt water intrusion; and quite likely preventing drainage by gravity flow in the course of time Increased weather irregularities, higher storm exposure, perhaps drought incidents Risk of land degradation due to water logging

3.4 Socio-economic and environmental implications

Challenges and opportunities

General climate-related threats in the study area include:

- Coastal erosion, accelerated by storms and sea level rise.
- Loss of livelihoods (within agriculture, fisheries and tourism).
- Deterioration of mangroves and coral reefs.
- Risks to human health.

Access to safe water and sanitation is an important general concern.

Paddy cultivation

One viable (and broadly acknowledged) strategy is a shift from (traditional) long-term varieties of rice to (new) medium- and short-term varieties. In the coastal areas, this will reduce the risk of exposure to seasonal sea water intrusion, storm surges and strong winds. In inland areas, where drought is a major concern, short-term varieties can be more resilient to seasonal water shortages. National expertise is available, and a range of locally tested varieties; but proper implementation depends on the site-specific context and requires knowledge about the local weather conditions. In some parts of the country, such information is provided by a network of agricultural experiment stations; but the network is patchy (and does not cover the areas of the present study).

Drought is not a problem in the study area (although there is some evidence of drought incidents in TuekL'ak early in the cultivation cycle). CC is expected to cause increased weather irregularities, which may well include more frequent dry spells early in rainy season (as it is the case elsewhere in Cambodia). If so, this area could be particularly vulnerable, because farmers (and authorities) are unfamiliar with this challenge. Experience is available from inland provinces and might be shared with the coastal area.

Livestock

Livestock must not be overlooked as a supplementary source of income, and, not least (in the case of buffaloes and cows) as a financial reserve for households that are otherwise vulnerable in this respect. There are visible differences within the study area regarding the state of the livestock, even within short distances, mostly (apparently) due to different breeds. For all kinds of livestock, expenses for fodder are regarded as high as compared with the potential income. This is also the case for fish farming. Profits are 'paper-thin' or non-existent. Vaccinations are piloted in some areas, while elsewhere, farmers are skeptical.

Suggestions on demonstration activities

Appropriate demonstration activities are characterized by:

- Support from intended beneficiaries and involved agencies;
- Clear social, environmental, and/or economic benefits achieved within a reasonable time scale - notably including livelihoods;
- Low risks in general, and to involved households in particular; and
- Realistic resource requirements, including capacity of implementing institutions and partners.

Some candidate activities have been identified for further consideration, as outlined below:

General

Support to formation/consolidation of farmer and fishery communities (for networking and learning from each other; information about production and damage control technologies; marketing of niche products; resource conservation; and perhaps savings/microcredit/insurance). These could be thematic, rather than geographically delineated.

Support directly to farmer households, covering for example use of high-quality seeds (including short-term varieties); use of inorganic fertilizer; pest control; livestock breeding and livestock vaccination; and small-scale supplementary dry season cultivation.

PeamKrasaob and TuolKokir communes, Koh Kong

The TuolKokir area reaches across high and low exposure to sea water intrusion, and yields vary accordingly, from around 1 to around 3 t/ha/year. The farmers are innovative (more

than 10 seed varieties are used) and the DoA is active in providing guidance regarding rice varieties and various cultivation and damage control techniques. The area could serve as a *'controlled laboratory' for identification of appropriate seeds and cultivation practices*, testing various options side by side, and with appropriate environmental documentation (rainfall, sunlight radiation, sea water exposure, adverse weather events, pest attacks, etc). Appropriate use of inorganic fertilizers could be included. The participating farmers should be secured against economic risks. Such an activity could provide highly useful knowledge to other coastal areas within and outside Cambodia, provided that results are duly disseminated.

- *Support to dissemination and promotion of recent, apparently positive experience with two crops per year*, using appropriate seeds and cultivation techniques. 2 ha was cultivated last year, with seeds from CARDI, and the area is being expanded this year. *Support to appropriate land use and soil management* in areas next to the mangroves (part of which are in a state of rapid deterioration).
- *Support to community-based zoning of fishing areas* (as suggested during consultations with district and commune representatives in May 2012). Efforts have been supported for a decade under CBNRM and IDRC, but the need seems to remain.

OuOkhna Heng, Prey Nob and TuolTotueng Communes, Sihanoukville

- *A tree-planting scheme*, to break the wind, using well suited species that can provide additional benefits. Possibilities include the sangkae and rang boeng trees, both of which are found locally. Another candidate is the teaptues tree. With suitable documentation, such a demonstration activity could provide a useful example for replication elsewhere.
- *Compartmentalization of the polders* (to confine exposure to sea water intrusion). One concern in this connection is the drainage implications; the feasibility needs to be further considered.
- *Systematic monitoring of salinity and land subsidence*.

Sameakki, TuekL'ak and TuekThla Communes, Sihanoukville

- *Support to appropriate use of fertilizer and pesticides*.
- *Promotion of better seeds*, particularly high-yield ST varieties.
- *Support to supplementary livelihoods*, including small-scale supplementary crops and livestock. This could involve networking among farmers within and outside the area, to learn from each other.

The bottom line

Many of today's agricultural practices in the study area are utterly unsustainable. Even with much higher rice yield and much better farmgate prices, many households will remain locked in poverty if they rely on existing cultivation as a main livelihood.

The transition between today and the future is a major challenge. If conducted smoothly, the sector will emerge as prosperous and competitive, well placed to generate income for the farmers and food for the population. If conducted less smoothly, there is a risk of unemployment, and farm incomes that are even lower than today. This can happen if the changes take place too fast, or without appropriate support.

4. Assessment of Community Vulnerability and Risks

This chapter is a summary of an assessment of vulnerability and risk to livelihoods in CARP's target communities in relation to current climatic conditions and projected trends; with a view to introduce alternative or modified livelihoods.

The assessment has been formulated as CARP output 2.4. The work is based on consultations with CCCA and stakeholders at province and commune levels from April-June 2012.

The full assessment – “Assessment of Community Vulnerability and Risks from Climate Change in the Coastal Zone of Cambodia”, October 2012 – can be downloaded on the CARP website (www.czmcam.org).

4.1 Vulnerability and Risk Assessments

The vulnerability and risk assessments for Prey Nob, PeamKrasaob and TuolKokir focus on four potential risk scenarios, namely the loss of crops in the wet season, the loss of crops in the dry season, loss of livestock and loss of fishing opportunities. Moreover, it is important to note that the assessments focus on the current sources of income. The results of the assessments are summarised below²:

PeamKrasaob Commune

Crops in the wet season: The risk scenario concerning the loss of crops in the wet season is assessed to be in the medium risk category by the year 2100. Although, SLR and increased rainfall will have an effect on cultivatable land and flooding, respectively, crops (rice) play only a very small part as a source of income for the community members. In fact, there exists only very few hectares of cultivatable land at PeamKrasaob. Therefore, despite there is a high likelihood that crops (in the wet season) will be lost due to climate change, the consequences of this may not be very critical.

Crops in the dry season: The risk scenario of loss of crops in the dry season is assessed to be in the low category. As stated in the aforementioned, there exists only very few hectares of cultivatable land. Therefore, there would be less serious repercussions for households in PeamKrasaob.

² The results matrices, the methodology used for the assessments as well as livelihood profiles of the target communes can be found in “Assessment of Community Vulnerability and Risks from Climate Change in the Coastal Zone of Cambodia”, October 2012.

Livestock: The risk scenario of loss of livestock is assessed to be in the low category. In PeamKrasaob, livestock do not play any significant role in terms of a source of income. Considering this, both likelihood and the consequence of the loss of livestock would not be severe.

Fisheries: The risk scenario in terms of loss of fishing opportunities is assessed to be in the High category in the very long term. Rising temperatures (sea and air), ocean acidification, SLR and higher amounts of rainfall are predicted to cause significant losses of the mangrove forests, sea grass and other habitats that provide shelter and food for coastal fish. These developments will negatively alter the distribution and productivity of fish, and thus the livelihoods of the people in PeamKrasaob, considering that almost 95% of villagers undertake fishing; while 64% of households have fishing as their main occupation.

The risk scenario in terms of loss of fishing opportunities is assessed to be in the high category towards the year 2100. PeamKrasaob mostly consists of water and mangrove forests and fisheries is a very important source of income for the people. Climate Change (and particularly SLR) is likely to cause significant losses of the habitats (the mangrove forests in particular) that provide shelter and food for fish. Such developments are likely to negatively alter the distribution and productivity of the fishing, and thus impact the livelihoods of the people. However, there is also a possibility that the mangrove are able to either survive in their current position or in fact move inland. This depends on the rate of SLR and whether there are ample sediment supplies. There is some uncertainty, however, whether this scenario will take place. As such, the likelihood of the losing fishing opportunities is not as great as the consequences would be. PeamKrasaob is, therefore, considered in the high risk category.

Generally: There is currently an unsustainable pressure on the marine life at PeamKrasaob. Not only are the inhabitants threatened by altered climate patterns, but their main source of income, fisheries, is also in danger – in part due to over fishing (and climate change). However, the movement of the PeamKrasaob village inland could present an opportunity of added income possibilities from backyard farming. Worth noting is that villagers have organised themselves to embrace eco-tourism, which is becoming an attractive alternative source of income. However, with climate change also threatening areas of tourist interest (predominantly, the mangrove forest), the long term sustainability of this is vulnerable. There is also the risk that sea water inundation, unless contained by protective dykes, will make all normal cultivation activities impossible; while homesteads may also have to be moved to neighbouring communes.

TuolKokir Commune

Crops in the wet season: The risk scenario of loss of crops in the wet season is assessed to be in the Extreme category in the very long term. In TuolKokir, the most important source of income is rice (more than half of the households' income is derived from crops). SLR would

cause the inundation of farming land. SLR would also affect the quality of both soil and groundwater, in terms of the salinization of both. Rainfall is also predicted to increase in the future. More frequent and heavier rainfall will increase the probability of flooding, which in turn will damage crops. Thus, the loss of crops (rice) will have severe consequences for TuolKokir.

Crops in the dry season: The risk scenario of the loss of crops in the dry season is assessed to be in the medium category in the very long term. In this risk scenario, SLR would also damage cultivable land. Rising temperatures and an increased possibility of droughts would escalate the need for irrigation. However, considering it is mainly supplementary crops that are grown in the dry season (i.e. vegetables); the consequences of the loss of these would not be dire, despite the high likelihood of this risk scenario actually happening.

Livestock: The risk scenario of the loss of livestock is assessed to be in the medium risk category in the very long term. More frequent and heavier rainfall will increase the likelihood of flooding. SLR will degrade the quality of soil and water, which will have a detrimental effect on the overall health of the livestock. Rising temperatures and heat waves increase the threat of livestock suffering from heat stress. The consequences of losing livestock would be very severe to the livelihoods of TuolKokir, as livestock are not only an important source of income (livestock provide one fifth of the source of income) but also important in the overall agricultural cycle as a workforce. The likelihood of this risk scenario happening, however, is not as large, therefore a medium risk category.

Fisheries: This risk scenario concerning fisheries is assessed to be in the medium category in the very long term. Rising temperatures (sea and air), ocean acidification, SLR and higher amounts of rainfall are predicted to cause significant losses of the mangrove forests, sea grass and habitats that provide shelter and food for coastal fish. However, considering that fishing in TuolKokir is only a supplement to the main source of income, crops, the consequences, however likely, will not be severe.

Prey Nob Communes

Crops in the wet season: The possibility of loss of crop (rice) in the wet season is assessed to be in the extreme risk category towards the year 2100. Particularly two climate change scenarios are predicted to have a direct influence on this. First of all, SLR would cause the inundation of farming land. SLR would also affect the quality of both soil and groundwater, in terms of the salinization of both. Either way, SLR will damage cultivatable land in Prey Nob. In addition, land subsidence may pose an even higher threat. Rainfall is also predicted to increase in the future. More frequent and heavier rainfall will increase the probability of flooding, which in turn will damage crops. In Prey Nob, crops remain the single most important source of income for households (three quarters of the households' income stem from crops). Thus, the loss of crops (rice) will have severe consequences for Prey Nob, just as there is a high likelihood that this risk scenario could happen.

Crops in the dry season: The risk scenario of losing crops in the dry season is assessed to be in the medium risk category towards year 2100. In this risk scenario, SLR would also damage cultivatable land. Rising temperatures and an increased possibility of droughts would escalate the need for irrigation. However, considering that it is mainly supplementary crops that are grown in the dry season (i.e. vegetables); the consequences of the loss of these would not be dire, despite the big likelihood of this risk scenario actually happening. This is therefore a medium risk category.

Livestock: The risk scenario of loss of livestock is assessed to be in the medium risk category towards the year 2100. More frequent and heavier rainfall will increase the likelihood of flooding; while more droughts in the dry season can put pressure on feeding ruminant livestock. This can probably be managed through appropriate fodder conservation measures. SLR will degrade the quality of soil and water, which will have a detrimental effect on the overall health of the livestock. Rising temperatures and heat waves increase the threat of livestock suffering from heat stress. The consequences of losing livestock would be quite severe to the livelihoods of the communes in Prey Nob, as livestock are not only used for household consumption but also in the overall agricultural cycle as a workforce. The likelihood of this risk scenario happening, however, is not as large, wherefore a medium risk category.

Fisheries: This risk scenario is assessed to be in the medium category towards the year 2100. Rising temperatures (sea and air), ocean acidification, SLR and heavier rainfall are predicted to cause significant losses of the mangrove forests, sea grass and habitats that provide shelter and food for coastal fish. However, considering that fishing in Prey Nob is only a supplement to the main source of income, crops, the consequences, however likely, will not be severe.

4.2 Vulnerability and adaptation capacity

There are several coping mechanisms in place in all target areas, such as trees being planted to protect against storms and ponds/basins for storage of drinking water. Also worth mentioning is the information dissemination of the importance of cleaning housing and surrounding areas after flooding and information on TV and radio concerning storms. A general problem with the coping strategies in the communities is that they lack long-term perspective. The strategies have too much emphasis on keeping the status quo, and not enough emphasis on improving the livelihoods on a more long-term basis. The coping mechanisms do not seem to come up with a solution on how the communities can engage in a sustainable way of living in the ecosystem surrounding them, on a long term basis.

Adaptation capacity refers to a given systems ability to change the way it works, the ability to manage (and reduce) the exposure and/or vulnerability to climate change. Thus, it implies that the system is not only to cope with the consequences of climate change but also to take advantage of the opportunities it presents. Although the target communities

have made commendable efforts to counter the effects of climate change, the current capacity to adapt to future climate change in the coastal areas is relatively low.

The specific understanding of climate changes relevant to livelihoods efforts and how these should be incorporated into adaptation strategies is often quite limited. Perhaps this is due to uncertainty on how climate change will in fact manifest itself at the local level.

Predictions on how the climate will develop are uncertain, and relating to various climate change scenarios is quite difficult. Better and more localised predictions would be an improvement and make communities more able to adopt relevant measures in this context. It is, therefore, clear that for the medium to longer term the adaptive capacity of the target communities is inadequate. Assistance from outside, from local as well as national authorities, is clearly needed in order to enable the communities to adequately cope with the predicted climate changes.

4.3 Proposed demonstration activities regarding livelihood adaptation

All the potential changes, as far as possible, subscribe to the 'no-regret' criteria stipulated by the CARP component document, i.e. that the changes will be effective and profitable even if the predicted climate changes do not fully occur. This is because the climate change predictions are associated with degrees of uncertainty.

The potential changes are specific to the targeted communities, that is, the six communes of TuekThla, TuekL'ak, Sameakki, TuolToteung, OuOknha Heng and Prey Nob in Prey Nob District, Sihanoukville Province, and the two communes of PeamKrasaob and TuolKokir, MondolSeima District, Koh Kong Province. An amount of US\$ 700,000 for overall adaptation is budgeted for such activities under the CARP. Economic justification of these activities is addressed in connection with the costs & benefits analysis described in the next chapter.

The proposed demonstration activities are summarised below (please refer to the main assessment report, October 2012, for a more detailed discussion of the activities):

- Integrated Farming Training Programme for (a) agricultural/fisheries extension staff and (b) households/families in multi-scale climate change adaptation strategies and integrated farming (integration of crops, livestock, fish, water) at 7 target communes. Preceded by Agro Ecological Systems analysis (Participatory Rural Appraisal methodology in use by MAFF), if required.
- Community Forestry projects in cooperation with the Forestry Administration, where possibilities exist at TuolKokir. This might include livestock grazing rights for livestock in forest areas as well as tree nurseries. The relation of community forestry to climate change adaptation is that tree planting is likely to be one of the measures for protecting homesteads, stabilising dykes, production of fuel wood and fruits as well as income generation, where suitable land may be present (as in TuolKokir).

- Community Fisheries project at PeamKrasaob in cooperation with the Fisheries Administration, especially in terms of strengthening regulatory measures and their enforcement. The relation of community fisheries to climate change adaptation is that general fishing developments and its regulatory measures are likely to be required to adjust the livelihood of fishing communities.
- Reinforcement of community dyke maintenance, drainage and irrigation systems management in cooperation with the MoWRAM – for Prey Nob and TuolKokir³.
- Promotion and increased availability of shorter duration seeds for crops; particularly for wet-season paddy, thus, possibly enabling harvest before onset of heavy flooding and sea water surges at all five communes. Such varieties will need to be tested (at no cost to farmers) in specific localities, where they are likely to be effective.
- Promotion of increased livestock keeping at five communes - by using a revolving scheme for improved breeds – tested successfully in Cambodia, Laos and elsewhere. This is in response to increased flooding problems as livestock are moveable.
- Possibly promotion of in-field water conservation and on-farm rain harvesting methods as a separate demonstration activity – to be decided

The very short project period (CARP ends 1st Quarter 2014) poses a challenge because it will allow one main crop season (2013) only for implementation. Such a short implementation period is unusual for development projects, where 3-5 year periods are the norm.

Nevertheless, the implementation of the proposed demonstration activities will still be able to commence as intended in the target areas. But more time would have been desirable for follow-up, consolidation, application of lessons learnt and harvesting of results – as well as for expansion of the created capacity to other areas.

5. Analysis of Costs & Benefits

This chapter is a summary of an analysis of economic and social costs and benefits of options for modified agricultural practices that are less vulnerable to impacts of climate variability and climate change.

³ The raising and extension of existing protective dyke systems as well as consideration of drainage and pumping requirements, especially for the Prey Nob area, but also for the dykes in Koh Kong areas, were identified by all interviewed stakeholders as the main adaptation mechanism. Unless effective solutions are found in this context, it is difficult to imagine that the identified demonstration activities would become sustainable, if the predictions of climate change materialise. All commune councils targeted echo this concern, and potential beneficiaries of demonstration activities may well show less interest, if these overriding dyke system considerations are not seen to become addressed. This general concern is thus seen as more serious than has been acknowledged to date.

The analysis was conducted in 2012 in order to assess the socio-economic potential of the demonstration activities proposed by the report on “Assessment of Community Vulnerability and Risks from Climate Change in the Coastal Zone of Cambodia”, October 2012, which was summarised in the preceding chapter. The analysis has been formulated as CARP output 2.5.

The full analysis – “Analysis of Costs & Benefits of Modifying Agricultural Practices for Climate Change at the Coast”, November 2012 – can be downloaded on the CARP website (www.czmcam.org).

5.1 Overview of demonstration activities recommended for economic analysis

The following five short-listed activities are subjected to economic analysis:

1. Integrated Farming Training Programme for (a) agricultural extension staff and (b) households/families in multi-scale climate change adaptation strategies and integrated farming (integration of crops, livestock, fish, water) at 7-8 target communes. Preceded by Agro-Systems analysis (a methodology in use by MAFF) as an integral part of the programme.
2. Community Fisheries project at PeamKrasaob in cooperation with the Fisheries Administration; especially in terms of strengthening regulatory measures and their enforcement. The relation of community fisheries to climate change adaptation is that general fishing developments and its regulatory measures are likely to be required to adjust the livelihood of fishing communities.
3. Promotion and increased availability of shorter duration seeds for crops; particularly for wet-season paddy possibly enabling harvest before onset of heavy flooding and sea water surges at all five communes. Such varieties will need to be tested (at no cost to farmers) in specific localities, where they are likely to be effective.
4. Promotion of increased livestock keeping at five communes - by using a revolving scheme for improved breeds – tested successfully in Cambodia, Laos and elsewhere. This is in response to increased flooding problems as livestock are moveable.
5. Possibly promotion of in-field water conservation and on-farm rain harvesting methods.

The report “Assessment of Community Vulnerability and Risks from Climate Change in the Coastal Zone of Cambodia”, October 2012, proposed two further demonstration activities – given below. However, these could not be subjected to economic analysis due to lack of data.

- i. Community Forestry projects in cooperation with the Forestry Administration, where possibilities exist at TuolKokir. This might include livestock grazing rights for livestock in

forest areas as well as tree nurseries. The relation of community forestry to climate change adaptation is that tree planting is likely to be one of the measures for protecting homesteads, stabilising dykes, production of fuel wood and fruits as well as income generation, where suitable land may be present (as in TuolKokir).

- ii. Reinforcement of community dyke maintenance, drainage and irrigation systems management in cooperation with the MoWRAM – for Prey Nob and TuolKokir.

The proposed demonstration activities for the CARP are generally characterised as:

- Containing most of the climate change counter measures suggested by the target communes and concerned officials. However, the implementation arrangements proposed are still to be discussed with these and other stakeholders. (But notably do not contain rehabilitation of dyke systems, which are a clear first priority for the target communes. This concern is left to other parts of the CARP, as agreed).
- Expected a priori (before calculations) to yield considerable social, environmental, economic and general livelihoods benefits; while at the same time being adaptive to the climate change predictions.
- Posing relatively low implementation risks generally and for the concerned households in particular – because the implementation modalities proposed are well and successfully tried in similar circumstances.
- Are expected to have realistic resource requirements.
- Are expected to be implementable by the concerned institutions and partners – with the capacity building measures defined in the proposals, where relevant.

Please refer to the full analysis report for the methodology, the design outlines and economic cost estimates of the proposed demonstration activities.

5.2 Summary of costs and benefits and other considerations

All in all, the economic benefits and social costs and benefits presented below point to good prospect for achieving substantial improvements in the livelihoods of the target communities (see the main analysis report, November 2012, for more details).

Economic benefits

Summary Cost Estimate for CARP Demonstration Activities

Activity	Description	Amounts (\$)
Activity 1	Farmer Training Programme in climate change adaptation and integrated farming in 7 communes	198,000
Activity 2	Community Fisheries project for PeamKrasaob, Koh Kong	42,000

Activity 3	On Farm Field Trials for Seed Varieties, demonstration and training in seed selection in 7 communes	32,000
Activity 4	Livestock Revolving Stock Scheme in 7 communes	225,000
Activity 5	On farm demonstration in water conservation, water harvesting and small-scale irrigation	50,000
Total:		547,000

The mentioned demonstration activities 1-5 are all profitable in economic terms for both the CARP and the participating households. The calculations are robust and likely to retain its high profitability even if assumed income levels and adoption rates become much lower than anticipated.

In economic terms, the analysed demonstration activities compare as follows:

Comparison of Economic Benefits

Demo Activity	Directly benefiting households	Internal Rate of Return	Net Present Value of Investment	Benefit per household
1 and 3: FFS	1200	193 %	\$1.7 million	\$1417
2: Peam Krasaob	277	60%	\$0.5 million	\$1806
4: Livestock	600	31%	\$0.3 million	\$500
5: Water Harvesting	200	56%	\$0.1 million	\$500

It is thus clear that all five demonstration activities covered by the economic analysis are to be considered real candidates for implementation – because they are all profitable investments. In case of fund limitations, the combined demonstration activities 1 & 3 are the most highly recommended, followed by the PeamKrasaob Community Fisheries project in second place. And only if funds are available for further investment should demonstration activity 4 be implemented.

Social costs and benefits

The proposed demonstration activities are all in line with the expressed priorities of community representatives and builds on their present coping strategies. There are, therefore, limited social costs but rather benefits associated with the proposed activities – exactly because they support expressed community priorities. It may be mentioned, however, that the proposed expansion of livestock (particularly smaller livestock) and vegetable production may put further stress on women's labour – because these activities are traditionally often considered to be women's responsibilities. This is an aspect that needs to be considered during implementation.

There are additional benefits, which are difficult to quantify. In brief, these include:

For demonstration activity 1 in particular:

- The reduction of the strain on the environment as well as on animal and human health through the promotion of Integrated Pest Management (IPM) technologies, which demonstrably has led to reduction of pesticide usage of 70-90% in e.g. Bangladesh (Danida Impact Study, 2003).
- The promotion of vegetable production with likely improved nutrition as well as income as result for the participating households.

For demonstration activity 3 in particular:

- Improved environmental management via sustainable measures for fodder development; for example aiming to avoid over-grazing.
- Improved nutrition of participating households via better access to livestock products.

Adaptation Capacity

The adaptation capacity of communities in relation to climate change has already been considered in the report “Assessment of Community Vulnerability and Risks from Climate Change in the Coastal Zone of Cambodia”, October 2012 (summarized in chapter 4). The proposed demonstration activities are in particular designed to fit closely with this capacity.

Institutional issues

All proposed demonstration activities depend for their implementation on the smooth cooperation between the CARP, the MoE and other RGC institutions – notably institutions under MAFF; including the provincial Directorates of Agriculture, Fisheries and PDWRAM. Such inter-ministerial cooperation in Cambodia has not always functioned as smoothly as could have been wished. However, it is imperative for the successful implementation in this context that such cooperation becomes both timely and appropriate.

The short Implementation period available

It has already been highlighted that the CARP component is due to close by end of 1st quarter 2014, thereby allowing only one main growing season (the wet season 2013) for implementation of demonstration activities. This is not an ideal situation as it would benefit from the component's presence in terms of follow-up and consolidation of results and outcomes.

Of the five proposed activities subjected to economic analysis, the activity 1, 3 and 5 are considered least sensitive to the short support duration – because the prime vehicle (the farmer field schools) in any case usually runs intensively for only one season per locality. Both activity 2 and 4 are more dependent on adequate follow-up and consolidation activities after the first implementation year. The PeamKrasaob income impact is thus only expected in full by year 5, while the Livestock Revolving Stock Scheme is expected to continue to take in new participants even for 10 years. Both of these activities 2 and 4 are therefore more risky because of this follow-up and consolidation demand.

The cost estimates for most activities do contain consideration of these follow-up and consolidation requirements by setting aside some funds per commune.

Please refer to the main analysis report, November 2012, for more details of the implementation plan for the proposed demonstration activities.

6. Implementation Capacity for Demonstration Activities

This chapter is a summary of a study conducted in May-August 2012 assessing the capacity of various government bodies to implement demonstration activities under the CARP component.

The study is related to Outcome 2 of the CARP: “Increased resilience of coastal communities and coastal ecosystem buffers to climate change and improved livelihoods”. Specifically, it is related to Output 2.1: “Assessment of implementation capacity of demonstration activities”. The work is based on consultations with sub-national authorities in Koh Kong and Sihanoukville Provinces, the Prey Nob Water User Community, as well as consultations in Phnom Penh with national administrative bodies and organisations.

The full study – “Implementation Capacity of Demonstration Activities”, October 2012 – can be downloaded on the CARP website (www.czmcam.org).

6.1 Climate-related governance challenges

The new implications imposed by climate change interact with existing and well-known challenges related to national and sub-national socio-economic development. Institutional capacity is a cornerstone in this connection. Accordingly, capacity building and human resource development is specified as one of the four strategic “growth rectangles” of Cambodia's Rectangular Strategy for Growth, Employment, Equity and Efficiency, Phase II, presented by Prime Minister Hun Sen, on 26 September 2008.

One important aspect of institutional capacity is that it is manageable - as compared with the weather itself. Therefore, capacity-building is among the attractive entry points to improved climate resilience. Capacity-building will almost always serve a range of good purposes that reach beyond the climate perspective.

In the coastal zone, as elsewhere in the country, a distinction can be made between immediate, medium-term and long-term aspects:

- Immediate concerns include public health (safe water and sanitation); livelihoods and production systems; and environmental health of coastal and marine habitats, including the mangroves.
- Medium- and long-term concerns include the smooth transition to a society that is visibly different from today's society. In the future, most people will live in towns, rather than in rural areas. Agriculture will remain an important sector but will employ

far less people than today, and the national economy will be supported by manufacturing, industries and the service sector - including tourism. This development is in full swing and is desirable in many ways. The challenge is a smooth transition, without excessive adverse social side effects, where a part of the population is left behind during the transition.

- Another important challenge is the continued strengthening of the national education system (from primary schools to the universities), and the consolidation of the national resource base of government officials and professional practitioners.

Good governance relies on adequate and responsive institutional capacity, and any efforts in this respect will inevitably contribute to a healthy and prosperous society.

6.2 Specific capacity needs

For the purpose of this study, “institutional capacity” is taken as the skills, tools and other resources available to an organisation to undertake its responsibilities in general or a specific task in particular. This includes:

- Staffing; human skills.
- Availability of relevant data and information, including maps and weather data;
- Facilities (such as computer hardware and software, transport, equipment for monitoring and analysis).
- Tools: Guidelines; decision-support tools.
- Financial resources: (1) for routine operation and maintenance; and (2), for implementation of development initiatives according to plans.
- Networking modalities (for dialogue with other management levels and with other agencies at the same level).
- Relations with (1) the service users; (2) the private sector; and (3) other stakeholders.

The significance of these characteristics is elaborated below:

Staffing, human skills

Human skills are important, not least because the requirements are evolving under the impression of added pressures imposed by climate change. A summary of climate-related needs is provided in the following table:

Overview of human skills requirements	
Impacts	Sea water intrusion control Coastal erosion control Drainage, flood control Drought preparedness and mitigation Mangrove health

Resilience	Safe water & sanitation Water resources management, water efficiencies Rice cultivation technology, production efficiency, and related threats Livestock breeding, production efficiency, and related threats Other production systems, production efficiency, and related threats Soil quality and soil improvement
Knowledge base	Data management

Many valuable skills development efforts have been made in the past, while others are in progress or being planned. Dialogue, and perhaps a bit of gentle coordination, could add value to the efforts at a marginal extra cost. This could include exchange of courseware, and perhaps, in due time, some sort of accreditation of the training, perhaps in collaboration with one or several universities.

Data and information

Data and information are needed for timely and appropriate decision-making. Much of Cambodia's recent, impressive infrastructural development has taken place on a basis of less than perfect knowledge, because data do either not exist, or are not easily accessible. A good basis for feasibility studies and design will increase the cost-benefit ratio of infrastructural developments, reduce the risks, and add to a good investment climate.

The rainfall has a pronounced seasonal variation, as well as random short-term variations. In the coastal zone, the rainfall varies significantly from one location to another. The annual average rainfall can vary by 1 m per year over distances of less than 50 km. Data from one station are often merely indicative for conditions at nearby locations. Knowledge about normal and extreme rainfall is needed for cultivation planning; irrigation system operation; and feasibility assessment and design of irrigation and drainage infrastructure. Some data exist, but they are fragmented and not readily accessible. A combination of ground monitoring and satellite data (free from the internet) would provide a much better coverage. A better dissemination will provide large benefits for a negligible cost.

Information about *monthly mean sea level, tidal heights and storm surge heights* is required for risk assessment of floods and saline intrusion, and for feasibility assessment and design of dyke heights and drainage capacity.

Data about *evaporation and sunlight radiation* are sporadic or non-existent, but would be useful in connection with selection of new and better seeds.

Land subsidence seems to be an issue in low-lying drained areas, notably the Prey Nob polders in Preah Sihanouk Province. Good quantitative evidence would highly facilitate

appropriate and timely decisions, feasibility assessment and design of sea walls and drainage infrastructure.

Socio-economic data, important for development planning and progress monitoring, are available at commune level from National Institute of Statistics, Ministry of Planning.

Facilities

Facilities include basic office equipment (printers, photo copiers); computer hardware and software; vehicles; cameras; and equipment for positioning, monitoring and analysis. Today, in the coastal zone, there is a visible scope for upgrading of facilities across nearly all province- and district-level government bodies. This is due to lack of funds. Even in the frequent case that some facilities were provided in the past, they may be idle due to lack of funds for operation and maintenance.

For example, there is a broad demand of *soil analyses*. Some farmers use inorganic fertilizers today; and more will do so in the time to come, in support of new and better rice varieties, as well as crops other than rice. But the choice of fertilizer - the N-P-K mix - depends on the contents of nutrients already available in the soil and in the water. If a less than optimal mix is applied, it may well have a certain, visible positive effect; but still, the farmer pays for unnecessary fertilizer components, and the environment will be polluted by the surplus. Knowledge about nutrients in the soil and water would support the farmers and the environment at the same time. Analyses could for example be provided by the Department of Agriculture, or by a private operator (possibly a fertilizer supplier), against a moderate fee. The farmers will quickly learn whether this is worthwhile or not.

Tools

A frequent suggestion during consultations in May 2012 was provision of *guidelines* on climate-related matters. Guidelines can be useful in connection with (1) knowledge base development; and (2) planning:

- Monitoring and documentation of climate-related vulnerabilities and impacts, including minimalistic (and low-cost) but systematic and targeted monitoring efforts;
- Screening of climate-related opportunities and risks, possibly coordinated (or integrated) with EIA screening;
- Mainstreaming of climate resilience into sub-national planning (including the commune level).

Several initiatives in this respect have been made recently, while others are planned or in progress, under the MOI, the MOP and the MOE (and possibly others).

In the medium term, *decision-support tools* can provide a cost-effective means to strengthen analyses of impacts and feasibility, and decisions on investments and other

development initiatives. This can add to the benefits (and reduce the risks) of physical and land use interventions, which are in progress or being planned across the coastal zone. Examples of analyses are environmental implications; surface runoff and drainage (including, but not limited to urban areas); and coastal erosion and accretion. *GIS tools* can highly facilitate both monitoring and planning, but require expensive hardware and software, and a “critical mass” of embodied skills for routine application.

Such tools can, in the course of time, be implemented for in-house application by various government bodies, and/or within the private sector or universities, who can make the tools (and the embodied expertise) available on demand.

Financial resources

Financial resources are needed for basic routine operation and maintenance. Additional resources (for non-routine activities) are needed for implementation of development initiatives according to plans, and would facilitate timely response to urgent and/or obviously beneficial development needs, for example as identified at the commune level. Financial resources are broadly inadequate in the study area.

A small step in the right direction could be made by introducing cost recovery where this is appropriate and can be done without adverse side effects. A water fee is already applied for fields served by irrigation and is intended to recover operation and maintenance costs (but not capital costs, because this would seldom be feasible). Perhaps fees could be charged for data; for EIA processing (like the fee routinely charged and broadly accepted for construction permits); for routine environmental inspections of factories and land concessions; for water abstractions (including groundwater); and for sewage disposal licenses.

Networking modalities

The networking capacity is an important characteristic of a public administrative body involved in service delivery. Networking comprises:

- Vertical liaison with other management levels (for example between a ministry, a province department, and the communes).
- Horizontal liaison with other agencies at the same level.
- External relations with (1) the service users, (2) the private sector, (3) other stakeholders, such as CSOs, and (4) the newsmedia.

At the province level, a formalised networking is in place under the auspices of the provincial governor. For example, the provincial development plans and public investment plans are prepared with active participation by the various departments. This works well in the study area, but could presumably be further consolidated in different ways. Also, the

networking between the province level, the district level and the communes works well in many cases. This networking is important, because some development needs and opportunities are identified at the commune level, but may be better suited for implementation (and financing) at a higher level. Even if it works well, any support to consolidation would be valuable.

New EIA law

A new EIA law is in preparation by MOE. It is expected to cover management of various emissions (including greenhouse gases) as well as land use. It would be relevant to consider whether the new law could accommodate some extent of “screening for climate resilience and disaster risk implications (threats and opportunities) where appropriate”.

6.4 Capacity-building opportunities

The consultations conducted under the present study identified human resources as a main constraint to climate-related institutional capacity. Training is a main priority, and provision of information and guidelines is another.

Province level

The province is the main vehicle for sub-national capacity. Many provincial departments have a quite fair capacity (although somewhat affected by frequent staff rotations), and a solid knowledge about development needs and opportunities. Presently, related capacity is being developed in the provincial administrations (under the governor's office). Inter-agency collaboration works well, and relations with service users and stakeholders are close and functional. The strategic development planning has a perspective that looks beyond immediate operation and maintenance needs, but funds for implementation are inadequate. The MoE's Coastal Coordination Unit (CCU) and the province-level inter-agency working groups under the Governor's Office offer a functional platform for provincial level capacity-building in relation to climate change, which, can provide a platform for support to the communes.

Commune and community level

The communes are strong in terms of insight into socio-economic development needs and priorities, but somewhat less so when it comes to management options - particularly in case of unfamiliar challenges, such as climate change and new production technology. The communes are staffed with one clerk each (seconded by MoI). There is no basis for comprehensive in-house capacity-building. Rather, expertise is provided on demand by the provincial line departments and by the Technical Support Units of the provincial administrations, for example in connection with the commune-level development and investment planning. Financial resources are broadly inadequate, in many cases impeding

urgent operation and maintenance of roads, irrigation infrastructure and flood protection. Hereby, access to expertise becomes a key to commune-level capacity.

Skills are urgently needed related to production systems in general and resource-based production systems in particular. This was clearly confirmed across the consultations. Farmers are aware of the need to adapt to climate change, but are unaware of the related new and unfamiliar challenges, for example when shifting from long-term to short-term crops, when preventing soil deterioration, or when implementing tree-planting schemes.

6.5 Suggestions on capacity-building activities

The suggestions made below take their starting point in needs related to the pilot activities under the CARP. It is not possible, however, to make a sharp distinction, in terms of scope and timing, between such targeted, immediate needs and more general climate-related capacity-building, which will in many ways require a longer time horizon than accommodated by the CARP. Capacity-building activities can support the implementation of demonstration activities, while, at the same time, serve highly useful purposes in their own right. Some suggestions are made below, in random order.

Provincial level

The provincial level of administration includes the ministerial departments and the province administrations with its technical support units. Immediate needs include:

- Technical expertise related to climate resilience of production systems and infrastructure.
- Tools (including guidelines for decision-support). Guidelines for strategic development planning are available and are presently being upgraded to accommodate climate change.

Examples of pilot activities

Immediate and short-term capacity-building may include for example:

- Thematic *inter-agency mini-seminars* with participation by national resource persons for discussion of climate-related vulnerabilities, opportunities and management options.
- *Inter-disciplinary CC training* at province and district level, aiming at identification of entry points for introducing the CR in the development planning, and promotion of sharing data and information. Some training was done in the past and was well received.

The Provincial Working Groups in the two target provinces are well placed to contribute, with their functional inter-agency networks.

Commune and community level

The communes and communities are in need of:

- Understanding of new and unfamiliar resource-based technology, including (but not limited to) new rice varieties, soil management and tree planting schemes.
- Understanding of related opportunities and management options.
- Consolidation of management of existing resource-based production systems and infrastructure.

Examples of pilot activities

Immediate and short-term capacity-building may include for example:

- An education and awareness-building campaign, starting with training-of-trainers at the province level, with subsequent pilot implementation in the target communes, involving commune councils and schools. Topics to be covered may include sea level rise, coastal/river mouth erosion, saline intrusion, mangrove habitats, sea grass and coral habitats, floods and storms. Courseware can be readily prepared by adaptation of a nice toolkit prepared for inland provinces by Save Cambodia's Wildlife (and NGO) with support from the MAFF, the UNDP and the GEF.
- Pilot/demonstration activities of climate-resilient cultivation (as outlined in a separate CARP working paper, prepared in parallel).
- A bridging programme, possibly involving exchange visits by farmers and salinity control operators with peers in the Cuu Long (Mekong) Delta in Vietnam, where a substantial experience has been achieved within cultivation in areas exposed to sea water intrusion;
- Support to water user communities, farmer's communities and fisheries communities, involving networking (learning from each other) and understanding of development opportunities and management options.

6.5 Long-term opportunities

Long-term initiatives, beyond the scope of the CARP (in terms of time and geographic coverage), may include:

- Support to dissemination of existing data (rainfall, wind, sea level); and guidance on improved monitoring (including inland surface water salinity and sunlight radiation) and data processing oriented towards scheme operation, choice of seeds, and structural design.

- A 'CC Atlas' for the coastal zone, including mapping of present (normal and extreme) rainfall and sea level, and flood risk. 'Safe (evacuation) areas' could be included if practical.
- Promotion of the use of maps, and support to better accessibility of existing maps, as well as guidance on the use of satellite data and imagery, including resources readily available from the Internet.
- Capacity-building in soil quality analysis and management, in support of guidance on selection of crop varieties, appropriate use of fertilizer and compost, and the prospects for alternative crops. In many places in the study area, soils are not readily suited for crops other than rice.
- Support to national networking about drought preparedness and drought mitigation - not a problem today in the coastal area, but it could well emerge as a new CC-related challenge. National expertise is available and could be shared with peers in the coastal area.
- A national MSc-level education in environmental management (including the climate perspective). (This is not available at present).
- Support to a national professional organisation in support of networking and knowledge-sharing among practitioners. The organisation could collaborate with one or several universities and/or alumni networks. It could arrange seminars and workshops, facilitate exchange visits and secondments, and perhaps publish a small newsletter (or even a scientific journal).
- Publication of policy briefs/case studies, including success stories (for example about innovative cultivation techniques, niche products, and private sector involvement).

7. Support to CC Education, Awareness-Building and FWUC Strengthening

This chapter is a summary of an assessment conducted in May and June 2012 of the training needs in relation to CC education, awareness-building and FWUC strengthening. The work is based on a series of consultations with government bodies, farmers, fishermen and others in Koh Kong and Sihanoukville Provinces, with subsequent reporting under the CARP.

The assessment is related to Outcome 2 of the CARP: “Increased resilience of coastal communities and coastal ecosystem buffers to climate change and improved livelihoods”. Specifically, it is related to the following activities: “Capacity of the local government strengthened in order to implement climate change adaptation and climate risk reduction activities”; “Development of awareness, outreach and training materials for community members”, and “Assessment of training needs and implementation of training in FWUCs with regards to climate risk management; involving local authorities”.

The full assessment—“Support to CC Education, Awareness-Building and FWUC Strengthening, December 2012 – can be downloaded on the CARP website (www.czmcam.org).

7.1 CC education and awareness-building

Two closely related activities are proposed:

- Training-of-trainers
- Pilot education and awareness-building sessions at commune level

Rationale

Cambodia's Human Development Report 2011 is dedicated to “Building resilience: The future of rural livelihoods in the face of climate change”. On its first page, it notes that “climate change is as much a human development issue as it is an environmental issue”. The need of human development (and institutional capacity) is amplified by the ongoing decentralization and deconcentration programme, supported by the National Committee for Sub-National Democratic Development (NCDD), which aims at increased sub-national participation in development and investment planning and related decision-making.

Consultations conducted under the CARP in May and June 2012 confirmed a broad need of improved knowledge about CC implications and adaptation options, from the province level to the district, commune, village, and indeed household level, supported by training-of-trainers. This is the background for CARP activities aiming at strengthened local government

capacity, and development of awareness, outreach and training materials for community members.

An awareness and education kit

A kit for CC education and awareness-building was produced and successfully implemented under the NAPA Follow-up Project by Save Cambodia's Wildlife (SCW) in collaboration with MAFF, UNDP and GEF. A cornerstone of the kit is a flip chart, consisting of 34 thematic pages, covering CC impacts, CC mitigation and adaptation, safe water and sanitation, waste disposal, rural livelihoods, resource conservation, and urban implications. The front sides of each sheet sides are nice artistic drawings in colour with CC-related themes (without texts), while the rear sides (in greyscale) are explanatory notes (with concepts, figures and diagrammes in Khmer). A presenter can show the front side to a group of trainees while using the notes on the rear side for guidance. Also, a “pocket version” has been produced, as well as a DVD with video presentations (in Khmer).

The flip chart was developed with a view to education of extension workers and communities. In reality, it could serve as a tool for discussion from kindergarten to university level. It is very clearly based on the Cambodian CC agenda, but does not cover the specific coastal zone challenges and adaptation needs. It is well suited for adaptation for use in the coastal zone, if it is modified to include themes relevant to the coastal zone agenda for CC preparedness and adaptation.

Proposed activities

The following activities are proposed under the CARP:

- Amendment of the flip chart to add coastal themes, such as sea level rise; coastal/river mouth erosion; saline intrusion; mangrove habitats; sea grass and coral habitats; and perhaps costal infrastructure. (Soil deterioration and urban drainage would be other candidate themes - the highly relevant topics of floods and storms are covered already).
- Skipping some of the existing pages, in order to obtain a concise and manageable toolkit, possibly ending up with around 24 pages.
- Preparation of 3 sets of handouts, largely reflecting the rear sides of the flip chart pages, and clearly related to each page of the flip chart: One comprehensive set of notes in Khmer; a similar set in English; and a set of concise notes in Khmer.
- Training-of-trainers from the PWGs (2 sessions, one in each target province), based on preliminary versions of the revised flip chart.
- Pilot implementation at commune/village level (4 sessions, two in each target province), with feedback from participants and trainers.
- Adjustment of the kit (presumably mainly the handouts rather than the flip chart itself).

- Production of 50 flip charts.
- Evaluation and reporting.

Objectives

The direct objective of the training-of-trainers and the pilot sessions is to achieve:

“Improved understanding of CC-related challenges and options in the context of the coastal zone, first among the PWGs and, subsequently, among local communities”.

The over-all objective is to establish:

“A model for context-specific, CC-related, inexpensive community education and awareness-building, suited for implementation by the PWGs”.

Implementation

Development of an amended flip chart and handouts will be undertaken by SCW in dialogue with the PWGs and with technical support by the TA team. Hereby, the finalization of the toolkit will take place interactively with the training-of-trainers. Training-of-trainers (from the PWGs) will be undertaken by SWC, who will also participate in the initial pilot applications. The PWGs will undertake subsequent routine applications in the communes.

The next steps may comprise:

- 1 Formal approval of the activity
- 2 Agreement with SCW on their contributions
- 3 Detailed planning
- 4 Upgrading of the flip chart and drafting of handouts
- 5 Training-of-trainers, back-to-back with pilot implementation at commune level
- 6 Adjustment of handouts (and, if needed, the flip chart itself)
- 7 Production and dissemination of flip charts and handouts
- 8 Evaluation and reporting

7.2FWUC strengthening

Training needs

Training needs were identified and evaluated during consultations under CARP in May and June 2012. The list is long:

- Water-sharing and water allocation management
- Irrigation system operation and management
- Drainage and salinity control

- Safe water and sanitation
- Soil management
- Tree-planting (for storm protection and other benefits)
- Disaster preparedness: Floods and storms
- Participatory monitoring of climate vulnerability and exposure
- Drought preparedness (Not an issue today, but the area is unprepared if and when a drought occurs)
- Choice of seeds, including short-term and high-yield varieties
- Shift from one to two crops per year
- Use of pesticides and fertilizers
- Livestock; aquaculture. In the pilot area, some farmers are quite successful, while others are less so. There is a clear scope for learning from each other.
- Small-scale supplementary dry season cultivation
- Post-harvest processing and marketing
- Access to credit/savings/insurance

All these are related to climate resilience/climate adaptation - in some cases directly and in other cases indirectly. Only selected (priority) needs will be accommodated during the pilot training proposed in the present study, as elaborated below. The Prey Nob FWUC is well operated by any standard (and as compared with many other Cambodian FWUCs). It is not in need of basic training.

Overview of proposed activities

Two independent activities are proposed:

- Two pilot FWUC training sessions, one in each province, each with a duration of 3 days, with 18 FWUC representatives participating in each session, with briefings on CC concerns and management options, and one day allocated for a site visit.
- A study exchange visit to Cuu Long Delta, with 24 participants (16 government employees and 8 FWUC representatives), and a return visit with 8 participants.

Objectives

The direct objective of the pilot sessions is to achieve:

“Improved awareness and understanding of CC-related challenges and options within CC resilient irrigation management and cultivation technology”.

The over-all objective is to establish:

“A model for context-specific, CC-related, inexpensive FWUC training, suited for implementation by the PWGs”.

Exchange visits

The direct objective is to achieve understanding of proven technology and management options related to:

“Salinity control of paddy fields; and high-yield double (or triple) cropping; from a environmental setting that is similar to the one in the CARP area”.

The overall objective is to:

“Strengthen the capacity of PWGs, provincial departments and the Governors' offices to meet climate-related, socio-economic development needs and opportunities by climate-resilient production systems and infrastructure”.

Hereby, it is expected that the exchange visits can add to the basis for the sub-national development planning.

Outline of training sessions

Rice cultivation in the pilot area is in a stage of transition piloted by entrepreneurial farmers, from traditional long-term and low-yield (but tasty!) varieties, with one crop per year, to more contemporary (and climate-resilient) short-term and high-yield varieties. Most experience is from other parts of the country, where conditions are different. The transition can be supported by exchange of knowledge from elsewhere, as well as within the pilot area. On this background, the rationale of the training sessions is to learn from each other, exchanging experience and ideas between and among farmers and PWG members.

A 3-days programme is proposed:

Day 1: Introduction; briefings by provincial departments, Prey Nob FWUC, CARDI and the TA consultant; welcome dinner

Day 2: Site visit to irrigated paddy fields/FWUCs/Farmers Associations in each province, including the Prey Nob Polder and (expectedly) TuolKokir

Day 3: Panel and plenary discussions, conclusions and recommendations

The pilot training is intended as a starting point for replication. A feedback survey will be conducted in support of improvements.

Outline of study exchange visit

The Cuu Long Delta is located 2-300 km from the target area. It is exposed to seasonal (dry season) sea water intrusion, affecting irrigation and urban water supplies. Irrespectively, the Delta is intensely cultivated, with rice yields around 4 t/ha in the wet season and 6 t/ha in the dry season, along with fruit trees and aquaculture. The new climate-related challenges to paddy farmers in Cambodia's coastal zone are well known in the Cuu Long Delta (the Vietnamese part of the Mekong Delta), where the Mekong meets the sea. Experience has

been built over decades in salinity control, soil management, and brackish water production systems other than rice cultivation. Technologies have been adapted with support from the scientific community and governmental technological service institutes.

There is a clear scope for gaining insight in this experience for the purpose of Cambodia's coastal zone. For the purpose, one study visit and one return visit are proposed:

- A 4-days visit by representatives from provincial departments and the governors' offices, and some FWUC representatives
- A 2.5 days return visit by Vietnamese resource persons for review of impressions and lessons learned on the background of the Cambodian development agenda

Implementation

The activities will be implemented by the Provincial Working Groups, with initial support from the CARP. Active participation has been assumed by:

- Provincial Department of Environment (involved in CC adaptation)
- Provincial Department of Agriculture (involved in cultivation technology)
- Provincial Department of Water Resources (involved in irrigation system operation)
- The Provincial Governors' Offices
- The Prey Nob FWUC
- CARDI
- Perhaps a rice miller

In Vietnam:

- Southern Institute of Water Resource Planning (SIWRP), and/or Southern Institute of Water Resources Research (SIWRR); and/or
- Can Tho University: Faculty of Agriculture, and/or Faculty of Technology

The next steps may comprise:

- 1 Formal approval of the activity
- 2 Agreements with implementation partners/resource persons
- 3 Preparatory visits to each province
- 4 Identification of trainees (jointly with PWGs/provincial departments)
- 5 Implementation
- 6 Evaluation and reporting
- 7 Related activities

The proposed activities are related to (and will conveniently complement and add value to) other climate-related capacity development initiatives (in preparation) under the CARP and beyond, aiming at strengthening of the provincial departments and the Governors' offices in

general, and the PWGs in particular, as well as building commune-level and farm-level awareness of climate-related challenges and adaptation options.

The proposed CC education and awareness-building pilot activities are well suited for routine replication (by the PWGs) beyond the CARP. In the course of time, the activities could be expanded to schools.

8. Implementation Plan for Demonstration Activities

This chapter briefly outlines implementation plans for six proposed demonstration activities under the CARP component.

Detailed information about the implementation plans is contained in the report “Detailed Implementation Plan for Demonstration Activities at the Coast”, March 2013, which can be downloaded on the CARP website (www.czmcam.org).

As part of the selection process, the demonstration activities were presented in September-December 2012 to the technical working groups and the commune councils at a series of workshops in Koh Kong and Sihanoukville. Feedback was received through these consultations regarding the ranking of the proposed demonstration actions in the target communities. Based on this, additional work was conducted to formulate the actions into concrete projects including budget and implementation plans.

8.1 List of demonstration activities

The six demonstration activities proposed to be implemented are as follows:

1. Integrated Farming Training Programme for (a) agricultural extension staff and (b) households / families in multi-scale climate change adaptation strategies and integrated farming (integration of crops, livestock, fish, and water) at 8 target communes. This is preceded by agro ecological analysis as an integral part and includes demonstration in on-farm water management measures. The demonstration activity is proposed implemented in partnership with the Department of Agricultural Extension, MAFF.
2. Community Fisheries project at PeamKrasaob Commune, especially in terms of strengthening regulatory measures and their enforcement. The relation of community fisheries to climate change adaptation is that general fishing developments and its regulatory measures are likely to be required to adjust the livelihood of fishing communities. The demonstration activity is proposed implemented in partnership with the Fisheries Administration, MAFF.
3. Promotion and increased availability of shorter duration seeds for crops, particularly for wet-season paddy possibly enabling harvest before onset of heavy flooding and sea water surges at target communes. Such varieties will need to be tested (at no cost to farmers) in specific localities, where they are likely to be effective. The demonstration activity is proposed implemented in partnership with the Cambodia Agricultural Research and Development Institute, MAFF.

4. Promotion of increased livestock keeping at eight communes - by using a revolving scheme for improved breeds – as tested successfully in Cambodia, Laos and elsewhere. This is in response to increased flooding problems as livestock are moveable. The demonstration activity is proposed implemented in partnership with the Center for Livestock and Agriculture Development (CelAgrid) in collaboration with the Project Management Unit, Ministry of Agriculture, Forestry and Fisheries.
5. Climate change awareness raising and training on climate change resistant irrigation in the target communes. A comprehensive training and awareness activity in relation to climate change impacts will be implemented applying experience from previous work in Cambodia. The work training will be done in all 8 selected communes. The demonstration activity is proposed for implementation through cooperation with a NGO and the established provincial working groups, who will be responsible for the implementation.
6. Adaptation measures integrated in Commune Development Plans in eightcommunes. Concrete demonstration actions will be done in each of the target communes based on the planned activities in the 2013 commune investment plans and implementing actions that will make the communes more resilient to climate change impacts. The demonstration actions will be conducted in cooperation with the commune councils, districts and the provincial working groups.

Most activities are to be implemented during 2013, but activity 4 will take about 3 years to implement, but the main part is to be implemented during 2013. It will, in addition, be necessary to have follow-up activities during 2014-15. It is proposed that such follow-up activities may take place under the LDCF-GEF part of the Coastal Adaptation Project, if feasible.

The background and basis for the demonstration activities are based on the activities and efforts summarised through the report.

The draft implementation plans and draft agreements was formulated during 1-15 December 2012 and finalisedin the beginning of 2013 by the project team in consultation with the mentioned implementing partners (DAE, FiA, CARDI and CelAgrid), and based on several consultations with the involved communes and working groups.

8.2 Priorities for demonstration activities of communes

In the period September-November 2012, the CARP held community stakeholder meetings to establish demonstration action priorities for the selected communes in MondolSeima and Prey Nob districts. These meetings included discussions with the Provincial Working Groups, including the commune chiefs of the eight target communes.

Prior to the stakeholder meetings, the CARP had studied data and on the basis of needs assessment composed a list of potential demonstration activities. Through an informal questionnaire, data was obtained via facilitated group discussions with community members, i.e. representatives of community council and community committee.

Information was gathered on the following themes:

- The most serious climate impacts
- The household's sources of income
- Recommendations for changed agricultural practices
- Recommendations for future demonstration activities

After all the data was collected and analysed, the CARP identified twenty potential demonstration activities. During the meetings in September-November, stakeholders were asked to rank each of the twenty activities. The commune chiefs of the target communes based their ranking upon the priorities of their respective communes.

Please refer to chapter 2 of the report "Detailed Implementation Plan for Demonstration Activities at the Coast", March 2013, for a list of the potential demonstration activities and their ranking.

9. Conclusions and Recommendations

This chapter provides an overview of the challenges and opportunities to strengthen the adaptation capacity among the target communities in the coastal zone and government authorities at national and local level to deal with the effects of climate change. It does so by consolidating the conclusions and proposed recommendations for action of each chapter.

Strengthening coping strategies

The following main challenges were identified:

- Building and maintaining dyke systems as a coping strategy is hampered by lack of financial resources and low technical capacity.
- A general structure to support the coping strategies at an individual and community level is not in place.
- There is no system in place for sharing relevant information between relevant stakeholders.
- Villagers perceive climate change and its impacts in relation to the local environment. They do not have the understanding of climate change in a global context which poses a risk for the implementation of not only climate change projects but also other development projects.

It is recommended to:

- Secure funds for the building and improvement of dyke systems and strengthen the technical capacity to develop them at an institutional level.
- Develop the organisational capacity at the community level before a technical capacity is developed in the target communities. Such a structure needs in a transparent way to ensure a better communication and technology transfer between the RGC, other development service providers and the villagers in the target communities.
- Create a system to ensure that relevant information is passed from the villagers to the authorities and vice versa prior to a weather hazard occurs, during its impact and after it has occurred and include it in the CDP.
- Carry out awareness-building activities that stress the interconnection between coping strategies for climate variability and its impacts and other development issues. Education materials should be developed based on two formats, (1) a coping strategy catalogue listing developed coping strategies in the target communities, (2) developing posters illustrating coping strategies.

Overcoming the vulnerability of existing agricultural practices

The following main challenges were identified:

- Many of today's agricultural practices in the target areas are unsustainable. Yields are low, land holdings small and paddy cultivation is adversely affected by low-quality seeds and lack or inappropriate use of fertilizer. Even with much higher rice yields and much better farmgate prices, many households will remain locked in poverty if they rely on existing cultivation as a main livelihood.
- The sustainable development of the Prey Nob polders is under threat as the margin between the land level (within in the polders, affected by land subsidence) and the sea level (outside the polders, affected by sea level rise) is declining.
- General policy implications relate to securing efficiency improvements in agricultural production; alternative livelihoods generation; applying a value chain perspective in support of generation of revenue and livelihoods; water use regulation; putting in place disaster preparedness; organisation of farmers; soil management, and improvements in the use of pesticides.

It is recommended to:

- Implement a major agricultural pilot and demonstration programme to serve as a “controlled laboratory” for identification of appropriate seeds and cultivation practices.
- Provide support to formation/consolidation of farmer and fishery communities and support farmers directly in the use of high-quality seeds and inorganic fertilizer; pest control; livestock breeding and vaccination, and small-scale supplementary dry season cultivation.
- Provide support to community-based zoning of fishery areas.
- Implement a tree-planting scheme, compartmentalise the polders to confine exposure to sea water intrusion and systematically monitor salinity and land subsidence.

Strengthening the adaptation capacity in view of vulnerability of and risks to livelihoods

The following main challenges were identified:

- There is considerable adaptation capacity and resilience displayed by the target communities in their attempts to cope with the impacts of climate change but their coping strategies are in response to the changes being experienced currently and expected in the short term. For the medium to longer term, they are clearly inadequate.
- The specific understanding of climate changes relevant to livelihoods efforts and how such climate changes should be incorporated into adaptation strategies is quite limited. Predictions on how the climate will develop are uncertain, and relating to various

climate change scenarios is quite difficult. Better and more localised predictions would be an improvement and make communities more able to adopt relevant measures.

- Outside assistance (from local as well as national authorities) is necessary in order to enable the communities to cope with the predicted climate changes.

It is recommended to implement the following demonstration activities:

- Integrated Farming Training Programme for (a) agricultural/fisheries extension staff and (b) households/families in multi-scale climate change adaptation strategies and integrated farming.
- Community Forestry projects in cooperation with the Forestry Administration.
- Community Fisheries project at PeamKrasaob in cooperation with the Fisheries Administration.
- Reinforcement of community dyke maintenance, drainage and irrigation systems management in cooperation with MoWRAM – for Prey Nob and TuolKokir.
- Promotion and increased availability of shorter duration seeds for crops, particularly for wet-season paddy, thus, possibly enabling harvest before onset of heavy flooding and sea water surges at all five communes.
- Promotion of increased livestock keeping at target communes - by using a revolving scheme for improved breeds – tested successfully in Cambodia, Laos and elsewhere.

The costs and benefits of modifying existing agricultural practices

The following conclusions were made:

- All five analysed demonstration activities are profitable in economic terms for both the CARP and the participating households.
- They are all in line with the expressed priorities of community representatives and builds on their present coping strategies. There are, therefore, limited social costs but rather benefits associated with the proposed activities.

Securing implementation capacity for proposed demonstration activities

The following conclusions were made:

- Many capacity gaps have been identified, but none that are “critical” to the proposed demonstration activities to an extent that these activities are obstructed. Rather, a minor extent of immediate capacity-building can add value to them and, at the same time, contribute to the basis for long-term generation of sustainable institutional capability. This can for example involve illustration of the significance of knowledge

gaps; of the value of awareness; the benefits of inter-disciplinary coordination; and identification of opportunities and entry points to climate change adaptation.

- Capacity-building activities can support the implementation of demonstration activities, while, at the same time, serve highly useful purposes in their own right.
- Hereby, the CARP can contribute to improved sub-national capacity, but cannot serve the entire set of needs - which will take much longer time and require substantial resources.

Supporting education and awareness-building activities

The following activities were proposed:

- Training-of-trainers (from the PWGs) and pilot education and awareness-building sessions at commune level.
- A series of two pilot FWUC training sessions, one in each province.
- A 4-day study exchange visit to the Cuu Long Delta in Vietnam.

With the following expected results:

- CC-related skills development at the provincial level.
- Increased local awareness and understanding of CC-related challenges and adaptation options.
- Improved understanding of climate-related challenges and options within irrigation management, cultivation technology and livestock breeding.
- Increased understanding of opportunities and management options related to salinity control of paddy fields; and high-yield double cropping.
- Strengthened capacity of the PWGs, provincial departments and the Governors' offices to meet climate-related, socio-economic development needs and opportunities by climate-resilient production systems and infrastructure.

Developing implementation plans for demonstration activities

As part of the selection process, the proposed demonstration activities were presented in September-December 2012 to the technical working groups and the commune councils at a series of workshops in Koh Kong and Sihanoukville. Feedback was received through these consultations regarding their ranking. Based on this, additional work was conducted to formulate the six demonstration activities into concrete projects including budget and implementation plans.

The successful implementation will depend on the smooth cooperation between the CARP, the MoE and other RGC institutions – notably institutions under the MAFF, including the

Provincial Departments of Agriculture, Fisheries and the PDWRAM. There may be some functional capacity limitations within the mentioned institutions. The timely consultation and negotiation of roles and responsibilities in regard to implementation is therefore of the utmost importance.

Most activities are to be implemented during 2013 but it will be necessary to have follow-up activities during 2014-15. However, the CARP component is due to close by end of 1st quarter 2014, thereby allowing only one main growing season (the wet season 2013) for the implementation. This is not an ideal situation as all demonstration activities would benefit from the component's presence in terms of follow-up and consolidation of results and outcomes.