SUPPLEMENTARY APPENDIX O

Climate Resilience Outputs and PPCR Funded Activities

June 2014

CAM: Greater Mekong Subregion Biodiversity Conservation Corridors Project – Additional Cofinancing from Pilot Program for Climate Resilience (PPCR)

ADB TA-7459 REG: Greater Mekong Subregion Biodiversity Conservation Corridors Project – Pilot Program for Climate Resilience Component – Cambodia

ABBREVIATIONS

ADB	Asian Development Bank
BCC	Biodiversity Conservation Corridors
CARDI	Cambodian Agricultural Research and Development Institute
CARP	Coastal Adaption and Resilience Planning Component
CBPF	Community-based Production Forestry
CIF	Climate Investment Funds
CF	Community Forestry
CFE	Community Forestry Enterprises
CSIRO	Center for Australian Weather and Climate Research
ELC	Economic Land Concession
GEF	Global Environmental Facility
GMS	Greater Mekong Subregion
FA	Forestry Administration
FMG	Forest Management Groups
IOM	International Organization for Migration
EA	Executing Agency
GhG	Greenhouse gas
GMS	Greater Mekong Subregion
IOM	International Organization for Migration
IPs	Indigenous Peoples
IUCN	International Union for Conservation of Nature
IRR	Internal Rate of Return
LMB	Lower Mekong Basin
MOE	Ministry of Environment
MAFF	Ministry of Agriculture, Forestry and Fisheries
Mekong ARCC	Mekong Adaptation and Resilience to Climate Change
MRC	Mekong River Commission
NAPA	National Adaptation Programme for Action
NGO	Non-government organization
NPA	National Protected Area
NSDP	National Strategic Development Plan
NTFP	Non-timber Forest Products
PPCR	Pilot Program for Climate Resilience
RCP	Representative Concentration pathway
RGC	Royal Government of Cambodia
R-PPTA	Regional Project Preparatory Technical Assistance
RRP	Report and Recommendation to the President
SCF	Strategic Climate Fund
Rice-SDP	Rice-Sector Development Program
SNAP	Strategic National Plan for Disaster Risk Reduction
SPCR	Strategic Program for Climate Resilience
SPF	Seima Protected Forest
SRI	System of Rice Intensification
TA	Technical assistance
ToR	Terms of Reference
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WUG	Water user group

Contents

I. OVERVIEW

A. Background

1. Cambodia is one of the pilot countries participating in the Pilot Program for Climate Resilience (PPCR) - one of three sub-programs of the Strategic Climate Fund (SCF) of the Climate Investment Funds (CIF).[1] The PPCR provides incentives for scaled-up action and transformational change in integrating consideration of climate risks and resilience in national development planning, consistent with poverty reduction and sustainable development goals. The priority sectors for PPCR in Cambodia include water resources, agriculture and infrastructure. In June 2011, the PPCR sub-committee endorsed Cambodia's Strategic Program for Climate Resilience (SPCR) with a funding envelope of up to $86 million ($50 million in grants and up to $36 million in concessional credit). Of this, an allocation of $8.0 million grant financing was endorsed for "Promoting Climate-Resilient Agriculture, Forestry, Water Supply and Coastal Resources in Koh Kong and Mondulkiri Provinces" as additional financing under PPCR for the Asian Development Bank (ADB) to be channeled through the Greater Mekong Subregion Biodiversity Conservation Corridors (BCC) Project. The initiatives proposed for PPCR funding, and the main results and indicators for success (consistent with PPCR results framework) are presented in Supplementary Appendix N: PPCR Summary Project Approval Request. This document describes the impact of climate change in Koh Kong and Mondulkiri and how the activities proposed for PPCR funding are complementary to the BCC Project by enhancing resilience of the BCC Project interventions.

2. The PPCR preparation grant of $0.6 million was used for project preparation activities, including climate change modelling and vulnerability assessment, identifying projected climate change impacts, exposure and sensitivities, gauging current coping mechanisms and identifying priority interventions in Koh Kong and Mondulkiri provinces (Supplementary Appendix M: Climate Change Impact Modeling and Vulnerability Assessment). The preparation team conducted four feasibility studies of subprojects as models that can be replicated across the project area. These subprojects contain site-specific technical considerations, social and environmental safeguards aspects, and financial and economic analyses. A fifth subproject was completed up to pre-feasibility stage, for which a full feasibility can be conducted during project implementation.

B. Cambodia's SPCR

3. The themes for intervention within Cambodia's SPCR include (i) climate risk management; (ii) flood and drought management; (iii) coastal resilience; (iv) disaster risk reduction; (v) ecosystem-based adaptation; (vi) business-focused adaptation; (vii) climate proofing of infrastructure including water supply and sanitation, post-harvest facilities and roads; (viii) capacity strengthening for mainstreaming resilience into development planning; and (ix) stakeholder participation. The SPCR for Cambodia has four investment components which will, through hard investment (such as infrastructure improvement), and soft investment (such as policy support, preparation of guidelines, and capacity building), scale-up activities that will lead to improved climate change adaptation. The four investment components are: (i) promoting climate resilience of water resources and related infrastructure; (ii) enhancing climate resilient agriculture and food security; (iii) improving climate resilient infrastructure; and (iv) providing coordination and support for mainstreaming climate resilience into development planning. The

[1] The other two sub-programs of the Strategic Climate Fund are the Forest Investment Program (FIP) and the Scaling up Renewable Energy Program (SREP) for low income countries.

second investment component was endorsed with an allocation of $18 million for two projects: (i) Promoting Climate Resilient Agriculture Forestry, Water Supply and Coastal Resources in Koh Kong and Mondulkiri, complementary to the BCC Project; and (ii) Climate Proofing of Agricultural Infrastructure and Business-focused Adaptation, blended with the Climate Resilient Rice Commercialization Sector Development Program (Rice-SDP). The former project, which includes elements of all the SPCR themes for intervention, is discussed below and is referred to as 'the Additional Financing'.

4. Relevant outcomes anticipated under the second component in the SPCR include (i) increased resilience and reduced poverty in rural, climate-hazard-prone areas, (ii) enhanced protection of coastal areas from storm surge / sea level rise / saltwater intrusion and improved resilience of agro-biodiversity, (iii) enhanced and continued water supply during dry season and drought periods, (iv) improved coping mechanisms of small farmers against climate change impacts, (v) enhanced demand-side water use efficiency, (vi) improved institutional structures to respond to climate change, and (vii) new and additional resources for enhancing resilience in agriculture and related infrastructure. Through various activities designed to achieve these outcomes, the capacity for developing and implementing climate-resilient infrastructure and other climate resilience initiatives within BCC executing agencies (EAs), the Ministry of Environment (MoE) and the Ministry of Agriculture, Forestry and Fisheries (MAFF) - and their provincial equivalents, will be enhanced. While data and information on global and regional climate change impacts are improving (and specific studies of climate change impacts in Koh Kong and Mondulkiri were undertaken as part of the design process[2]), it is still challenging to inform the design of engineered structures (primarily irrigation and water management, and sea barriers) with precision, especially in Cambodia, where the lack of available climate and climate change impact assessments and data adds to the uncertainty. In addition, the location of many remote communities precludes cost-effective infrastructure adaptation. However, several low risk and no-regrets resilience measures, such as introduction of climate resilient agricultural techniques, irrigation system rehabilitation, rainwater harvesting ponds, bioengineered sea barriers and the more innovative piloting of a catchment approach, will be undertaken in the most vulnerable BCC communities.

C. GMS BCC Project

5. The impact of the BCC project is climate resilient sustainable forest ecosystems benefiting local livelihoods in the biodiversity corridors of Cambodia. The BCC Project outcome is sustainably managed biodiversity corridors in Cambodia.

6. The expected outputs from the BCC project include:
   (i) Institutional and community strengthening for biodiversity corridor management;
   (ii) Corridor restoration, ecosystem services protection, forest protection and management;
   (iii) Livelihoods improved and small-scale infrastructure support in target villages; and
   (iv) Project management support for national, provincial, and district government agencies.

7. The Additional Financing will be used to complement the ongoing BCC project efforts by

[2] Katzfey, J., Jiao, X., Suppiah, R., Hoffmann, P., Nguyen, K. C. and Poun, S.(2013) Climate change projections for Mondulkiri and Koh Kong Provinces in Cambodia. CSIRO, Australia.

augmenting activities in the BCC target communes that are most vulnerable to climate change, with proposed climate change adaptation activities that assist local communities to develop resilience and therefore reduce their dependence on unsustainable forest product exploitation. The PPCR funded interventions will support BCC O*utput 3: Livelihoods improved and small-scale infrastructure support in target villages*, by strengthening climate resilience in the communes most vulnerable to climate change.

8. The BCC project aims to enhance transboundary cooperation for preventing and mitigating the fragmentation of biodiversity rich forest landscapes of the tri-border forest areas located in eastern Cambodia and closely related forest areas in Viet Nam and Lao PDR. In Cambodia, the proposed biodiversity conservation corridors will connect seven protected areas (i.e. protected forests, wildlife sanctuaries, national parks) spread over 22 communes in two provinces (Mondulkiri and Koh Kong) with an aggregate forest area of 1,560,236.88 ha (including protected areas but excluding bamboo forest and plantations). In line with the targets of the Royal Government of Cambodia's (RGC's) National Social Development Plan (NSDP), Update 2009 - 2013, the project aims to restore and maintain forest cover contributing to the national target of returning forest cover to the 60% figure for 2005 by 2015 and to contribute to achieving social sector targets such as decreasing poverty to below 19.5% of population by 2015.

II. THE CLIMATE CHANGE SCENARIO

A. Climate Change Impacts in Cambodia

9. According to the World Risk Report 2012, Cambodia ranks 8th among the top 15 countries with the highest risk of impact from climate change and has very low capacity to adapt. Climate change has increased the number of extreme climate events such as floods and droughts in Cambodia. In the coastal regions, the impacts of sea level rise and saltwater intrusion are expected to be severe by 2050. Loss in paddy output in Cambodia due to climate change is estimated to already be significant.[3] Of the total loss, 70% is predicted to be due to the occurrence of floods, 20% due to droughts, and 10% due to other reasons such as pest and diseases.[4] In this regard, climate change is expected to exacerbate food insecurity, which is already a problem in one quarter of provinces of Cambodia. A major component of the vulnerability is the risk to the Tonle Sap ecosystem. Most of Cambodia's proteins come from the fish caught in the Tonle Sap Lake and the three million people who live along the Lake and bordering provinces depend on the Lake for their livelihood. This freshwater resource is threatened by the rise of sea-levels caused by changes in the monsoon rains and decrease of melt water from the Himalayas and is vulnerable to increased salinity in the lower Mekong arising from sea level rise. Should the fishery resources of the Tonle Sap ecosystem be damaged by climate change it will be vital that communities and administrations throughout Cambodia are prepared to meet the resulting protein deficit from alternate sources.

10. To address the impacts of climate change, the government prepared the National Adaptation Program of Action (NAPA) to Climate Change in 2006. NAPA identified climate change adaptation activities such as the improvement of rainwater harvesting facilities at the community level; adopting system of rice intensification (SRI) to reduce vulnerability to changing

[3] Government of Cambodia. 2011. *Strategic Program for Climate Resilience Prepared for the Pilot Program for Climate Resilience*. Phnom Penh.
[4] Cambodia Water Partnership. 2010. *The State of Climate Change Management in Cambodia.* Phnom Penh.

rainfall amounts and patterns; modifying the designs of reservoirs and irrigation systems/channels; and managing natural ponds to better manage climate change induced risks. Despite these efforts, adaptation to climate change is often challenged by (i) limited information on local impacts; (ii) low awareness in governance and administration; (iii) limited institutional, personnel and technical capacities; (iv) weak cross-sector and cross-regional coordination; and (v) lack of suitable technologies and data, reliable disaster control and forecast mechanisms, and budgets.

B. Climate Change Impacts on Mondulkiri and Koh Kong Provinces

11. Mondulkiri and Koh Kong are the two provinces with the highest percentage of remaining forest cover in Cambodia. They also have the lowest populations and population densities. Communities are scattered, road access, particularly in Mondulkiri, is poor, and rice production is limited and based on traditional low risk production techniques. Poverty levels are higher than the national average and educational attainment lower. Agriculture is the prime source of livelihood. Climate and water flow datasets have only been available in the last few years and arise from a limited number of locations. An analysis of climate related stresses and vulnerability related to Mondulkiri and Koh Kong has been undertaken under the project preparation, supported by the PPCR funds to cover aspects of Climate Change Risk Assessment and Impact Modeling (modeling climate change using latest greenhouse gases and aerosols scenarios to be used by the next Intergovernmental Panel on Climate Change (IPCC) assessment) and Community Vulnerability / Coping Mechanism and Adaptive Capacity Assessment (assessing current impacts on beneficiary communities). These assessments have been validated using secondary sources (Supplementary Appendix M: Climate Change Impact Modeling and Vulnerability Assessment).

12. Temperature will continue to increase for both provinces in the future (0.7°C for representative concentration pathway (RCP) 4.5[5] and by about +1.0 °C for RCP 8.5 by 2025 and by about 2°C by mid-century, and by 4.0°C by end of century for RCP 8.5.) with large increase in number of hot days and heat waves and potential also for enhanced evaporation and changes in pest and pathogen populations. Annual rainfall changes are more complex, with the models showing both seasonal increases and decreases in the future with suggestion of decreases in summer rainfall (wet season) and increases in winter rainfall (dry season).

13. The most severe impact is likely to arise from the trend to greater frequency of long-term droughts, which could have the most impact in the next 20 years with potentially less groundwater due to less recharge and greater extraction. More and longer droughts for Koh Kong could exacerbate problems with salt water intrusion. An increase in extreme rainfall amounts is predicted in Mondulkiri (potential for more flash floods) but only small changes in extreme rainfall amounts for Koh Kong.

14. Sea-level rises were estimated using tidal data from neighboring countries because tidal data is hard to obtain in Cambodia. Sea level has been observed to rise 10 to 20 cm in the past 40 years and will continue to rise, by an estimated 40 to 60 cm, by the end of the century. A one-meter sea-level rise would lead to loss of 44 sq km of coastline in Koh Kong (0.4 percent of total area), contribute to the flooding of about 56 percent of settlement areas and significantly raise the risk of severe flooding in Koh Kong city. Sea-level rise is more important in the dry season from December to February (time of highest annual sea level) and there is a trend of

[5] Two emissions scenarios were considered: RCP 4.5 (lower greenhouse gas concentrations) and RCP 8.5 (higher greenhouse gas concentrations).

greater tidal and storm extremes in coastal regions of Koh Kong whilst storm events are likely to reduce in upland regions of Koh Kong.

15. Of particular significance to rice (and other crop) production are projected changes in the seasons and in the distribution of precipitation during the year. A shift in the onset of the wet season and an increase in the intensity of precipitation are projected. These increase risk related to decisions pertaining to the most opportune time to plant rice, which variety to plant, the risks of flooding and consequent crop losses. Furthermore, the wet season is projected to be briefer and the dry season longer, increasing reliance on stored water and improved efficiency of irrigation infrastructure. More uncertainty exists over the timing of seasons and distribution of precipitation than there is over broad temperature changes. The findings of climate modeling on shifts in the seasons and precipitation patterns are sensitive to assumptions on levels of greenhouse gas emissions. For example, under the high emissions scenario, modeling suggests that wet season rainfall may decrease in the coming years (up to 2025) and then increase towards the end of the current century, while under the low emissions scenario, an increase is expected in the shorter term, with a decrease in the second half of the century. Any of the above changes will also lead to changes in pest and pathogen populations and communities are already observing severe crop losses arising from unexpected infestations.

16. Drought is not adequately monitored in Cambodia but has devastating effects for a country, which relies so heavily on agriculture. There are four characteristics of agricultural drought in Cambodia: (i) unpredictable delays in rainfall onset in the early wet season, (ii) erratic variations in wet season rainfall onset, amount, and duration across different local areas, (iii) early ending of rains during the wet season, and (iv) common occurrence of mini-droughts of three weeks or more during the wet season, which can damage or destroy rice crops without irrigation. Vulnerability to drought, particularly longer term drought, will increase in nearly all parts of Mondulkiri and in the coastal communes of Koh Kong.

C. Vulnerability to Climate Change in BCC Communes

17. A commune level vulnerability assessment mentioned above (SD 15) confirmed the results of a number of recent studies. A participatory vulnerability analysis of Mondulkiri, undertaken by the International Organization for Migration (IOM) in 2009 indicated high levels of vulnerability to flooding in Mondulkiri, with "a total of 65% of surveyed villages found to be at a high risk for flooding. Villages facing a medium risk of flooding comprised a total of 27% of at-risk areas. Communities surveyed were found to be at risk for not only seasonal, slow-onset flood events, but also for flash flooding, which can occur in a swift and severe manner". The commune level vulnerability assessment under this project preparation confirmed local concerns about flash flooding. Despite this, Mondulkiri is not yet included in the Strategic National Plan for Disaster Risk Reduction for 2008-2013 (SNAP) or the National Adaptation Programme for Action (NAPA). This may be because the economic damage caused by flooding in an area of highly dispersed population is so far small. The worst damage the project preparation team has been able to identify is loss of small quantities of livestock and partial crop losses (with little or no risk to life and housing) on average once in three years on areas of a maximum of 150 ha. Such losses are not of sufficient economic value to justify major investment in physical infrastructure although they can be devastating to individual households. The importance of the livestock sector to farm incomes in Mondulkiri would suggest that any crop insurance scheme would require the added complication of including livestock and the lack of historical climate data would make such a scheme difficult to operate.

18. The IOM study also confirmed that a total of 74% of surveyed villages were found to be at high risk of both seasonal and agricultural drought, with those at medium risk comprising an additional 23% of surveyed areas. "Drought affects the agricultural outputs of communities, as well as the health of both villagers and animals alike, as well as the availability of water resources for personal consumption and household use". On the basis of field visits and discussion with local focus groups, the project preparation team assess the economic impact of drought as already high because it prevents second season cropping, reduces average first season yields and severely impacts on livelihood and quality of life.

19. Finally, the IOM report states that "insect infestations, though often unreported to officials by villagers, were found to be a high risk hazard to a striking 92% of villages surveyed. The remaining 8% of communities included in this research were identified as being at medium risk for infestations, therefore, all villages covered by this project were found to be at either medium or high risk to the hazard of insect infestations and such infestations are changing in nature due to climate change". The most recent study, the Mekong Adaptation and Resilience to Climate Change (Mekong ARCC) Synthesis Report,[6] published in March 2013, also identifies Mondulkiri as an area of high vulnerability to climate change.

20. Of the Project areas, the Cardamom Mountains in Koh Kong are predicted to be the least affected[7]. Temperature rises are unlikely to exceed 2°C up to 2050 and the rainy season, already eight to nine months long, may be extended with slightly higher overall rainfall, although with slightly more severe rainfall events. The risk of severe flood events may increase and conserving forest cover in the upper reaches of key watersheds will be the best way to mitigate potential flood risks. Road access, at this time better than in Mondulkiri, could be damaged, and better quality road construction will be important.

21. In coastal regions of Koh Kong, the predictions are for a 60 cm sea level rise by 2100, rising to up to 7m in the century that follows. Clearly the timing of larger investments is crucial but scenarios of another 10 cm or more of sea level rise over the next 20 years do not justify immediate investment in concrete sea dykes except perhaps for Koh Kong city itself (even over longer periods of time it is unlikely that internal rate of return (IRR) calculations on flood control investments will yield 12% outside of major urban centers). In their "Vulnerability and Capacity Assessment of Koh Kong and Kampot Provinces, Cambodia", the International Union for Conservation of Nature (IUCN) report that communities describe how storm surges and high tide events related to a sea level rise of 20cm in the past 30 years are already causing inundation of crop areas by salt water and damage to infrastructure (particularly roads) constructed at the edge of the sea. Local communities identify significant rises in such events over the period since 2000.

22. BCC operates in 22 communes in Koh Kong and Mondulkiri that adjoin protected forests, wildlife sanctuaries or national parks. Tables 1 and 2 below are derived from the assessment of climate change vulnerability in BCC target communes mentioned above[8] and on focus group discussions in communes visited by the project preparation team. It should be noted that if the accelerated pace of forest clearance experienced in the past decade continues then temperature rises are likely to be higher than predicted, rainfall patterns even less predictable than estimated, and severe weather events more likely to occur. Similar concern

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[6] Mekong Adaptation and Resilience to Climate Change (Mekong ARCC) Synthesis Report, sponsored by the USAID/Asia Regional Environment Office, Contract Number: AID-486-C-11-00004, March 2013

[7] The Cardamom Conundrum, Timothy J Killeen, NUS press Singapore, 2012

[8] Katzfey, J., Jiao, X., Suppiah, R., Hoffmann, P., Nguyen, K. C. and Poun, S.(2013) Climate change projections for Mondulkiri and Koh Kong Provinces in Cambodia. CSIRO, Australia.

exists for the loss of mangrove forest in coastal communes. The most vulnerable communes are rated as category 1, the least vulnerable as category 3.

23. In addition to the 10 communes in Koh Kong and 12 communes in Mondulkiri that are being supported by the BCC Project, the project preparation team also did a vulnerability assessment of several other communes in the two provinces, some of which are also highly vulnerable to climate change risks and impacts, such as Koh Kapik, Kandol, and Chi Kha Kraom communes in Koh Kong, and Dong Peng Multiple Use Area, and Ou Buon Leu Commune in the northern part of Mondulkiri Protected Forest. Of all these non BCC-communes, Kandol in Koh Kong ranked the highest in vulnerability to drought/water shortage and saltwater intrusion which are similar to the climate change impacts on the neighbouring BCC Andoung Teuk commune. Because of similar intervention that would be possible for both communes, and the request for support from the communities in Kandol, the project preparation team recommended to include the commune of Kandol in the Additional Financing, making the total number of communes for the whole project 23. This recommendation was later accepted by ADB and the government of Cambodia.

Table 1: Climate Change Vulnerability Analysis of BCC Communes in Mondulkiri Province

Commune	District	Drought	Floods	Sea Inundation & Other	Vulnerability
Romonea	Saen Monourum	Drought for six months all four villages	Road access during wet season is poor (flash floods)	Minor	1
Bus Sra	Pech Chreada	Drought for six months per year	District confirmed no flash flood problems	Minor	1
Pu Chrey	Pech Chreada	Drought for six months per year	District confirmed no flash flood problems	Minor	1
Krang Teh,	Pech Chreada	Drought for six months per year	District confirmed no flash flood problems	Minor	1
Dak Dam	Ou Reang	Drought less severe than in other communes	No flood problems except on cassava (soil erosion from flash flood)	Minor	2
Srae Chhuk	Kaev Seima	Drought less severe than in other communes	No significant flood problems	Minor	2
Srae Khtum	Kaev Seima	Drought for six months per year	Some flash floods but not economically major	Typhoon damage	1
Srae Preah	Kaev Seima	Drought for six months per year	No significant flood problems	Minor	1
Chong Phlah	Kaev Seima	Drought for six months per year	No significant flood problems	Minor	1
Sokh Sant	Kaoh Nheaek	Drought for six months per year	No significant flood problems	Minor	1
Srae Huy	Kaoh Nheaek	Drought for six months per year	River dyke breaks and rice flooded but not economic to repair	Minor	1
Nang Khi Lik	Kaoh Nheaek	Drought for six months per year	Not visited but informed major river overflow in August / September damaging several 100 has of irrigated rice in some years.	Minor	1

Table 2: Climate Change Vulnerability Analysis of BCC Communes in Koh Kong Province

Commune	District	Drought	Floods	Sea Inundation & Other	Vulnerability
Pak Khlang	Mondol Seima	Medium exposure to drought but most houses have piped water	Little flood damage	Sea water intrusion damaging village (200 hh), land, crop and road, storms and heavy rain events	2
Peam Krasaob	Mondol Seima	Annual drought (Dec. to Apr.). Very hot.	Little flood damage	Saline water intrusion (Nov. to Dec.), storm/ heavy rain (June to Aug.)	1
Ta Tai Kraom	Kaoh Kong	Medium exposure to drought.	Heavy rain/ flood, road damage. Little river flooding.	Saltwater intrusion (Dec. to Mar.), large area of paddy abandoned (protected area?). Little storm exposure.	2
Trapeang Rung	Kaoh Kong	Minimal drought problems	Flood affecting a few houses and agriculture but economic loss not major	Minor risk of salt water intrusion	3
Ruessei Chrum	Thma Bang	Minimal drought problems	Little flood damage	Little risk of storm damage	Cardamom forest, low vulnerability, 3
Ta Tay Leu	Thma Bang	Minimal drought problems	Little flood damage	Little risk of storm damage	Cardamom forest, low vulnerability, 3
Chi Phat	Thma Bang	Drought annually (Feb. to Apr.)	Little flood damage	Little risk of storm damage	3
Thma Doun Pov	Thma Bang	Minimal drought problems	Little flood damage	Little risk of storm damage	Cardamom forest, low vulnerability, 3
Andoung Tuek	Botum Sakor	Drought annually (Feb. to Apr.)	Heavy rain/ flood, road damage. Little river flooding.	Saline water intrusion (Nov. to Dec.), storms annually but very bad in 2013.	1
Chi Kha Leu	Srae Ambel	Drought annually (Feb. to Apr.)	Little flood damage	Little risk of storm damage	2
Kandol	Botum Sakor	Drought annually (Feb. to Apr.)	Heavy rain/ flood	Saline water intrusion (Nov. to Dec.)	1

III. PRIORITIZATION

A. Priorities Used to Select PPCR funded interventions

24. The following steps were followed to identify priorities for PPCR financing:

(i) Overall social and economic vulnerability to climate change in Mondulkiri and Koh Kong was identified for the next 20 years. The main vulnerability is primarily agricultural vulnerability to drought, to pest and pathogen population changes, and to sea water inundation in coastal communes; but with additional vulnerability of individual poor households to flash floods in some communes.

(ii) The BCC communes with high vulnerability to climate change were identified (10 out of 12 communes in Mondulkiri and 5 out of 10 in Koh Kong (all coastal), plus one non-BCC commune in Koh Kong, Kandol).

(iii) Community concerns about climate changes and their priorities to develop resilience were identified, and from these priorities initiatives that would require stand-alone projects to develop were discarded.

(iv) At the thematic level, possible initiatives were appraised against six key priorities and only those initiatives were selected for feasibility study that met all the six priorities.

25. Four interventions have been developed for the prioritized initiatives in specific communes (see below). Two of those interventions (rainwater harvesting ponds with climate resilient high value crop productivity, and bioengineered sea barriers reducing salt water intrusion) are considered 'models'. A site for each of these interventions has been identified and full feasibilities study have been developed for them (Supplementary Appendices P and R). It is assumed that these models can be replicated in other communes with minimal adaption and the site-specific criteria have been developed to identify future interventions based on these models. Feasibility studies have also been developed for two interventions of (i) climate resilient irrigation and system of rice intensification techniques (Supplementary Appendix Q), and (ii) ecosystem-based adaptation in two catchments in Mondulkiri (Supplementary Appendix S). However these two interventions while having potential for replication are not to be replicated using PPCR funding. A set of tables showing the outcomes of the prioritization exercise are shown in Appendix 1.

26. Many, if not most, vulnerable BCC communes prioritized road improvement or construction. Particularly in Mondulkiri most roads are poorly constructed laterite roads and access is virtually non-existent during the rainy season. Improved road access would increase access to agricultural markets and have a positive impact on livelihoods. However roads are very much "normal" RGC and ADB business.

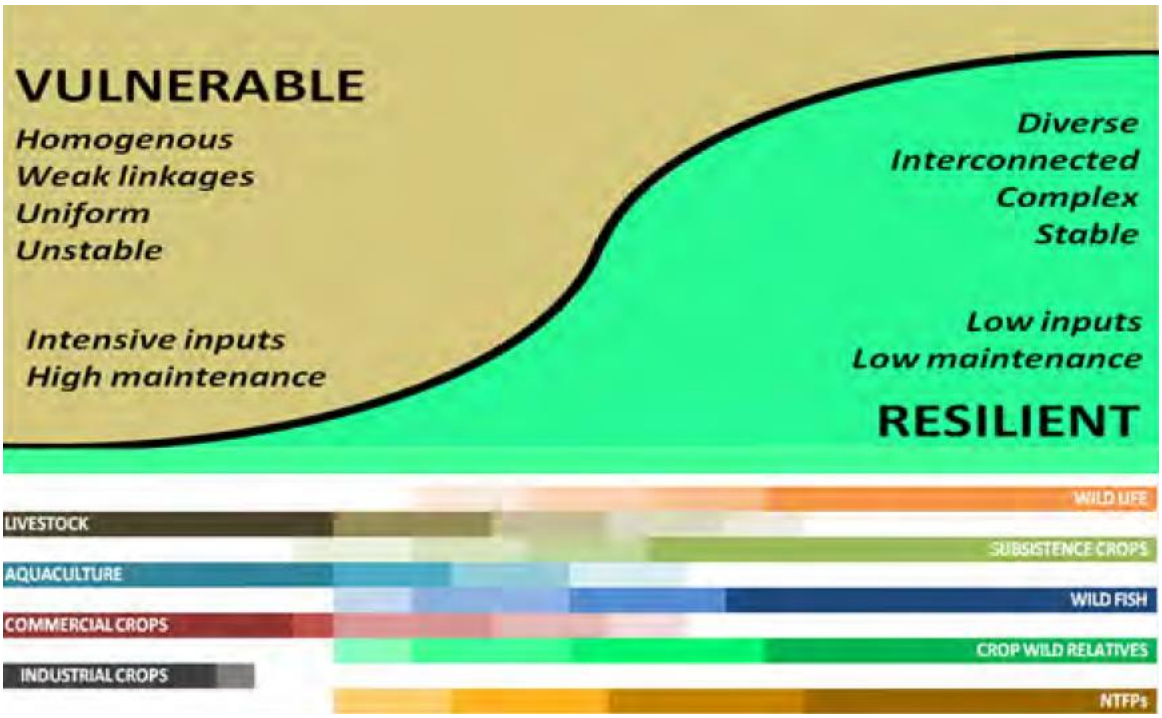
27. Provision of year round water resources is another high priority but many communes lack economically viable water sources, information on groundwater resources is poor (and groundwater is frequently tainted in Cambodia) and viable areas of level land where irrigation schemes can be initiated or rehabilitated at a viable cost are scarce.

28. All communities prioritized support to develop agricultural productivity and to learn agricultural techniques that would confer climate resilience. An approach to sustainability would be to provide support to the extension services, however, especially in remote and upland provinces, RGC extension services have minimal personnel with low capacity. In addition, extension services are trained to promote commercial agriculture and in the context of poor and remote communities, with farmer practice of extensive as opposed to intensive agriculture, and

being under pressure from in-migration as well as climate change, commercial agriculture has high risks.

29. From a systems perspective, the higher vulnerability of commercial farming systems is clear cut. Figure 8 consolidates all of the issues involved. On the right hand side we have subsistence-based agricultural systems and more extensive remaining natural systems; on the left we have commercial-based systems and more extensively modified ecosystems. The most important point illustrated by the continuum is that most lower Mekong basin (LMB) farming systems are a complex mix of natural resource dependency and more intensive and sometimes commercial activities. Each of the farming system components displayed in the diagram tend to have differing prevalence and importance as rural communities shift along the continuum from right to left. Farming systems tend to simplify and intensify as they shift from subsistence to commercial footing. Commercial systems are heavily dependent on a few inputs and highly sensitive to their fluctuations or failures.

Figure 8: Agro-ecological systems and climate change vulnerability continuum



Source: Mekong Adaptation and Resilience to Climate Change: First Draft Synthesis Report, March 2013.

30. It is therefore proposed that the PPCR Project strategy is to work with the NGO sector to provide agricultural support services and community development and aims to build sustainable capacity amongst NGOs with a long term commitment to Cambodia.

IV. ADDITIONALITY OF INTERVENTIONS TO BE FINANCED BY PPCR

A. Rainwater Harvesting Ponds with Climate Resilient High Value Crop Productivity

31. The RGC has addressed drinking water shortages in remote areas through both rainwater harvesting from tin roofs and rainwater harvesting ponds. In the context of drinking water provision ponds have failed because of livestock intrusions, filtration failure and pond

invasion by frogs (considered poisonous in many remote areas of Cambodia). The ponds currently being recommended for construction (largely through community labor) by RGC and by some donors and by most NGOs, are too small to provide secure water supplies during the dry season. The proposed Additional Financing model combines the successful rainwater harvesting approach with a new larger and deeper pond design (rainwater harvesting ponds) that requires a 1.5 ha site to harvest sufficient rainwater to work at design capacity. The increased capacity and specific targeting of 50 households, combined with the BCC intervention which will introduce rainwater harvesting from tin roofs for drinking water, will deliver a more holistic approach to water requirement and thereby address several village level priorities. The model subproject (a single pond unit for 50 households) has been screened for potential negative social and environmental impacts and is considered a viable investment. When the sub-project is replicated, it will be similarly screened under already established BCC project procedures.

32. The model addresses poverty and will develop coping mechanisms to mitigate drought and therefore develop resilience to climate change. The PPCR grant will be applied to construct climate resilient rainwater harvesting ponds for: dry season irrigation, community fish farming, livestock water supplies and supplementary household use. The water supplied will be used to develop small scale horticulture on 300 m^2 plots near to residences and farm households will be trained to improve the efficiency of irrigation water utilization. As a consequence resilience to climate change will be enhanced, specifically to the increased risk of long term drought. The overall model seeks to (i) promote irrigation techniques that conserve water, including drip irrigation, raised beds, black plastic mulching and compost techniques, (ii) develop intensive plots near to households and also communal fish ponds so that they meet family nutritional objectives and contribute small cash incomes, and (iii) provide supplementary water supplies for livestock to increase survival rates during long periods of drought.

1. Water Requirement

33. The major elements of additionality for the proposed design of rainwater harvesting tanks are:

(i) detailed water calculations so as to provide sufficient water throughout the dry season rather than just supplementary water during the wet season.
(ii) design of a separate off-take pond for cattle combined with strong fencing to reduce damage to the main pond,
(iii) use of gravity towers to deliver water closer to home gardens to reduce labor.

34. Assuming each household will have 300 m^2 for home gardening.

(i) Based on the crop water requirement, 2.5 l/day/m^2 is required.
(ii) Total Area for 50 households = 300*50 = 15,000 square meter = 1.5 ha
(iii) Total water requirement for home gardening per day = 15,000*2.5 = 37,500 l
(iv) Assume irrigation for home garden will be required for a full 6 months dry season supply, starting from November to April.
(v) The total water requirement for 6 months = 37,500*6*30 = 6,750,000litres = 6,750.0 m^3

35. This amount of water will be lifted manually to the overhead tank as indicated in drawings (see Appendix 5 of Subproject Feasibility Study – Rainwater Harvesting Ponds with Climate Resilient High Value Crop Productivity) and supplied to five sub-tanks near the village and finally to home gardens by gravity through pipes.

36. In order to minimize losses, drip irrigation technology will be promoted. Three drip irrigation kits will be provided to one sub-project (one unit of rainwater harvesting pond) by the Additional Financing. These are the demonstration kits. With the operation of these, the remaining farmers will be encouraged to buy the drip kits themselves and use it in future. The remaining farmers will irrigate their fields through flood irrigation methods using pipes fitted with regulators.

37. Water Requirement for Cattle
- (i) Assume total population of cattle for 50 households = 250
- (ii) Assume about 50% of cattle population will require water from Pond
- (iii) Total water requirement for cattle per day = 250* 40*0.5 =5,000 l/day
- (iv) Total water requirement for cattle for 6 months = 5,000*5*30 = 75,000 liters = 900,000 liters = 900 m^3

38. Total Water Requirement
- (i) Total water requirement for irrigation + cattle = 900+6,750 = 7,650 m^3
- (ii) Losses on evaporation + infiltration is adopted as 50% in 6 months.
- (iii) The quantity of loss = 7,650.0* 0.5 = 3,825 m^3.
- (iv) Total design capacity of the rainwater harvesting tank =7,650+ 3,850 =11,475.00 m3 say 12, 000 m^3.

2. Tank / Pond Sizes Currently Being Promoted in Cambodia

39. The following recommendations were extracted from a UN document in Cambodia without citation, but are typical of recommendations normally made.

Table 5: Approximate Garden Size And Costs For Ponds

Length m	Width m	Depth M	Volume m^3	Water Available m^3	Area of Garden[9] m^2	Example	Approx. Cost[10]
10	5	2	50.67	25.33	35	7m x 5m	$ 100.00
20	10	3	366.00	183.00	244	12m x 12m	$ 500.00
50	25	4	3,885.33	1,942.67	2,500	25m x 100m	$ 3,000.00

40. A pond costing about $100 to excavate will provide enough water for a small vegetable garden for household consumption. A large pond costing $3,000 will provide enough water for a commercial vegetable garden of 0.15 ha, or for very small household gardens for about 50 families.

41. The rainwater harvesting pond size recommended for the Additional Financing of 12,000 m^3 is similar to those recommended by one or two NGOs operating in Cambodia such as GRET[11]. By the time water delivery structures, adequate fencing, and a supplementary pond to provide water for livestock have been added the cost is calculated at US$46,000, US$920 per household. The investment is viable and, especially when combined with drinking water supply

[11] Groupe de Recherche et d'Echanges Technologiques

will provide a much more secure source of climate resilience against drought. Given that the major source of labor for home gardens is expected to come from female householders, release from dry-season potable water collection through the BCC initiatives is an important complementarity as a combined model, with the additionality from PPCR Project combined with the BCC water supply investments ensuring adequate holistic household water supplies to provide a climate resilient model applicable to BCC communes that are extremely vulnerable to drought. The model can only be introduced in villages that a) have sufficient flat land to make available for the rainwater harvesting tank(s), and b) where houses are organized in a configuration that allows effective water delivery.

B. Climate Resilient Irrigation and System of Rice Intensification (SRI) techniques

42. The recent changes in cropping patterns in Cambodia with increased focus on the early wet season rice crop compared to the late wet and upland crops is evidence of farmers' response to climate change and their attempts to minimize risk. In 2010, the early wet season crop increased by 29,000 ha over the equivalent 2008/09 crop and the normal wet season crop was over 90,000 ha larger than the previous year whilst the late wet season crop actually declined by over 32,000 ha between the two years. This trend has continued in subsequent years with the improved availability of short maturation rice varieties (seed is mainly from Viet Nam). The area planted to upland rice crops is also decreasing progressively. In 2010-2011, the dry season cropped area reached just over 400,000 ha with a higher yielding crop averaging 4.2 t/ha in that year. The area of the irrigated crop is limited by water availability and farmer's access to irrigated land. The run-down condition of much of the irrigation systems constructed before the 1979 civil war provides an opportunity to dramatically impact total production through scheme rehabilitation and by adopting improved production technologies on rehabilitated schemes.

43. The above changes to rice production patterns in Cambodia have not yet reached Mondulkiri, where population density is the lowest in the country and rice production of lesser importance. In addition, much of the irrigation infrastructure in Mondulkiri was poorly constructed during the Pol Pot era. Rehabilitating such irrigation schemes is expensive because they are small and poorly designed, because access is poor and limited to the dry season, and because all materials need to be transported over large distances. It is proposed that PPCR funds are used to rehabilitate one such scheme to provide a model of climate resilient infrastructure in the district.

44. SRI rice production techniques combined with varietal improvement are recognized as the most effective way to improve climate resilience in irrigated rice production and these technologies have not yet been introduced in Mondulkiri. Koh Knaek district in Mondulkiri is the major paddy rice producing area of the province, with nearly 3,500 farm households producing irrigated rice. This intervention comprises a single discrete subproject investment that contributes to developing climate resilience. The investment has been studied for feasibility and screened for potential negative social and environmental impacts and it is considered a viable investment. Subproject investments comprise a significant civil works portion with incremental associated soft initiatives to enhance the impact of the civil works. Farmers on the site will be trained in SRI techniques for two seasons and will then be paid to train farmers on other sites in Koh Knaek. A small group of farmers will be supported by BCC to establish a seed production cooperative and will be supported with training and equipment (to which they will contribute part of the cost). The seed production cooperative will primarily supply other farmers on the PPCR Project site but will be expanded if demand from elsewhere in the province justifies expansion.

45. Intervention 2 will establish a model production area in Koh Knaek to: (i) introduce climate resilient approaches to irrigated rice production to farmers and provincial authorities in Mondulkiri province, (ii) improve rice productivity in Kaoh Kneaek district, and (iii) introduce low input pest and disease management techniques to prepare farmers for the anticipated changes in pathogen populations, (iv) introduce sustainable supplies of improved rice seed from appropriate varieties for the changing climate conditions. It is planned to link the intervention with the ADB / PPCR supported Rice-SDP which will encourage more widely replicable work on the introduction of climate resilient varieties. Associated activities will also address the threat of climate change with initiatives designed to build the capacity of the sector to accommodate such changes.

46. The resilience of irrigation infrastructure will be enhanced by improved design approaches and construction supervision. The design process will draw on lessons learned by Rice SDP, which is due to start implementation at least 12 months ahead of PPCR Project. Design approaches will incorporate capacity building into the development of design criteria, based on site characteristics and consideration of increased frequency of intense precipitation, increased severity and occurrence of flooding events and prolonged periods of drought. Specific engineering measures to take into account include (i) adequate provision for interceptor drains and culverts for cross drainage, (ii) larger spillways to cope with more rapid flows of flood water, (iii) design of canal cross sections to substantially exceed full supply level, (iv) specification of non-dispersing soils for embankment construction, (vi) inclusion of geo-nets for embankment strengthening where warranted, and (vii) provision of surface protection, such as stone pitching or small concrete flow control details to protect structures from scour as flood waters recede. Initiatives will also include support for water user groups (WUGs) in understanding the need for efficient water utilization through water scheduling and improved maintenance regimes.

47. To render the scheme more tolerant of climate change, detailed designs have been scrutinized by the relevant technical agencies at province level to incorporate higher design standards to accommodate the impact from climate change. For example, reservoir walls have been designed for a 1:50 year flood compared to the existing design frequency of say a 1:20 year event.

48. Seed quality is the basis for improved productivity within the commercial rice producing sub-sector. The tradition of retaining seed from the previous crop leads to a progressive reduction in potential yields as the genetic content of seed material diminishes. As a risk minimization strategy, farmers use the ‘free’ seed from their previous season’s crop as they do not want to risk losing expensive new seed material in the event of a flood or drought. Whilst Rice-SDP is not developing flood tolerant varieties, it will develop a mechanism to ensure seed quality through a certification system for foundation, certified and commercial seed producers, resulting in a more resilient crop. It will also promote incremental production of foundation seed of preferred market varieties as well as certified seed to be grown on experimental research stations or by commercial seed producers. Under the Additional Financing, the forest border rice subproject will be the means for multiplying this seed into quality commercial seed based on the certification system introduced. Only with the use of quality seed will the subsector be in a position to maximize productivity in a relatively insecure climate environment. The Additional Financing will work with Rice-SDP to obtain appropriate varieties for both rainfed and irrigated production in Mondulkiri.

1. SRI Rice Production Demonstrations and Field School Training

49. A major recent study by USAID (The Mekong ARCC study[12]) distills climate change adaptation in agriculture in the Lower Mekong Basin into five strategies that aim to improve the resilience of small-scale producers in subsistence and industrial crops. The main orientations are:

(i) "Strengthening resilience in rainfed and irrigated rice-based systems with improved varieties, better management practices, and protective measures against extreme events. This includes the use of varieties that are early maturing to avoid flooding, that are flood tolerant, or that are drought resistant in drought prone areas. The positive lessons from application of the "System of Rice Intensification" (SRI) techniques should be built into the cropping system.
(ii) Improving water efficiency and water management techniques (water harvesting, small–scale irrigation, etc.) in drought prone areas in order to alleviate rain shortages that cause crop failure.
(iii) Improving soil fertility and soil management of both cash and subsistence systems in plains, plateaus and uplands.
(iv) Promoting agriculture techniques that reduce greenhouse gas (GhG) emissions.
(v) Promoting agriculture diversification to reduce reliance on monoculture".

50. SRI Rice production methods, combined with varietal improvements will be introduced in this intervention. This element of the proposal is linked to irrigation rehabilitation, is not included in the design of BCC Project and is additional to BCC efforts and will add climate resilience to several BCC communes.

2. Knowledge Products

51. Another area of relevance being developed under Rice-SDP to address the impact of climate change comes with technical information generation and development of knowledge products, six of which have already been prepared on various aspects of rice production. It is proposed to review these technical bulletins and update their content to improve farmers' ability to respond to climate change in Mondulkiri and Koh Kong. The choice of crops, the varieties grown, water management in paddies, preparation of seed beds and the application of agro-chemicals are areas where technical recommendations will be upgraded to accommodate potential climate change impacts.

C. Bioengineered Sea Barriers Reducing Salt Intrusion and Coastal Climate Change Adaptation

52. Coastal communities in Koh Kong are suffering from dry season salt water inundation caused by the high tidal events that occur around the Gulf of Siam from November to February. These high tides are not initiated by storms. Wind patterns force water into the Gulf of Thailand and cause the sea level to rise above normal levels in the months of November to February and the sea at high tide just moves across low lying crop production areas along the Koh Kong coast. Sea level is rising due to climate change and will continue to rise and since 2000 local communities have observed that salt water inundation during the dry season has become more

[12] Mekong Adaptation and Resilience to Climate Change (Mekong ARCC) Synthesis Report, Sponsoring USAID Office: USAID/Asia Regional Environment Office, Contract Number: AID-486-C-11-00004, Contractor: DAI, Date of Publication: March 2013

frequent and extends over larger areas of crop land. In addition, destruction of mangrove forests and an increase in storm events has reduced fishery incomes for coastal communities and increased dependence on rice (and to a lesser extent other crop) production. Initiatives under this intervention include (i) construction of protective bioengineered sea barriers, first of about 5km in Andoung Teuk commune, to be extended to a further 10km in Kandol commune (with self-closing culverts to allow fresh water egress but to prevent sea water entering cropping areas) to protect cropping areas from salt water inundation, and (ii) introduction of saline resilient crops to improve livelihoods and introduce more climate resilient farming techniques. Significant sea level rise and land losses are not expected until near the end of the century and provincial planning needs to accommodate the expected changes. The Coastal Adaption and Resilience Planning Component (CARP) project is developing a Provincial Climate Change Management Committee and the initiatives under this intervention will be coordinated with this committee.

53. The resilience of locally constructed sea barriers will be enhanced by improved design approaches and construction supervision. Local sea barriers are reasonably effective because they are easy to maintain but they are constructed from local soil, which is full of organic matter and subsides unevenly, allowing sea water to cross the barrier in some locations. Gaps in the barriers remain where streams need egress to the sea. When high tide events occur, salt water passes through these gaps and thus the barriers provide partial protection at best. The sea barriers will be constructed with clay and the sea facing sides planted with local mangrove species to stabilize slopes. The design height of proposed sea barriers is greater than traditional sea barriers to accommodate expected sea level rises. The sea barriers will include culverts with self-closing rubber flaps that can remain open throughout most of the year, allowing streams to reach the sea and not interfering with rice land drainage but which will close once the rising sea reaches a set level when tidal events occur during the dry season.

1. Seasonal Tidal changes

54. In the wet (summer) season, strong SW monsoon winds over the region move water in the South China Sea towards the north-eastern end of the sea and produce currents which drag water out of the gulf of Thailand lowering the sea level. As a result of the NE dry (winter) monsoon winds, water levels in the south-western corner of the South China Sea are increased and this increased water level spills into the Gulf increasing sea levels. The average monthly tide height for Ko Sichang in Chon Buri province in Thailand shown in Figure 1 supports the observations of the community leaders that tidal heights are at the highest levels from November to February. The average Sea Level is 450 mm lower in June than it is in February and this phenomenon is also evident in other ports around the Gulf of Thailand[13]. District and community officials have stated that tides are higher in the dry season resulting in saline intrusion into rice fields during the harvest period.

[13] Permanent Service for Mean Sea Level (PSMSL); http://www.psmsl.org/.

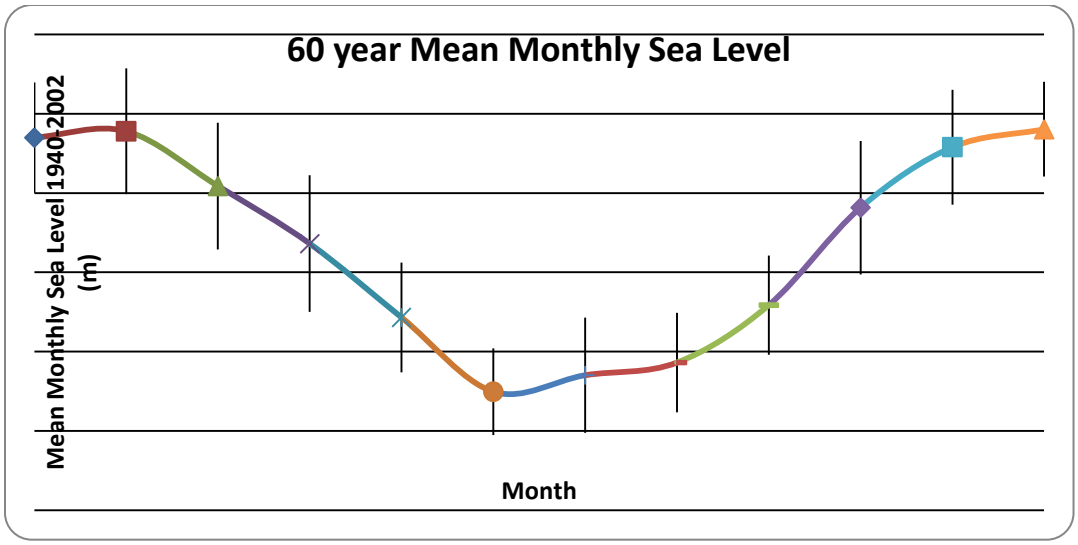


Figure 1. Monthly Sea Level averaged over the 60 year period from 1940 to 2002 for Ko Sichang, Chon Buri, Thailand. Error bars show the standard deviation.

2. Sea level rise

55. Historical sea level data for Cambodia is difficult to access and the nearest available source of long term sea level data from tidal gauges is Ko Lak, Prachuap Khiri Khan, Thailand, 350 km on the other side of the Gulf of Thailand. The average yearly sea level from the tidal gauge at Ko Lak in Figure 2 shows that sea level has displayed a rise in the order of 150 mm since 2002. This trend of recent rises has been seen in all of the other ports around the Gulf of Thailand[14].

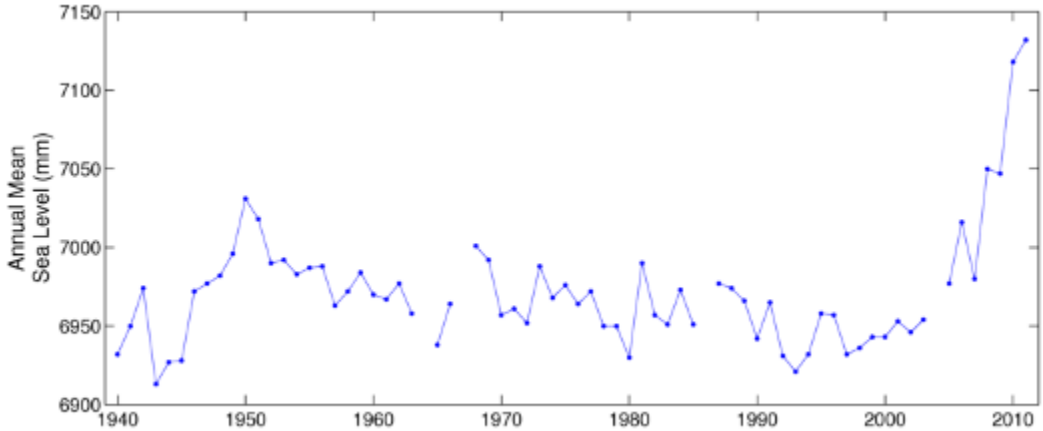


Figure 2. Annual Mean Sea Level in millimeters above the Thailand National Datum at Ko Lak Tidal Station Prachuap Khiri Khan, Thailand from 1941 to 2010 (from www.psmsl.org 2013)

56. The preliminary sea level rise projection curve for Nha Be, Viet Nam indicates that by

[14] Trisirisatayawonga, I., Naeijeb, M., Simonsb, W. and Fenoglio-Marcc, L., (2011). Sea level change in the Gulf of Thailand from GPS-corrected tide gauge data and multi-satellite altimetry. Global and Planetary Change 76, 137–151.

2050 sea level is projected to increase by a maximum of 300 mm in the RCP 8.5 Scenario. The new, high-resolution projections of future climate (Supplementary Appendix M: Climate Change Impact Modeling and Vulnerability Assessment) indicate that local sea level at Koh Kong is projected to increase by approximately 10 cm above the 1986-2005 baseline by 2025. Sea-level rise is likely to be more important in winter (the time of highest annual sea level), and storm surges may also be affected.

3. Modified Dyke Construction

57. The construction of mud / laterite dykes is regularly carried out throughout the region and tradition, trial and error, funding restrictions and lack of alternative materials has led to the development of a standard dyke design. The current polder design as used in Kandol commune has been successfully operating and maintained for 15 years. There does not appear to be a national standard for the design of this type of bioengineering sea barriers. There are some potential problems with the local method of using onsite materials for dyke construction. If soil material for the dyke construction is excavated off the foreshore, the trench that is created along the entire length of the seaward dyke represents a vulnerable area for erosion which can develop turbulences within the trench, due to outgoing waves. The turbulences will gradually destroy the slopes and create more erosion channels in the sediment of the foreshore and once this has happened, the erosion channels will expand. Additionally the soil material used to create the dyke is a mix of organic material and clay. The nature of the excavated material and the haphazard placement by the excavator results in an inhomogeneous structure that has weak points where organic material has decomposed or where compaction was not sufficient.

58. The use of clay imported from local quarries will result in a much more homogeneous and stable structure. Additionally, the sides of the dyke can be steeper, reducing both the footprint of the dyke and the amount of material required. In the case of the existing sea dyke in Ta Meakh that will be rehabilitated, the seaward side is exposed to minor erosion during the dry season when winds blow from the north-east. This also coincides with the times of extra high tides. It would be prudent to use some form of protection from these waves to protect the softer clay and laterite materials of the dyke.

59. The Provincial Authority has plans (but no budget) to build a sea dyke in Ta Meakh at a cost of $8,000 per km. However this cost only covers using the local method and includes neither the cost of modifications to increase climate resilience nor the construction of culverts and planting. The proposed bioengineering will significantly improve the effectiveness of the structure and reduce the maintenance costs. In the subproject the existing dyke will be increased in height, repaired where necessary and rolled prior to improvement works. In addition:

(i) New material for the dyke will be sourced from local quarries.
(ii) After the height is increased, the dyke will be re-rolled prior to topping with laterite
(iii) The laterite topping will be rolled after application.
(iv) The seaward side of the dyke will be planted with Lumnitzera plants that have been raised in a nursery.

60. For the construction of the new sea dykes in Ta Meakh and Ta Ok villages in Andoung Tuek commune:

(i) The line of the dykes will be completely cleared of vegetation and made level and rolled prior to construction.
(ii) The dykes will be constructed from clay transported from nearby quarries.

(iii) Any onsite material used for the dykes will be excavated from the landward side and NOT from the sea ward side. This applies to the entire length of both dykes.
(iv) The 12 month settling period is continued
(v) After the 12 month settling the dyke will be filled where necessary and re rolled prior to topping with laterite
(vi) The laterite topping will be rolled after application.
(vii) The seaward side of the dyke will be planted with *Lumnitzera racemosa* plants that have been raised in a nursery at a spacing of 1 plant per 0.5 meters

61. The highest projections for sea level rise may be up to 15 mm per year in the near future so dyke design will need to allow for a sea level rise of 150 mm in the next 10 years and for a rise of 300 mm by 2030. As the wave regime in the target area is constrained by the geography and geomorphology, there is little likelihood that wave activity will increase to any significant extent. Therefore climate resilience can be achieved by ensuring that dykes are constructed to allow for the upper limit of the possible sea level rise. Given that overtopping of the existing shorefront only occurs in the period when tides are at their peak (during the top 100mm of the average seasonal range), the dykes would need to be constructed at least 450 mm above the existing shoreline or ground level. This is more than adequately covered by the proposed design.

62.

D. Ecosystem-based adaptation in two catchments in Mondulkiri

63. Rural communities living in and near protected areas and protected forests in Mondulkiri are the most vulnerable to climate change. This is because of their dependence on ecosystem services and a lack of alternative, climate-resilient livelihoods. As a result of changes in rainfall and consequent decreasing agricultural productivity, these communities are increasingly reliant on forest ecosystems to provide supplementary food sources and income from forest products. Widespread degradation of forest ecosystems, however, is reducing the efficacy of this adaptation response. Building on the BCC project activities in establishing and managing community forests (CFs) and community protected areas (CPAs), the PPCR grant will take a catchment approach to build resilience of the communities living in CFs and CPAs to climate change. This approach seeks to sustain agricultural/food production, conserve biodiversity and ecosystems and support local livelihoods, to be implemented in at least two catchments.

64. Catchments will be selected where participating communities in the BCC project are managing their CFs or CPAs. In this intervention, the PPCR grant will support activities for the communities to include criteria for climate resilience to screen and prioritize their activities in water management, agriculture, forestry, and climate-resilient livelihood options. This intervention will seek to achieve coordinated planning and management of catchment resources through a catchment governance committee where decisions can be taken across a range of sectors in the catchment and existing sector managers can be involved in the catchment decisions.

65. The proposed intervention will test systems that improve climate resilience of communities from managing natural resources within a wider catchment framework. Major outputs include: (i) Criteria to select a catchment; (ii) Guidelines and rules for a catchment governance committee based on review of experience in Cambodia and other countries; (iii) Catchment governance committees established and operational in the selected catchments in the intervention; (iv) Forest management plans for CFs/CPAs adjusted to include activities to

improve climate resilience of the forest ecosystems such as habitat restoration and conservation and sustainable use of forest resources; (v) Plans for activities and investments in the catchment that will improve climate resilience including catchment risk mapping and monitoring, flood proofing, and forest-based livelihoods or alternative climate resilient livelihoods such as intensifying/diversifying existing agricultural areas and introducing conservation agriculture practices; (vi) Evaluation of the effectiveness of selected activities and investments for improving climate resilience; and (vii) A case study describing the learning from the intervention and the key issues to be addressed if a catchment landscape approach is to be adopted more widely in Cambodia forest and biodiversity management. While the size of the catchment and the exact number of households to benefit from the intervention are unknown before all the catchments are identified, given the population in Mondulkiri, it is estimated that at least 900 households will benefit from this pilot.

66. A possible catchment for inclusion in this intervention is in Srea Preah commune, O Por catchment in Mondulkiri. An opportunity arises to further enhance the resilience of the ecosystems and the communities in Srea Preah where the Seima Protection Forest and its surroundings are located, due to the long engagement by ADB in the first phase of the Biodiversity Conservation Corridors Initiative (2006-2010), and followed up activities supported by the ongoing BCC Project. A strong presence of an international conservation organization, Wildlife Conservation Society, in the area has been helpful in promoting a community and ecosystem based approach towards climate change resilience. Activities are proposed to be in an area of approximately 9,000ha in the buffer zone15 of the Seima Protection Forest in Srae Preah commune. This intervention aims to conserve forests, and forest products and ecosystem services including protection of the watershed, protection against landslides, erosion and land degradation, and provision of habitats of aquatic and terestrial animals to buffer the impacts of climate change on water users and provide safety nets for local communities when agricultural crops fail. Srae Preah commune in Mondulkiri province is extremely vulnerable to the expected increases in prolonged drought, number of hot days and heat waves, enhanced evaporation and the resulting increase in pest and pathogen populations. Market access is difficult, alternative water sources for agriculture are largely unavailable and alternative sources of livelihood difficult to develop. The most effective way to improve climate resilience of the communities is to preserve forest and diversify incomes based on forest resources.

67. This Seima Protection Forest buffer zone is within a suspended logging concession in Mondulkiri and Kratie provinces. The threats to forests in the buffer zone are alarming. In the past 3 years, a significant portion of the buffer zone has already been converted to economic land concessions for rubber, and the area delineated under this intervention is now the most important remaining portion of the buffer zone. By being empowered to manage the forest, the community will be enabled to resist external pressures to convert forest land[16]. Experience elsewhere[17] shows that, once communities get engaged and see real benefits from forest

[15] This buffer zone is peripheral to the Seima protected forest. It is is equivalent to category VI of the IUCN, which is defined as 'areas that conserve ecosystems and habitats, together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.

[16] Payments for biodiversity conservation in the context of weak institutions: Comparison of three programs from Cambodia, Tom Clements, Ashish John, Karen Nielsen, Dara An, Setha Tan, E.J. Milner-Gulland, Ecological Economics 69 (2010) 1283–1291;

[17] Mexico's Community-Managed Forests as a Global Model for Sustainable Landscapes, David Barton Bray, Leticia Merino-Pérez, Patricia Negreros-Castillo, Gerardo Segura-Warnholtz, Juan Manuel Torres-Rojo, and Henricus F. M. Vester, Department of Environmental Studies, Florida International University, Miami, FL 33185, U.S.A., ; Forest

management in an appropriate institutional framework, local people can resist deforestation better than in those areas that rely solely on policing.

68. The PPCR grant will support the communities in Pu Cha, Ou Chra and Pu Kong villages in Srea Preah commune to develop and implement the forest management plans, which is the basis for the establishment of the community forests in Cambodia. Activities under the forest management plans will be identified by the communities, and can include, among others: (i) demarcation of forest areas; (ii) community-based forest protection and conservation such as patrolling; (iii) forest restoration and/or assisted natural regeneration; (iv) forest inventory; and (v) support to livelihoods improvement through sustainable use of forest resources. The forest is to be managed by two layers of community-based organizations: (a) at the village level, forest management groups have been established in the above mentioned villages with support from the BCC project and WCS and will continue to prepare and implement the forest management plans; and (b) at the commune-level, a broader organization is planned, including representatives of all the forest management groups, as well as other important local stakeholders, to be established as a Community Forest Enterprise. Both of these organizations are to be represented in the catchment governance committee. Sustainability of this intervention will be ensured by: (i) collaborating with communities, fostered by the consultative and participatory approach under the PPCR grant; (ii) training of local communities on climate change adaptation responses; (iii) establishing multi and sustainable use of forests that will incentivize protection of the forests because of the value of the productive landscape; (iv) drawing lessons and recommending revisions to policy and legislation on community forests especially on sustainable use and tenure; and (v) training communities on business plan development to ensure that alternative livelihoods are successfully implemented through support to the community forest enterprise. This intervention will complement activities planned in a proposed ADB/GEF project in the upper Prek Thnot watershed of Cambodia, which aims to improve on-farm soil and water management practices and promote forest ecosystem restoration in a community forest in the province of Phnum Sruoch[18]. See Supplementary Appendix S to the Board Paper for details.

V. PUBLIC PRIVATE PARTNERSHIPS AND PRIVATE SECTOR PARTICIPATION[19]

69. The Additional Financing will promote public private partnerships and private sector / civil society participation in three areas, including (i) cooperation with the NGO sector on community development and training;; and (ii) development of CFE.

(i) Cooperation with the NGO sector on community development and training: The PPCR project will work with the NGO sector to provide agricultural support services and community development, and aims to build sustainable capacity amongst NGOs with a long-term commitment to Cambodia. NGOs will be invited to bid to support activities under the interventions, and if successful, will be engaged as implementation contractors.

(ii) Development of a community forest enterprise. Development of a community forest enterprise. To strengthen the management of the forest in the buffer zone by the Seima protection forest, a community forest enterprise or cooperative will be established to empower the communities in forest management through

concessions in the Maya Biosphere Reserve, Guatemala: A decade later, Jeremy Radachowsky, Victor H. Ramos, Roan McNab, Erick H. Baur, Nikolay Kazakov, Forest Ecology and Management 268 (2012) 18–28

[18] Collaborative Management for Watershed Ecosystem Service Protection and Rehabilitation in the Cardamom Mountains, Upper Prek Thnot River Basin

[19] Referred to in the Cambodia's SPCR as "Business-Focused Adaptation" features.

protection and sustainable use of forest resources. This organization is planned at commune-level and includes representatives of all the Forest Management Groups, as well as other important local stakeholders. Its primary roles will be to hold the management rights to the forest area, develop and execute forest management plans including protection and restoration activities, ensure sustainable use of forest resources, market and sell forest products, and share benefits amongst the communities. A contract will be competitively awarded to undertake the work and provide the Forest Stewardship Council certification program.

OUTCOMES OF THE PRIORITIZATION EXERCISE

A. Community Identified Vulnerability and Priorities

1. Results from the Community Vulnerability / Coping Mechanism and Adaptive Capacity Assessment[20] in BCC communes are summarized in the following tables:

Figure A1: Methodology

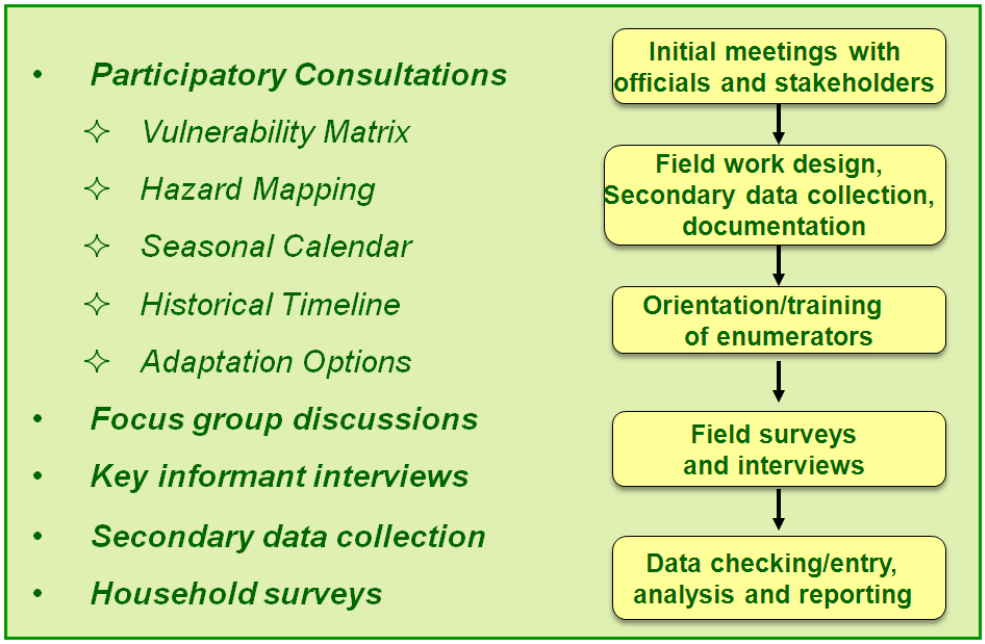


Table A1: Climate Change Vulnerability Matrix for Selected Communes in Koh Kong

No.	Commune	Climatic Risks (Exposure)	Affecting Systems (Sensitivity)	Adaptive Capacity (Existing measures)	Adaptation priorities
1	**Andoung Tuek**	**Seawater intrusion** November-December, annually) (high exposure)	**Agriculture** - destruction of paddy rice up to 100% - soil salinity/ reduced fertility (up to 40% of land flooded) - paddy dyke erosion (high sensitivity)	- existing dykes in Chimeal and Tameak village (insufficient) - salinity tolerant crop varieties	- sea dykes and land dykes - water drainage - canal irrigation system (high priority)
			Water supply - freshwater shortage (in Ta Meakh and Ta Ok villages) (high sensitivity)	- buy water - travel far to other villages/sources - water saving	- dig wells - technical assistance on water management - water storage (high priority)

[20] Katzfey, J., Jiao, X., Suppiah, R., Hoffmann, P., Nguyen, K. C. and Poun, S.(2013) Climate change projections for Mondulkiri and Koh Kong Provinces in Cambodia. CSIRO, Australia.

No.	Commune	Climatic Risks (Exposure)	Affecting Systems (Sensitivity)	Adaptive Capacity (Existing measures)	Adaptation priorities
		Drought - Dry spells during rainy season June-October (medium exposure) - Very dry and high temperatures mid-April – May, annually (high exposure)	**Agriculture** - crop failure/ productivity loss (high sensitivity)	- change crop variety	- build reservoir - technical assistance on agricultural practice (high priority)
			Health - diseases (diarrhea) /sickness (medium sensitivity)	- existing health center (limited capacity)	- improve health care capacity and facilities
			Water supply - water shortage for domestic use (high sensitivity)	- buy water - travel far to other villages/source - water saving	- dig wells - technical assistance on water management - water storage (high priority)
		Storm/ heavy rain June-September annually, very seriously in 2013 (medium exposure)	**Fishery** - loss of fishing days (high sensitivity)	- find other alternative livelihood sources	
			Housing - damage to houses & assets (low sensitivity)	- repair houses - assistance from Red Cross	- mangrove and forest restoration (high priority)
			Infrastructure - damage to dykes, roads, bridges, channels (medium sensitivity)	- repair roads	- infrastructure upgrade and maintenance - improve drainage system
			Human life - accidents during storm events (low sensitivity)	- radio communication for information and rescue	- early warning system and awareness raising
2	**Peam Krasaob**	**Drought** - Very dry and High temperature mid-April – May, annually	**Water supply** - domestic water shortage (esp. potable water) - *associated with seawater intrusion* (high sensitivity)	- buying water (60% of HH) - existing water supply system (bad water quality) - rain water harvesting and storage	- water supply from Koh Kong City water distribution system - water harvesting and storage facilities (high priority)

No.	Commune	Climatic Risks (Exposure)	Affecting Systems (Sensitivity)	Adaptive Capacity (Existing measures)	Adaptation priorities
		(high exposure) - Dry spells during rainy season June-October (medium exposure)	**Agriculture** - vegetables/plantations die - livestock diseases/death (medium sensitivity)		- technical support on livestock raising
			Health - Diseases (low sensitivity)	- go to health center - drink boiled water	
		Saltwater intrusion and high tide November-December, annually (high exposure)	**Agriculture** - damage to crop production (incl. fruit trees and vegetable gardens) - soil salinity (high sensitivity) - loss of livestock (medium sensitivity)	- old land dyke (low capacity, could not prevent intrusion entirely, and prone to erosion - keep livestock in higher cages	- repair and upgrade the dyke - technical assistance on agricultural production and climate-resilient crops (high priority) - technical assistance on livestock protection and disease prevention
			Fishery **-** affects sea crab fishing (high sensitivity)	- find alternative income sources	
			Infrastructure - road and dyke erosion (medium sensitivity)	- road maintenance	- repair and upgrade the dyke/road
		Storm/ heavy rain June-August (high exposure)	**Fishery** - loss of fishing days (high sensitivity) - loss of fishing gear - affects aquaculture (medium sensitivity)	- find alternative income sources (rather difficult)- - face food shortage, have to borrow food/money - mangrove restoration	- mangrove restoration - technical assistance on aquaculture (snail, fish raising) (high priority)
			Infrastructure and housing/assets - damage to houses/boats - damage to roads/dykes (low sensitivity)	- build climate-resistant housing (e.g. lower structures)	- early warning system/information sharing - improve water drainage system

No.	Commune	Climatic Risks (Exposure)	Affecting Systems (Sensitivity)	Adaptive Capacity (Existing measures)	Adaptation priorities
		Storm surge June–September old villages on the island (high exposure)	**Coastal erosion** - mangrove destruction - loss of land/ erosion (high sensitivity)	- relocation of villagers to mainland (some households remain living on the island and many households sold newly allocated land on the mainland)	- coastal area protection and mangrove restoration in the coastal area (high priority)
3	**Ta Tai Kroam**	**Heavy rain/ flash flooding** July–August, annually (high exposure) **River flooding** (Very low exposure)	**Infrastructure/housing** - damage to roads/ bridges/ drainage systems/ channels - flooded houses/assets (high sensitivity)	- repair roads and maintenance - improve drainage system	- upgrade and build new roads and bridges - improve drainage system (high priority)
			Agriculture - destruction of paddies and other crops - pests/insects - loss of livestock (high sensitivity)		- build channel to divert/discharge flooding water - technical assistance on crop production and livestock raising and disease prevention (high priority)
		Saltwater intrusion December–March, annually) 15 days per month (high exposure)	**Agriculture** - damage to paddy fields (saltwater intrusion covers a large area of abandoned paddy rice since it is located in the protected area) (medium sensitivity)	- harvest before saltwater intrusion *few households remain practicing paddy rice cultivation on their land (18 HH)*	- build land dyke
		Drought <u>- Very dry and high temperatures</u> mid-April –	**Water supply** - domestic water shortage (esp. potable water)- <u>*associated with seawater intrusion*</u> (high sensitivity)	- existing water well (not so good quality)	- more water wells (high priority)

No.	Commune	Climatic Risks (Exposure)	Affecting Systems (Sensitivity)	Adaptive Capacity (Existing measures)	Adaptation priorities
		May, annually - Dry spells during rainy season June-October (medium exposure)	**Agriculture** - affects crop production(i.e. cash crops, fruit trees) - affects livestock raising, lack of water, animals get diseases/deaths (low sensitivity)		- technical assistance on livestock raising (high priority) - technical assistance on agricultural production (esp. on seed variety) (high priority)
			Health - disease/sickness (medium sensitivity)		
		Storms June-August (low to medium exposure)	**Housing** - damage to houses (low sensitivity)	- repair housing - local knowledge for weather prediction	

Table A2: Climate Change Vulnerability Matrix for Selected Communes in Mondulkiri

No.	Commune	Climatic Risks (Exposure)	Affecting Systems (Sensitivity)	Adaptive Capacity (Existing measures)	Adaptation priorities
1	**Srea Khtum**	**Drought** - Delayed/shortened rainy season and dry spells during rainy season May-October, every 1-2 years - High temperatures and prolonged dry season April–May (high exposure)	**Agriculture** -*Paddy* loss of paddy rice productivity due to water shortage (low sensitivity) -*Cash crops:* cassava, soy bean etc. loss of productivity (low sensitivity) - *Livestock* death because of disease. (medium sensitivity)	- there is an existing dyke and irrigation system established since Khmer Rouge. - replant after crop failure - vaccinate livestock (but low effectiveness)	- establish irrigation system/facilities (high priority) -technical assistance on livestock/ agricultural practice (high priority)
			Water supply - domestic water shortage (esp. potable water)	- use unclean water from the channels	- digging pond for water harvesting and storage (high priority)

No.	Commune	Climatic Risks (Exposure)	Affecting Systems (Sensitivity)	Adaptive Capacity (Existing measures)	Adaptation priorities
		Flood /heavy rain It normally lasts 1-2 days. Serious event in Ou Rona village 2012 (high exposure)	**Housing/infra structure** - damage to roofs/walls - limited accessibility during rainy season (low sensitivity)	- repair housing	
			Agriculture **-** destruction of short-term *cash crops and upland rice* - *livestock* loss/death (medium sensitivity)	- replant	
		Storms Very strong in 2013 in Or Arm and 2011 in Chhneng village. (medium exposure)	**Housing** -7 houses fell down and were damaged - destruction of roofs and walls. (high sensitivity)	- housing repair by individual households	- early warning system/weather forecasting information on TV or radio. (high priority)
		Thunderstorms 2011-2013 very strong. (low exposure)	**Infrastructure** - damage to school building, roofs and walls. (medium sensitivity)	- local authority and villagers repaired the school and students could go back to school.	- early warning system
			Human life 3 people were killed by thunderstorm events (high sensitivity)	- be cautious and stay at safe places when storm and thunder occur.	
	Bu Chri	**Drought** <u>- High temperatures and prolonged dry season</u> April–May happens every year (high exposure) <u>- Delayed/shortened rainy season and dry spells during rainy season</u> May–October, every 1-2 years *In 2012 there was a serious drought/dry spell during the rainy season from September to*	**Agriculture** - loss of *rice* productivity 50-70% - loss of *peanut* productivity 50-70% - *livestock* disease and deaths (high sensitivity)	- rehabilitate the well/pond but not sufficient with high demand. - provide vaccination for disease prevention.	- reservoir for water harvesting and storage - irrigation system for agriculture. (high priority) -technical assistance on agriculture technical training. (high priority)
			Water supply - shortage for domestic use and most of villagers are facing water shortage (medium sensitivity)	- existing old wells in the village	- build new wells and rehabilitate old well in the village. (high priority)

No.	Commune	Climatic Risks (Exposure)	Affecting Systems (Sensitivity)	Adaptive Capacity (Existing measures)	Adaptation priorities
		November. (high exposure)	**Human health** - Disease (i.e. malaria) and getting sick more often (medium sensitivity)	- go to nearby clinic /commune health center (limited capacity)	- strengthen local health care service. (medium priority)
		Storm / thunderstorm Happens every year but very strong in 2011 (medium to high exposure)	**Housing** - 23 houses were damaged (medium sensitivity)	- repair houses with support from community	- plant fruit trees around homestead area to prevent storm impact.
			Agriculture - *cash crop:* 70% of cassava destroyed in the village. (2011) (medium sensitivity) - 100 *fruit trees* fell down (2011). (low sensitivity) - 20%-30% of young *rubber trees* affected (medium sensitivity)	- replant	
			Human life - 1 person was killed by a thunderstorm in 2011. (low sensitivity)		
		Heavy rain/flood June–September (medium exposure)	**Agriculture** **-** destruction of short-term *cash crops* during harvesting (especially peanut) (medium sensitivity)	- replant	- technical assistance on agriculture technical training. (high priority)
	Sr ea Huy	**Flood/heavy rain** <u>River flooding</u> every 2-3 years water runoff from the Ou Koah Nhek to Ou Chbar, depth of flood approx. 2 - 3 m (low to medium exposure) <u>Heavy rainfall</u> June-September (high exposure)	**Agriculture** - 200ha - rice productivity lost more than 50% in 2009. - loss of livestock and animal deaths (high sensitivity) - damage to roads/irrigation facilities - limited accessibility (medium sensitivity)	- replant after flood event - road built along the river could prevent part of the flooding - plant bamboo along the river bank - build bamboo rafts - annual maintenance	- rehabilitate/ construct river dyke (4km) (medium priority)

No.	Commune	Climatic Risks (Exposure)	Affecting Systems (Sensitivity)	Adaptive Capacity (Existing measures)	Adaptation priorities
		Drought - Delayed/shortened rainy season, lack of rainfall May-October, serious in 1994 (high exposure) - High temperatures and prolonged dry season April–May) happens every year (high exposure)	**Agriculture** - loss of rice productivity up to 70% (high sensitivity) - *cash crops* loss of productivity (1993-1995) (medium sensitivity) - livestock disease and deaths (60-70% in Chhloul village in 2012) (high sensitivity)	- replant - there are some existing dykes for water storage but still insufficient to supply to the paddy area - pump water from nearby water source if available and affordable - vaccination and medicine for livestock (low effectiveness)	- rehabilitate the existing reservoir and - establish new reservoir with irrigation system for water supply to paddy land. (high priority) - technical assistance on agriculture - technical training. (high priority)
			Water supply - lack of clean water for domestic use, 7 areas in the commune facing water shortage (high sensitivity)	-collect water from river or steam far away from the village. - buy water for drinking	- provide more wells in the village - rehabilitate the existing pond or basin for water harvesting/storage . (high priority)
		Storms Not very strong or often (low exposure) **Thunder/lightning** It happens during rainy season and comes with storms, but is not frequent. (low exposure)	**Housing/infra structure** - 5 houses fell down/roofs were destroyed - limited accessibility to roads/services (medium sensitivity)	- rebuild/ repair - try to get information on TV or radio about weather forecast.	
			Forest and plantation - 2-3% of fruit trees destroyed - difficult/dangerous to access forest area/products (low sensitivity)		
	Ro monea	**Drought** - Very dry climate and high temperatures April - mid-May, annually)	**Water Supply** - water shortage affecting more than 40% of villagers during dry season. (high sensitivity)	- save/reduce water usage - collect water form river or canal far from home.	- establish water harvesting and storage system (reservoir/ basin) - provide more wells for water supply. (high Priority)

No.	Commune	Climatic Risks (Exposure)	Affecting Systems (Sensitivity)	Adaptive Capacity (Existing measures)	Adaptation priorities
		(high exposure) - Prolonged dry season / Dry spells in rainy season May-July, not so often - Shortened rainy season and lack of rainfall at end of the rainy season August-October, every few years - Temperature increases during planting season (medium exposure)	**Human Health** - malaria and other diseases (heat/high temperature) (medium sensitivity)	- go to health center near village or/and in the province.	- improve health care capacity. (medium priority)
			Agriculture **-** lack of water for *cash crop cultivation* (cassava and bean, loss of 60% productivity.) (high sensitivity) **-** *Paddy* crop failure due to dry spells during rainy season (150ha of paddy area in Srae I village) (medium sensitivity) - *Livestock* disease/deaths 50% of buffalos got sick and 30 died (heat/rainfall) (high sensitivity)	- replant, but not so effective. - lowland farms could survive. - treatment by veterinary volunteer in village.	- establish irrigation system (high priority) - TA on agriculture technical training for disease prevention. (high priority)
		Heavy rain and flash flooding June-September (medium exposure)	**Infrastructure** - limited accessibility during rainy season (medium sensitivity)	- road maintenance (low capacity)	- improve/upgrade road (esp. for Srae I village) (medium priority)
		Storm/thunderstorm May–September Serious storm events in 2013, not very often in this commune (medium exposure) Normally thunderstorms happen with storm and heavy rain. Stronger since 2000 (high exposure)	**Housing** - damage to houses/home gardens (low sensitivity)	- repair of roofs/walls by individual households	
			Agriculture - *Livestock deaths* (4 cattle died) - *Plantations* (A few trees were destroyed - *Cash crops* (5% of cassava plantation destroyed) (medium sensitivity)	- get information about weather forecast on TV or radio. - awareness raising	- Early warning system

Table A3. Summary of Climate Change Vulnerability of Selected Communes in Koh Kong & Mondulkiri

No.	Commune	Flood/ Heavy rain	Drought/ water shortage	Saltwater Intrusion	Storm/ Storm surge
1	Andoung Tuek (KKG)	x	xx	xxx	xx
	Ta Tai Kraom (KKG)	xx	x	xx	x
	Trapeang Rung (KKG)	xx	x		
	Bak Khlang (KKG)		x	xx	xx
	Peam Krasaob (KKG)		xxx	xx	xxx
	Chi Kha Leu (KKG)		xx	x	xx
	Ta Tey Leu (KKG)	x			
	Ruessei Chrum(KKG)	x	x		
	Chi Phat(KKG)	x	x	x	
0	Thma Doun Pov (KKG)	xx			x
1	Romonea (MDK)	x	xx		xx
2	Dak Dam (MDK)		xx		x
3	Chong Phlah (MDK)	xxx	xx		x
4	Srae Chhouk (MDK)		xx		
5	Srae Khtum (MDK)	xx	xxx		x
6	Srae Preah (MDK)	x	xx		x
7	Nang Khileuk (MDK)	xxx	x		
8	Sok San (MDK)	xx	xx		x
9	Srae Huy (MDK)	xxx	xx		x
0	KrangTeh (MDK)	x	xxx		x
1	Bu Chri (MDK)	x	xxx		xx
2	Bu Sra (MDK)	xx	xx		x
3	Koh Kapic (KKG-NBCC)		xxx	x	xxx
4	Kandol (KKG-NBCC)		xxx	xxx	
5	Chroy Svay (KKG-NBCC)		xx	xxx	xx

6	Toul Korki (KKG-NBCC)		**xx**	**xxx**	
7	Ou Buon Leu (MDK-NBCC)	**xxx**	**xx**		**x**

B. Summary of Community Priorities

2. The following figures summarize community priorities from the same commune vulnerability analysis

Figure A2: Climate Change Adaptation Capacity and Needs in Koh Kong

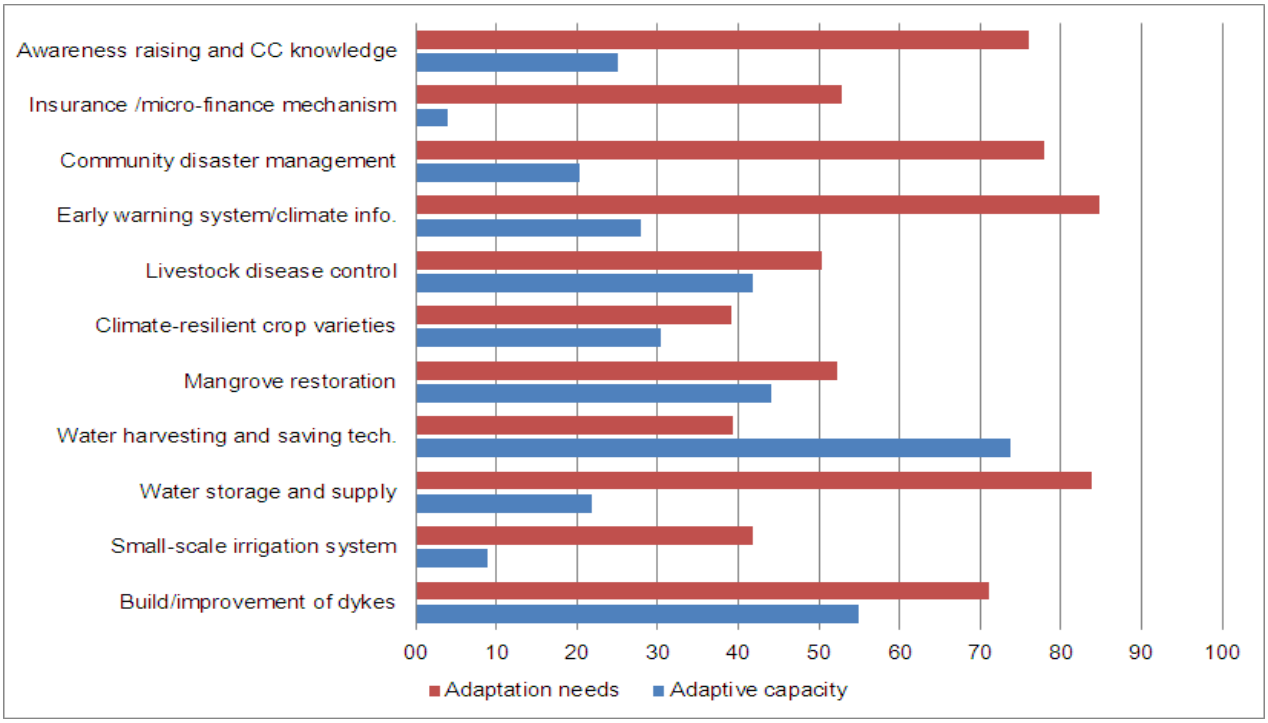


Figure A3. Climate Change Adaptation Capacity and Needs in Mondulkiri

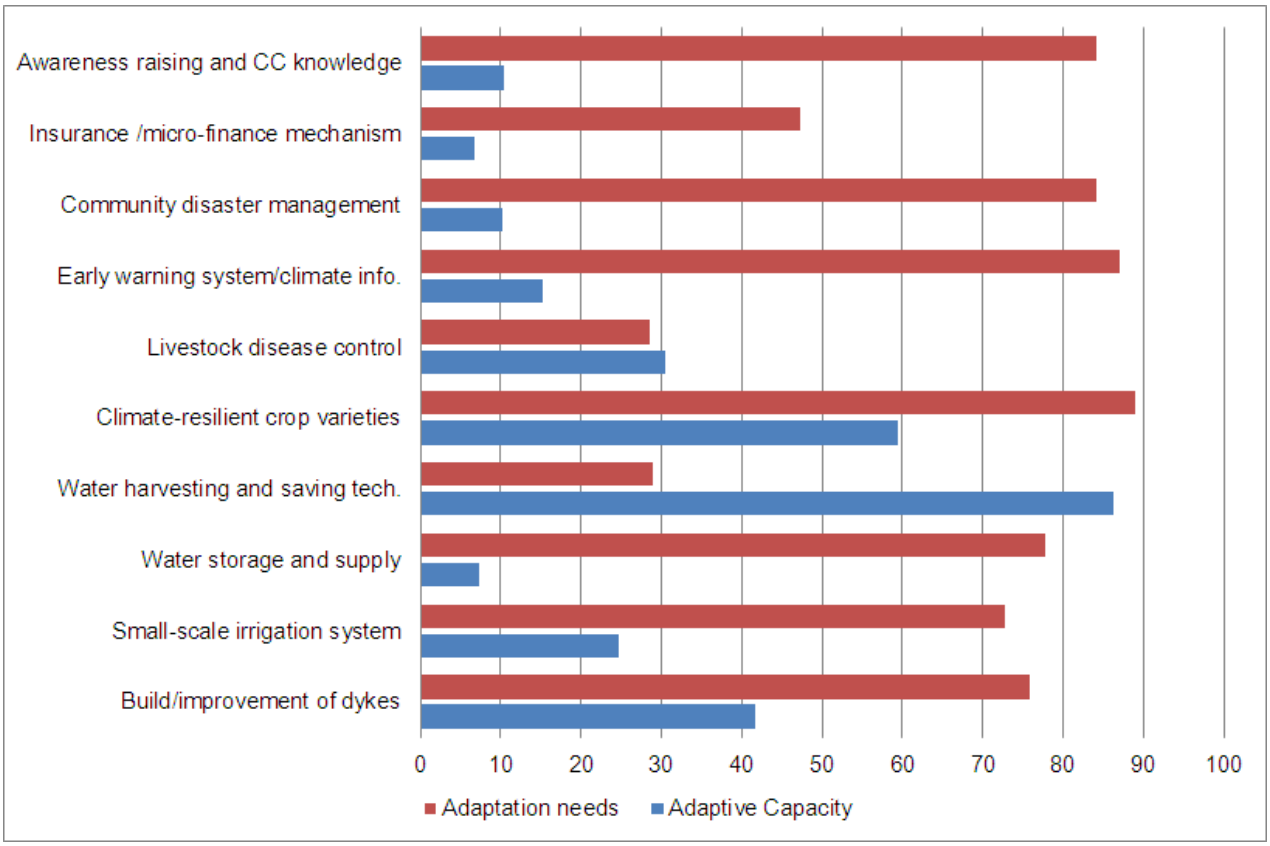


Table A4: Pre-Selection of Initiatives from Community Priorities

Priorities Identified by Communities	Comments
Koh Kong	
Reduction of flood damage / drought impacts	
Early warning systems	Mondulkiri is much more vulnerable to floods than than Kok Kong. While it is intended that this is partially addressed in the catchment model, it has been decided that the intervention for catchment planning will be implemented in Mondulkiri
Community disaster management	Mondulkiri is much more vulnerable to flash floods than than Kok Kong. While it is intended that this is partially addressed in the catchment model, it has been decided that the intervention for catchment planning will be implemented in Mondulkiri.
Awareness raising and climate change information	Awareness raising and climate change information will be part of the training activities by the BCC Project.
Insurance / microfinance	The target provinces have a diversified agricultural base and a shortage of climatic information so that trying to develop a microfinance / crop insurance system would be better managed within a standalone project.

Priorities Identified by Communities	Comments
Reducing drought impacts	
Water supply and storage	All of these issues, with the exception of the livestock disease control, will be addressed within the proposed activities. Livestock disease control requires a veterinary system to be sustainable.
Livestock disease control	
Small scale irrigation systems	
Water harvesting and supply	
Climate resilient crop varieties	
Reduction of salt water intrusion / storm impacts	
Build / improve dykes	The issue was looked at but basic financial calculations indicated that concrete dykes were not viable and there are risks from dyke construction to mangrove populations because dykes can change wave behavior. Bioengineered structures from softer materials will be used.
Mangrove restoration	
Mondulkiri	
Drought impact reduction	
Climate resilient crop varieties	These issues will be addressed within the proposed activities.
Water supply and storage	
Build improve dykes for river flooding and mountain water harvesting	River dyke improvement requires major investment and financial losses do not justify such investment. Mountain rainwater harvesting will be addressed within the catchment intervention.
Small scale irrigation systems	These issues will be addressed within the proposed activities.
Water harvesting and supply	
Livestock disease control	Livestock disease control requires a veterinary system to be sustainable.
Reduction of flood damage / drought impacts	
Early warning systems	It is intended that this is partially addressed in the catchment model. The project preparation team felt that trying to develop a provincial warning system by phone or radio was beyond the scope of implementation under the BCC Project.
Awareness raising and climate change information	It is intended that this is partially addressed in the watershed model by establishing watershed management committees and planning for disaster. The BCC project will contribute generally to awareness raising. They have a large training budget and it is suggested that climate change awareness modules are included.
Community disaster management	It is intended that this is partially addressed in the catchment model by working with the community forest management committees and community protected area management committees.
Insurance / microfinance	The target provinces have a diversified agricultural base (with livestock being important) and a shortage of climatic information so that trying to develop a microfinance / crop insurance system would be better managed within a standalone

Priorities Identified by Communities	Comments
	project.

3. Analysis of commune vulnerability combined with analysis of community priorities (see figures 1 and 2 above) led to a focus on drought mitigation and on the development of measures to develop climate resilience for coastal communities. As shown in table 3 above, certain approaches were not regarded as feasible (e.g. disaster warning systems, crop insurance, microfinance, livestock disease control) as these would require specific, stand-alone project initiatives. Initiatives under PPCR financing emanate from a combination of experience from both within Cambodia and experience from other countries to select initiatives that might assist communities to overcome the climate vulnerabilities they identified as the most severe and to at least go some way to providing solutions that accorded with community priorities. The next two sections document lessons learned. Combining lessons learned with community priorities led to a sub-project selection process that draws on the lessons learned from relevant experience and establishes priorities to be used for sub-project selection at the thematic level.

C. Criteria for Subproject Selection

4. Table 3 above illustrates how the project preparation team pre-selected activities identified as priorities by communities and combined this with relevant experience of both the team and of relevant projects in consultation with the EAs and the BCC implementing team. The project preparation team then identified six core priorities for selection of sub-projects that they felt were necessary conditions for any sub-projects to be selected. These priorities have been applied to all the sub-projects considered at the thematic level during the analysis phase to prioritize sub-project selection. This prioritization exercise has resulted in the sub-projects identified in section H below. The six priorities are described below and the application of these priorities to sub-projects is shown in Table 16 which follows:

(i) **Improve Climate Resilience in the BCC Communes Most Vulnerable to Climate Change now** The most vulnerable BCC communes are experiencing climate change related problems already and it is a high priority to mitigate these problems.

(ii) **Support Biodiversity Conservation Corridor objectives:** The BCC has the overall objective of climate resilient sustainable forest ecosystems benefiting local livelihoods in the biodiversity corridors of Cambodia, while the intended outcome is sustainably managed biodiversity corridors in Cambodia. BCC plans to support local communities inhabiting the biodiversity corridor so as to enlist their support in achieving the objectives and to this end will implement all livelihood and infrastructure initiatives within a framework of specific management plans and of a Biodiversity Corridor policy and legal framework. PPCR investments should support the BCC efforts.

(iii) **Feasibility of Implementation within BCC Implementing Structure:** Initiatives designed under the PPCR project preparation will be implemented by BCC. They should not place severe strains on the implementation capacity of that project.

(iv) **High priority for communities:** Community support is required to achieve success and high community ranking of the proposed activity is a condition for BCC support within the BCC project administration manual (PAM). This suggests to the R-PPTA team that high community ranking of any proposed development to mitigate climate change is a priority.

(v) **Potential for Scaling Up and Alignment with National and Local Development Strategies:** the long term impact of initiatives designed by the PPCR R-PPTA will be amplified if the initiatives can be scaled up at a later date and the R-PPTA team consider the introduction of elements that will increase awareness of measures that will assist to develop climate resilience an important element of their work. In order to have a realistic chance of being scaled up, initiatives designed by the PPCR R-PPTA must be aligned with national and local development strategies.

(vi) **PPCR Project Initiatives should not Duplicate Activities Financed in other Projects:** Activities to be financed by PPCR funds can supplement but should not duplicate activities already being funded by either SFB, CARP or COMPASS (or other specific local initiatives).

5. During the detailed design phase the further priorities below will be applied at the site specific level for selected sub-projects. The BCC project will apply the same criteria when selecting further sites for implementation from the long list of projects. If any sub-project does not meet one of the criteria then the project management will be required to justify its selection to ADB.

(i) **Continued Impact on Climate Resilience to 2030:** the trend is for many climate related problems to gradually worsen up to 2030 and then to accelerate up to 2100. Investment requirements will change after 2030 but investments made now should continue to create climate resilience over the next 15 to 20 years.

(ii) **Positive Economic Return:** ADB normally requires a positive economic return (IRR) of 12% on investments and this is one means of selecting the best option for use of scarce funds. Investments for the long term may not yield such a return (implying that other investments are a higher priority now).

(iii) **Capacity to increase awareness of climate change trends amongst local authorities and communities:** there are important elements of climate change awareness that have not reached local government and local communities. Increasing such awareness is also an important project element.

(iv) **Impact on vulnerable groups and indigenous peoples (IPs):** priority should be given to initiatives that will impact positively on vulnerable groups such as women, children and indigenous peoples. Subprojects do not adversely affect IPs, households headed by women, disabled, elderly or other similarly vulnerable groups. Rights and needs of IPs will be fully addressed in accordance with ADB's relevant policies and applicable laws and regulations of the Government. In particular, the Project shall be carried out in accordance with the Indigenous People Development Framework, as agreed between the Government and ADB. The Government will ensure that no subproject with significant impacts on indigenous groups is financed under the Project. For subprojects in which indigenous groups are present and affected, an Indigenous People's Development Plan will be prepared in accordance with the Indigenous People Development Framework. The Government will ensure that, measures to improve the welfare of IPs are built into the overall subproject design where the IP population exceeds 60% and no negative impact on such IPs is expected.

(v) **No "Capacity A" sub-projects on the environment**: the BCC environmental assessment and review framework (EARF) for Cambodia stipulates that subprojects categorized as Category A (likely to have significant adverse environmental impacts) will not be admissible. Therefore subprojects should not be likely to have significant adverse environmental impacts (environmental

safeguard Category A) - the subproject complies with BCC subproject admissibility described in the BCC EARF.

(vi) **No land acquisition (voluntary or involuntary) and no significant impact on resettlement**. No subproject with the ADB's Category A resettlement criteria is financed under the Additional Financing and no subproject involves any land acquisition. Any subproject involving any land acquisition will be not eligible for funding under this Additional Financing. In the event that any of the subproject does have any land acquisition, the Government will ensure that all steps required to ensure that all subprojects under the Project comply with the applicable Government laws and regulations, the Resettlement Framework and with ADB's SPS 2009.

(vii) **Opportunity for Poverty Reduction:** finally the overall impact on poverty is an important element given that the poor lack time to support BCC objectives and hat poverty reduction is a major RGC objective.

Table 5: Prioritization of Potential Initiatives to Develop Climate Resilience in BCC Communes

	1. Improve Climate Resilience in the Most Vulnerable BCC Communes now:	2. Support Biodiversity Conservation Corridor objectives:	3. Feasibility of Implementation within BCC Implementing Structure:	4. High priority for communities:	5. Potential for Scaling Up Alignment with National & Local Dev't Strategies: :	6. Not Duplicating Activities Financed in other Projects		a. Continue to Impact on Climate Resilience in 2030:	b. Positive Economic Return:	c. Increase awareness of climate change trends amongst local authorities and communities:	d. Impact on Vulnerable Groups:	e. No Capacity A sub-projects	f. No forced or economic resettlement	g. Opportunity for Poverty Reduction	NOTES
INITIATIVES IN KOH KONG	THEMATIC STAGE							SITE SPECIFIC STAGE							
Sea Dyke in Pak Khlang commune	√		√	√	√	√									Sea Dykes can have a negative impact on mangrove forest
Sea Dyke in Andoung Tuek and Kandol communes	√		√	√	√	√									Sea Dykes can have a negative impact on mangrove forest
Water supply pipeline in Peam Krasoab commune.	√	√	√	√	√										It would be possible to link one village to the municipal water supply but continued supply cannot be guaranteed
Mangrove restoration In Andoung Tuek, Kandol and possibly Trapeang Rung communes	√	√	√	√	√	√									A BCC activity
Mangrove restoration In Peam Krasoab commune	√	√	√	√	√										The CARP project will finance mangrove restoration in Peam Krasoab
Bioengineering (dunes, other barriers) in Andoung Tuek villages	√	√	√	√	√	√									
Integrated farm models for saline soils in Andoung Tuek villages	√	√	√	√	√	√									

Irrigation scheme in Koh Kong	√	√		√	√	√									No feasible sites discovered (such sites as exist require pumping from water sources)
Water supply reservoir in Koh Kong	√	√		√	√	√									This is a BCC activity and specific site visits are necessary to determine feasibility
Integrated farm models for Ta Tey Leu, Ruessei Chrum, and Thma Doun Pov communes	√	√	√	√	√	√									Project will concentrate on SRI rice. Farmers trained in Andoung Tuek will train other farmers in other communes.
Integrated farm models for Peam Krasoab commune	√	√	√	√	√										The CARP project will finance integrated farm models in Peam Krasoab
Integrated farm models for Andoung Tuek, Trapeang Rung, Ta Tai Kraom, Chi Phat and Chi Kha Leu communes	√	√	√	√	√	√									Project will concentrate on SRI rice. Farmers trained in Andoung Tuek will train other farmers in other communes.
Rainwater harvesting for Andoung Tuek, Trapeang Rung, Ta Tai Kraom, Chi Phat and Chi Kha Leu communes	√	√	√	√	√	√									A BCC activity
Rainwater harvesting for Peam Krasoab commune	√	√	√	√	√	√									A BCC activity.
Community based production forestry in Ta Tey Leu, Ruessei Chrum, and Thma Doun Pov communes		√	√	√	√	√									These communes do not currently have high vulnerability to climate change
Establishing and working with Provincial / district working groups	√	√		√	√										The CARP project will develop and support a provincial working group
Aquaculture in Andoung Tuek, Trapeang Rung, Ta Tai Kraom, Chi Phat and Chi Kha Leu communes	√	√			√	√									The lesson learned from other projects is that aquaculture requires a high level of support
INITIATIVES IN MONDULKIRI	**THEMATIC STAGE**							**SITE SPECIFIC STAGE**							
Integrated farm models for Mondulkiri communes with drought (all communes)	√	√	√	√	√	√									Various farming models are included in three of the proposed interventions
Rainwater harvesting for Mondulkiri communes with drought (all communes)	√	√	√	√	√	√									A BCC activity

Irrigation re-hab and SRI rice models in Srae Chrey, Huy, Bus Ra, Krang Teh and Bu Chri communes	√	√	√	√		√									There are only four potential sites within the BCC communes in Mondulkiri and rice production is not widespread in these areas.
Irrigation re-hab in Srea Chhuk commune	√	√		√		√									The R-PPTA team have been informed that much of the land with irrigation potential may fall under a rubber concession and is expected to be lost to farmers.
Irrigation re-hab in Romonea commune	√	√		√		√									The water source is 7 to 8 meters below the land to be irrigated and so any scheme would require pumping. The technical complications of introducing and ensuring O&M for a pumped irrigation scheme are too complex for the BCC project.
Reforestation in watershed that feeds Kaoh Nheaek to mitigate flooding		√	√		√										Koh Khmer is the district with the most severe flood problems and these are predicted to worsen. However, the watershed (s) for Kaoh Kneaek are complex, extend across borders into Viet Nam and are large. It would require a comprehensive study, beyond the scope of either this R-PPTA of the BCC project to establish flood routes and expected changes and to predict and plan re-planting measures that might mitigate against floods.
Community based production forestry in Mondulkiri	√	√	√	√	√	√									
Community based production forestry in Koh Kong	√	√	√		√										No sites yet identified and initial work has been done in Mondulkiri.

Support to commune councils	√	√	√	√	√										Commune councils need considerable support to implement any initiatives but support is already being given to commune councils in Mondulkiri by the SFB project.
Communal land title for indigenous peoples' villages in Mondulkiri	√	√	√	√	√										This is ranked as a very high priority by all indigenous peoples but is already being within the objectives of both BCC and SFB
Establishing and working with Provincial / district working groups		√			√										District working groups need considerable support to assist communes to implement any initiatives but support is already being given to commune councils in Mondulkiri by the SFB project.