

CPWF Project Report

Commune Agroecosystem Analysis to Support Decision Making for Water Allocation for Fisheries and Agriculture in the Tonle Sap Wetland System

Project Number 71

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Program Preface

The Challenge Program on Water and Food (CPWF) contributes to efforts of the international community to ensure global diversions of water to agriculture are maintained at the level of the year 2000. It is a multi-institutional research initiative that aims to increase the resilience of social and ecological systems through better water management for food production. Through its broad partnerships, it conducts research that leads to impact on the poor and to policy change.

The CPWF conducts action-oriented research in nine river basins in Africa, Asia and Latin America, focusing on crop water productivity, fisheries and aquatic ecosystems, community arrangements for sharing water, integrated river basin management, and institutions and policies for successful implementation of developments in the water-food-environment nexus.

Project Preface

The Project on Commune Agroecosystem Analysis to Support Decision Making for Water Allocation for Fisheries and Agriculture in the Tonle Sap Wetland System was undertaken with the aim of improving fisheries considerations in the Commune Agroecosystem Analysis (CAEA) process undertaken in Cambodia, to facilitate better planning at the commune level. Under this project a number of changes were made to the CAEA tools and process and pilot tested in an adaptive, iterative manner in four communes – two that had conducted a CAEA previously and two that had not. Results and analyses indicated that the project had significantly strengthened the manner in which livelihoods, water resources and fisheries are now addressed by CAEA. The revised CAEA guidance manual has also shown potential for having wider uptake, and a number of tools have been used by several other projects within Cambodia.

CPWF Project Report Series

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Abbreviations and Acronyms

ADB	Asian Development Bank
AEA	Agroecosystems Analysis
AusAid	Australian Agency for International Development
CAEA	Commune Agroecosystems Analysis
CAP	Commune Agricultural Plan
CDP	Commune Development Plan
CGIAR	Consultative Group on International Agricultural Research
CIP	Commune Investment Plan
CPWF	CGIAR Challenge Program on Water and Food
D&D	Decentralisation and Deconcentration Program (formerly Seila)
DAE	Department of Agricultural Extension, Cambodia
DIW	District Integration Workshop
EC	European Commission
FiA	Fisheries Administration
FSMIS	Farming Systems [Extension] Management Information System
IFReDI	Inland Fisheries Research and Development Institute, Cambodia
IWMI	International Water Management Institute
JICA	Japanese International Cooperation Agency
MAFF	Ministry of Agriculture Forestry and Fisheries, Cambodia
MOWRAM	Ministry of Water Resources and Meteorology, Cambodia
NTFPs	Non Timber Forest Products
OAE	[Provincial] Office of Agricultural Extension
PDA	Provincial Department of Agriculture
PDE	Provincial Department of Environment
PDWRAM	Provincial Department of Water Resources and Meteorology
RGC	Royal Government of Cambodia
RRA	Rapid Rural Appraisal
SOAS	School of Oriental Studies, University of London, UK
TIPs	Technology Implementation Protocols
WorldFish	World Fish Center

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RESEARCH HIGHLIGHTS

CAEA is a participatory approach that enables local communities to improve decision making at the commune level. The CEA approach was initiated in Cambodia in 2001, but until 2008 it focused mainly on agricultural issues, while the fisheries sector closely interlinked to agriculture in Cambodia had not been adequately addressed. In this regard, the Challenge Program on Water and Food (CPWF) Project Number 71 titled "*Commune Agroecosystem Analysis to Support Decision Making for Water Allocation for Fisheries and Agriculture in the Tonle Sap Wetland System*" was conducted between 2008 and 2010. This project aimed to improve fisheries considerations in the CEA process that would facilitate better planning at the commune level in addition to identifying institutional and policy considerations.

Research highlights include:

- A good example of a demand-driven piece of research that has had a high degree of success. The Department of Agricultural Extension (DAE) of the Ministry of Agriculture, Forestry and Fisheries, Cambodia (MAFF) recognized the need to strengthen the fisheries aspects of CEA and requested for assistance to improve this component through this research project.
- Successful incorporation of fisheries parameters in relation to fisheries biology, water resources and livelihoods into the CEA process. The results and analyses have clearly shown that CPWF PN71 has significantly strengthened the manner in which these aspects are now addressed by CEA, compared to a previous narrower focus solely on agricultural production systems.
- Since 2004 the use of CEA has been officially adopted as a national policy for agricultural development, with the DAE of the MAFF as the executing agency. In this regard, the revised CEA methodology (incorporating fisheries aspects) under PN71 is to be institutionalized by MAFF and used in future CEA assessments in Cambodia and, therefore, there has been direct influence at the policy level through the project.
- The revised CEA guidance manual has also shown potential for having wider uptake and a number of tools have been used by several other projects within Cambodia as well as in Lao PDR.

EXECUTIVE SUMMARY

Cambodia is the fourth largest producer of freshwater fish in the world (Keskinen 2003) with an estimated total catch of approximately 400,000 tons per year (t/yr) (Van Zalinge and Nao 1999). Fish and fish products are therefore considered an important source of nutrition, livelihood and income for the entire country, especially in the rural areas (Ahmed et al. 1998 in Keskinen 2003).

In the Tonle Sap area particularly, fishing-related activities play a very important role. In villages close to the lake border, fishing naturally forms the major livelihood activity of many people. However, even in the floodplain in areas not adjoining permanent water bodies or small rivers or streams, fisheries often play a critical role in terms of subsistence. For instance, during the flooding or wet season, fishing takes place in flooded forest areas and rice fields (Keskinen 2003). Moreover, it appears that in the dry season, people from many communes migrate to the floodplain area from their villages and engage in fishing. Rice cultivation alone is inadequate to obtain income for daily subsistence, especially during certain times of the year and, therefore, farmers have diversified their livelihood activities and engage in fishing. Thus fisheries and farming systems are closely interlinked in Cambodia and the preservation and enhancement of both systems, and the contributions that these can make to the livelihoods of the poor require a comprehensive and integrated approach.

Agroecosystems Analysis (AEA) is a methodology for the analysis of agricultural livelihood systems and for planning and prioritizing research and development activities. It was developed in the late 1970s and has since been used for research and extension planning in a range of locations and environments. In Cambodia, the AEA at the commune level was initiated in 2001, and in 2004 this approach was officially adopted as a national policy for agricultural development, with the DAE of the MAFF as the executing agency. Commune Agroecosystems Analysis (CAEA) is used by the DAE for agroecological analyses at the commune level and is the primary needs-assessment and planning tool for the agriculture sector. By mid-2010 a CAEA had been conducted at least once in over 500 of the 1,621 communes nationwide.

CAEA uses multidisciplinary investigation and participatory analysis to understand and describe the major farming systems practiced in each commune, and to identify and prioritize the most important problems facing the farmers. Further, systems analysis is then conducted to plan interventions to address problems and opportunities identified.

In the original CAEA there was however a clear demand for the fisheries component to be improved. In this regard, the Challenge Program for Water and Food (CPWF) Project Number 71 titled "*Commune Agroecosystem Analysis to Support Decision Making for Water Allocation for Fisheries and Agriculture in the Tonle Sap Wetland System*" was conducted. The main aim of the project was to improve fisheries considerations in the CAEA process that would facilitate better planning at the commune level in addition to identifying institutional and policy considerations. This included not only the biophysical aspects of fisheries but also the socioeconomic, livelihoods and governance aspects as well to ensure a holistic view of the main issues that need to be taken on board.

As a result of PN71, a number of changes to the CAEA tools were made and subsequently field-tested in the four pilot CAEA exercises (in two communes that had an earlier CAEA report and two communes that had not). Changes were of two main types: First, entirely new tools were introduced to address important water resource, fishery and livelihood issues not covered by the original CAEA tools. Second, existing tools were modified to better address key issues in a more complete or comprehensive manner. At

the end of the testing phase, an assessment was made of each individual tool to gauge its effectiveness and the benefits it provided compared to the original CAEA procedures.

It is clear from the project results and analyses that the CPWF PN71 has significantly improved the way fisheries, water resources and livelihoods are now addressed by CAEA. When comparing the new CAEA outputs and previous CAEAs conducted in the two control communes it is apparent that the revised CAEAs exhibit an emerging recognition of the importance of awareness-raising and capacity development at the community level as compared to the previous narrower focus solely on agricultural production systems.

Moreover, the continued application of the PN71 outputs such as the revised CAEA guidance manual beyond the life span of the project ensures the increased impact of PN71. For example, the DAE plans to use the revised version of the CAEA Manual (incorporating fisheries aspects) in future CAEA assessments in Cambodia. In addition, a number of revised CAEA tools have been used by several other projects within Cambodia thus showing its potential for wider uptake and representing an opportunity to introduce effective changes throughout the country. There is also the potential for CAEA to be adopted in neighboring countries (such as Lao PDR) – for example in the Agro-Biodiversity Initiative (TABI) in Lao PDR. TABI is a long-term commitment by the Government of Lao PDR and the Swiss Development Corporation (SDC).

However, despite the very clear benefits of the revised CAEA process, a number of important challenges still remain if the lessons learned from PN71 are to be fully capitalized and institutionalized within government planning processes.

1 INTRODUCTION

In the economy of most Mekong Basin countries, agriculture is the dominant sector. However, the majority of the rural population also depends on the river and associated floodplain wetlands directly for food and livelihood purposes. In Cambodia, for instance, freshwater capture fisheries ranks fourth in the world in terms of estimated total catch (approximately 400,000 t/yr) and these fisheries account for 31% of the GDP contribution of the primary sector of the economy. These fisheries are vulnerable to long-term ecohydrological modification of critical habitats arising from agricultural and water management practices. However, some of these practices can also support fisheries or increase overall system productivity. For this to happen, the consideration of fisheries in decision-making processes related to developmental investments and activities is crucial. While national strategic plans and policy statements, including the most recent Poverty Reduction Strategy Paper (PRSP), acknowledge and give weight to fisheries, fisheries aspects of agroecosystem analysis are relatively limited and data on these aspects are lacking. Overall, the political ecology of current decision making is heavily skewed towards the agronomic perspective.

The preservation and enhancement of both fisheries and farming systems, and the contributions that these can make to the livelihoods of the poor require a comprehensive and integrated approach. A clear threat to fisheries arises from the intensification and expansion of irrigated farming as well as from other infrastructural development on existing fisheries. Despite this recognized threat, planning and development often lack adequate assessment of the environmental and socioeconomic implications of agricultural development on fisheries.

This neglect is mainly due to a lack of understanding of the interactions between fisheries, agriculture and water management and respective cross-scale linkages. As a result, the inadequate evaluation of fisheries coexisting with both current and emerging farming systems can lead to unsustainable or undesirable use of natural resources, conflicts between farmers and fishers, loss of access to water bodies, missed opportunities to sustain or create employment and enhance livelihoods, and degradation of the ecosystem. A more comprehensive and integrated analysis of biophysical, socioeconomic and governance processes is required to understand and assess the complex and seasonally dynamic interactions between fishing and farming, and aquatic ecosystems.

Agroecosystems Analysis (AEA) is a methodology for the analysis of agricultural livelihood systems and for planning and prioritizing research and development activities. It was developed at Chiang Mai University in the late 1970s and has since been used for research and extension planning in a range of locations and environments.

In Cambodia, the existing CAEA system that has been adopted by the Ministry of Agriculture since 2001 is commendable in seeking to encompass the issues related to water, land and socioeconomic development while recognizing the potential trade-offs between productivity, equity and sustainability of agroecosystems. CAEA is used by the DAE for agroecological analyses at the commune level and is the primary needs-assessment and planning tool for the agriculture sector. CAEA uses multidisciplinary investigation and participatory analysis to understand and describe the major farming systems practiced in each commune, and to identify and prioritize the most important problems that the farmers face. Based on this, further analyses are conducted to plan appropriate agricultural interventions to address the problems and opportunities identified. Such interventions usually take the form of Technology Implementation Protocols (TIPs), which describe improved agricultural technologies developed to solve farming problems. TIPs can best be defined as '*the entire package of information*,

procedures, methods and materials necessary for an extension worker to implement the improved technology' (DAE and CPWF 2010), and are held in a database. TIPs are intended to facilitate the replication of improved technologies across communes according to local agroecological and socioeconomic conditions.

This methodology is particularly useful to commune organizations (especially commune councils) and provincial administrators that plan extension. CAEA is normally implemented through contracts with Provincial Departments of Agriculture (PDAs) with the guidance of the DAE. The CAEA can identify and prioritize agricultural development needs at the commune level and feed into the commune agricultural plans (CAPs). CAEA was officially adopted as national policy for agricultural development by the Government of Cambodia in 2004, with the DAE of the MAFF as the executing agency. By mid-2010 a CAEA had been conducted at least once in approximately one-third of the 1,621 communes nationwide and the process had been supported by a variety of funding sources including MAFF, Decentralisation and Deconcentration Program (formerly Seila) (D&D), Australian Agency for International Development (AusAID), International Fund for Agricultural Development (IFAD), Japanese International Cooperation Agency (JICA), Asian Development Bank (ADB), European Commission (EC) and a number of NGOs. The CAEA for each commune is expected to be revised from time to time in order to capture a contemporary picture of the commune, its agricultural development status, and any new issues and problems that have arisen.

Until 2008, CAEA had focused mainly on agricultural issues, but problems of the fisheries sector closely interlinked to agriculture in Cambodia had not been adequately addressed. Moreover, the existing data collected were insufficient to encompass the range of variables required to address the combined use of water by fisheries and agriculture and development interactions. As a result, significant uncertainties were creating a bias or impeding effective decision making on the management of water for coexisting agriculture and fisheries systems. CAEA users recognized this weakness and were in agreement that the water and fisheries component be strengthened.

In this regard, CPWF Project Number 71 titled "Water Allocation in the Tonle Sap" was conducted between 2008 and 2010. This project aimed to improve fisheries considerations in data collection systems and in particular the CAEA process that would facilitate better planning at the commune level, in addition to identifying institutional and policy considerations. As a consequence, the revised CAEA adopted a more holistic approach through incorporation of fisheries variables and also looking at land, water, livelihoods and institutional issues that influence commune development planning.

2 PROJECT OBJECTIVES

1. Identification of key fisheries variables in the context of fisheries biology, land and water, livelihoods and institutions, to be considered by CAEA through the contributions of an interdisciplinary team of scientists and local stakeholders at community and provincial levels.
2. Testing of the revised CAEA through a comparative analysis of initial versus revised CAEA in selected paired sites (where two sites had earlier CAEA reports and two had not).
3. Finalizing revision of the CAEA and highlighting management and policy implications.

3 OVERALL METHODOLOGY

A common methodology in terms of the CAEA review, testing and revision is included for land and water resources, fisheries ecology and livelihoods and institutions. Thereafter, the results from these different components can be described separately.

The methodology adopted in the PN71 project was based on a three-stage process:

- Stage one – screening and scoping
- Stage two – field-testing of the revised CAEA tools and methodologies
- Stage three – finalizing revision of the CAEA and highlighting management and policy implications

Each stage included a number of key activities. In stage one (screening and scoping), key variables and existing data collection systems in the context of the CAEA were reviewed and the range of additional fisheries parameters needed to be considered in the CAEA determined. The review was essentially organized into four components – fisheries parameters in the context of (i) land and water resources; (ii) fisheries biology; (iii) livelihood and governance; and (iv) integration across the first three sectors and disciplines.

Each component proposed a revision of CAEA from their perspective and analysis, using the knowledge gained through screening activities and literature reviews. The integration of all revised outputs led to the first revision of CAEA to enhance the integration of fisheries in agroecosystem analysis. The revisions essentially recommended incorporation of new variables to CAEA and the adjustment of existing tools and the incorporation of new tools adapted to the existing CAEA structure. Fisheries parameters in the context of fisheries biology, land and water, livelihoods and governance were incorporated into the CAEA process for field-testing, based on what was feasible, given the existing capacity, capabilities and resources – so that the process would not become unmanageable.

A stakeholder workshop was held thereafter (in September 2008), to present the first results of the project and recommendations for integrating fisheries in agroecosystem analysis, in particular at the commune level. Workshop outputs further contributed towards refining the CAEA revisions proposed. The workshop participants were mainly government officials from the Departments of Agriculture, Fisheries, Environment and Water resources, a few NGOs, and the project partners and team.

In stage two (field-testing of the adapted CAEA), two paired sites (communes) were selected (where two sites had earlier CAEA reports and two had not), for the pilot testing of the revised CAEA. The selection of suitable sites was carried out using the following key criteria:

Coverage of a wide range of agroecological zones
 Significance of fisheries in the commune
 Pairs of sites 'with vs. without' implementation of CAEA
 At least one site with significant irrigation development

On the basis of the above criteria four communes (in two provinces) were selected (Figure 1):

- Chamnar Krom (with CAEA) and Samproch (without CAEA) in Kampong Thom Province
- Sna Ansar (with CAEA) and Sya (without CAEA) in Pursat Province

Figure 1. Map of the four selected communes.



To undertake a comparative analysis of the old and revised methodology, two of the communes selected had an earlier CAEA report and two did not. Both sites where the adapted CAEA was implemented for the first time, were closely comparable and with similar conditions to the communes where an original CAEA was carried out before the methodology revision (Table 1).

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Table 1. Overview of the agroecological zones in the four communes.

Sna Ansar	Sya	Chamnar Krom	Samproch
10 villages	11 villages	10 villages	17 villages
6 AE zones	3 AE zones	4 AE zones	6 AE zones
1. Mountain zone 2. Upland zone 3. Lowland middle-terrace zone 4. Lowland lower-terrace zone 5. Floodplain zone 6. Tonle Sap Lake zone	1. Lowland middle and lower terrace used for wet- and dry-season rice 2. Upper floodplain used for deep water and dry-season rice 3. Lower floodplain comprising flooded forest and grassland	1. Mixed crop residential zone with rain-fed lowland rice and cash crops 2. Lowland terrace zone with short flood period for recession rice 3. Seasonally flooded zone with recession rice and grassland 4. Floodplain and flooded forest zone	1. Medium terrace 2. Lowland lower terrace--wet-season rice 3. Lowland lower terrace--long period rice and deepwater rice 4. Floodplain for recession and dry-season rice 5. Floodplain with flooded forests and fish reserved 6. Tonle Sap Lake (permanent flood water)

Note: AE=Agroecological.

Pilot testing in the four communes was carried out between January and October 2009. Each testing cycle per site (commune) took approximately one month – 5 days for the CAEA orientation, data collection and preliminary analysis; 3 days for the rapid rural appraisal (RRA), 3 days for systems analysis; and the rest for report writing. After each pilot testing in a commune, the CAEA Manual was revised taking on board the lessons learned during data collection and analysis. While some bigger changes were made during the first two rounds of testing, thereafter it was mainly fine-tuning and further refinements of the methodologies and tools that were used. Revisions and recommendations were made on both the CAEA tools and the process. After the pilot testing was completed in the first two sites, a 2-day ‘mini-stakeholder’ workshop was held in June 2009. This was used to reflect further on the revisions made in the first two rounds of testing and to discuss and obtain feedback from key stakeholders before proceeding to undertake the field-testing in the third and fourth sites that did not have

an earlier CAEA report. Two key aspects were covered in this workshop – a review of the CAEA tools and the CAEA process.

To compare original and revised CAEA assessments, the evaluation focused on a number of aspects including ease of use, the variables included in the assessment, and the implications for decision makers. The revision was carried out in the context of the different components, fisheries biology, land and water, livelihoods and governance.

The third stage consisted of finalizing revision of the CAEA and highlighting management and policy implications. A final stakeholder workshop was held in March 2010, the main objective being to present and discuss the results from the CAEA field-testing in the four communes and discuss the revised CAEA Manual. The extent of benefits to the commune planning processes through the revised CAEA approach was explored. Steps to improve the institutionalization of the CAEA results in the commune development planning process were also discussed.

3.1 Methods and Tools with Emphasis on Land, Water Resources and Fisheries

A number of spatial and temporal tools were applied during the RRA stage of CAEA to gather information on land, water resource and fisheries at the commune level, which are:

Spatial Analysis

- *Maps and overlays*
- *Water-body attribute analysis matrix*
- *Fish species assessment table*
- *Water resource use matrix*
- *Flow diagrams*
- *Transect diagram*

Temporal Analysis

- *Land and water resources management strategies*
- *Historical profile*
- *Seasonal calendar*

3.1.1 Spatial Analysis

Maps and Overlays

In the old CAEA manual true-to-scale sketch map layers for overlaying of administrative boundaries, land use, soil types, water resources, etc., were used to identify AEA zones. It was based more on diagrams and schemas than on GIS maps. In the revised CAEA Manual a specific checklist is provided with rivers, streams, *boeungs* (natural ponds or small lakes) and other important water resources (including main fishing grounds, places for fish refuge, feeding and breeding – thus showing much utility for fisheries considerations) and irrigation systems (functioning systems and those in disrepair).

The advantages of the revised tool are (i) better identification of key water bodies and infrastructure. For example, both Sna Ansar and Sya are located on the Tonle Sap, and the mapping/overlay tool shows the extent of flooded forest in each commune, which is an area particularly important to fisheries. This is an improvement over the previous CAEA approach, where zones were identified but not clearly mapped; and (ii) this tool is also useful in applying other tools (transect diagrams, etc.).

The disadvantage of the revised tool are the need of experts and more information to draw new information types accurately and to scale on sketch maps. Satellite imagery (e.g., Google Earth) could help, as illustrated in an example of Chamnar Krom Commune shown in Figure 2.

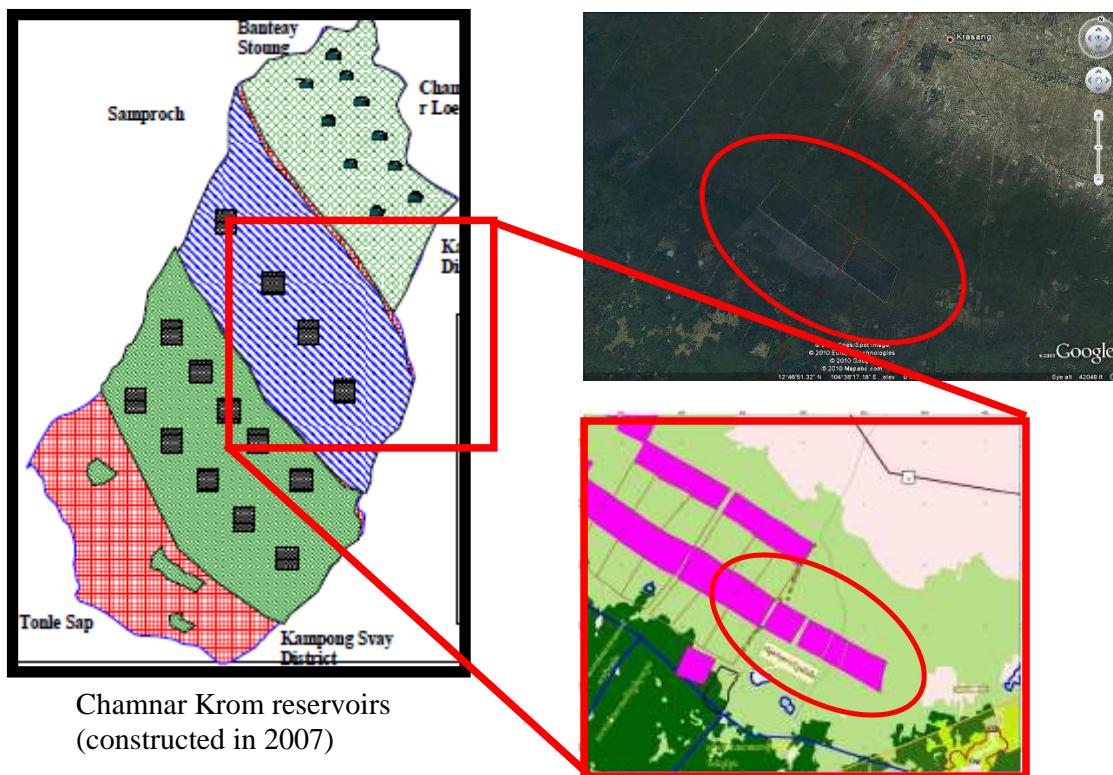


Figure 2. Example of using satellite imagery for maps and overlays.

Water-Body Attribute Analysis Matrix (WBAAM)

This is a new tool that did not exist in the old CAEA and was developed during the PN71. It is used to analyze the various uses and characteristics of the water bodies present in the commune. The matrix shows water body type vs. attributes, including accessibility of each type to provide stable, year-round benefits, comparison of productivity levels and identification of reasons for the differences.

The advantages of this tool are that i) it provides additional information on water resources and water use for agriculture and fisheries; ii) it provides information on seasonality of water bodies and connectivity between water bodies which were considerations largely absent using the prior tools; (iii) water use conflicts were identified using this tool in both Sna Ansar and Sya, which were not identified with the previous CAEA tools; and (iv) it gives a framework for water resource use analysis.

The issues or difficulties in application are that i) it is important to be specific about the characteristics of water body types in different zones (e.g., ponds are permanent in the floodplain, but ephemeral in uplands); and (ii) there is some overlap with the water resource use matrix introduced below (Table 2).

Table 2. Water-body attribute analysis matrix results from Samproch Commune 2010
CEA (simplified from final report version).

Water body	Creeks/streams (ou)	Reservoirs	Tonle Sap Lake
AEA zone	Medium and lower terraces Lower terrace for deepwater rice	Floodplain for recession and dry-season rice	Permanent flood water body (Tonle Sap-).
Water source	Stoung River Rain	Rain Tonle Sap	Permanent water body Mekong River
Water availability	From May to January	Year-round	Year-round
Major conflict in the use of water body	None	None	None
Link to other water bodies	Link to reservoir and lake in wet season	Link to Tonle Sap	Permanent water body Link to Mekong
Conflict	None	None	Conflict on fishing boundary between lot owner and small-scale fishers
Water use regulation	None	The contract between reservoir owner and farmers on using the water for recession rice	Lot owner does not respect the fisheries law Electrocute fish Use other illegal fishing gear
Water uses by women	For watering vegetables Fishing For watering animals For washing	Recession rice Fishing For animals	Fishing
Water uses by men	Same as by women	Same as by women	Same as by women
Fish breeding, feeding, refuge	Feeding, breeding	Feeding, breeding	Feeding, breeding
Migration of important fish species	Stoung River O'Roum Chek Creek Paddy field Pond Reservoir Lake	Lake Reservoir Migrate back to pond, small river, lake	From June to November, fish breeding in flooding forests, then migrate back to the lake. Fish, normally, lay eggs from June to August
Affecting environment of each water body	The application of pesticide in paddy field Electrocuting fish	The application of pesticide and chemical fertilizer in recession paddy field The chemical pesticide affects animal health	Use of chemical pesticide in recession paddy field Illegal fishing (using more tree branches to attract fish causes the lake to become shallow and spoil water quality) Electrocute fish

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Fish Species Assessment Table

This new tool (Table 3) created during PN71 is used to identify the five most important fish species water bodies of each zone and to rank priorities of the species by importance in local livelihoods, abundance, and value. This tool was used differentially in the Sna Ansar and Sya assessments; in Sna Ansar, each zone is considered individually, whereas in Sya the six zones are simply grouped into one of two categories (lower terrace or floodplain/seasonal flooding). Rankings of fish species are generated by either method, though grouping as with the Sya CAEA simplifies the overall output.

Table 3. Fish species assessment table (simplified) from Chamnar Krom 2010 CAEA report.

Water resource	#	Fish species	Season	Fishing gear used	Why are species important?	Change in last 10 years (%)	Species category	Quality rank
Lake	1	Snakehead	Year-round	Long line, gill net, trap, net	Like it as it is available in a lake and a place of sanctuary, especially the floodplain area	Decline 80%	Black	1
	2	Catfish				Decline 50%		5
	3	Climbing perch				Decline 60%		2
	4	Moonlight gourami				Decline 50%		3
	5	Southeast Asian yellow tail rasbora				Decline 50%		4
Canal	1	Mystus mysticetus	By season	Trap, cast net, gill net	For family consumption	Decline 50%	Gray	1
	2	Ompok hypophthalmus			Available to fish from December to February	Decline 70%	Gray	4
	3	Southeast Asian yellow tail rasbora				Decline 20%	Gray	5
	4	Trey Srakakdam				Decline 50%	Gray	3
	5	Moonlight gourami				Decline 50%	Black	2

Water Resource Use Matrix

This tool is used to improve understanding about the use of different water sources in the commune at different times of the year and was included in the old 2007 CAEA Manual, but was not applied under this matrix form in the original commune reports. In the revised CAEA Manual a new template is used, with additional parameters on resource characteristics (water quantity, quality, productivity, reliability, equitable access) that are explicitly linked to the WBAAM through water body types (Figure 3).

The advantages of this revised tool are that (i) it provides details on multiple uses of water, including fisheries; (ii) it helps in identifying water sources (providing a check on maps and WBAAM); (iii) it includes three categories relevant to fisheries: fishing, aquaculture, and fish productivity rankings and shows which type of water body(ies)

is(are) the most important for fisheries in both the wet and dry seasons (i.e., in Sya, the river and natural lake in the dry season vs. only the natural lake in the dry season); (iv) it can also reveal opportunities for fisheries (i.e., canals/reservoirs not being used for fish production); and (v) the template is easy to follow, with questions that are meaningful for the communities.

Its shortcomings are that (i) some overlap occurs with WBAAM on reliability, access and quality; and (ii) it requires a degree of prior knowledge to assess/estimate some of the parameters.

Water source	Reservoir	Creek/ Stream	Rain	Canals	Small lake	Tonle Sap Lake	Pond	Tube well
Wet season (June – December)								
Water use								
Fishing	✓✓	✓✓			✓✓	✓✓	✓	
Aquaculture							✓	
Water resource characteristics								
Fish productivity	✓✓✓	✓		✓✓	✓✓			

Figure 3. Simplified water resource use matrix for the Sampach Commune, adapted from 2010 CAEA. Only fisheries-relevant data are shown, and for one season only.

Flow Diagrams

Flow diagrams are used to describe the flow of materials, money, information, labor, etc., between the different zones in the commune. In the old CAEA Manual, a range of visual representations were suggested, with a note that these are "equally valid, and selection should be made according to the preference and familiarity of the participants." Minimal information on fisheries was included in these diagrams.

In the revised CAEA Manual, the flow diagram is split into two separate diagrams and color coding is introduced to present the up-down system hierarchy, flows into and out of the commune and zone-to-zone interactions, including fish migration in wet and dry seasons (Figure 4).

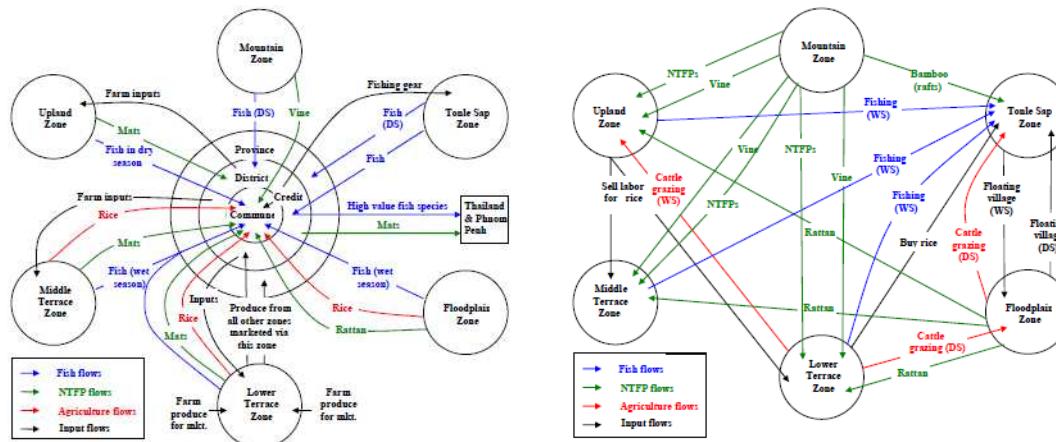


Figure 4: Flow diagrams for system hierarchy (left) and zone-to-zone interactions (right) Note: mkt.=market

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The advantages of these flow diagrams are that i) they are easier to create with the contribution of participants, and (ii) they constitute a clearer representation of the flow of different products through the interactions among zones.

In most cases, land and water issues are not explicitly included in flow diagrams in the current reports, but are represented within other flows (such as inputs, production), since land elements do not "flow" (although inputs such as fertilizers do) and as the flow of water is usually obvious, it needs to be included only if there is something unusual (e.g., pumping between areas). Where water quality is an issue, flow of pollutants should be captured.

Transect Diagrams

Transect diagrams are used to describe and compare agroecosystems based on a list of physical and socioeconomic parameters. Digital photos can be used to illustrate the ecosystems. Before PN71, this tool included fisheries in both land use and opportunities, but fisheries were only associated with the water resources zone where wild fish were identified as a resource (not in other zones). Several issues and opportunities pertaining to this zone were identified, but other opportunities in other zones were possibly overlooked.

In the revised CAEA new variables on water resources, fish and nutrition are included (Table 4), and an iterative process of revision and refinement throughout the CAEA process is proposed.

The advantages of the revised CAEA are that i) additional information is provided, so that participants can clearly see the relationships and connectivity from one zone to another across different sectors; (ii) participants can check data provided from other sources; and (iii) CAEA provides an initial analysis of important problems and opportunities. However, a disadvantage of this tool is that its use is time-consuming.

Table 4. Comparison of checklists for transect diagrams provided in the old and new CAEA manuals.

New manual	Old manual
Representative photo	Photo
Agroecosystem	Agroecological zone
Land cover	
Topography	
Natural ecology, wildlife	
Geology and soils	Soil type
Hydrology	Hydrology
Important water bodies	Water source
Irrigation schemes/types	
Wet-season land use	Land use
Dry-season land use	
Crops	Crops
Livestock	Livestock
Fisheries	
Major income sources	
Major nutrition sources	
Problems	Problems
Opportunities and key issues	Opportunities

Table 5. Fisheries component of the transect diagram of Sna Ansar Commune (2010 CEA), simplified from the complete table in the report.

Description	Mountainous zone	Lowland lower terrace	Floodplain	Tonle Sap Lake zone
Water resources	Year-round streams with deep pools	Seasonally dry creeks	Lakes (21) and trap ponds (3)	Permanent water body
Fish	Catfish, snakehead, <i>Trei Sarn</i> Catches stable	Black fish Catches down by 70% since 2002	Gray fish Catches down by 70% since 2002	Gray fish Catches down by 60-70%, but some species increasing
Wet-season land use	Cattle grazing	Medium and long-duration paddy rice, vegetables, fruit trees, residential	Deepwater rice, collection of non-timber forest products (NTFPs) such as rattan, fishing, floating village	Fishing, cage-culture (4-5 families)
Dry-season land use	Fishing in deep pools, timber extraction, NTFPs, hunting, cut-and-carrying grass	Fruit trees, cut-and-carrying grass, sugar palm	Fishing, collection of NTFPs (rattan and roof thatch), cut-and-carrying grass, firewood	Fishing, limited recession rice on islands, cage-culture (4-5 families), floating village
Animals	Wildlife, cattle in wet season	Buffalo, pig, poultry,	Wildlife, cattle grazing	Fish
Major income sources	1. NTFPs (vine and <i>dipterocarp</i> resin) 2. Wildlife 3. Fish	1. Rice 2. Fish 3. Rattan weaving	1. Rice 2. Fish 3. NTFPs (rattan)	1. Fishing 2. Pig-raising 3. Fish cage culture
Major nutrition sources	1. Fish 2. NTFP (edible tree leaves) 3. Wildlife	1. Rice 2. Fish 3. Vegetables	1. Deepwater rice 2. Fish 3. Edible tree leaves (flooded forest)	1. Fish 2. Edible tree leaves (flooded forest) 3. None
Problems and key issues	Reduction in availability of NTFPs (vine and resin). Wildlife hunting. Illegal logging Destruction of forests Soil erosion	Siltation of waterways Low soil fertility Lack of improved rice varieties Inappropriate rice production techniques Rice insect pests Unserviceable irrigation infrastructure	Fishery law regulations too strict for livelihood needs Low deepwater rice yields Lack of capital to buy fishing gear Decreasing availability of rattan Decline in fish stock	Strong winds deter boats New seine net fishing destroys gill nets Fish disease in cage culture (gill flea) Fishery law not followed Lack of non-fish family nutrition sources
Opportunities	Watershed conservation	Irrigation rehabilitation	Replanting of flooded forest	Vegetable gardens on

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Description	Mountainous zone	Lowland lower terrace	Floodplain	Tonle Sap Lake zone
	Ecotourism development Wildlife conservation Establishment of forestry community	Improved rice technology (varieties, practices, etc.) Improvement in soil fertility using compost Chicken vaccination Aquaculture Agricultural credit	Firebreaks in flooded forest Improved vegetable-growing techniques Irrigation development for recession rice	islands or rafts Improved cage- culture techniques Improved pig-raising techniques

3.1.2 Temporal Analysis

Land and Water Resources Management Strategies

In the old CAEA Manual, land management strategies were developed for agroecological zones by using a template of land type, land use, strategy, and technical elements by zone. The strategies were not provided in this form in reports but instead only identification of issues/questions/innovations was mentioned. In the revised CAEA Manual, strategies for management of water and fisheries resources strategies are added separately. The advantages of this revised version are (i) adding an important water dimension to the strategies and (ii) explicit consideration of interactions between land, water and fisheries management. The disadvantage is the complexity in adding strategies for a dynamic resource such as water that is, in many cases, out of the management capacity of the commune.

Developing strategies requires “visioning” of optimal future use for each zone. There was a perception at commune level that this is difficult and/or risky when based on estimated or incomplete data, limited capacity and limited understanding of land use planning at the commune level. In addition, strategies have not been used widely in developing commune plans, and so are not linked to funding streams and are seen as an academic exercise. However, designing strategies for each zone is a crucial component of CAEA, as it is a way of integrating plans and proposals from all sectors and capturing potential interactions and impacts. It is an important step in thinking beyond the current status to the desired future, and the steps needed to get there. To realize their full value, strategies must be better integrated into the commune planning process.

Historical Profile

Before PN71, this tool was called a “commune profile,” and gave general background information from 1970 to the present. Data were arranged only by data per se in this early version of the tool, and were not grouped under headings (such as fisheries, etc.).

After PN71, this tool attempts to provide a much more detailed historical record of agroecosystem characteristics and changes from 1960 to the present (this change was incorporated after the first pilot testing in Sna Ansar). This profile is more organized, and includes explicit information on fisheries, particularly changes in the proportion of fishers in the commune and the abundance of fish over time. While this information is clearly presented in the revised CAEA, it would be of greater use to further summarize the information to make it clearer where, when, and by what degree changes have occurred, rather than exhaustively listing the characteristics of each time period. In this manner, the 2010 CAEA of Sna Ansar serves as a preferable template, as the CAEA historical

profile of Sna Ansar (Table 6) is relatively brief and places more emphasis on important changes.

Table 6. Partial historical profile of Sna Ansar as pertaining to fisheries, circa 2010 (adapted from Sna Ansar 2010 CAEA).

Political	1970-1975	1975-1979	1979-1990	1990-1993	1993-1998	1998 - 2003	2003-2009
Environment	Negligible environmental impact			Impacts begin		Large impacts	
Periods	Pre-1979		1979- 1990	1990 - 1998		1998-2009	
Change in fish stocks (production, species mix, local extinctions)	• Catch < 20 kg fish/day • Many species caught	• Catch < 15 kg fish/day	• Fish catch < 10 kg/day. • Fish extinctions begin • 40% decrease in stocks	• More local extinctions of fish species • 70% decrease in stocks			
Fishing changes sites, access, people, gear, laws, etc.	• Fishing in groups (10-15 persons) • Homemade fishing gear • Gill nets introduced in the late 1960s	• Fishing in groups	• Cage culture introduced • Aquaculture begins • Illegal fishing begins	• Small-scale fishing declines • Large-scale fishing starts to dominate • Aquaculture increases			

Seasonal calendars

Before PN71, this tool presented a wide range of data pertaining to commune activities arranged by seasonal occurrence. Data on fisheries, however, were lacking from the original CAEA, as in the 2005 CAEA of Sna Ansar, the seasonal calendar makes no mention of fishing activities. The 2008 CAEA of Chamnar Krom, meanwhile, only includes seasonal prices of fish, again omitting information on seasonal fishing activities.

After PN71, this tool has been revised to better summarize the wide variety of activities in the context of when they are performed throughout the year, including fisheries. For example, in the 2010 Chamnar Krom CAEA, this tool identifies the timing and location of seasonal fishing activities. While useful for a summary of seasonal activities, from a fisheries perspective, some of the information here is redundant following the tools already discussed, particularly the Water-Body Attribute Analysis Matrix, which has a "seasonality" section that includes the bulk of the information presented for fisheries in the seasonal calendar (Figure 5).

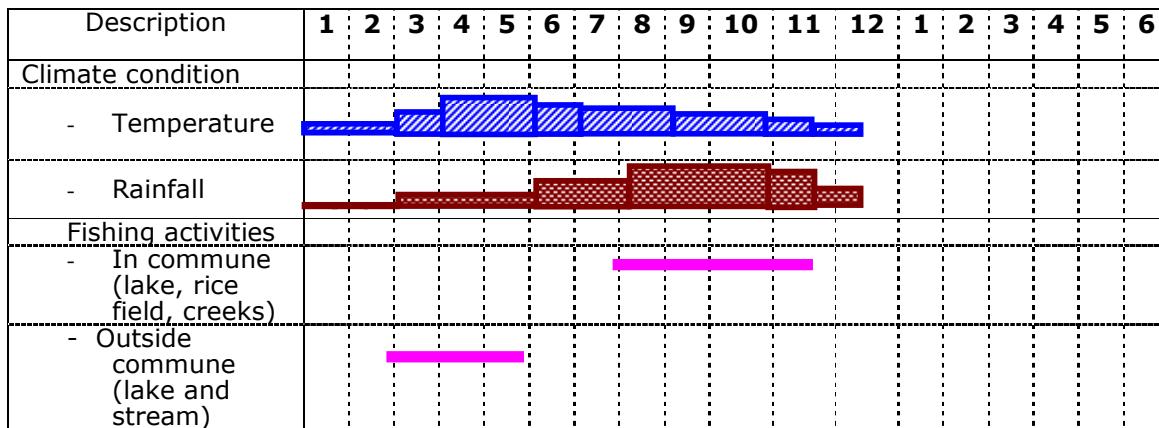


Figure 5. Seasonal calendar of fishing activities from Chamnar Krom (adapted from 2010 CAEA) (numbers 1 to 12 and 1 to 6 represent names of months of the year in ascending order).

3.1.3 Results for Land, Water Management and Fisheries

The key results from the CAEA reports in terms of priority issues and actions for land and water management are set out in Table 7 for the northern communes (Chamnar Krom and Samproch) and in Table 8 for the southern communes (Sya and Sna Ansar).

Northern communes - Chamnar Krom and Samproch

Chamnar Krom and Samproch are adjoining communes, and have similar issues and priorities. Samproch includes areas along the Tonle Sap Lake, whereas Chamnar Krom is separated from the lake by the Phat Sanday Commune, and the communities distinguished slightly different AEZs (see Table 7). Priority issues and actions identified varied between the different AEZs as shown in Table 7.

In the 2007 report, in Chamnar Krom, the main focus was on issues relating directly to agricultural production (rice cultivation methods, irrigation infrastructure, management of fishing grounds), and strategies were developed for the commune as a whole, not for the different zones. In the 2010 report, using the new CAEA Manual, strategies were differentiated across zones, and there was a stronger emphasis on resource management, as well as on production. The main issues identified were:

- Canal rehabilitation to improve irrigation access for wet- and dry-season rice, and dry-season vegetables.
- Management of the 21 irrigation reservoirs constructed in 2007, and assessment and management of their impacts on fish and ecology.
- Improved on-farm water management, through construction of dykes, leveling of fields and construction and management of community ponds.
- Provision of reliable domestic water supplies was identified as the most pressing need in the dry season; options were identified to use existing irrigation canals to supply domestic water, and for multiple use for gardens and livestock.
- Protection of flooded forest and grassland areas as fisheries habitats.

In Samproch (2010 report) the main focus was on:

- Improved access to water for rice, cash crops and animals, through feasibility studies on irrigation, rainwater harvesting, and extension and training on irrigated farming.
- Improved water management for recession and dry-season rice through community management of 18 reservoirs constructed in 2007 (including assessment of the impacts of these reservoirs on ecology and fisheries), establishment of a farmer water user group and training in irrigation system operation and management.
- Improved on-farm water management, through construction of dikes, leveling of fields, construction and management of community ponds and introduction of water-saving technologies
- Lack of domestic water in the dry season was identified as a significant issue, with impacts on health as well as on nutrition, due to constraints on dry-season production from gardens and livestock.
- Protection of flooded forest and grassland areas as fisheries habitat.

There is an obvious commonality of issues and actions identified across the two communes. Both these recent reports identify a review of the new reservoirs (constructed in both communes in 2007) as a high priority. Concern was expressed regarding construction of reservoirs without consultation, training or impact assessment, and without consideration of issues of landownership and access. High priority is given to both assessing the impacts of disruption in water flow on grasslands and fish and identifying methods to operate the reservoirs to mitigate these impacts.

In terms of the fisheries sector, in the reports prepared using the new manual, there is a notable shift in emphasis from catch control (illegal fishing and management of fishing grounds) to inclusion of habitat protection (management of flooded forests and natural ponds). The new reports demonstrate a greater awareness of impacts of land and water use, and the significance of the condition of the resource base for production of both fish and crops (e.g., soil and water pollution). There is also a new focus on community-based *conservation* groups (flooded forests, wildlife) as well as *resource* groups (water user group, community fishery group), and active engagement in conservation initiatives such as demonstration sites for habitat management and replanting days for forests.

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Table 7. Priority issues and actions from CAEA for Chamnar Krom and Samproch communes.*

Proposed actions land and water strategies	Chamnar Krom 2007	Chamnar Krom 2010	Samproch
Construction or repair of irrigation infrastructure	X	1,2,3	3
Improved irrigation practices (including review of operation and impacts of constructed reservoirs)		2	2,3
Water user associations	X	1,2,3	
Rural roads			1
Ponds (community/farm) and aquaculture	X	1,2	1
Improved rice cultivation methods [System of Rice Intensification (SRI), Integrated Pest Management (IPM), soil fertility management, change to recession rice]	X	1	1,2,3
Diversified cash crops			1,2
Protecting natural habitats (ponds, flooded forests) – establishing conservation sites and/or community conservation groups	Fisheries only	2,3	2,3 4,5
Managing fishing grounds	X	2	3,4,5,6

*Numbers refer to the AEZs for which particular strategies were proposed in the reports, as follows:

Chamnar Krom

1. Lowland lower terrace (mixed crop and residential area)
2. Lowland lower terrace (short period flooding for recession rice)
3. Lowland lower terrace (long period flooding for recession rice)
4. Lowland with reserved flooded forests

Samproch

- 1 Lowland lower terrace, wet-season rice
- 2 Lowland lower terrace, long-period rice and deepwater rice
- 3 Floodplain for recession and dry-season rice
- 4 Floodplain with flooded forests and fish reserved
- 5 Tonle Sap Lake (permanent water)
- 6 Lowland lower terrace, wet-season rice

Note: X denotes topics where it was not clear a) which specific units had these issues and b) whether they were relevant for all units.

Southern communes – Sna Ansar and Sya

Sna Ansar and Sya communes are close, but not adjacent. Both include areas along the Tonle Sap Lake, but Sna Ansar runs back from the lake further into the uplands, and the

community in Sna Ansar has identified mountain and upland zones that are not present in Sya that, however, has distinguished more zones within the lowland terrace and floodplain. Priority issues and actions identified varied between the different AEZs as shown in Table 8.

In the report prepared for Sna Ansar in 2005, strategies focused on production methods, and control of fish catch through community fishery and awareness of fisheries law. Strategies were not differentiated across zones. In the 2010 report for Sna Ansar, an additional zone was identified which distinguishes the floodplain from the zone of open water, recognizing the importance of the seasonally wetted zone as a habitat. Strategies and actions were differentiated for the different zones. Priority issues identified included:

- A proposal for the a) Royal Government of Cambodia (RGC) as part of the Commune Development Plan to establish a Social Land Concession in order to improve access to land for poorer families, discourage land grabbing by powerful interests, and prevent deforestation and b) a preliminary survey to identify available land and land-poor families.
- Irrigation improvement, including rehabilitation of existing systems for wet- and dry- season rice and diversified cash cropping, and provision of water for domestic purposes. This includes feasibility studies, field surveys, training and capacity development.
- Improved on-farm water management through construction of dikes, leveling, community and farm ponds, and introduction of water saving technologies.
- Protection of upland forests, flooded forests and grassland areas as habitats.

The report prepared using the new manual has a stronger focus on protection of habitats not only for fisheries, but also for the uplands; conservation zones are proposed in the uplands to protect biodiversity and catchment areas. The newer report demonstrates a greater awareness of a diversity of water sources, with proposals to develop storage in the uplands and groundwater in lowland terraces, as well as improvements to irrigation infrastructure. Water quality and sanitation issues are identified as a priority, with an understanding of the impacts of livestock-raising on water quality and proposals for improved livestock management in the lake zone.

In Sya, priority issues identified included:

- Improved water access for rice, cash crops and animals through improvement of secondary and tertiary canals from the Charek Reservoir for both wet- and dry-season use.
- Improved irrigation management, through extension and training on irrigated farming and sustainable operation and maintenance (O&M) of irrigation systems, and the establishment of a farmer water user group (based on participatory irrigation management principles).
- Improved on-farm water management through construction of dikes, leveling, community and farm ponds, and introduction of water saving technologies.
- Provision of reliable domestic water supplies was identified as the most pressing need in the dry season; options were identified to use existing irrigation canals to supply domestic water, and for multiple use for gardens and livestock.
- Implementation of integrated water resources management (IWRM) principles to support multiple uses of water (fisheries, irrigation, domestic use, etc.).
- Protection of flooded forest and grassland areas.

In both communes, the newer reports identified the need for community-based *conservation* groups (flooded forests, wildlife) as well as *resource* groups (water user group, community fishery group).

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Table 8. Priority issues and actions from CAEA for Sna Ansar and Sya communes.

Proposed actions land and water strategies	Sna Ansar 2005	Sna Ansar 2010	Sya 2010
Construction or repair of irrigation infrastructure		3,4,5	1,2
Irrigation management and impacts		3	1
Water user association			1,2
Bank protection works (manage cattle route)			1,2
Ponds (community/farm) and aquaculture	X	3	1,2
Improved rice cultivation methods [System of Rice Intensification (SRI), Integrated Pest Management (IPM), soil fertility management, change to recession rice]	X	2,3,4	1
Diversified cash crops	X	2,4	
Protecting natural habitats (ponds, flooded forests) – establishing conservation sites and/or community conservation groups		1,2,5,6	2,3
Community fisheries group/management of fishing grounds	X	5,6	2
Groundwater development		3	2
Ecotourism		1,5,6	
Social land concession		2	
Water quality management (sanitation/livestock)		6	

Note: X denotes topics where it was not clear a) which specific units had these issues and b) whether they were relevant for all units.

* Numbers refer to the AEZs for which particular strategies were proposed in the reports, as follows:

Sna Ansar	Sya
1 Mountain zone	1 Upper terrace (mixed crop and residential area)
2 Upland zone	2 Lowland lower terrace
3 Lowland middle terrace zone	3 Lowland lower terrace (Long period flooding for dry rice)
4 lowland lower terrace zone	4 Floodplain for deepwater rice
5 Floodplain zone (2010 report only)	5 Floodplain with reserved flooded forests
6 Tonle Sap Lake zone	6 Scrubland-grassland

3.1.4 Discussion on Land, Water Management and Fisheries

Common issues emerged from all communes regarding access to irrigation and on-farm water management. Although there were differences of emphasis in the proposed solutions, all communes identified the need for information and training on farming and irrigation techniques, and O&M of irrigation infrastructure. Similarly, all communes identified the need to establish and/or better support farmer water user groups.

Provision of reliable domestic water supplies in the dry season was identified as a very high priority in all areas. Suggested solutions included a more integrated approach to water supplies, with multipurpose use of canals and ponds for agriculture, fish and domestic use.

All communes recognized the importance of community approaches to land and water management, and proposed the establishment of relevant community management groups (farmer water user groups, conservation groups for flooded forests).

The reports prepared using the new CAEA manuals demonstrated a broadening of focus from dominantly production issues (rice aquaculture, livestock) to a combination of both production and natural resources management, and a much greater understanding of the importance of habitat and resource conditions (including water quality) in ensuring production. The newer reports had greater emphasis on water in terms of a greater diversity of water sources, greater awareness of issues of water access and a more integrated approach to multipurpose use of water supplies.

With regard to the revised tools, some of the important aspects that have emerged are as follows:

- *Maps and overlays* are important tools for spatial analysis; in particular, the water resources are strongly linked to the availability and development of infrastructure; and they have significant impacts on fisheries. The development of media, Internet, mobile phones, etc., also provides significant information to the communities in identifying the location of their resources.
- *WBAAM* is a new tool to support the *Water Resource Use Matrix* to provide detailed variations in water resources that are important for agriculture and, in particular, for fisheries and aquaculture. A constraint in using these tools is the dynamics of water that requires more regular updated information on its variations; therefore, these tools should be reapplied more often in combination with other water-related tools such as the land and water management strategies.
- Two color *flow diagrams* for system hierarchy and zone-to-zone are useful tools to show the linkage in production systems and also the sharing of resources and benefits that are strongly influenced by the institutional structure and the culture of the communities. These tools are supported by the *transect diagram* that presents the interactions of resource uses across agroecological zones and impacts on the new focused products of this CAEA revision, i.e., fish and other aquatic products.
- *Land and water resources management strategies* are identified more explicitly with the revised CAEA Manual. The outputs are more useful information to the community and provincial as well as sectoral development plans. The process of developing the strategies can also be considered as a participatory planning exercise with a bottom-up approach that brings up comments of the communities to the development strategies developed by higher-level managers. On the other hand, during this exercise, the communities also have opportunities to understand and revise the existing strategies.

3.2 Methods and Tools with Emphasis on Livelihoods

Under the livelihoods analysis, there were six key tools used in the CAEA approach in the RRA stage. These are:

- Wealth ranking
- Developing livelihood profiles
- Gender analysis
- Non-Timber Forest Products (NTFPs)
- Gross margin analysis
- Market and value-chain analysis

In addition, relevant fisheries livelihood variables were incorporated into all the other spatial, temporal and economic analyses and decision-making tools as well.

Wealth Ranking

Wealth ranking is a popular tool used in PRA methods. Wealth rankings undertaken by local people can be used to study the variations in the poverty levels within a community. They are useful not only to determine what criteria communities use to measure wealth, and what their definitions and indicators of wealth are, but also to learn about the socioeconomic stratifications that exist within a community (Reitberger-McCraken and Narayan 1998). Usually, wealth rankings are conducted at the village level to better understand the variations in the wealth status of different households within the village.

In the case of the original CAEA, wealth-ranking exercises were conducted at the commune level usually to develop general farming system typologies for each wealth class within the commune that was then used for comparison and analysis. They were used to gain insights into the characteristics, needs and opportunities of each wealth class, particularly of the poor. Wealth analysis helped refine key questions to ensure that they target the poorest as a priority (CAEA 2007). In this case, it is not possible to collect information on individual households in the commune.

In the case of the revised CAEA, for the wealth-ranking exercise, the criteria for distinguishing between wealth groups were broadened to include fisheries-related criteria that can help differentiate between different wealth groups, e.g., type of fishing engaged in, different gear owned and used, and relative income obtained from fishing.

In addition, the importance of ensuring that the correct participants were engaged in the exercise was emphasized. For instance, it was made clear that respondents should include those engaged in fishing (both men and women), different age groups and, most importantly, representatives from different wealth groups.

The advantage of the revised wealth-rankings methodology was that it helped identify fisheries-related issues faced by different wealth groups and helped assess the relative importance of fishing compared to other livelihoods activities.

One of the key disadvantages (in both old and new versions) was that there were some difficulties in aggregating wealth-related information at the commune level.

Developing Livelihoods Profiles

This was a new tool developed under PN71 and adopted in testing from the second pilot site onwards. Adapted from the sustainable livelihoods approach, livelihood profiles were developed to provide greater focus and to integrate an assessment of livelihood assets (capital) and key factors that affect livelihood opportunities into the CAEA process.

The major income-generating activities within an AE zone provide the focus for this assessment. The tool should be used for each agroecosystem zone individually unless the major livelihood activities are similar across all zones. Usually, up to three major income sources (i.e., livelihood activities) are identified for each agroecosystem. These will often be noted during the identification of agroecosystem zones in the commune during the preliminary analysis (stage 3) of CAEA. They may also be identified based on the findings of the transect walk or wealth ranking.

Some activities such as fishing may be found in more than one zone and the assessment for that activity need not be repeated for one commune. But fishing in one zone might be very small-scale, occurring in rice fields and carried out by poor people while fishing in another zone might be in deeper water and require boats and different fishing gear. In this case, the livelihood profile should be completed for each of the two different fishing activities.

A table has been designed to fill in each livelihoods profile. The first part of the table identifies who is involved in the activity (record the gender and wealth categories). The second part considers each of the livelihood assets: human, natural, physical, financial and social capital and records the most important of these assets needed for the particular livelihood activity and what may be missing or lacking, either for everyone in the commune or for one or more of the wealth categories.

In addition, vulnerability factors are considered. These are aspects that can influence the success of an activity and how much income it generates but are beyond the control of people in the commune. For example, some crops may be more vulnerable to extreme weather or to variation in market prices. Some forms of fishing may be more vulnerable to overfishing by others.

Thereafter, key organizations that help an income-generating activity to succeed are noted. This could be a formal organization such as agricultural extension which provides the necessary technical advice, for example, how to control animal diseases. Or it could be an informal village organization which arranges labor-sharing or helps people borrow money to buy inputs.

Finally, the laws, rules or customs (institutions) necessary to ensure that the income-generating activity is successful and can continue in the long term are recorded.

Each row in the table considers whether the issue is the same for all people or whether there are worse problems for women compared to men, or for poor people compared to wealthier people. Any problems identified are noted.

Therefore, one of the advantages of the livelihoods profile was that it helped identify problems associated with different livelihoods and key institutions that could help solve the problem.

One of the key issues associated with the tool was that the general livelihoods terminology may be unfamiliar to some facilitators who may therefore find difficulties in obtaining the best results from the tool. To address this problem a simple glossary of livelihoods terms was developed and incorporated as an Appendix in the revised CAEA Manual.

Gender Task Analysis

The Gender Task Analysis tool provides disaggregated information on the proportion of men and women who engage in each livelihood subtask. This provides a better understanding of the different roles played by men and women in the various livelihood activities undertaken in the commune as this will help ensure that the needs of both men and women can be adequately addressed during the formulation of key questions and the designing of solutions and innovation assessments. It will also help in better understanding both the positive and negative impacts potential TIPs could have in the case of gender.

In the original CAEA, the Gender Task Analysis simply provided an idea of whether males or females were involved in a particular livelihoods subtask. No information was given on the more detailed labor breakdown. Also more emphasis was placed on agricultural subtasks and less information was gathered on the other livelihood activities in the commune.

In the revised CAEA, the specific check list includes a listing of all important livelihood activities in the commune including all fisheries activities, e.g., fishing (for income and consumption), marketing, processing, preparation for cooking, making fishing gear, and so on. Moreover, the role of men and women in each livelihood activity is determined and the labor involvement in terms of gender is quantified as a percentage. The advantage of this is that it gives a clearer picture regarding gender disaggregation in each activity, provides more details in relation to gender-labor breakdown and therefore helps identify target groups for livelihoods training programs that may be linked to innovation assessments and TIPs.

Non-Timber Forest Products (NTFPs)

The collection of NTFPs is often an important livelihood activity, particularly for poor families. In the context of the CAEA, the term 'NTFPs' has been extended to include aquatic resources found in the flooded forests. It is important to gain an understanding of NTFPs during CAEA because agricultural and other livelihood development activities may impact on their availability. It is also useful to explore possibilities for sustainable harvesting and domestication, especially if the NTFPs are significantly contributing to the livelihood portfolio of poorer families. In the original CAEA there was no disaggregation of collection of NTFPs in terms of gender and no attempt to quantify the decline in NTFPs.

In the new version, there is gender disaggregation at the commune level and the decline is quantified as a percentage and reported over the last 5 years. The advantage of this is that presenting the decline in a quantified manner makes it easier to prioritize the key NTFPs that require conservation action or a sustainable use action plan. For example in Sna Ansar, rattan and vine for mat weaving are two important NTFPs from a perspective of livelihoods and these are decreasing significantly. In this case, the possibility of domestication can be explored and also linking to other relevant initiatives, for example, the OPEC FAO project that is working in the floodplains within an area of 100 ha and looking at sustainable use of NTFPs. The gendered differentiation of who is involved in the collection of different NTFPs will help provide a more gender-sensitive targeting approach when undertaking innovation assessments and livelihood programs.

Gross Margin Analysis

Gross margins for major enterprises are developed using information derived from the farmers during the RRA stage. In the original CAEA, gross margins were used to promote a better understanding of local production systems, and to help identify where improvements can be made. With regard to fish and NTFPs, gross margin analyses are

generally only conducted for aquaculture or domesticated enterprises in NTFPs, not wild, for capture systems.

In the revised CAEA, gross margin analysis is conducted for three enterprises with respect to income including one fisheries enterprise (plus one agriculture- and one livestock-linked). The advantage in terms of fisheries enterprises would be to provide a good idea of the fisheries-related innovations that can be promoted in the commune.

One issue facing *both old and new versions* is the difficulty to get accurate data sometimes (e.g., breakdown of costs, as estimates of most participants are vague).

Market and Value-Chain Analysis

This is a new tool included under the RRA stage of the CAEA process. Value-chain mapping allows for better understanding of market-related problems and opportunities for important livelihood products (crops, livestock, fish, NTFPs, and so on). Value-chain maps show the flow of a product through the marketing chain and help identify where and how value is added to the product by the activities of different actors in the chain.

Analysis of completed value-chain maps allows price and market constraints to be identified along with opportunities for enhancing value added by additional or alternative operations by value-chain actors. The advantage of the analysis is that outputs of the value-chain maps can be used to plan market-related interventions (marketing TIPs).

One of the issues with the tool is that, for some parts of the chain occurring outside the commune, it is not easy for participants to provide accurate data.

3.2.1 Results of Livelihoods Analyses

With regard to the wealth rankings, in the pilot testing undertaken in the four communes, the results indicated that there were common indicators of wealth that were usually used at the commune level to distinguish between different wealth groups (see Table 9). For example, the major indicators of wealth were landholding size, possession of farming assets, fishing assets and ownership of cattle and pigs. For the poorest wealth category, the lack of land or landlessness was an important indicator of poverty. In terms of fishing, they did not have access to more productive fishing grounds due to not owning fishing boats or appropriate fishing gear. In the first piloting, the participants divided their commune into three broad categories of wealth whereas in the subsequent three pilots, the participants divided each commune into four wealth categories in line with the more realistic scenario in these communes.

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Table 9. Summary results from the wealth-ranking exercises conducted in the four communes.

Sna Ansar	Sya	Chamnar Krom	Samproch
WR exercise per AE zone	WR exercise for the commune as whole	WR exercise for the commune as whole	WR exercise for the commune as whole
Divided into three wealth groups -- better-off, medium and poor	Divided into four wealth groups -- better-off, medium, poor and poorest	Divided into four wealth groups -- better-off, medium, poor and poorest	Divided into four wealth groups -- better-off, medium, poor type 2 and poor type 1
Major indicators of wealth -- landholding size, possession of farming assets, fishing assets, ownership of cattle and pigs	Major indicators of wealth -- house type, landholding size, farm size, possession of farming assets, fishing gear, ownership of livestock, cattle and pigs	Major indicators of wealth -- house type, landholding size, house plot, possession of farming assets, fishing gear, ownership of livestock, cattle and pigs	Major indicators of wealth -- land for settlement, ownership of household assets, size of paddy fields (rain-fed and recession), ownership of livestock, cattle, pigs, chicken and ducks
Poor group -- Very small land holdings (< 0.25 ha) in all AE zones – lack of land a major driver of poverty Own no cattle or pigs but do own poultry No access to more productive fishing grounds (because of not owning boats, etc.)	Poorest group -- Very small farm (land) size (0- 0.25 ha), lack of land a major driver of poverty Own no cattle or pigs but do own poultry (about 1-5 chicken/ducks)	Poorest group -- Do not own land (landless), lack of land a major driver of poverty Own no cattle, pigs or poultry Sell labor Use NTFPs Own some fishing gear	Poorest group -- Do not own land (landless) Do not own paddy fields Own no cattle, pigs or poultry Sell labor Engaged in fishing

Livelihood activities appeared to be in general similar in the four communes as they share a similar geographical location in terms of being adjacent to the Tonle Sap Lake. A livelihood profile was developed for the following livelihood activities in the Sya, Chamnar Krom and Samproch communes (Table 10). The tool was not used in Sna Ansar.

Table 10. Different livelihoods profiles conducted in the communes.

Sna Ansar	Sya	Chamnar Krom	Samproch
Tool not used	1. Deepwater rice/floating rice 2. Chicken-raising 3. Fishing (upper and lower floodplain zones)	1. Fishing (lowland lower terrace zone with short flood period for recession rice zone) 2. Fishing (floodplain seasonally flooded zone)	1. Medium duration rain-fed rice 2. Fishing (deepwater rice zone and seasonally flooded zone) 3. Fishing (deepwater rice zone and seasonally flooded zone)

An example of a livelihood profile developed for fisheries for Chamnar Krom (Table 11) is given below.

Table 11. An example of a livelihood profile provided for fishing in Chamnar Krom.

Agroecosystem zone 2	Floodplain seasonally flooded zone	
Livelihood activity	Fishing	
Primarily involves	Comment:	
Men	√	Men about 95%
Women	√	
Wealth category		
Better-off	√	3%
Medium	√	50%
Poor	√	80%
Landless	√	100%
Key livelihood assets	Description	Deficiencies/needs:
Human capital	Skill in using gill net, trap, cast net, etc. Knowledge on the availability of fish	Lack of technique in fishing Illegal fishing
Natural capital	Pond/marsh, lake, flooded forests, river, creek, canal, fish	Loss of fish species Canal, pond shallower
Physical capital	Fishing gear: trap, cast net, gill net, boat	Not allowed to use gill nets with small holes Electrocuting fish (forbidden)
Financial capital	Contracted credit without interest payment (middleman giving an advance payment with the caveat that the recipient should not sell the catch to other	Lack of capital Difficult to access credit from micro-finance institutions Price controlled by credit provider

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	persons) Own investment	
Social capital	Fish-lot owner Trader Savings group Community fisheries	Community fisheries are still weak
Vulnerability factors	Chop flooded forests along the ponds Loss of fish species Illegal fishing	Need to strengthen community fisheries for assisting in protecting flooded forests and stopping illegal fishing
	Description	Comment
Key organizations	FIA (Fisheries Administration), Ministry of Environment, local authority Stop illegal fishing Stop chopping flooded forests	Awareness of conservation of flooded forests Strengthen the capacity of community fisheries
Laws, rules and customs affecting livelihoods	Fisheries Law Local practice (clearing flooded forest, illegal fishing)	Relevant institutions do not cooperate in implementing the Fisheries Law Need to curb some local practices that contribute to the loss of the fish habitat

From the gender task analysis it appears that overall livelihood tasks are fairly equally shared by both men and women, although there is a distinct gender disaggregation in some tasks. For example, in wet-season rice cultivation, while both males and females are equally engaged in sowing the seeds, they focus on different tasks (females soak seeds while males assist in broadcasting them). Providing additional observations during the gender-analysis exercise was therefore useful to distinguish between tasks. On the other hand, certain livelihood activities may be mainly done by males and other activities mainly done by females. These activities showed similarities between the different communes although the exact percentages varied somewhat by commune. For example while fish processing and storage are considered about a 90% female-linked task, in the Sya commune, the corresponding ration in Samproch is 100%.

Table 12. Summary results from the gender analysis conducted in the four communes.

Sna Ansar	Sya	Chamnar Krom	Samproch
Livelihood activities: rain-fed rice cultivation, fishing activities, NTFPs, cattle-, pig- and poultry-raising, home-gardening, handicrafts, labor work (on-farm), off-farm employment (garment factories and construction work)	Livelihood activities: rice production (wet season), vegetables, cash crop, collection of aquatic plants, cattle-, pig- and poultry-raising, fishing activities, aquaculture, economic activities (selling of different agricultural products)	Livelihood activities: wet-season and recession rice cultivation, home-gardening, cattle-, pig- and poultry raising, fishing activities	Livelihood activities: rain-fed rice cultivation, fishing activities, NTFPs, cattle-, pig- and poultry raising, home gardening, migration for jobs
Overall livelihood tasks are fairly equally shared by both men and women, although there is a distinct gender disaggregation in some tasks; but no quantification had been given	While both males and females are engaged in different livelihood activities, quantifying the labor practiced by gender as a percentage, gives a clearer picture regarding gender disaggregation in each activity		
Even if both genders show an equal percentage for a particular livelihoods activity, men and women may be engaged in different tasks, e.g., rice cultivation (wet season), sowing the nursery, both males and females engaged equally (50% each), but involved in different tasks (females soak seeds and males assist in broadcasting them). Providing additional observation was therefore useful to distinguish between tasks.	<ul style="list-style-type: none"> Mainly male responsibility, e.g., rain-fed rice cultivation (land and dike preparation and water control; transporting 	<ul style="list-style-type: none"> Certain activities may be done mainly by males, e.g., paddy rice activities -- land preparation 	<ul style="list-style-type: none"> Certain activities may be done mainly by males. e.g., paddy rice activities -- preparing field for

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<p>seedlings and cutting rice) Fishing activities (making fishing gear and protecting fishery resource; (patrolling) is undertaken only by men</p> <ul style="list-style-type: none"> • Mainly female responsibility, e.g., rain-fed rice cultivation -- sowing the nursery, weeding; fishing activities such as fish processing and storage; poultry raising -- only women 	<p>with 80% males and 20% females; aquaculture, pond and cage preparation with 90% males and 10% females</p> <ul style="list-style-type: none"> • Certain activities may be mainly done by females, e.g., fish processing and storage with 90% females and 10% males; collection of aquatic plants with 80% females and 20% males 	<p>transplanting with 95% males and 5% females; fishing with 95% males and 5% females</p> <ul style="list-style-type: none"> • Certain activities may be done mainly by females, e.g., fish processing with 100% females; home-gardening with 90% females and 10% males 	<p>field for transplanting 80% males and 20% females; collecting firewood with 90% males</p> <ul style="list-style-type: none"> • Certain activities may be done mainly by females, e.g., fish processing with 90% females; selling fish with 100% females; home-gardening with 80% females
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Overall, it appeared that in all four communes, NTFPs are important for both subsistence use and as a source of income (usually, after processing; Table 13). Both males and females are involved in collection of NTFPs, and depending on the commune and the specific NTFP being considered there may be only one gender involved in its collection and the other in its processing. Quantifying the decline in NTFPs over the last 5 years is also an important addition to the new version.

Table 13. Summary results from the gender task analysis conducted in the four communes.

Sna Ansar	Sya	Chamnar Krom	Samproch
NTFPs range from rattan, firewood, wild fruits, wild mushrooms, edible wild leaves and aquatic resources	NTFPs range from firewood, grass for thatching, water lily, lotus, and aquatic resources such as snails, crabs, etc.	NTFPs range from rattan vines, reeds for mat-weaving, firewood, grass for thatching, water lily, lotus, and aquatic resources, such as snails, etc.	NTFPs range from firewood, reeds for fish fencing, grass for roofing, harvesting bees, and hunting for turtle and snake
Important for both subsistence use and as a source of income (after processing)	Important for both subsistence use (snail, firewood) and as a source of income (lotus, water lily)	Important for both subsistence use (bamboo shoot, snail, grass thatching) and as a source of income (rattan vines, water lily)	Important for both subsistence use and as a source of income (after processing)
Most NTFPs come from the mountain, upland and floodplain AE zones	NTFPs are found in all the zones	NTFPs are found in all the zones	Most NTFPs come from zones 4 and 5
Collection mainly by males whereas processing is done mainly by females	Collection by both males and females Some NTFPs appear to be only collected by males (honey, firewood) and others by only females (water lily, grass for thatching) Some by both men and women (wood for fencing, crabs)	Collection by both males and females Some NTFPs appear to be collected only by males (snails) and others only by females (grass for thatching, reed for mat-weaving). Some by both men and women (firewood, rattan vines, wild mushrooms)	Collection by both males and females Some NTFPs appear to be obtained only by males (turtle and snake hunting) and others by both men and women (grass for roofing, reed for fish-fencing)
Rattan and vine for mat weaving are two important NTFPs from the perspective of livelihoods; these NTFPs are decreasing significantly			

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Gross margin analyses (Table 14) were conducted for the following economic enterprises for each of the communes:

Table 14. Gross margin analyses conducted in each commune.

Sna Ansar	Sya	Chamnar Krom	Samproch
1. Rain-fed paddy rice, 2. Pig-fattening 3. Cage-culture of catfish	1. Floating rice, 2. Chicken-raising 3. Wild capture of fish	1. Recession rice 2. Fishing, using cylindrical traps	1. Rain-fed paddy rice 2. Duck-raising 3. Fishing (catfish)

A number of conclusions can be drawn from the gross margin analyses in Sna Ansar. For example in terms of the following:

- Paddy rice production – this activity appears to be more a food security than an income-generation objective.
- Pig-raising - opportunity cost for female labor around the house and in the home garden is low and the flexible timing of labor inputs for pig-raising is compatible with the other tasks of women around the house.
- Cage culture of catfish – this is seen as a means of “adding value” to the low-quality fish species caught in the Tonle Sap rather than an alternative enterprise to wild-capture fishing.

In Sya the key outcomes of the gross margin analyses can be summarized as follows:

- Floating rice - there does not appear to be much opportunity for value adding. However, on the input side, the high price of labor and machinery may provide an opportunity for producer groups to pool and share resources to maximize efficient use of labor and machinery.
- Chicken-raising - there appears to be little opportunity for value adding at the local level. Although higher prices can be obtained in the Pursat Province markets for slaughtered and prepared chicken, the mark-up is only in the order of Riel3,000/kg, and reflects the cost of labor for slaughter and dressing. However, there may be opportunities to target production to coincide with the Chinese New Year in February, when higher prices can be obtained.
- In the case of fish, there are value-adding opportunities in the form of processing, namely drying and fermenting (*Partook*). Here again, higher prices can be obtained in the Pursat market, but any gains are outweighed by the convenience of being able to sell to merchants at the boat-landing sites. There may be opportunities for marketing by group cooperation to bulk the higher-value fish species into sufficient quantities to attract traders for sale to Thailand and thereby benefit from the higher prices received there.

In Chamnar Krom the following were the main conclusions:

- For wet-season rice, if new technologies are introduced the expected yield could increase to 3.5 t/ha.
- Some farmers already obtain yields of over 3.5 t/ha with improved rice varieties, good-quality seed, optimal fertilizer use and better water control.
- Fishing, using cylindrical nets: it can be seen that if motorized fishing boats are used then net revenue drops to less than \$12/yr. However, if rowing boats are used profits can reach about \$350/yr, or for a day's work, over \$2. This is just a case of using a single fishing gear. In reality, fishers who use motorized fishing

boats are better-off as they can access to different fishing grounds where there are more fish and they also use other fishing gears, i.e., fyke net, and enclosure net with lead fences. Once applying the gross margin analysis tool, the team decided to use the cylindrical nets as the example because this gear is common for both poor and better-off fishers as the both type of fishers can afford for the cost. Better bargaining power for negotiating with the middlemen is one possible way of increasing the prices received and subsequently the profit from fishing, as in the case of processing to increase value added.

In Samproch:

- Rain-fed rice
 - For wet-season rice, if new technologies are introduced the expected yield could increase to 4.5 t/ha.
 - Some farmers already obtain yields of over 4.5 t/ha with improved rice varieties, good-quality seed, optimal fertilizer use and better water control.
- Duck-raising is an important source of cash income for all villagers, including medium and poor families. Net returns are high in duck-raising during 3 months if the extension recommendations are followed along with materials available from MAFF's Department of Agricultural Extension in the form of TIPs.
- The maximum price for ducks (Riel12,000/head) coincides with the Chinese New Year in February, and offers an opportunity for adding value. Indeed, many producers already try to maximize production at this time of year. The lowest prices (Riel8,000/kg) are in June and July.
- Fishing is also a most important farm enterprise after farming and rice is an important source of cash income for all villagers, including medium and poor families. Fishing appears to be undertaken at a loss due to declining fisheries resources.

For each of the communes where pilot testing of the revised CAE was conducted, market and value-chain analyses (Table 15) were conducted for the following livelihood products:

Table 15. Market and value-chain analyses undertaken in the four communes.

Sna Ansar	Sya	Chamnar Krom	Samproch
1. Fish 2. Rattan-woven mats 3. Chicken	1. Floating rice 2. Chicken 3. Capture of wild fish	1. Dry-season recession rice 2. Chicken	1. Dry-season rice 2. Fish (both rice field and Tonle Sap) 3. Duck-raising

Sna Ansar

- Cage culture fishing: Low-value fish are used as feed for raising higher-value fish species in floating cages in the Tonle Sap Lake.
- Rattan mat-weaving: Collection is time-consuming as the wild base is depleted. Domestication of rattan to increase availability and save time; weaving time-consuming but can be done at times of day or year where opportunity cost of women's labor is low. Formation of mat-making cooperatives/groups in the village to enhance bargaining power to get better prices. Poorer families have difficulties joining due to high membership fee and cost of shared capital.

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- Poultry (chicken)-raising: The production system is vulnerable to the spread of diseases. A poultry vaccination program is one way to add value while noting that poorer families are engaged in poultry-raising.

Sya

- Cage culture fishing: Low-value fish are used as feed for raising higher-value fish species in floating cages in the Tonle Sap Lake.
- Poultry (chicken)-raising: The production system is vulnerable to the spread of diseases. A poultry vaccination program is one way to add value while noting that poorer families are engaged in poultry-raising.
- Paddy cultivation: The prices are low in the commune and the rice mills in the Pursat Province. Prices could be increased when middlemen sell in Phnom Penh, Thailand and Vietnam.

Chamnar Krom

- Recession rice: Gross-margin analysis and value-chain mapping exercises show that although yields are high (4 t/ha) margins are very narrow and extremely sensitive to both paddy price and input cost fluctuations, in particular the cost of contract services on which the enterprise is highly dependent. Analysis also showed that there is little or no price premium for high-quality, aromatic rice varieties, thus posing the question as to whether there is an opportunity to develop a niche market for aromatic rice to satisfy the growing domestic demand for a higher-quality product.
- In regard to chicken, the maximum price received (Riel15,000/kg) coincides with the Chinese New Year in February, and offers an opportunity for adding value. The diversity of the value chain and the large number of different actors and middlemen mean that competition among traders is strong, keeping farm-gate prices fairly high. However, these characteristics also make the production system vulnerable to the spread of diseases, and losses from certain diseases are extremely high. A poultry vaccination program for these diseases would be one way of adding value to the chicken-raising enterprise. The complexity of the chain and the large number of actors would also make the system extremely vulnerable to the transfer of Avian Influenza to humans if an outbreak were to occur.

Samproch

- The paddy value chain showed that the price of paddy is low, for example, approximately Riel700-800/kg in the commune and Riel1,000/kg in the rice mill. The price could be increased to Riel1,200/kg when middlemen sell in Phnom Penh, Thailand and Vietnam.
- Fish (both in rice fields and the Tonle Sap): The revenue from one day's labor from fishing is in the region of Riel20,000 to 30,000. This depends on the capacity of fishing per day and the price in the market. Better bargaining power for negotiating with the middlemen is one possible way of increasing the price received for the fish. Other problems affecting the fish value chain is that many small mesh nets block the watercourses and reservoirs along which fish migrate, and burning the flooded forest for hunting, grazing and other purposes has impacted fish-breeding sites.
- In regard to ducks, the diversity of the value chain and the large number of different actors and middlemen mean that competition among traders is strong, keeping farm-gate prices fairly high. However, these same characteristics make the production systems extremely vulnerable to the spread of diseases. A poultry vaccination program for these diseases would be one way of adding value to the duck-raising enterprise.

3.2.2 Discussion on Livelihoods Analyses

Key Livelihoods Issues in the Four Communes

Agricultural livelihood activities

- Improved wet-season rice varieties and production technologies to improve rice yields: Agricultural extension services use participatory training and extension (e.g., FFS), on-farm demonstrations, etc.
- Improved dry-season recession rice varieties to improve rice yields: For appropriate rice varieties to be used in the floodplain, agricultural extension services use participatory training and extension (e.g., FFS), on-farm demonstrations, etc. (but in Sna Ansar, it is reported that the recession rice cultivation has dropped due to irregular changes of the water regime).
- Cash crops, vegetable diversification: Irrigation improvement, water saving technologies, good-quality seed, post-harvest processing and marketing, appropriate extension methods.
- Cattle-raising: TIPs developed by DAE and systematic extension programs involving animal husbandry, health and nutrition.
- Chicken-raising: TIPs developed by DAE can be used for a poultry extension program.

Fisheries livelihood activities

- Aquaculture.
- Developing suitable fisheries TIPs.
- Improving post-harvest processing of fish products.
- Improving marketing networks and providing better rates for products.
- Sustainable fisheries management through setting up of fisheries communities and enforcement of fisheries laws and regulations (reducing the use of illegal gear).
- Protection of all fish habitats such as flooded forests and grassland areas (demarcation of the boundaries of flooded forests, replanting flooded forests, preservation of natural ponds, deep pools (Sna Ansar), etc.

NTFPs in livelihood activities

- Develop, implement and enforce the sustainable management of the major NTFPs through exploring the possibility of establishing nurseries, planting some key forest products, domesticating some NTFPs and developing sustainable harvesting systems.

General finance and marketing services related to different livelihood activities

- Credit (high interest rate of current system): Establish community-managed revolving funds and farmer/fisher organizations (with affordable interest rates).
- Market support (poor market linkages, poor-quality ungraded products): Extension workers link farmer/fisher organizations with the traders/market chain, providing business development and management skills in farmer/fisher groups, and communication channels with marketing networks.

Focus of 2008 Chamnar Krom vs. 2010 Chamnar Krom and Samproch 2010

- With respect to the key questions that emerged in relation to the different livelihood activities undertaken in the commune, key differences noted between the 2008 and 2010 CAEA reports are the following:
 - The 2010 CAEA reports give a more holistic view of all the different livelihood activities (e.g., Chamnar Krom: rice cultivation, cash crops and vegetable cultivation, cattle-raising, fisheries, NTFPs) undertaken in the commune whereas the 2008 CAEA reports a narrower focus on three categories (rice cultivation, cattle-raising and fisheries).
 - Fisheries-related livelihoods are covered in both the 2008 and 2010 reports. The 2008 report focused on aquaculture (fish culture and hatchery). Overall, 2010 focused more on sustainable fisheries management.
 - All AE zones were covered by key questions and 'solutions' for rice cultivation and fisheries.
 - General issues affecting all livelihoods such as credit and marketing networks were covered in 2010 and not in 2008.

Focus of 2005 Sna Ansar vs. 2010 Sna Ansar and 2010 Sya

- With respect to the key questions that emerged in relation to the different livelihood activities undertaken in the commune, key differences noted between 2005 and 2010 CAEA reports are the following:
 - The 2010 CAEA report gives a more holistic view of all the different livelihood activities undertaken in the commune whereas the 2005 report gives a narrower focus.
 - Fisheries-related livelihood activities were covered both in 2005 and 2010 but there was more emphasis in 2010 as the number of questions had increased. Overall, the 2010 report focused more on sustainable fisheries management but it does not mention much about fish culture as the 2005 report does.
 - AE Zone 1 was not covered by overall key livelihood questions and 'solutions' in the 2005 report but in 2010 all AE zones were covered.
 - General issues affecting all livelihoods such as credit and marketing networks were covered in the 2010 report but not in the 2005 report.

Both the current research base and national policy in Cambodia clearly favor intensification of irrigated agriculture, typically without adequate consideration of water requirements to sustain fisheries and ecosystems. Through the revised CAEA, a set of suitable tools has been developed while the capacity at the local and national levels has been built to offset this policy bias. In addition, researchers and local officials involved in the revised CAEA process have identified policy implications from the local analyses to share with policy officials at the national level.

- Incremental improvements were made within the existing framework.
- Needs further capacity-building for effective implementation.

The revised version encourages more cross-provincial departmental participation which could ensure the CAEA result would be more acceptable. The revised CAEA not only strengthens cross-departmental cooperation but also encourages better management of water for agriculture and fisheries at the commune level.

3.3 Methods and Tools on Integration of Land, Water Resources, Fisheries and Livelihoods

Integration of the different components of the analyses in relation to land use strategies, water resources, fisheries and livelihoods takes place during the Systems Analysis phase of the CAEA process. Following RRA, the information gained from the use of the tools is organized and prepared for further analysis. Systems analysis proceeds, in plenary session, through a number of steps using the following tools:

- SWOT analysis.
- Analysis of system properties.
- Formulation of key questions.
- Innovation assessment.
- Problem tree analysis.
- Technology Implementation Protocols (TIPs)

Systems Analysis

SWOT Analysis

The SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis, allows the assessment team to systematically determine positive and negative influences on production, sustainability, stability and equity. Incorporating the SWAT analysis at this stage in the CAEA process has the advantage of developing a deeper understanding of the technical issues as they relate to land and water, environment and forestry, livelihoods, agriculture, fisheries and law and policy. This is a fairly straightforward and well-understood tool which can be applied easily to a range of contexts. Care needs to be taken in ensuring translated terms, e.g., strengths and opportunities are clearly differentiated in the Khmer language.

Analysis of System Properties

This tool is designed to support the analysis of attributes having positive or negative effect on the system properties. It follows on directly from the SWOT analysis and employs what is termed a “force field analysis” on the four system properties. It provides a systematic approach to evaluating the costs and benefits to different system properties in the agroecosystem by entering the attributes of the different agroecosystem (and their effects, both positive and negative) on the system properties.

The tool can help provide a better understanding of the commune, e.g., in terms of whether one agricultural system can be more or less productive, i.e., recession-rice cultivation. If it is more productive whether what they are doing is sustainable or just stable, and whether the rice field is equitably accessible by all wealth groups. This exercise can be a backstop to the scoring of each intervention activity in the Innovation Assessment Table. The analysis also allows for selecting/prioritizing one or more system properties over another.

Care needs to be taken to ensure that technical terms are properly understood, and that attributes can be both positive and negative for the same property.

Formulating Key Questions

Key questions focus on important issues identified by the CAEA. They are generated throughout the CAEA process and tend to become increasingly focused as the analysis proceeds. The questions themselves are used to solve problems by guiding agricultural extension and development activities.

The process itself can provide valuable insights into the nature of the problem and the steps necessary to address it. This part of the systems analysis delivers a more nuanced approach to problem identification and solution, and deeper analysis and perspectives on the issue. It helps in identifying what technical components are suitable to be considered appropriate solutions for particular problems. Finally, it also helps identify activities to be carried out in order to solve the problems. This then provides the basis for establishing guidelines and implementation plans.

A range of elements for each development intervention are identified, e.g., the identification of the technical components of the proposed program, the extension methods and delivery mechanisms, the extension materials, potential partners, target farmer groups and AEA zones where the proposed technology will be used. Overall, it is quite a lengthy procedure and somewhat complex; however, its iterative and step-wise nature makes it an extremely useful analytical tool.

Innovation Assessment

This tool helped in assessing/prioritizing and modifying potential interventions derived from the key questions. It was applied through a matrix table which scored each of the interventions against seven factors (productivity, sustainability, stability, equitability, value, time, availability).

The revised tool is used in the same way, with additional assessment on impact on gender, terrestrial environment, aquatic environment, poverty, compatibility with the Commune Development Plan (CDP), the Commune Land Use Plan (CLUP), the Strategy for Agriculture and Water (SAW) and with government policy. Improved guidance is also now included on how to apply the tool, which in sum, allows for a more holistic approach to assessment; however, it is time-consuming and requires care to ensure that subjectivity is kept to a minimum.

Problem tree analysis

This tool attempts to break down individual problems in the commune (identified during the CAEA) into component causes, from which potential solutions may be identified. For example, this tool is used in Chamnar Krom (2010 CAEA). In this commune, problem tree analysis is applied to the problem of poor fish-culture lot technology to break down three fisheries issues into component problems: illegal fishing, lack of technique for fish culture, and lack of fish breeding. From these components, the underlying root causes may be identified, and suggested solutions to these can be supplied in the conclusions of the report.

TIPs

Suggested TIPs are included in the CAEA, and TIPs related to fisheries are mentioned (i.e., TIPs on aquaculture suggested for use by the 2010 CAEA of Chamnar Krom). Inclusion of fisheries TIPs is an improvement in the revised CAEA, as the pre-PN71 CAEA for Chamnar Krom made no mention of TIPs for fisheries issues.

4 OVERALL CONCLUSIONS

4.1 Summary of CAEA Tool Effectiveness

As a result of PN71, a number of changes to the CAEA tools were made and subsequently field-tested in the four pilot CAEA exercises. Changes were of two main types. First, entirely new tools were introduced to address important water resources, fishery and livelihood issues not covered by the original CAEA tools. Second, existing tools were modified to better address key issues in a more complete or comprehensive manner.

Some of the changes introduced in the early pilot CAEAs were ineffective in meeting their objectives and were dropped, others were modified over the course of the four pilots to improve their effectiveness, and some tools were used with little or no change to their original format over the entire course of the PN71 project.

At the end of the testing phase an assessment was made of each individual tool to gauge its effectiveness and the benefits it provided compared to the original CAEA procedures. A summary of the results of this assessment are presented in Table 16.

Table 16. CAEA tools: Summary comparison.

Old tool	New tool	Changes made	Advantages/benefits obtained and/or problems encountered
Map overlays	Map overlays	Introduction of an additional water resources map layer	Better identification of important water bodies and an improved assessment of water use
-	Water body attribute analysis	Entirely new tool	Additional information on water resources and water use for fisheries and agriculture and a better understanding of water-related constraints
-	Fish species assessment table	Entirely new tool	Identifies the five most important fish species, as well as information on fish ecology (these are important data for inclusion in the Farming Systems [Extension] Management Information System [FSMIS])
Transect diagram	Transect diagram	Added new variables for water, fish and family nutrition	Helped in the identification of water-use conflicts and highlighted the importance of fish as a source of protein nutrition
Flow diagram	Flow diagram	Split into two diagrams: (i) hierarchical and (ii) zone to zone; and introduced color coding	Improved clarity of the flows thus facilitating analysis Also improved comprehensiveness of the information collected
Historical profile	Historical profile	Added impact and community response Changed time-periods to regime periods	Additional valuable information on community impact and response Easier for key informants to recall and document events
Seasonal	Seasonal	Standardized	Standardization kept variables to

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Old tool	New tool	Changes made	Advantages/benefits obtained and/or problems encountered
calendar	calendar	variables, reduced the number of variables, and conducted zone-by-zone	a manageable number Conducting by zone improved clarity and helped identify key issues
-	Livelihoods asset diagnosis	Entirely new tool tested during Sna Ansar CAEA	Failed to provide useful information or add value, and was therefore dropped after the first pilot CAEA (Sna Ansar)
-	Livelihoods profile	Entirely new tool following a livelihoods-asset-based approach	Helped identify problems associated with livelihoods Helped identify key institutions that can solve the problem
Wealth analysis	Wealth analysis	Conducted for each zone Added additional fisheries variables	Increased clarity and level of detail Helped assess type/relative importance of fishing in livelihoods and fisheries parameters in the disaggregation of wealth classes
Water use analysis	Water use analysis	Added some parameters	Helped identify all water sources Provided details on how water sources are used for fishing
Gender task analysis	Gender task analysis	Disaggregation of labor practiced by gender as a percent rather than just affirmatives (Yes) or negatives (No)	Provided more details in regard to breakdown of gender and labor Helped identify changes in gender roles over time
NTFP analysis	NTFP analysis	Quantified decline over last 5 years	Provided more details on rate of decline making it easier to prioritize key NTFPs for conservation
Venn diagram	Venn diagram	No change	NA
Gross margins	Gross margins	Included one fisheries gross margin	Provided economic information on a key fisheries activity
-	Value-chain mapping	Entirely new tool	Helped identify opportunities for marketing interventions Helped identify inputs-constraints and high input costs
Problem prioritization	Problem prioritization	Prioritized within agriculture and fisheries categories separately	Reduced overemphasis on irrigation development Did not identify comparative farmer priorities for agriculture and fish
Cause-effect diagram	Cause-effect diagram	Fewer problems analyzed	Helped save time during RRA, but reduced the amount of information obtained
SWOT analysis	SWOT analysis	No change in the tool itself, but information on fish available from other tools	Better treatment of fisheries issues by the SWOT
System properties	System properties	No change in the tool itself, but more	Better treatment of fisheries issues in the analysis and more

Old tool	New tool	Changes made	Advantages/benefits obtained and/or problems encountered
		information on fish available from other tools	comprehensive fisheries content in the System Properties Table
Formulation of key questions	Formulation of key questions	No change in the tool itself, but more information on fish available from other tools	Larger number of key questions related to fisheries issues, but often not sufficiently detailed or specific
Innovation assessment	Innovation assessment	Added additional criteria for prioritizing key questions	Greater details give more balanced priorities, but are more time-consuming and some new criteria are difficult to understand by the commune.
Land management strategies	Land and water management strategies	Added water management strategies	Adds an important water dimension to the strategies, but is only useful to the Commune Council if it is done thoroughly

Overall, it was clear that the modifications to the CAEA process following the CP71 project have increased both the quantity and quality of data on fisheries and the consideration given to fisheries in these assessments, and reflect better in commune management plans the importance of fish in the food security and economic well-being of local communities.

The clearest result of this project has been the unambiguous identification of (i) the large importance of fish in communes, previously overshadowed by agriculture, (ii) the many issues facing commune fisheries, including both commune-specific problems and problems shared by all four communes in the pilot study, and, most importantly, (iii) the great ecological and economic fisheries opportunities that exist in these communes.

4.2 The Way Forward

The results and analyses have clearly shown that the CPWF PN71 has significantly strengthened the manner in which livelihoods, water resources and fisheries are now addressed by CAEA. Comparisons between the new CAEA outputs and previous CAEAs conducted in the two control communes also demonstrate an emerging recognition of the importance of awareness-raising and capacity development at the community level as compared to a previous narrower focus solely on agricultural production systems.

Challenges Facing Institutionalization and Uptake

Despite the very clear benefits of the revised CAEA process, a number of important challenges still remain if the lessons learned from PN71 are to be fully capitalized and institutionalized within government planning systems. The key challenges include:

1. *Strengthening the links between the CAEA process, the Commune Development Planning (CDP) and the Commune Investment Planning (CIP) processes.* With the decentralization and deconcentration administrative policy adopted in Cambodia, the Commune Council plays a crucial role in managing development initiatives at the local level. Thus the CAEA contributes to the local planning process in terms of contributing to the commune agriculture development plan which is a part of the CDP and/or CIP. PN71 is exploring how the revised CAEA process can best be linked to the CDPs and CIPs which in turn are discussed at an annual District Integration Workshop (DIW) where

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funds are provided through the government to undertake various development activities at the commune level as specified in the CDPs and CIPs. PN71 is trying to get a better understanding on how best fisheries-related issues can be appropriately taken up in this forum, through the information collected using the revised CAEA.

2. *Ongoing AEA development.* Since it was first used in the late 1970s, AEA has undergone a number of improvements and modifications, and although PN71 has significantly upgraded the procedures, this is an adaptive learning process and hence the process should continue to evolve and refined further. The challenge now facing DAE, FiA and other AEA users is how to maintain the momentum generated by PN71 so that users can critically review AEA procedures on an ongoing basis to ensure its future evolution in the face of changing situations and new challenges.

3. *Trade-offs between agriculture and fisheries.* The results of PN71 clearly show that, unlike land, water is usually a common, shared resource whose management can create conflicts among different users. At the same time, PN71 has successfully highlighted the importance of water as a key link between fisheries and agriculture, with both potential positive and negative trade-offs. The key challenge remaining is how to modify procedures and/or add new tools to specifically address the most important trade-offs.

4. *Marketing issues.* Although the introduction of the value-chain mapping tool helped promote a better understanding of important market chain issues, it was not particularly helpful in developing appropriate interventions to address the problems identified. The remaining challenge for follow-up work is how to convert this improved understanding into simple and relevant marketing TIPs for use by extension agents in the field.

5. *Community development TIPs.* CAEA outputs under PN71 are characterized by a shift in emphasis from key questions which focus mainly on productivity and stability to key questions that more closely address sustainability and equitability. This was accompanied by less emphasis on the 'hardware' of production system improvement to a greater focus on the 'software' of community-based interventions that address community organization, capacity development and empowerment. This shift in emphasis will require the development of a different category of TIPs needed to address these usually more complex 'software' issues.

6. *Replicability of the results.* The focus of PN71 on communes bordering the Tonle Sap, all with similar agroecosystems, means that the new tools and procedures have yet to be tested and shown to be usable across the broader range of highly divergent agroecosystem types found in Cambodia. The use of the new tools under different agroecological and socioeconomic conditions will require further adaptation and refinement, and will need to be closely supported by the experienced team of RGC officials who were involved in PN71.

7. *Agroecosystems analysis tool kits.* Results from PN71 and experience from the broad range of other applications where agroecosystem analysis has been used indicate that AEA is not a single 'hard-and-fast' methodology, but rather makes use of a 'basket' of tools from which individual tools are selected and integrated into the most appropriate 'tool-kit' according to the specific purpose and tasks being addressed. If the adaptive potential and inherent flexibility of AEA are to be maintained, guidelines will have to be developed to assist users in assembling the most appropriate set of tools for the specific purpose in hand.

8. *Cross-sectoral integration.* Because of AEA's focus on livelihoods, its outputs are closely linked to other commune development sectors such as education, health, environment, etc. Engaging and involving other government agencies and assimilating CAEA procedures and findings into their sectoral plans as part of a comprehensive and integrated commune development plan remains a key challenge to fully capitalize on the potential benefits of methodology.

9. *CAEA for research planning.* PN71 focused on the use of CAEA as a tool to identify commune-level development and extension opportunities in agriculture and fisheries. However, the results obtained include a number of key issues that need to be addressed by research rather than by extension institutions, particularly for fisheries. The challenge here will be to analyze the CAEA results obtained in the four pilot communes from a research perspective and to formulate important key research questions so that these can be articulated to relevant research institutions.

10. *CAEA and climate change.* CAEA outputs under PN71 clearly identified a number of emerging climate-change impacts such as a changing hydrology in the annual Tonle Sap flood cycle, increased drought and flood incidence, shifts in the farming season, etc. Such impacts will have to be increasingly addressed by the commune development planning process, and the increasing recognition of the importance of climate-change, which means that CAEA must be able to adequately address these issues. Although not explicitly designed to address climate change, a number of the tool additions and modification introduced by PN71, with further refinement, have the potential to identify appropriate interventions that respond to both climate-change adaptation and mitigation.

11. *The cost of CAEA.* The modifications introduced under PN71, although adding value to CAEA, have also added to the time and human resources required. This adds to the cost of the exercise, and has significant implications for the future adoption and use of CAEA by government, other projects and donors. CAEA will never be perfect and the remaining challenge is to find the correct balance under which the methodology produces the required results in a scientifically rigorous, but simple and affordable way.

Future Steps

Although the above-mentioned challenges will have to be addressed over the longer term, a number of more immediate, concrete steps need to be taken to fully capitalize on the benefits and make use of the results obtained by the PN71 program.

Production of the CAEA Guidance Manual

As part of PN71, the "Commune Agroecosystems Analysis Guidance Manual" was updated to include the new and modified tools introduced under the Project through the pilot testing in four communes as well as the mini stakeholder workshop. Moreover, the new manual was used and tested as the basis of the Training-of-Trainers (ToT) course provided to officials from the key RGC agencies. As a result of the testing, some final minor changes were made. To prepare the manual ready for wide-scale use in Cambodia it will have to be translated, printed and disseminated to all Provincial Departments of Agriculture nationwide and to other potential users in the NGO and donor communities. Clearly, the English version of the guidance manual has the potential for wider usage and it is envisaged that it can be adapted for use in other countries in the region. Ideally, the launch of the new manual should be a high-profile event in order to publicize its availability. Donor support for the printing and launch of the manual may have to be sought. AusAID (via CAVAC), as the original funder of AEA development and D&D (via UNDP), as the main users of AEA outputs are two potential sources of support. Moreover, an effort should be made to make the new manual available to other interested parties and where appropriate, provide refresher training on the new procedures.

Refresher Training for Provincial Agencies

Following the publication and launch of the new manual, refresher training will have to be provided to provincial CAEA teams across the country. This will be conducted by the ToT team who were prepared for the job under PN71, supported by selected provincial staff from Pursat and Kampong Thom involved in the pilot CAEAs under PN71.

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Ideally, two or three ToT teams should be formed and operate independently in different provinces in order to speed up the training. These teams will have to be established and prepared, and appropriate training materials will have to be developed. The training should include some theory on the new tools but should focus mainly on hands-on training in the field while conducting an actual CAEA using the new procedures. The training will have to include the additional agencies that are involved in the new procedures rather than just the Offices of Agricultural Extension as was previously the case. Additional agencies that should participate in the training include FiA, PDWRAM and PDE.

Updating the CAEA National Database

The Cambodian Agricultural Extension System includes a national Farming Systems Management Information System (FSMIS) database to support the storage, management and dissemination of CAEA and TIPs data to agricultural development stakeholders at the national and provincial levels. FSMIS software has been installed on the computers of Provincial Offices of Agricultural Extension (OAE), and AEA data are entered into the system by OAE staff. The data are used by the province for management and planning purposes, and are also transferred to DAE's national FSMIS database in Phnom Penh. The FSMIS comprises five major types of information:

1. Agricultural and Socioeconomic Conditions. This database table contains CAEA-generated data on (i) land types, (ii) topography, (iii) soil types, (iv) current land use, (v) cropping systems, (vi) crops grown, (vii) water resources, and (viii) socioeconomic indicators (family labor, landholding, off-farm work, rice self-sufficiency, number of livestock, and major income sources).
2. Major Farmer Problems. This database table contains CAEA-generated information on (i) the major problems encountered, their priority and the root causes; (ii) the nature of the impact of the problems on the farming system; (iii) the farm enterprise(s) affected; (iv) the discipline(s) involved in solving the problems; and (v) the type of farmer(s) affected by the problem.
3. Available Technologies (TIPs). This database table contains TIPs information on improved agricultural technologies available to solve the problems identified. The FSMIS holds all the information necessary to implement the TIPs which will thereby become available to all provincial OAEs and PDAs.
4. AEA Report Archive. This archive holds copies of all Commune AEA reports produced to date. The reports can be accessed and the information in them retrieved by the user.
5. Secondary Data. This part of the database contains a range of additional statistical and spatial data sets for use by agricultural extension personnel and researchers.

The FSMIS has been designed to provide a number of different functions to a wide range of users, including MAFF departments, research agencies, NGOs, donor organizations and the private sector. Various reporting formats have been developed that allow users to query the database and generate a variety of outputs according to their specific needs. Potential uses of the database include:

- Targeting TIPs at priority problems under relevant agricultural conditions.
- Locating sites with specific agroecological and socioeconomic characteristics.
- Locating sites where particular crops are grown.
- Identifying national priorities for agricultural research.
- Identifying market potential and private-sector opportunities.
- Identifying environmental impacts and key issues related to natural resources management.

As a result of PN71, the database will have to be modified to create extra data fields for the storage of additional information generated by the new CAEA tools. In addition, new report formats will have to be created to allow queries in regard to the new data fields, in particular those related to water resources and fisheries. Once these upgrades to the system have been completed, the modified system will have to be reinstalled in the provincial OAE computers and, where considered appropriate, on the computers of FiA, PDWRAM, PDE and D&D.

In order to enhance access to the data and information stored in the FSMIS, the database should be developed into an interactive web-based system so that any user can access the data, run queries and download information from the system. Development along these lines will require significant effort and the services of an experienced database management and ICT specialist. As such, it is likely to require donor support and may be an appropriate sub-project for funding under AusAID's CAVAC program. If additional resources can be found, FSMIS development priorities would include:

1. Creating new database tables for water resources attribute data.
2. Creating new database tables for fisheries attribute data.
3. Creating new database tables for livelihoods asset attribute data.
4. Developing an interactive menu to allow FSMIS users to conduct their own queries and generate output reports incorporating the new data fields.
5. Posting the FSMIS on a dedicated CAEA website so that users can access information in an interactive on-line environment.

Development of New TIPs

Results of the CAEAs conducted under PN71 identified the need for the production of several new TIPs, particularly in the fields of integrated water resources management, community fisheries management and community organization and strengthening. The required TIPs need to be commissioned by DAE, developed by the appropriate technical institution and then officially endorsed by MAFF through the existing peer-review process.

Fisheries TIPs revised and reproduced under PN71 constituted one on small-scale pond fish culture produced by the Department of Aquaculture Development in collaboration with DAE in 2006. As small-scale aquaculture development was proposed by local communities in the communes surveyed, the original TIPs needed to be adapted to fit the Tonle Sap agroecosystem. It also needed to be updated, especially with regard to the process of site selection, pond digging techniques, selection of fish species and fingerling size, preparation of fish pond, management of fish pond including feed and feeding, water-quality management, and harvesting the fish which needed to consider the Tonle Sap agroecosystem. These TIPs will be given free to these and other communities in the Tonle Sap.

Once fisheries concerns have been identified in the revised CAEA, TIPs should be prepared for immediate dissemination to the communes, and can be grouped under several general headings, shown in Figure 6. Note that most of these proposed TIPs currently exist only as extension materials and must be converted to the TIPs format; it is recommended that these TIPs be produced immediately, so that their utility in following CAEAs can be assessed.

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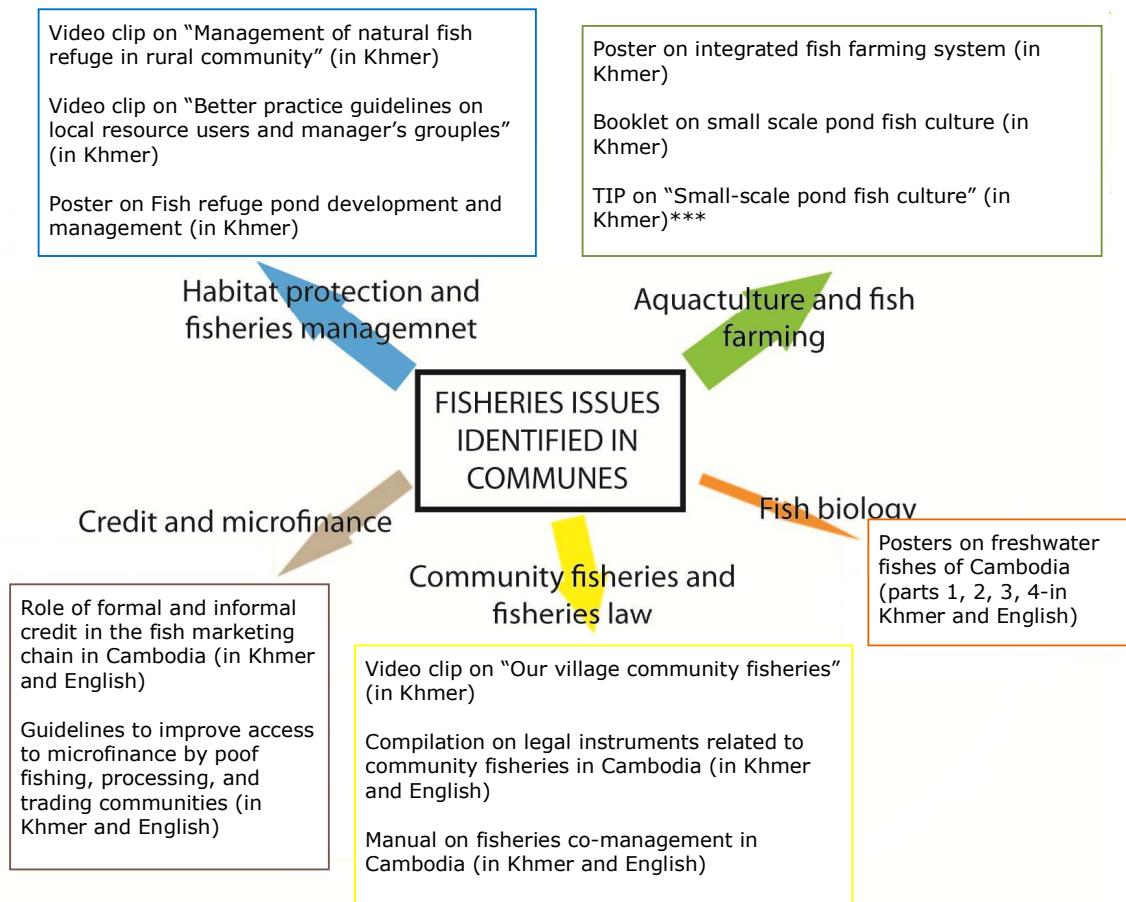


Figure 6. TIPs as applicable to fisheries issues thus far identified in the pilot CP71-revised CAEA process. Note that the majority of TIPs must still be created from existing extension material; Of the TIPs only one has at this point been created (on "Small-scale pond fish culture", as indicated *** above). Adapted from Baran et al. 2010.

Other CAEA Applications

In addition to its use by DAE for commune agricultural development planning, CAEA procedures have also been used by ADB, AusAID and Ministry of Water Resources and Meteorology, Cambodia (MOWRAM) for the design and development of irrigation schemes – the Irrigation Systems Agro-Ecosystems Analysis (ISAEA) and by the German Technical Cooperation (GTZ), the World Bank and provincial authorities for planning the development of the Social Land Concession Agro-Ecosystem Analysis (SLCAEA)). Many of the new tools and procedures developed under PN71 are also being adapted and used in other projects in Cambodia. For example, the Rural Livelihood Improvement Project (RULIP) funded by IFAD proposes to use the revised CAEA tools for their participatory assessments to be undertaken in the three provinces Preah Vihear, Kratie and Ratanakiri between 2009 and 2011. For the Sustainable Land Management (SLM) project funded by UNDP and MAFF some of the revised CAEA tools are proposed to be adapted to suit the objectives of their project. Therefore, enhancing and revising the CAEA methodology represent an opportunity to introduce effective changes throughout the country.

Regional AEA Networking

Agroecosystems analysis procedures are used by a range of institutions in a number of Southeast Asian countries; for example, by regional universities in Thailand for research and development planning, in Lao PDR by the National Agriculture and Forestry Research Institute (NAFRI) for prioritizing research activities and by the Ministry of Agriculture and Forestry to plan field-level interventions on (i) agrobiodiversity management and conservation, (ii) aquatic biodiversity management, and (iii) land use management planning, and NTFP marketing and management.

The new CAEA tools developed under PN71 are already being used in Lao PDR, and indeed, they have been further modified and adapted by Lao practitioners, for example in The Agro-Biodiversity Initiative (TABI) in Lao PDR. TABI is a long-term commitment by the Government of Lao PDR and the Swiss Development Corporation (SDC). The first phase of the project will run from May 1 2009 to April 30 2012. TABI aims to improve the livelihoods of upland farm families by the productive use and conservation of agrobiodiversity resources and hopes to adapt the revised CAEA approach in the project.

Development of a regional agroecosystems analysis network could be valuable to promote exchange among different users in different situations for different purposes and allow its members to learn from one another with the aim of supporting the ongoing development and application of the AEA methodology.

5 OUTCOMES AND IMPACTS

The anticipated eventual impact of PN71 was improved fisheries considerations with regard to fisheries biology, water resources and livelihoods in the commune agroecosystem analysis (CAEA) process, resulting in a more holistic, integrated assessment of these issues, compared to a previous narrower focus of the CAEA solely on agricultural production systems. The intended beneficiaries ranged from the implementers of the CAEA approach – the Department of Agricultural Extension (DAE) of the Ministry of Agriculture, Forestry and Fisheries (MAFF), other government agencies that were partners in the CAEA process and, most importantly, the local communities where the CAEA was conducted. These communities were expected to benefit through the CAEA contributing to better commune-level decision making and planning.

This section of the report focuses on the impact that the project has actually had. In common with all CPWF projects, a participatory impact pathway approach was adopted. The primary objective of this was to maximize the impact of the project by purposefully designing a strategy for uptake of research results, rather than leaving it to chance.

From the start of the project, one of the primary outputs was intended to be revised CAEA guidelines with improved fisheries considerations (in both Khmer and English). Another expected output was communications material to document and disseminate the revised approach and results including four CAEA reports for Sna Ansar, Sya, Chamnar Krom and Sampuch, where pilot testing of the revised tools was undertaken. In addition, improved capacity of the core CAEA training team and the provincial technical teams to implement the revised CAEA approach was expected to be a major output of PN71.

The proforma below indicates the main impact pathways through which the project was intended to have impact.

5.1 Proforma

Summary Description of the Project's Main Impact Pathways

Actor or actors who have changed at least partly due to project activities	What is their change in practice? That is, what are they now doing differently?	What are the changes in knowledge (K), attitude (A) and skills (S) that helped bring about this change?	What were the project strategies that contributed to the change? What research outputs were involved (if any)?	Please quantify the change(s) as far as possible
Department of Agricultural Extension (DAE) – Project Implementers and next users	Conducting the CAEA using the revised CAEA incorporating fisheries aspects	K: Increased knowledge on the importance of using a more holistic, integrated approach to fisheries, water resources and livelihoods when conducting the CAEA	Revised CAEA guidance manual (in Khmer and English); Training of trainer in the revised CAEA methodologies for CAEA implementers; four CAEA reports for Sna	The revised guidance manual being institutionalized and utilized by DAE for conducting any future CAEAs 300 copies of Khmer and 500 copies of English versions of the

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		<p>A: Understanding the value of working in an interdisciplinary team with close partnerships with other national partners</p> <p>S: Enhanced capacity through training on fisheries aspects to enable them to conduct the revised methodologies</p>	<p>Ansar, Sya, Samproch and Chamnar Krom communes, that have used the revised CAEA methodologies</p>	<p>revised CAEA manual being published</p> <p>Uptake of revised tools and methodologies by other projects in Cambodia and Lao PDR.</p>
Inland Fisheries Research and Development Institute, Cambodia (IFReDI) and the Department of Water Resources Management & Conservation (DWRM&C) national partners in CAEA and next users	Being part of the CAEA training pool – to train and conduct CAEA	<p>K: Increased understanding on the value and usefulness of the revised CAEA process and how it can be used in their work</p> <p>A: Sense of ownership for the revised CAEA process</p> <p>S: Enhanced capacity through training on the revised CAEA tools and process</p>	<p>Revised CAEA guidance manual (in Khmer and English); Training of trainer in the revised CAEA methodologies for CAEA implementers; A Technical Implementation Package (TIPs) on small-scale fish culture that was revised and reproduced by IFReDI under PN71</p>	<p>300 copies of Khmer and 500 copies of English versions of revised CAEA manual being published. A portion of these copies will be distributed and used by national partners</p> <p>1,000 copies of the fisheries TIPs being printed and disseminated by IFReDI or DAE/MAFF to all five provinces around Tonle Sap Lake</p>
IWMI and WorldFish Center (researchers and project implementers)	Promotion of the revised CAEA tools and methodologies in other research projects (e.g., – some of these tools will be adapted in Mekong 1 Project)	<p>K: Better understanding of the usefulness of the CAEA tools and methodologies in participatory assessments</p> <p>A: Building strong relationships</p>	<p>Revised CAEA guidance manual; training of trainer in the revised CAEA methodologies for CAEA implementers; four CAEA reports for Sna Ansar, Sya, Samproch and</p>	<p>Uptake of revised tools and methodologies by other projects in Cambodia and also Lao PDR</p>

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		<p>with national implementers can assist in uptake</p> <p>S: Enhanced capacity through development of revised and new tools</p>	<p>Chamnar Krom communes, that have used the revised CAEA methodologies; fisheries and livelihoods component reports; six monthly PN71 progress reports</p>	
Commune Councils (end users)	<p>Better understanding of how to incorporate the findings and recommendations of the CAEA into the commune planning process (CDP and CIP)</p>	<p>K: Participating in the mini-stakeholder workshop would have helped enhance knowledge on the revised CAEA tools</p>	<p>Participating in the mini-stakeholder workshop and final stakeholder workshop enhanced knowledge on the CAEA process and tools and helped with the cross-fertilization of learning experiences between the two different commune councils</p>	<p>Too early to quantify whether the recommendations in the CAEA report will be included in the CDP and CIP it will show uptake of new information and strategies</p>

Of the changes listed above, which have the greatest potential to be adopted and have impact? What might the potential be on the ultimate beneficiaries?

Greatest potential to be adopted:

The revised CAEA methodology developed under PN71 is to be institutionalized by MAFF and used in future CAEA assessments in Cambodia.

- Uptake and adoption of different tools from the revised CAEA in other projects in Cambodia. For example, the Rural Livelihood Improvement Project (RULIP) funded by IFAD proposes to use the revised CAEA tools for their participatory assessments to be undertaken in three provinces, Prah Vihear, Kratie and Ratanakiri between 2009 and 2011. For the Sustainable Land Management (SLM) project funded by UNDP and MAFF it is proposed that some of the revised CAEA tools will be adapted to suit the objectives of their project.
- Upscale and adoption of the revised CAEA process developed under PN71 in neighboring countries. For example, in the Agro-Biodiversity Initiative (TABI) in Lao PDR. TABI is a long-term commitment by the Government of Lao PDR and the Swiss Development Corporation (SDC). The first phase of the project will run from May 1 2009 to April 30 2012. TABI aims to improve the livelihoods of upland farm families by the productive use and conservation of agro-biodiversity resources and hopes to adapt the revised CAEA approach in the project.

What still needs to be done to achieve this potential? Are measures in place (e.g., a new project, [ongoing commitments] to achieve this potential? Please describe what will happen when the project ends.

For uptake of the revised CAEA to achieve its potential:

- The revised CAEA guidance manual has been endorsed by the DAE of MAFF and will be used in future CAEAs conducted in Cambodia (the Khmer version of the revised CAEA guidance manual is in the process of being printed and has to be distributed to relevant provincial CAEA teams; a pool of trainers for the revised CAEA tools has been established under PN71 and may be called upon to provide training before conducting the CAEA using the new process).
- For further uptake of the revised CAEA tools by other projects in Cambodia it would be useful to provide the English version of the CAEA Manual to other donors and project implementers. For example, during the CPWF Donor Visit to Cambodia in March 2010, the IFAD representative expressed interest to learn more about the CAEA tools and guidance manual. (We will follow up on this request and explore opportunities for future work using these methodologies).
- For the uptake of CAEA in neighboring countries. Through the TABI project in Lao PDR, some of the revised CAEA tools have already been adapted together with the assistance of the national partner National Agriculture and Forestry Research Institute (NAFRI), to be used for district-level land use planning and an AEA handbook prepared. Potential for future collaboration between the PN71 project implementers and the TABI team is currently being explored. In addition, for the CPWF Mekong 1 Project on Optimizing Reservoir Management for Livelihoods, several of the revised CAEA tools will be used in the livelihoods component of the Project in all three sites (i.e., in Lao PDR, Vietnam and Cambodia).

Each row of the above Table is an impact pathway describing how the project contributed to outcomes of a particular actor or actors. Which of these impact pathways were unexpected (compared to expectations at the beginning of the project?)

- (i) Uptake of revised CAEA tools so quickly by other projects in Cambodia.
- (ii) Uptake of revised CAEA tools and concepts in neighboring countries.

Why were they unexpected? How was the project able to take advantage of them?

This uptake took place during the PN71 – not on project completion. Therefore, it was very quick, considering that PN71 was a short project. The main reason for this was the early endorsement and buy-in of the revised tools by the national partners (DAE) who then promoted these revised tools to other projects that they were involved in. Also having team members who were convinced of the efficacy of the revised methodologies/concepts being involved in the TABI helped “spread the message” very quickly and effectively.

What would you do differently next time to better achieve outcomes (i.e., changes in stakeholder knowledge, attitudes, skills and practice)?

Since this is a short, 2-year project, it is difficult to determine how the revised CAEA has contributed to the CDP and CIP process. An ex-ante evaluation should be conducted in the four communes used for the pilot study to determine in the end if the recommendations of the revised CAEA reports had any uptake within the commune planning process (CDP and CIP). This assessment is not part of the original project plan and ideally needs to be conducted if funds and additional time can be provided.

5.2 International Public Goods

Key public goods produced include:

- The revised CAEA guidelines (in Khmer and English) with improved considerations of fisheries, water resources and livelihoods aspects.
- Four papers on various aspects of CAEA and their applicability and usefulness (currently submitted to CP Secretariat as final drafts).
- Several non-peer-reviewed papers and reports published during the course of project duration.

5.3 Tools and Methodology

The revised CAEA guidance manual (the primary output from the project) with improved fisheries considerations proved to have significantly improved how fisheries, water resources and livelihoods are now addressed by CAEA. This would ultimately help with better planning at the commune level taking on board a more integrated, holistic view of the main issues that need to be considered.

5.4 Project Insights

Of the knowledge gained in this study, perhaps the most beneficial in the long-term will be:

- The insights gained by addressing fisheries, water resources and livelihoods issues in the commune in a more comprehensive manner and the potential value of the knowledge gained in commune planning in addition to an emerging recognition of the importance of awareness-raising and capacity development at the community level as compared to a previous narrower focus only on agricultural production systems.
- The insights gained on the importance of water as a key link between fisheries and agriculture, with both potential positive and negative trade-offs. The key challenge remaining however is how to modify procedures and/or add new tools to specifically address the most important trade-offs. This could be part of a new research initiative.
- The insights gained on how to set about better linking the CAEA results and recommendations with the commune development plans and commune investment plans and how the findings can be presented at the District Integration Workshop.
- The insights gained in the potential for broader uptake of the CAEA approach in other instances in Cambodia and also in a regional context.

5.5 Partnership Achievements

- Perhaps, since this piece of research was demand-driven, there was strong involvement and commitment of the major national partner (DAE) in the project implementation from the very onset. This has contributed to building a strong foundation for future uptake and the revised CAEA methodology is expected to be

used in future CAEA assessments in Cambodia and can therefore be attributed to having direct impact on a national level.

- Capacity building of NARES partners in using an integrated approach to understand fisheries in agroecosystems and water management and, in particular, the participatory tools used in the revised CAEA approach. The main national partners were the DAE, the Fisheries Administration (FIA) and, in particular, one of its branches, the Inland Fisheries Research and Development Institute (IFReDI), and the Department of Water Resources Management & Conservation (DWRM&C). IWMI, WorldFish and School of Oriental Studies, University of London, UK (SOAS) were the international partners working together as part of this interdisciplinary team.

5.6 Recommendations

Future research. The CAEA operates at commune level, which is a scale that may arguably hide the needs of the most vulnerable groups in the commune in some instances. This is especially true for more precise targeting of interventions towards the poorest or landless households. In this context, it would be useful to adapt and pilot some of the revised CAEA tools to be used at the village level, to determine whether more disaggregated data on poverty variations, livelihood portfolios and the different needs of the poorest can be obtained. In fact, there has been an expression of interest from certain donors to undertake such a pilot testing of tools and methodologies that could be developed as a methodology for development interventions at the village level. This option should be explored further. Another important point to note is that the focus of PN71 was on communes bordering the Tonle Sap and that therefore the pilot testing of revised tools took place in relatively similar agroecosystems. This means that the new tools and procedures have yet to be tested and shown to be usable across the broader range of highly divergent agroecosystem types that are found in Cambodia. It is likely that the use of the new tools under different agroecological and socioeconomic conditions may require further adaptation and refinement. This is perhaps another area of research that is important to explore.

Extension. As discussed earlier, the revised CAEA methodology will be utilized by the DAE when conducting future CAEA assessments. It would also be of value if other national partners engaged in PN71, utilize and adapt relevant tools from the revised CAEA when conducting their own research and projects, wherever appropriate, noting that AEA is adaptive and not a single 'hard-and-fast' method, but rather a 'basket' of tools from which individual tools are selected and integrated into the most appropriate 'tool kit' according to the specific purpose and tasks being addressed.

Policy. In 2004, the CAEA was sighted as a policy instrument in MAFF for the assessment of agricultural interventions and needs at the commune level. Since the revised CAEA approach was endorsed by MAFF, it means it will be adopted in future CAEA assessments conducted by DAE and therefore it has policy-level implications. It would be useful to investigate this aspect more closely and in a rigorous manner to determine how the changes brought about by the project actually play out in practice.

Institutions. How best the results of the CAEA report can be fed into the commune development plan and commune investment plan and thereafter presented at the District Integration Workshop, needs to be explored further as only a preliminary assessment of this was conducted under PN71.

5.7 Publications

Papers under preparation for submission to peer-reviewed journals/RR series (end 2010)

- Hoanh, C. T., Johnston, R., Senaratna Sellamuttu, S., Baran, E., Mith, S., Craig, I., Smith, L., Mak, S., Sameng, K., Khean, S., Say, T., Nam, S., Sy Vann, L., Seung, S., Seun, N., Theng, T and Sam On, S. Incorporating fisheries into community agro-ecological analysis: Lessons from Cambodian cases.
- Johnston, R., Thuon, T., Senaratna Sellamuttu, S., Mak, S., Mith, S and Craig, I. Improving irrigation planning in Cambodia: The role of community agro-ecological analysis.
- Laurence, S., Senaratna Sellamuttu, S., Nguyen Khoa, S. and Mith, S. Evaluating and enhancing community agro-ecosystems analysis in Cambodia from a livelihoods and poverty reduction perspective.
- Mith, S., Mak, S., Sovannara, K., and Dubois, M. Commune agroecosystem analysis: Systems thinking for decentralised natural resources management.

Internally peer-reviewed reports

- Baran, E., DeFalco, T., Sy Vann, L., Nam, S., Sueng, S. and Seung, N. 2010. Commune agroecosystem analysis to support decision-making on water allocation for fisheries and agriculture in the Tonle Sap wetland system. Fisheries Component. Analysis of the revised CAEA methodology as applied to fisheries, 20p.
- Baran, E., Nam, S., Sy Vann, L. 2008. Commune agroecosystem analysis to support decision-making on water allocation for fisheries and agriculture in the Tonle Sap wetland system. Fisheries Component. Integrating fish resources to agro-ecosystem analyses, 41p.
- Department of Agricultural Extension and the Challenge Program on Water and Food. 2010. Guidance manual. Commune agroecosystems analysis in Cambodia, 89p.
- Department of Agricultural Extension and the Challenge Program on Water and Food. 2010. Agroecosystems analysis of Sna Ansar Commune. CAEA Report, 76p.
- Department of Agricultural Extension and the Challenge Program on Water and Food. 2010. Agroecosystems analysis of Sya Commune. CAEA Report, 64p.
- Department of Agricultural Extension and the Challenge Program on Water and Food. 2010. Agroecosystems analysis of Samproch Commune. CAEA Report, 100p.
- Department of Agricultural Extension and the Challenge Program on Water and Food. 2010. Agroecosystems snalysis of Chamnar Krom Commune. CAEA Report, 81p.
- Senaratna Sellamuttu, S.; Smith, L.; Nguyen-Khoa, S. December 2008. Integration of fisheries in commune agro-ecosystem analysis. Livelihoods and governance component. Water allocation in the Tonle Sap wetland system. CPWF Project Number 71 (PN71), 27p.

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http://www.water.hut.fi/wr/research/glob/egloshow/eglob_TonleSap.html

Reitbergen-McCraken, J. and Narayan, D. 1998. *Participation and social assessment: Tools and techniques*. Washington, DC, USA: World Bank.

Van Zalinge, N.P. and Nao, T. 1999. Summary of project findings. Present status of Cambodia's freshwater capture fisheries and management implications. In Van Zalinge, N. P., Nao, T. and Deap, L. (eds), *Present status of Cambodia's freshwater capture fisheries and management implications*, pp. 11-20. Nine presentations given at the Annual Meeting of the Department of Fisheries, Phnom Penh, 19 – 21 January 1999. Phnom Penh, Cambodia: MRC Secretariat and Department of Fisheries, 149p.

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