THE MEKONG RIVER COMMISSION SECRETARIAT

Integrated Flood Risk Management Plan for the West Bassac area in Cambodia

The Flood Management and Mitigation Programme, Component 2: Structural Measures & Flood Proofing in the Lower Mekong Basin

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Guide to the reporting structure of the Flood Management and Mitigation Programme - Component 2, Structural Measures and Flood Proofing

Component 2 on Structural Measures and Flood Proofing of the Mekong River Commission's Flood Management and Mitigation Programme was implemented from September 2007 till January 2010 under a consultancy services contract between MRCS and Royal Haskoning in association with Deltares and Unesco-IHE. The Implementation was in three Stages, an Inception Phase, and two implementation Stages. During each stage a series of outputs were delivered and discussed with the MRC, the National Mekong Committees and line agencies of the four MRC member countries. A part of Component 2 - on 'Roads and Floods' - was implemented by the Delft Cluster under a separate contract with MRC.

The consultancy services contract for Component 2 specifies in general terms that, in addition to a Final Report, four main products are to be delivered. Hence, the reports produced at the end of Component 2 are structured as follows:

Volume 1	**Final Report**
Volume 2	**Characteristics of Flooding in the Lower Mekong Basin:**
Volume 2A	*Hydrological and Flood Hazard in the Lower Mekong Basin;*
Volume 2B	*Hydrological and Flood Hazard in Focal Areas;*
Volume 2C	*Flood Damages, Benefits and Flood Risk in Focal Areas, and*
Volume 2D	*Strategic Directions for Integrated Flood Risk management in Focal Areas.*
Volume 3	**Best Practice Guidelines for Integrated Flood Risk Management**
Volume 3A	*Best Practice Guidelines for Flood Risk Assessment;*
Volume 3B	*Best Practice Guidelines for Integrated Flood Risk Management Planning and Impact Evaluation;*
Volume 3C	*Best Practice Guidelines for Structural Measures and Flood Proofing;*
Volume 3D	*Best Practice Guidelines for Integrated Flood Risk Management in Basin Development Planning, and*
Volume 3E	*Best Practice Guidelines for the Integrated Planning and Design of Economically Sound and Environmentally Friendly Roads in the Mekong Floodplains of Cambodia and Vietnam*[1]
Volume 4	**Project development and Implementation Plan**
Volume 5	**Capacity Building and Training Plan**

Demonstration Projects
Component 2 prepared five Demonstration Projects which have been reported separate from the main products:

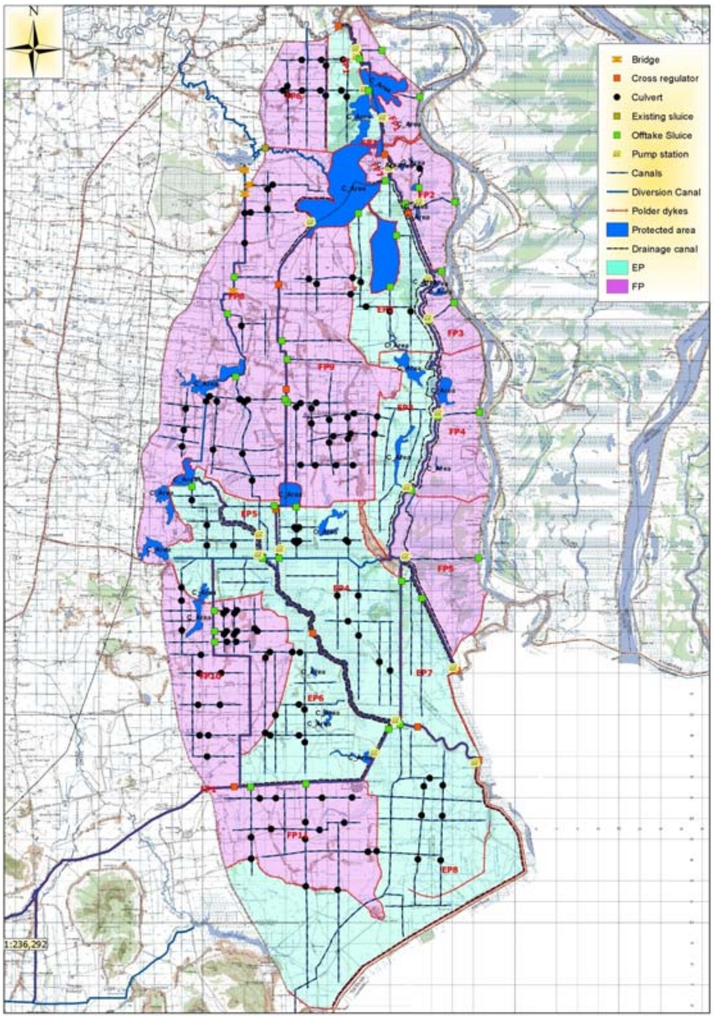
Volume 6A	*Flood Risk Assessment in the Nam Mae Kok basin, Thailand;*
Volume 6B	*Integrated Flood Risk Management Plan for the Lower Xe Bangfai basin, Lao PDR;*
Volume 6C	*Integrated Flood Risk Management Plan for the West Bassac area, Cambodia;*
Volume 6D	*Flood Protection Criteria for the Mekong Delta, Vietnam*
Volume 6E	*Flood Risk Management in the Border Zone between Cambodia and Vietnam*

The underlying report is **Volume 6C** of the above series.

[1] Developed by the Delft Cluster

Summary

This report presents the findings of the FMMP-C2 Demonstration Project that aims to assist Cambodia in formulating an ***Integrated Flood Risk Management Plan for the West Bassac area i***n the south-western part of the country; the area is located in Kandal and Takeo provinces.



The West Bassac IFRM Plan area.

Integrated Flood Risk Management Strategy

Three flood risk management zones were identified based on present flood conditions, existing road and flood embankments, human settlements and land use. Subsequently, the type of structural components required for each area has been identified and preliminarily designed. The formulated scenario is based on the concept of living with flood and to take maximum advantage from flood and to reduce risk by avoiding the maximum flood period for agricultural activities in deep flooded areas. Due to the low level of infrastructure development in the area, flood risk reduction alone could not justify large investment for flood protection. On the other hand it would lead to an optimum use of the land use potential of the area by increasing the crop intensification and diversification. The West Bassac area can be sub-divided into three management zones

Zone 1

This zone is delimited to the east by the RN21, a flood free road built on existing river levees along the Bassac River. The RN21 runs from Phnom Penh to the Cambodian-Vietnamese border at Chhrey Thom. To the west, zone 1 is partly delimited by the existing left embankment and the planned embankment of the flood plain main drain. Currently some 90 colmatage canals divert a large amount of the Bassac flood water across this zones extending 2 to 5 km into the flood plain conveying and storing water through and in the flood plain. Behind the Bassac levees (RN 21), land elevation is about 3.5 to 4.0 m sloping towards the flood plain.

Major population settlement is concentrated along the RN21 road embankment and parts of the Preik Ambel embankment and a few higher road embankments around Sa’ang town. Land use intensification and diversification potential of this area is amongst the highest in the part of the Mekong delta in Cambodia.

Currently only a few of the existing colmatage canals are gated providing water control capability. A small portion of this zone has been developed to be a polder (pilot stage). Under existing conditions, the “Chamcar” occupies higher ground near to the RN21 and the area near to the flood plain main drain is generally used for rice flood recession crop. With steady improvement of the road embankment of the left bank of the Preik Ambel, the area tends to develop itself as a series of polders. This can only be successful with a comprehensive integrated plan combining integrated flood risk management and integrated water resources development taking the whole flood plain into consideration.

It is proposed to conceive zone 1 as an area with full flood protection but with the benefits from flooding. This means that the infrastructural design and management should allow controlled flooding for re-supply of sediment and sanitation of farm conditions. Zone 1 will be sub-divided into five large polders using the flood free RN21 as a protection dike from the Bassac.

On the western side the embankments of the flood plain main drainage channel function as flood protection dikes. The number of colmatage canals will be reduced to only one per polder connecting between the Bassac and the flood plain main drain. Remaining colmatage canals will be closed but will be maintained and improved for drainage and irrigation water supply to each part of each polder. Existing lateral irrigation/drainage canals of each polder will be improved. Each polder will be equipped with a pumping station equipped with a reversible pump installed at the lowest part of the polder serving both for drainage and irrigation water supply.

The deep flooded area has limited settlement space, the right bank of the flood plain main drain will be raised to a flood free level with a series of flood proof causeways of 100 m long at an interval of every 2km for flood passage with design crest above 10 year return period of July maximum water level. The crest of the embankment of the flood plain main drain on the left bank is designed for a 100 years annual maximum return period flood.

The flood plain main drain will be dredged and improved for navigation with rural port facilities at Angkor Borei, head of Preik Ambel and Sa’ang. The hydraulic simulation model will be used for determination of appropriate canal dimensions following the Best Practice Guideline for Structural Measures for Integrated Flood Risk Management.

The Preik Ambel is affected by tide, the operation of the diversion/drainage canal and the related water control infrastructure shall be the main focus during the operation phase to optimize the operation cost. The water management shall be the task of a specialized qualified government line agency. It is expected that water use communities will be established for the management of each polder. Farmer will use their own pumps to irrigate their field from the existing network of colmatage canals.

The design of Integrated Flood Risk Management and Integrated Water Resources Management in Zone 1 is based on existing and new infrastructure and local condition specific to each polder. The approach used is based on the maximum use of benefit from flooding which would rely mainly on the management capability and flexibility rather than on a full control by protecting against maximum design flood and assure timely drainage for different sets of crop calendars.

The following infrastructures are proposed:

1. The RN21 which is currently flood free will be reviewed according to standards developed by proposed Best Practice Guideline for development and design of structural measures and flood proofing;
2. A main flood plain drainage channel connecting the Preik Ho- Priek -Ambel-Preik Moat Chhrook to the border with Vietnam. The final drainage capacity will be based on modelling exercise in such a way that it could carry sufficient flow capacity without increasing water level in the Bassac. The left embankment of the flood plain main drain will be raised to 100 year return period protection level.
3. Five principal diversion/colmatage canals linking the Bassac with each of the five polders and the main flood plain drain/diversion canal. Each of the canals will be fully controlled by sluice gates in such a way that they could be used not only for flood diversion but also for water supply for irrigation taking advantage of tidal effects and the need for drainage of local rainfall;
4. Each principal diversion/colmatage canal is equipped with two control gates, one at the Bassac side and one at the flood plain main drain side.
5. Review and improved existing colmatage canals (disconnected with the Bassac) which will be used as irrigation/drainage canals connected with the main drain of each polder;
6. A main irrigation/drainage canal in the lowest part of each polder (improvement of existing canals linking with ponds and/or depressions and a pumping station equipped with reversible pumps capable for the polder drainage and polder irrigation water supply. This main drain is linked with the main colmatage canal with a control gate to allow flooding condition as might be required.
7. The left bank embankment of the main flood plain drainage canal will be upgraded to flood free level. It will be used to extend settlement areas from Ta Khmao town to the Cambodian-Vietnamese border and also functions as a flood free road with a crest at 100 years maximum flood return period.
8. An access road parallel to each of the main polder colmatage canals to the left embankment of the main flood plain drainage canal to ease canal maintenance and access road in addition to separation dike between each polder.
9. The main flood plain drainage/diversion canal will serve as a flood diversion canal during high flood periods and as drainage and irrigation canal during early flood and flood recession period. Access to water for supplementary irrigation is difficult for early crop and during the last period of recession crop. Depressions and deep lakes will be used as flood water storage for recession crop and as excess rainfall collector for early crops. Their storage capacity will be improved by surrounding dikes including intake structures to the main drain. Maximum use of the tide will be made by controlling entrance and exit of water during low and high tide. This will reduce pumping costs for drainage and irrigation water.

Zone 2

The deep flooded area zone 2 is a large flood storage and conveyance area of 85,000 ha covering almost ¼ of the total provincial area extending from the Ta Khmao town to Phnom Den at the Cambodian-Vietnamese border, delimited to the east by the zone 1 and to the west by the non flooded and shallow flooded area zone 3. Almost all the surface runoff and rainfall in the province including the Mekong flood water are stored and conveyed in and through this area. Land elevation of this zone varies between somewhat less that 2.0m to 5.0m with some small hill and higher ground around S'ang district and Angkor Borei constituting as a natural screen hindering hydrological regime and alluvial deposition in the northern and southern part of the zone 2.

A number of natural drainage channels, river branches and canals run into and through this zone: They supply this zone with the Mekong flood water and surface runoff from the western catchments and drain it across the Cambodian-Vietnamese border.

This zone is mainly occupied by flood recession rice area, waste land, flooded forest, protected areas for Cyrus Crane (Preik Lopeou, 9,000 ha) and deep lakes.

Fishery known to be one of the major natural resources of this zone has declined rapidly due to poor management and systematic destruction of habitat (encroachment of flooded forest and overfishing), the number of commercial fishing lot has dropped from 21 to 8 only now for the benefit of fishery community. Remaining commercial fishing lots are mainly concentrating around Angkor Borei area. Current total provincial average fish catch is about 10,700 t/year giving average consumption of only 13 kg/person/year which is very low as compared to national average 30kg per person per year. Aquaculture has a potential for development with improvement of water resource management.

In contrast to deep and prolonged flooding of this area, flood recession cultivation from water course suffers from shortage of water for supplementary irrigation due to insufficient and inadequate irrigation system. Only a limited number of reservoirs (flood water storage) can supply water for irrigation. Limited number of farms located near to the river and canals are able to produce two crops per year making use of tidal effect (recession crop and fully irrigated dry season crop). Most existing irrigation/drainage canals in the zone are silted up quickly due to lack of maintenance.

Due to prolonged flood period only a few population settlement were established in this zone in some small villages along the higher levees of the Takeo River and Moat Chruok canal as well as on spots of higher ground.

Based on the concept of living with flood and the above strategic direction for the Cambodian Mekong delta part, it is proposed to conceive for the protection of the zone 2 only against the early flood and for agriculture development only with consideration on the ecological balance in this zone.

Critical requirement for IFRM structural planning and IWRM in this zone are:

- the capacity for timely drainage of excess flood recession water for field preparation for recession crop (November-March);
- protect early crop (May-July) from early flooding and local excess rainfall;
- provide source of water for supplementary irrigation with least pumping cost
- provide adequate transport infrastructures for easy access to cropping areas
- propose a conservation area for ecological balance

- propose new and improved settlement scheme for effective economic development of the area.

To achieve the above, following infrastructures are proposed:

1. Dike embankment along the flood plain main drain between the Zone 1 and zone 2, a dike with crest designed at 100 years return maximum flood for residential areas with causeway (spillway for maximum July flood at 10 year return period);
2. Dike embankment for maximum water level flood water storage around deep natural lakes for irrigation water supply (e.g Boeung Chhoeung Luong);
3. A dike embankment for early flood protection (Maximum July flood level at 10 years return period) along the border area preventing flood water from entering from the southern side of the area.
4. A drainage canal along the western side of the flood plain main drain/diversion canal for drainage of excess local rainfall for early crop harvest.
5. Dredging of the Stung Takeo from Samrong to Borei Chulsa with dike embankment and drainage.
6. Improvement of existing dike and canal between Angkor Borei and Stung Takeo as part of the flood plain main drain.
7. To take maximum benefit from investment for IFRM and IWRM in this zone, it is proposed also that existing settlement areas will be improved in terms of flood proofing and all year round accessibility to the market and other communities, for example flood proofing of the Angkor Borei historic town could be one of the priority, new settlement areas are also to be planned according to the future land use expansion.

For supplementary irrigation, the source of water will be existing and new reservoir, the flood plain main drain, the Stung Takeo, the Takeo canal, the proposed canal linking the Boeung Chhoeung Luong with the Takeo flood plain and canal storage regulated according to tidal conditions. For the most southern part, south of Takeo Canal, existing main irrigation will be used as main irrigation canal.

Zone 3

The zone 3 extends along the RN 2 to the east and consisting of non-flooded and shallow flooded areas. Soil of this area is dominated by grey leached soil type on ancient alluvium terrace extending from the western foot hill until the north of Preik Ambel in northwest southeast direction with different characteristics from north to south, in north and northwest area at an elevation more than10 m, terrace with high content of sand and fine gravel, towards the south in terrace at elevation between 6 and 7m, consisting of silt and clay mineral, and interface with recent sediment of the Mekong system at elevation between 2 and 5m. In the shallow flooded area different type of recent alluvium soil stretches across the Bassac/Stung Takeo flood plain littoral in thin layer from Bati until Angkor Borei. The part of the shallow flooded area is affected by regular Mekong flood in spite the advantage of being closer to the water source. Existing flood protection dike system is not operational.

Zone 3 is the most populated area of the West Bassac area with large population concentration along RN2 and rural roads. With population increase, land plots are increasingly dispersed and smaller and risks of agricultural drought are also increasing due to change in local hydrological conditions caused by extensive irrigation canals network but most of them functions as drainage canals instead due to lack of appropriate source of water and water control structures, surface runoff is drained rapidly into the flood plain leaving the field dry. Erratic rainfall regime (early, mid season or late season droughts) is another limiting factor for agricultural development of this area.

Major water source for supplementary irrigation of this area is non reliable depending on small western sub catchments and the Tonle Bati Lake which depend on the Preik Thnot flow regime. There is no storage reservoir in the Preik Thnot basin.

Potential for crop intensification and diversification is rather limited as compared to zone 1 and zone 2. Many farmers are now looking to expand their cultivated land into the zone 2 causing increasing number of land encroachment in protected areas in this zone damaging fishery resources of the region. Transportation and public facilities are extremely poor between the zone 3 and zone 2. Crop intensification need intensify capital and labour intensive such as weeding, pest management, water control etc. this can be optimized only when accessibility and travel distance and security are optimally met. There is a need for joint and integrated planning between the two zones especially for the establishment of new settlement areas and their accessibility.

The integrated flood risk management and integrated water resource management of the zone 3 is focusing on:

- securing full wet season crop in non flooded area by providing access to reliable and affordable water source for supplementary irrigation water;
- Reduce risk of flood damage from western catchment by diverting excess surface water from the cultivated area;
- Providing full flood protection of shallow flooded area along the Bassac flood plain;
- building and strengthening capacity in integrated water resource management to achieve optimum operation of structures for flood risk and water resource management.

Proposed infrastructure for integrated flood risk and integrated water resources management:

1. improvement of link irrigation/drainage canal between Boeung Tonle Bati and Samroung reservoir and Stung Takeo flood plain;
2. improvement of existing irrigation/drainage canal with appropriate water control structure;
3. surrounding dike around the Boeung Chhoeung Luong to be used as excess surface water collector for early crop protection and storage for supplementary irrigation for recession crop.
4. Dike embankment along the eastern part of the shallow flooded area, design at 100 years maximum flood level;
5. Main irrigation/drainage canal linking the Boeung Chhoeung Luong with the Takeo flood plain with related irrigation/drainage canal system (based on existing canals) and water control structures (off take, cross regulators etc) and main pumping station;
6. Main irrigation/drainage canal linking the Takeo canal with the Rominh canal including lateral irrigation canal system and a main pumping station.

Future agricultural development

Future without plan

According to the commune database 2007, agriculture in the area had a low cropping intensity of 90% of total potential land (176,830ha) for agriculture. The cultivated crops were 158,576ha of which 79,378ha of cultivated dry season rice, 74,632ha of cultivated wet season rice, 788ha cultivated upland rice, and 3,770ha cultivated non-rice crops. There were 87% cultivated dry season rice being irrigated by different water sources: pond/lake, well, river/stream, and canal/reservoir. Supplementary irrigation for rice in wet season covered 12% of the cultivated area.

The land very suitable for agriculture, however main constrain for agricultural development in the area is availability of water in dry season and flooding. Crop field elevation is varied from 6 to 8m above MSL and water level in Bassac river in dry season in an order of 2 m, pumping irrigation would be required for the area from canal distribution net-work to the field. Possibility for gravity irrigation is limited except from some existing natural lake/pond.

There would certainly be a small-scale irrigation scheme development in future without the plan. However, It is expected that an irrigated area from new irrigation schemes would be balanced the deteriorated rate of existing irrigation schemes. With this assumption, it is expected that future without plan would be more or less the same as existing agriculture.

Future with the plan

The plan provides irrigation facilities (canal, regulators, pumping stations), and flood control measures (ring dykes, compartment dykes, sluice-gates) for early flood protection in July to ensure the double cropping system in the deep flooded area and year around full flood protection for zone 1 and Zone 3 (shallow flooded area).

The first crop in the area would be planting in November-December and harvesting in March-April which is fully irrigated in dry season. The second crop would be planting in March-April and harvesting in June-July when early flood arrives in the area. The early flood protection (embankments and gates) would ensure the second crop safely harvested. Irrigation is also needed during April-June when no rain or insufficient rain compared to crop requirement. The third crop in full flood protection areas would be planted in August and harvested in November. This crop season would be rain-fed with provision of flood protection and local rain drainage.

For the purpose of a preliminary assessment on economic feasible for flood control measures and irrigation development, it is assumed that:

1. Agricultural land in future with the plan would be reduced by 5% compared to future without plan for infrastructure development (canal systems, embankments, rural roads and on-farm development, etc)
2. Cultivated crops would cover at a maximum rate of 90% land availability;
3. Zone 1: In dry season crops planted mainly non-rice crops. In wet season 50% of area planted by rice and the remains for non-rice crops. There would be 10,000ha (48% of the area) that the third non-rice crop could be planted;
4. Zone 2: Crops are mainly rice for dry and wet seasons. There would be two crops per year. Triple crop land in the area would not be possible.
5. Zone 3: “Lowland” would be planted wet and dry rice crops (two crops/year). “Highland” would be planted wet and dry non-rice crops (two crops/year). There would be about 20,000ha (27% of the area) in the low land that third crop of non-rice could be planted.
6.

With the above assumption, it is expected that:

- Cultivated dry season rice would be about 110,000ha with full irrigation of which more than 65,000ha in zone 2 and 45,000ha in zone 3. There would be no dry season rice in zone 1, since zone 1 in the dry season would be covered totally by non-rice crops;
- Cultivated wet season rice would be nearly 120,000ha with supplementary irrigation, of which about 9,000ha in zone 1, 65,000ha in zone 2, and 45,000ha in zone 3;
- There would be no upland rice in future with plan, this land would be convert into non-rice crop area;
- Cultivated non-rice crops would be mainly covered by red corn in wet and dry seasons for animal feeds, there would be some other potential non-rice crops such as green bean, soy bean and peanut for domestic consumption. Total cultivated area of non-rice crops would be about 102,000ha of which 38,000ha in zone 1, 900ha in zone 2, and 63,000ha in zone 3.

Overall cropping intensity in 2007 and future *without* plan conditions was 90%, of which 95% in Zone 2, 90% in Zone 3 and 73% in Zone 1. With the plan it is expected that cropping intensity would be 228%, 180%, and 207% in zone 1, zone 2, and zone 3 respectively.

Even with full flood protection in zone 1 and zone 3 the expansion of third crop in the area would be limited due to limitation of irrigation water in dry season. It is noted that there would be significant needs for agricultural extension services in the plan area for supporting farmers in cultivation techniques, new crop varieties, proper application of fertilizers & pesticides, and marketing. Short-term credit would also be provided to farmer to cover their physical inputs required during crop cultivation.

Flood Risk

Flood Hazard

The flood hazard has been assessed with the ISIS Mekong Delta model, using the most up to date data on the physical representation of the infrastructure and boundary conditions for discharges, local rainfall, water use etc. Flood hazard has been analyzed with historical time series of discharges in the Mekong River. Flood hazard maps have been produced for various exceedance frequencies of flow in the rivers for the current conditions and for a number of flood protection scenarios for the whole Mekong Delta.

Flood Damages

The flood damages have been assessed through analysis of official flood damage data as was inventoried for all districts. The data has been categorized in three groups, damages to i) a wide range of public services facilities, referred to as “Infrastructure”, ii) domestic properties referred to as “Housing”, and ii) “Agriculture”, comprising also losses in aquaculture. Flood damages have first been translated into flood damage curves, relating damages to (maximum) water levels based on seven years of available damage data. The simulated water level series were then subjected to the flood damage functions to produce the flood damage probability curves for each of the three damage categories (and the total).

Flood Risk

Through integration of the flood damage probability curves, the annual flood risks have been determined for a series of probabilities of exceedance. The protection levels that were taken in the design of the IFRM Plan lead to an annual risk reduction of 1.56 mln through reduction in flood damages. Flood risk is highest in agriculture (59%); and

Infrastructure and housing (41%), damages to housing is relatively minor showing that people are adapted to living with the flood.

IFRM Plan cost estimate and feasibility

The costs of the plan have been estimated at US$ 301 mln, with US$ 75 mln for Zone 1, US$ 85 mln for Zone 2 and US$ 141 mln for Zone 1.

With the annual benefits of US$ 75 mln from agricultural development, annual flood risk reduction of US$ 1.6 mln. and taking into account losses in fisheries resulting from reduced water body areas, and reduced soil fertility from reduction in silt supply, the net present value amounts to US$ 75 mln; the economic internal rate of return is estimated at 16%.

Plan implementation is estimated to take nine years.

The plan could be sub-divided into a number of projects at national, provincial or district level and be divided in phases.

TABLE OF CONTENTS

List of Appendices

Abbreviations and Acronyms

ADB	Asian Development Bank
asml	Above mean sea level
BDP	Basin Development Plan Programme
DEM	Digital Elevation Model
DSF	Decision Support Framework
DTM	Digital Terrain Model
DWR	Department of Water Resources in Thailand
EIA	Environmental Impact Assessment
FMM	Flood Management and Mitigation
FFMP	Flood Management and Mitigation Programme
FMMP-C1	Component 1 of the MRC FMMP: Flood Warning and Preparedness
FMMP-C2	Component 2 of the MRC FMMP: Structural Measures and Flood Proofing
FMMP-C3	Component 3 of MRC FMMP: Mediation of Trans-boundary Flood Issues
FMMP-C4	Component 4 of the MRC FMMP: Flood Emergency Management Strengthening
FMMP-C5	Component 5 of the MRC FMMP: Land Management
FRM	Flood Risk Management
GEV	Generalised Extreme value
GIS	Geographic Information System
IFRM	Integrated Flood Risk Management
IKMP	Information and Knowledge Management Programme of the MRC
IWRM	Integrated Water Resources Management
KOICA	Korea International Cooperation Agency
LMB	Lower Mekong Basin
MRC	Mekong River Commission
MRCS	Mekong River Commission Secretariat
NGO	Non Government Organisation
NMC	National Mekong Committee
POR	Plain of Reed
PR	Provincial Road
ProDIP	Project Development and Implementation Plan
RNE	Royal Netherlands Embassy
TCEV	Two Component Extreme Value
TOR	Terms of Reference
WUP	Water Utilization Programme of MRC
WUP-A	WUP Basin Modelling and Knowledge Base Project
WWF	World Wildlife Fund
1D / 2D / 3D	One Dimensional / Two Dimensional / Three Dimensional

IFRM Glossary

Damage curve	The functional relation between inundation characteristics (depth, duration, flow velocity) and damage for a certain category of elements at risk.
Direct damage	All harm which relates to the immediate physical contact of flood water to people, property and the environment. This includes, for example, damage to buildings, economic assets, loss of standing crops and livestock, loss of human life, immediate health impacts and loss of ecological goods.
Exposure	The people, assets and activities that are threatened by a flood hazard.
Flood control	A structural intervention to reduce the flood hazard.
Flood damage	Damage to people, property and the environment caused by a flood. This damage refers to direct as well as indirect damage.
Flood damage risk (= Flood risk)	The combination or product of the probability of the flood hazard and the possible damage that it may cause. This risk can also be expressed as the *average annual possible damage*.
Flood hazard	A flood that *potentially may* result in damage. A hazard does not necessarily lead to damage.
Flood hazard map	Map with the predicted or documented extent / depth / velocity of flooding with an indication of the flood probability.
Flood proofing	A process for preventing or reducing flood damages to infrastructural works, buildings and/or the contents of buildings located in flood hazard areas.
Flood risk management	Comprehensive activity involving risk analysis, and identification and implementation of risk mitigation measures.
Flood risk management measures	Actions that are taken to reduce the probability of flooding or the possible damages due to flooding or both.
Flood risk map	Map with the predicted extent of different levels / classes of *average annual possible damage.*
Hydrological hazard	A hydrological event (discharge) that may result in flooding.
Indirect damage	All damage which relate to the disruption of economic activity and services due to flooding.
Integrated flood risk management	The approach to Flood Risk Management that embraces the full chain of a meteorological hazard leading to flood damages and considers combinations of structural and non structural solutions to reduce that damage.

Meteorological hazard	A meteorological event (storm) that may result in a hydrological hazard and, eventually, in flooding
Resilience	The ability of a system / community / society to cope with the damaging effect of floods
Susceptibility	The opposite of resilience, that is to say the **inability** of a system / community / society to cope with the damaging effect of floods
Vulnerability	The potential damage that flooding may cause to people, property and the environment

1 INTRODUCTION

1.1 Background

In the Stage 1 Workshop of the Component 2 of the Flood Management and Mitigation Programme (FMMP-C2), held Ho Chi Minh City 25 September, 2008, it was agreed that the Preparation of and Integrated Flood Risk Management Plan for the West Bassac will be one of the Demonstration Projects during the Stage 2 Implementation of the FMMP-C2.

The scope of this project was presented in the workshop as follows:

1. The strategic direction as formulated under stage 1 will be translated into IFRM plans. For this planning exercise the input of BDP is required for the formulation of the land use and water resources development scenarios in these areas.

2. The plan will cover the whole area of the West Bassac including the potential land use intensification for agricultural development altogether with the Implementation of Integrated Flood Risk reduction.

Regarding the implementation of this project it was agreed that a " Working -group" will be established for the following purposes:

1. Provide guidance to the FMMP-C2 consultant team in the implementation of the Demonstration project, especially regarding policy, strategy and institutional issues

2. Participate in technical sessions for the transfer of technology from the side of the consultant to the technical working group members.

The Demonstration Projects are also meant to apply best practice guidelines that are developed under FMMP-C2. The following best practice guidelines are intended to be used in the implementation of the Demonstration Project:

1. Guidelines for Risk assessment;
2. Guidelines for IFRM Planning and Impact Evaluation;
3. Guidelines for the Development and Design of Structural Measures;
4. Best Practice guideline for the BDP

The Demonstration Project is an extension of the activities that were carried out during the stage 1 regarding the flood risk assessment and development of strategic directions in the Right Bank Bassac Focal Area. During the Stage 1 only flood damage curves in two districts have been developed (Koh Andeth and Koh Thom). The establishment of the IFRM plan of the West Bassac region requires the extension of the flood risk study to the remaining districts of the area.

1.2 Purpose of the report

During *Stage 2 Implementation* of the FMMP-C2 strategic directions were developed for the West Bassac area (see Figure 1.1) with the aim to investigate options for flood risk reduction and agricultural development. The proposed options for flood protection consist of embankments and polders. These options are currently considered as alternatives that are being investigated in the demonstration project for the development of an Integrated Flood Risk Management Plan for the West Bassac area in Stage 2 of FMMP-C2.

In parallel, a Public Participation Plan has been implemented in June 2009 in order to involve all stakeholder groups in this planning exercise to better understand and take into account their interests and point of views.

The alternatives developed in Stage 1 of FMMP-C2 constitute rather large-scale structural measures for flood risk reduction. As expressed in the Initial Environmental Examination (IEE) of FMMP-C2 the potential environmental impacts of these measures are expected to be substantial. The structural measure will optimise the exploitation of particular ecosystem services (i.e. water for agriculture), but in the same time it is expected to impact negatively on other ecosystem services and goods sustaining the communities in the area and downstream (i.e. fish production, pest control).

In the mean time, a Public Participation Plan has been implemented. Through this exercise, the local population and managers expressed their main concerns faced during daily life, as well as their vision of development in the area.

This report was prepared to have a comprehensive understanding of all the ins and outs of the Integrated Flood Risk Management (IFRM) Plan to develop the West Bassac area with an Integrated Water Resource Management (IWRM) approach, integrating the management of water, land and related resources.

As IWRM is based on a collective vision and collective actions, this report was prepared to guide the technical development of the plan in order to meet the collective vision of the local population. The latter is crucial to secure their willingness to further participate in the development of the structural measures, as well as in the construction and the management of them at a later stage.

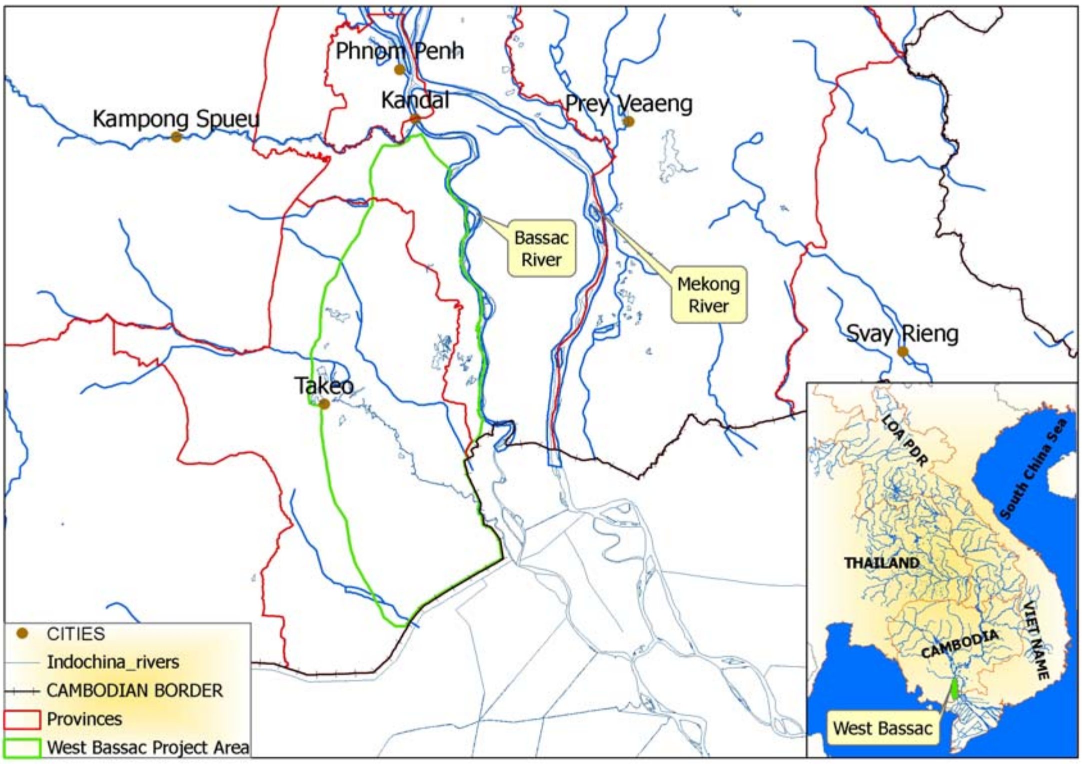


Figure 1.1 Location of the West Bassac Area in the South-west of Cambodia

1.3 Contents of the report

Chapter 2 presents the main characteristics of the West Bassac area. Chapter 3 describes the impact of floods and flooding in the area. Strategic directions for flood risk management are discussed in Chapter 4. The West Bassac integrated flood risk management plan is elaborated in Chapter 5. Public participation in the plan preparation is discussed in Chapter 6. The outcome of an initial environmental examination of the plan proposals is presented in Chapter 7. Chapter 8 presents a cost benefit analysis. Chapter 9 discusses the required institutional development. Chapter 10 refers to the transboundary impacts of the plan. Finally the Terms of Reference for a feasibility study for the next phase are discussed in Chapter 11.

2 THE WEST BASSAC AREA

2.1 Location

The West Bassac area, as part of the Mekong Delta, is located in the extreme southwestern part of Cambodia and is located in the Sub-area 10C of the MRC Basin Development Plan (BDP) (see Table 2.1 and Figure 2.1. The northern boundary of the area is formed by the Strung Preik Thnot, the Bassac River forms the eastern boundary. To the south, the area extents to the Cambodia-Vietnam border, to the west National Road no 2 forms the boundary.

The area is 227,119ha and covers 85 communes in Takeo and Kandal provinces of which there are 63 communes in 9 districts of Takeo and 22 communes in 4 districts of Kandal. Forty four communes are totally located in the area of which 40 communes in Takeo and 4 communes in Kandal.

The Bassac area is essentially a floodplain that is bordered by the natural levee of the Bassac River and the higher terrain in the West. The elevation ranges from about 1 to 10 meters above mean sea level and at some locations the plains are bordered by low hills. The Bassac River and the smaller tributaries are bordered by natural levees that are formed through silt depositing. The levees are intensively used for living and transportation. The levees separate the rivers from depressions that flood during the flood season. A system of colmatage canals has been developed over the centuries to (partially) control the water flow in and out of the floodplain depressions to support the cultivation of rice. As compared to Vietnam the floodplains in Cambodia are largely undeveloped. The floodplains of Cambodia are characterized as in Table 2.1 Figure 2.1 [3].

Table 2.1 General characteristics of the West Bassac Floodplain

Floodplain	still quite natural
Infrastructure	few roads, colmatage irrigation systems, a few small-scale irrigation schemes
Housing and development	mainly along levees bordering rivers
Economy	extensive agriculture and fisheries
Land use and ecology	no national parks, but floodplains and flooding essential for biodiversity in the region
Hydraulics	largely natural flooding, only obstructed by roads and to some extent levees

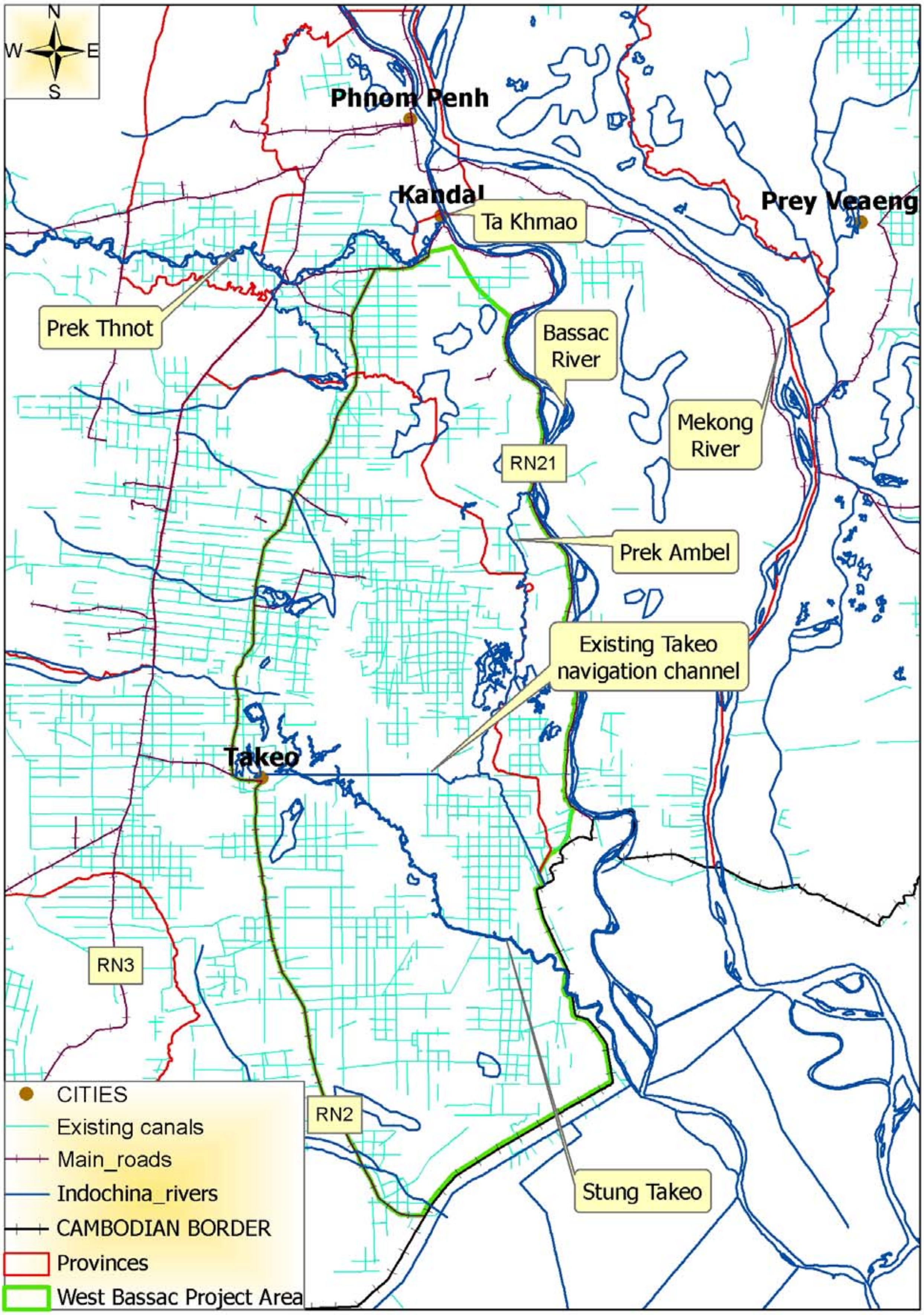


Figure 2.1 Location of the West Bassac area in Kandal and Takeo provinces

2.2 Climate and meteorology

The area has a tropical monsoon climate. December and January are the coolest months, while March and April are the hottest. The rainy season extends from May to October when some 80% of the annual average rain occurs. The average annual temperature is about 27°C.

February is normally the driest month in this region. The average rainfall in the eastern part of the sub-area is high compared with other locations, ranging from 1,173 - 1,867 mm/year. The southwest zone generally has a somewhat lower annual rainfall, ranging from 937 - 1,817 mm/year.

Annual evaporation in the Mekong basin in Cambodia ranges from 1,300 to 1,900 mm.

2.3 Infrastructure

2.3.1 Roads

The area contains quite a number of roads, though besides the national roads that form the boundary of the zone and a short section south of Ta Khmao all roads are dry weather roads, cart tracks and footpaths. The larger of these roads can effect small floods and floods in the early and latter stages when water levels are still low if they have been built on dykes, which is often the case.

In the West Bassac area there are numerous canals, flood control dikes and water control structures. A number of water retention reservoirs have been built in the low-lying areas for irrigation water supply to dry season flood recession crops.

Most infrastructure was built in the recent past, mainly during the Democratic Kampuchea period. Although some of the infrastructure has recently been rehabilitated, most of it is of little use for flood risk reduction or integrated water resources management purposes. Financial and technical capacity for operation and maintenance is lacking and many structures are incomplete. Significant investment is needed for rehabilitation and operation in a sustainable manner.

2.3.2 Flood management infrastructure

For generations people living in flood prone areas have developed a way of life in coping with flood by limiting risk of exposure to flooding (houses on stilts and villages at the limit of maximum flood level). Phnom Penh is the only city of the country protected against flooding by surrounding road/dike and an internal drainage system. In addition to the Mekong floods, the new industrial zone in the south western side of Phnom Penh suburb (not within the old city plan) is also often threatened by floods from the Preik Thnot River, a flash flood type or a combined flood.

The Preik Thnot River enters into its flood plain at the provincial capital of Kompong Speu some 46 km from its mouth at Ta Khmao, the provincial town of Kandal, running through vast flood plain of about 50 km wide occupied principally by subsistence rice field. At RN 51, part of the Preik Thnot flood flow is drained by the Stung Tauch which meets the RN2 to the east of the Tonle Bati Lake joining by the affluent of the Tonle Bati before ending in the deep flooded area of the West Bassac at Boeung Choeung Luong. During high flood period large amount of over bank flows is accumulating in the upstream side of the railway embankment, the RN3 and RN2, the natural drainage capacity of the Stung Preik Thnot downstream of the RN 2 is not sufficient for the maximum flood discharge of this river. After the major floods of 1994, 1995 and 2000s assisted by a number of donors, JICA, World Bank, ADB and other bilateral donors) many projects have been implemented under the Flood Emergency Rehabilitation projects. Main objectives of the projects were to rehabilitate infrastructure damaged due to lack of maintenance during the war period and floods especially the 2000s floods. They are isolated projects aiming at improving drainage capacity of existing water crossing infrastructures but not under a well design and comprehensive flood risk management framework.

For flood management in the West Bassacs area, following flood management structures have been built or function as flood protection infrastructures:

1. The Kampong Toul sluice gate built on the flood diversion branches of the Preik Thnot River and to store water for supplementary wet season irrigation;
2. The Kamong Toul weir, to control water level of the Preik Thnot upstream of the RN 3
3. A sluice gate built by grant aid from Japan under the Kandal Stung Irrigation Rehabilitation Project to control water level upstream of the RN 3
4. A dike system protecting cultivated areas along the Preik Thnot River, immediately upstream of the Kampong Toul area.
5. A diversion canal linked Preik Thnot with Stung Touch , a branch of the Preik Thnot River linking with the Tonle Bati, a lake between the RN3 and RN 2.
6. A flood diversion canal across the RN 2 near Preik Ho to convey the Preik Thnot over bank flow to the flood plain of the West Bassac.
7. The national road RN 21 linking Phnom Penh with the Viet Nam border has been raised above maximum flood level;
8. Some 90 colmatage canals divert flood water from the Bassac to the deep flooded area at both sides of the Bassac, only a few of the colmatage canals are gated allowing possibility for flow control.
9. The Preik Ambel is one of the most significant natural flood diversion channels from the Bassac into the flood plain of the deep flooded area preventing water level rise in the Bassac,
10. The most significant drainage catchment between Stung Preik Thnot and Takeo town is the Stung Slakou draining a catchment area of 2,100 km2. This catchment is rather underdeveloped; most agricultural lands are still under subsistence rain fed wet season rice cultivation. The O Saray reservoir is the only significant water storage in this sub-catchment. This reservoir could not be used for flood management since it is equipped with an automatic gate otherwise it could be to some extent control flood in the area near to Thnot Te reservoir.
11. A flood protection/irrigation project (Pich Sar) consisting of a network of embankments is located between Takeo and Phnom Den at the Vietnamese border. On the eastern side of RN2, in the shallow flooded area, an area of 17,248 ha is protected against peak floods. 1,859 ha are irrigated in the dry season by pumping.
12. A dike embankment system along the eastern side of the shallow flooded area from Ta Khmao town to Angkor Borei and south of Angkor Borei to Stung Takeo, Stung Takeo to Koh Andeth and Phnom Den.
13. A dike and canal from S’ang to Tonle Bati.
14. The road embankment Bati - Prey Kabbas - Angkor Borei is flood free. The embankment continues to Stung Takeo (Borei Chulsa)-Borei Chulsa-Koh Andeth-Kampong Chrey on RN2 (probably flooded during peak flood period);
15. Road embankment Takeo-Sambour-Thnot Chum-Trapeang Tonle-Kampong Chhrey on RN2

16. Road embankment from Thlea Prachum (on the road from RN2 - Koh Andeth) to Krapum Chhuk - Prey Yuthka and to RN2;
17. Road embankment from Andaung Samreth on the road to Rominh - Prey Khla - Krapum Chhook - Pong Andeuk - Anh Chanh on the Cambodia-Vietnam border.

2.3.3 Irrigation and drainage infrastructure

Similar to any other parts of the country, most existing irrigation/drainage canals and related water control structures of the West Bassac area were built during the Democratic Kampuchea period. Most of the constructions were not completed, badly designed (regular interval in east- west; north- south directions) or were damaged later due to lack of maintenance. Some have been rehabilitated and put into operation recently. The majority of the canals are not connected to water sources such as rivers or reservoirs or need a pumping station; almost all of them are not equipped with a functional water control structure. Generally, due to lack of maintenance, irrigation canals built during that period function purely as a drainage canal causing great changes in hydrological conditions of the area. The surface water is drained away faster, causing risk of water shortage during prolonged dry spells.

Preliminary identification shows that water sources for supplementary irrigation could be identified as:

(i) In the non flooded area and shallow flooded area (mainly for wet season) :
   a. To the north : The Preik Thnot River, the Stung Touch-Tonle Bati;
   b. The central part: the Samrong- Bat Rokar, Chook Sar reservoirs.
   c. The southern part (south of Takeo): The Stung Takeo, Boeung O Tom

(ii) In deep flooded area (mainly flood recession cropping):
   d. In the Bassac and Stung Takeo Flood plain: the Preik Ho, the Preik Ambel, the Stung Takeo, the Preik Moat Chrrouk, The Takeo canal;
   e. The Thnot Te, The Thammanon and the following reservoirs: Chhook Sar, Thnot Te, Thammanon, Ang Tom, Boeung Takeo.

(iii) The “Chamcar”along the Bassac: The Bassac, the colmatage canals, the Preik Ho and the Preik Ambel

2.4 Navigation

In the Cambodian delta, water transport is traditionally the principal means of travel for much of the population. Locating their communities on or near waterways has enabled local population to trade with neighbouring communities up and downriver.

With Phnom Penh at its most northern point, the Delta sub-area includes a major water transport network. Navigation is crucial for shipment between Phnom-Penh and the Delta region for fish, agricultural produce and supplies, gasoline and heavy equipment.

For 89 kilometers from Phnom Penh to the Cambodia/Vietnam border the Bassac River is navigable for 50-ton ships year round, and for 200-ton vessels during the rainy season. The river links Phnom Penh with Chau Doc, the capital of Vietnam's An Giang Province and is connected to a network of tributaries and canals, mostly in Takeo Province. This tributaries and canals can take up to 100-ton boats at high water, but loads can be limited to 10 tons at low water. Most vessels on this network are in the 20-30-ton range, and are used for trade between Takeo and the Vietnam Delta area. There is a small international port at Kampong Ampil in Takeo Province, which is used by trucks from Phnom Penh.

2.5 Population and living situation

2.5.1 Population

Ta Khmao and Takeo are the main build up areas. Along the rivers and along elevated roads many houses are built in the form of ribbon development. People in the region have a long experience in 'living with the flood'. Communities establish themselves in villages at the limits of the flood plain and build their houses on stilts.

The total population in the area according to 2007 commune database was 682,200 of which the female population occupied 51%. There were nearly 128,600 families in the area with an average size of 5.31 persons,

A small minority (1.4%) is Islamic, whereas 0.54% of the population is Vietnamese.

Two districts composing partially the West-Bassac project have been assessed during stage one of the FMMP-C2: the Koh Andet district and Koh Thom district. Table 2.2 presents the household characteristics of both districts.

From the perspective of vulnerability to flood impacts:

(i) The social and cultural homogeneity of the population increases resilience to flooding. It supports social and community networks.

(ii) Poverty is a key indicator of vulnerability to the impacts of flooding. Poor people tend to live in housing of inferior quality located in more vulnerable areas which means they may experience greater damages and losses due to flooding. Poor people have lower cash incomes and rely more on loans that they may have difficulty to repay; they are more at risk of having to sell products at lower prices (not able to store until prices are better) or to sell off land and other assets to pay for extra expenses due to floods.

Table 2.2 Household Characteristics West Bassac

Household Characteristics West Bassac Focal Area, Cambodia				
Indicator		*Unit*	*Koh Andet*	*Koh Thom*
HH size (average)		Pers.	5.1	5.5
HH head	Male	%	86.1	87.0
	Female	%	13.9	13.0
Male/female ratio			0.95	0.96
Children < 17 years		%	43.5	38.0
Dependency ratio		ratio	0.99	0.91
Source: District Flood Vulnerability Baseline Database, Cambodia				

(i) Poverty tends to be higher among female-headed households, making them more vulnerable to the adverse impacts of flooding.

(ii) The large proportion of children in the area tends to increase vulnerability to the impacts of flooding. Children are often at risk of physical injury, drowning and diseases during floods.

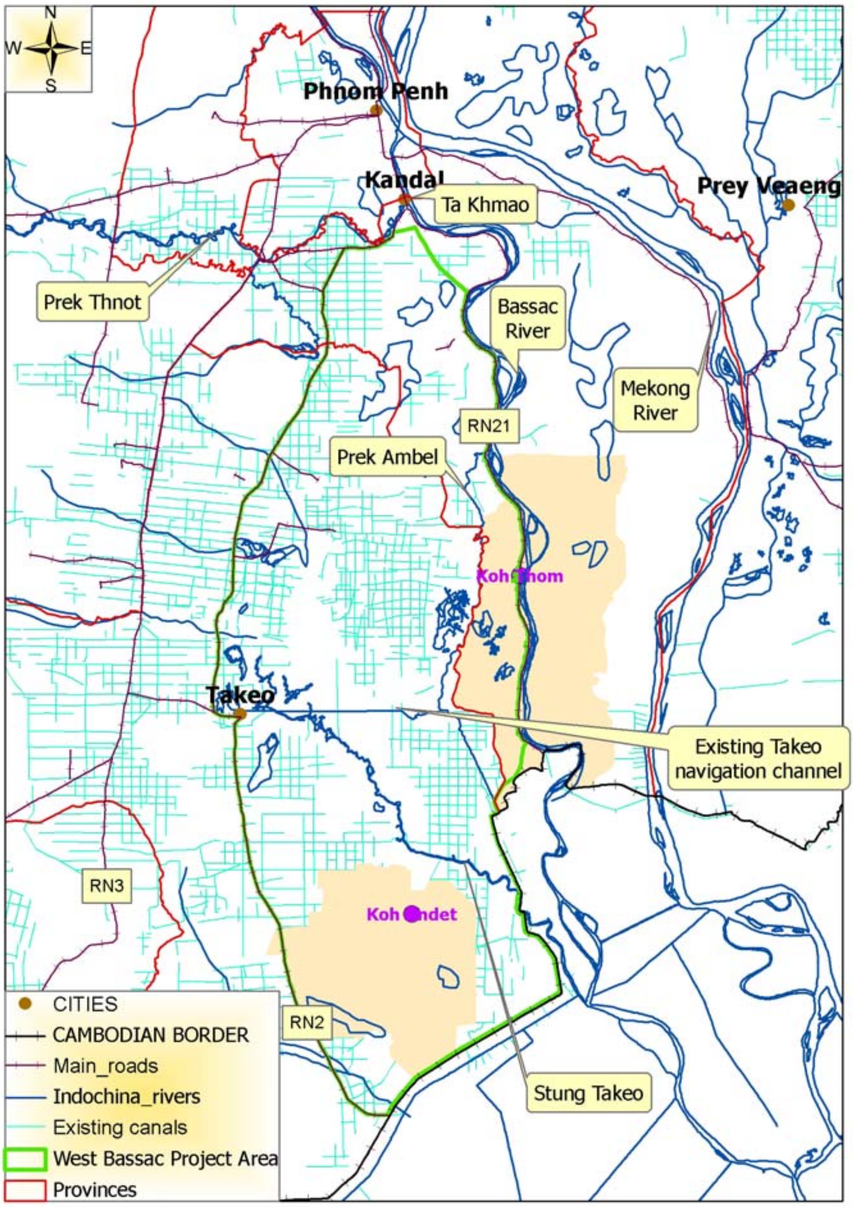


Figure 2.2 **Location of Koh Andet and Koh Thom districts.**

Table 2.3 **Community Characteristics West Bassac**

Community Characteristics West Bassac Focal Area, Cambodia			
Indicator	*Unit*	*Koh Andet*	*Koh Thom*
Population	No.	50,716	150,517
Number of HH	No.	9,975	27,250
Ethnicity			
Khmer	%	98.3	87.4
Cham	%	1.7	2.8
Vietnamese	%	0.0	11.2
Poor population	%	22.6	30.0
Popn growth, 2001-2006	%	1.6	1.3
Source: District Flood Vulnerability Baseline Database, Cambodia			

2.5.2 Land use and tenure

In Koh Andet, the principal portion of the focal area, nearly the entire land area is allocated to paddy cultivation (98%); about 2% is residential land where people live. In Koh Thom, on the other hand, there is a greater diversity of land uses. Nearly half of the district is flooded forest although this is located between the Bassac and Mekong rivers outside of the focal area. The four communes on the west bank of the Bassac include an area of higher land immediately behind the embankments that line the river; this area has been intensively developed for cash cropping to take advantage of the low flood risk and the proximity to markets in Phnom Penh. The remainder of these communes is in the floodplain where rice is the dominant land use. Table 2.4 presents the land use in the two districts.

Table 2.4 Land uses

Land Uses West Bassac Focal Area, Cambodia			
Indicator	*Unit*	*Koh Andet*	*Koh Thom*
District area	ha	24,749	47,860
Rice land (dry season)	%	43.8	27.1
Rice land (wet season)	%	54.0	4.6
Orchard land	%	0.0	15.0
Residential	%	2.3	3.1
Commercial/industrial	%	n/a	n/a
Institutional	%	n/a	n/a
Forest (flooded)	%	n/a	50.2
Communal	%	n/a	n/a
Source: District Flood Vulnerability Baseline Database, Cambodia			

In Cambodia, an ongoing project to implement systematic land titling has not yet extended to the jurisdictions within the West Bassac area. Therefore, tenure for agricultural land is based on other forms of documentation. 66% of the agricultural households in Koh Andet have land titles while only 33% in Koh Thom have land titles. Koh Andet district authorities report no landless households. In Koh Thom, just over 4% of household do not have agricultural land; many of these are ethnic Vietnamese who work as fishers. With regard to residential land, nearly all Koh Thom households have secure tenure; the data for Koh Andet indicate a low proportion of households with legal documents for their residential land. In terms of social vulnerability to flooding, the following are the risks in this focal area:

(i) The reliance of livelihoods on agricultural land increases the direct and indirect costs of flooding, particularly in Koh Andet. Household expenditures for food and other basic needs will increase if people are unable to cultivate rice or vegetables in riverbank gardens; incomes decrease from the loss of cash crops.

(ii) The lack of secure land tenure is a major risk factor for many households in Cambodia. They lack collateral to obtain loans to rehabilitate property damaged during a flood, finance agricultural inputs or meet other household needs (e.g., health care).

(iii) People without productive land are at risk during a flood because, in most cases, they work as agricultural labour on other people's land. They lose this source of income if land is inundated for extended periods and/or the rice crop is damaged or destroyed. As they are generally poor, they have few alternative resources to meet basic or flood-induced needs (e.g., health care).

2.5.3 Housing and other structures

Housing constitutes nearly all of the main structures in the focal area (97-99%). Commercial and institutional structures account for the remainder. There are no industrial structures. All households and/or businesses own their structures.

In general, people living in this focal area do not relocate during floods to safe areas. However, they employ some traditional coping measures to protect their houses and other property against flood damage:

(i) Households build on higher ground if it is available and away from rivers, streams and other water courses. If higher ground is not available, they will often raise the level of house sites with earth or rubble.

(ii) The traditional house exists of a wood frame built on stilts. The stilts are wood or concrete columns, the latter being naturally water resistant. Prior to floods, households will increase the strength of house struts and bracing timbers.

The implications for assessing the vulnerability of households to flood damages are as follows:

(i) The sitting of houses and traditional construction techniques reduce the risks of flood damages to housing for most people. Poor people, however, tend to live in temporary housing structures built on the ground. They are highly vulnerable to having their structures damaged or swept away during floods.

(ii) Small, temporary agricultural buildings are highly vulnerable to damage or loss, depriving people of places to store rice or the use of kitchens or latrines.

2.5.4 Economic activities

The main occupation in the area is crop cultivation: 82% of the families are involved in agriculture, a small percentage of the population (1%) has fishing as its main occupation, part-time fishing is done by a much larger percentage of the population. About 15% of the families are involved in trading and services.

In Koh Andet, the farmers mainly crop rice, while in Koh Thom people are engaged in a combination of growing cash crops, fishing and rice farming.

At the district level, the more urban character of Koh Thom is reflected in the higher proportions of people employed in the public and private sectors as well as trade and other services. However, the four communes in the focal area are more rural in character and, therefore, non-agricultural activities are more likely to be similar to those in Koh Andet. The implications in an assessment of social vulnerability to flooding are:

(i) Vulnerability to economic losses due to flooding is directly related to the high proportion of people engaged in agricultural activities, particularly in Koh Andet.

(ii) Businesses and shops are often located along roads that are generally constructed along dykes. This would tend to minimize disruption of these economic activities during normal floods.

Table 2.5 Economic activities

Economic Activities West Bassac Focal Area, Cambodia			
Indicator	*Unit*	*Koh Andet*	*Koh Thom*
Economically active popn.	No.	11,138	31,167
Proportion 18-60 years	%	43.8	39.6
Rice farming	%	85.0	52.0
Fishery	%	0.1	7.9
Other agriculture	%	0.1	19.7
Employment-government	%	4.6	3.5
Employment-private	%	5.8	9.1
Trading & other services	%	4.3	7.8
Source: District Flood Vulnerability Baseline Database, Cambodia			

2.5.5 Rural livelihoods

Agricultural production and rural livelihoods are significantly different in the two districts surveyed in the Right Bank Bassac focal area. The principal reasons for the differences include the topography and flood risks as well as the proximity to major urban areas. Different varieties of rice, the principal crop, are planted at different times in the upland and lowland portions of the floodplain in the focal area. Most farmers have plots in different areas.

(i) At the beginning of the wet season (May), a “heavy”/late variety of rice is planted in upland areas (above 5-m contour); strong, tall stalks remain above floodwater levels.

(ii) During the wet season, lowland areas are not cultivated.

(iii) At the end of the wet season (November), a dry-season recession rice crop is planted in lowland areas (3-5 masl). In Takeo, swamps in remote portions of lowland areas are being reclaimed to expand the area of recession rice crop.

Farmers employ various strategies to reduce risks to their rice crops due to abnormal floods and/or drought such as adapting sowing and transplanting dates to rain conditions and planting additional fast-maturing crops if conditions are favourable during the wet season. However, according to FG participants, many farmers in this focal area have stopped cultivating wet season rice, relying more on dry season crops: since the late 1990’s in surveyed communes in Koh Andet, 30-40% of farmers have switched from producing wet and dry season crops to producing only dry season rice. High yield rice varieties have been selected with short durations.

The partially-protected areas immediately adjacent to the Bassac River have a lower risk of serious floods; they also benefit from floods that deposit silt and cleanse the soils, improving the soil capacity of these areas. Good access to water and road transport networks and, particularly in the case of Koh Thom, proximity to urban markets has led to increased intensification and diversification of cash cropping in these areas. These crops have higher yields per area and higher market prices compared with rice.

The role of fishing activities in livelihoods varies across the focal area, based on information provided by FG participants. Whereas fishing is primarily to supplement household diets in Koh Andet, fishing plays an important role in the livelihoods of people in Koh Thom particularly minority Cham and Vietnamese communities. In fact, in Leuk Dek fishing is the sole source of income for many families during the flood season.

Table 2.6 Fishing activities

<table>
<tr><th colspan="2">Fishing Activities
Right Bank Bassac Focal Area, Cambodia</th><th>Main Income Source</th><th>Household Consumption</th></tr>
<tr><td>Pech Sar (Koh Andet)</td><td rowspan="2">▪ 2-month season</td><td>▪ 1% population
▪ 5-7 kg per day</td><td>▪ 30% population
▪ 1 kg per day</td></tr>
<tr><td>Rominh (Koh Andet)</td><td>▪ 20% population
▪ 7-10 kg per day</td><td>▪ 60% population
▪ 2 kg per day</td></tr>
<tr><td>Preik Thmey (Koh Thom)</td><td>▪ 7-month season</td><td>▪ 30% population (Cham & Vietnamese)
▪ 20 kg per day</td><td>▪ 5% population
▪ 1 kg per day</td></tr>
<tr><td>Leuk Dek (Koh Thom)</td><td>▪ 3-month season</td><td>▪ 80% population (Cham & Vietnamese)
▪ 7-10 kg per day</td><td>▪ 20% population
▪ 2 kg per day</td></tr>
<tr><td colspan="4">Source: Focus group discussions, Cambodia</td></tr>
</table>

Raising livestock is a more important aspect of rural livelihoods in Koh Andet compared with Koh Thom. Approximately 70% of households in Koh Andet raise cows and pigs. Each household has, on average, 3 pigs that are grown both to meet household consumption needs and to generate cash income from sales. In Koh Thom, less than 50% of households raise these animals. They also tend to have fewer animals per household. Nonetheless, throughout the focal area the importance of livestock means that many households will move their animals to higher ground to protect them from floodwaters.

Households in Koh Andet have paddy areas that are, on average, 60% greater than the area belonging to people in Koh Thom. Regardless of the area of paddy owned and the cropping patterns, the yields are similar in the two districts: the wet season crop produces 2.1-2.4 tons/ha while the recession crop yields 3.3-3.8 tons/ha. Due to the low yield levels, at least 50% of the crop is used to meet basic household consumption needs. Nonetheless, according to FG participants, many households experience rice shortages of 1-2 months in a normal flood; the duration of shortages may increase to 4-6 months in years with higher-than-normal flooding.

Based on data collected from surveyed households in the focal area, the average household income from all sources is 30% higher in the 4 communes in Koh Thom compared with Koh Andet. Moreover, in Koh Thom, the income ratio for people living in semi-permanent housing to those living in temporary housing is 3.2, compared with 2.7 for the same groups in Koh Andet. The higher income levels in Koh Thom reflect, among other factors, the value of cash cropping that is relatively more important than in Koh Andet, as well as greater opportunities for non-agricultural economic activities offered by access to transportation networks and urban centres.

The livelihoods of people living in the West Bassac area are highly vulnerable to the impacts of floods. Some of the key issues raised by FG participants include:

(i) In bad flood years, the wet season crop may be damaged or lost. Moreover, the planting of the recession crop may be delayed. Low yields are further reduced and there is increased risk of food shortages.

(ii) Households often borrow from family, friends and NGOs to have enough money to buy food. They also borrow to purchase inputs for their rice crops. Therefore, much of the crop is sold while still in the field or at harvest (when prices are low) because the proceeds are required to repay these loans.

(iii) The opportunities for fishing become critical, for example, in areas such as Leuk Dek commune where there is little or no wet season rice crop. Poor households that do not own a boat are particularly vulnerable. All fishers are vulnerable if, during a bad flood, there are high winds and waves that make fishing dangerous or not possible.

(iv) Due to the lack of food and money, poor people in particular increasing rely on "free" sources of food and income such as fishing, catching crabs and snails, collection of wild vegetables. This may be possible during a normal flood season if people have access to boats or other means to access natural resource areas, but it becomes difficult or not possible during bad flood seasons.

(v) Some households faced with food shortages will reduce the number of meals from three to two per day; women are more likely to go without food in order to feed their husbands and children. This has adverse consequences for the general health of women as well as their vulnerability to disease.

(vi) Distress sales of land and animals often occurs when households lose rice crops and require money for food, medical or other expenses. A common cause of people becoming landless is the sale of land to pay for medical expenses. People will often sell animals prior to a flood (at significantly reduced prices) if they are worried they cannot protect their animals, find grass to feed them or pay for animal feed during the flood.

(vii) Many households must rely increasingly on selling their labour and other non-agricultural activities to supplement their incomes. This includes men and women who migrate, for example, to Phnom Penh to work at MOTORDOP drivers or food sellers. In some parts of the area, families are permanently migrating to other parts of the country because they cannot sustain their livelihoods.

(viii) The most vulnerable groups include a) women who head households because they lack male labour, b) landless people who rely on working as agricultural labour, c) poor households and d) households headed by elderly and disabled people who do not have young people in their households to help support them.

(ix) The cumulative impacts of flood losses are evident when there very bad floods (e.g., the 2000/2001 floods) or several above-normal floods within several years. Poor households in particular may have difficulty to recover from a single flood event – rebuilding housing, obtaining money to plant a new crop, repairing or replacing damaged assets, etc. A cycle of indebtedness is established with people repaying cash and in-kind loans often at high interest rates. As a result, they are more vulnerable in subsequent years even to the impacts of normal flooding.

2.5.6 Access to electricity, water and sanitation

In the Takeo provinces only about 40% of the population has access to safe drinking water. During the dry season, the number of households with access to safe water even further declines in both urban and rural areas. It is estimated that for the poorest 20% of the rural population, the percentage drops to 4%. Only a small number of families has a connection to a water distribution net and receives purified water (5%), 37% use pump wells and 6% use open (dug) wells. Nearly 50% of the population use surface water from lakes, ponds and rivers. Two percent use rain water storage facilities. According to the 2006 census data, 36% of the families have access to water at their house; 20% get water from public taps or wells within 150m of the house, and 44% of families has to get water at a distance of more than 150 m from the house.

Sanitation levels are extremely low, the latrine rate is very low with 19% of the houses. Urban concentrations are not equipped with wastewater treatment plants. Municipal liquid waste is directly discharged into rivers, streams and canals. Most industries also release wastewater into municipal sewers, which then empty into rivers and streams.

Diarrhoea and dengue fever are two of the major health issues in the area, and both are water-related.

In each of the two districts, there is one public system providing grid electricity and one public water supply system. In each district, similar proportions of households are connected to these systems: 4-4.5% of households in Koh Andet and 14-16% of households in Koh Thom. In general, these are the wealthier households and those that live in the district towns.

Table 2.7 Power and water supply

Power and Water Supply West Bassac Area			
Indicator	*Unit*	*Koh Andet*	*Koh Thom*
Number of HH	No.	9,975	27,250
Public systems			
Grid electricity	% HH	4.4	16.1
Water supply	% HH	4.1	14.5
Electricity - other sources	% HH	61.0	73.1
No electricity	% HH	34.5	10.8
Source: District Flood Vulnerability Baseline Database, Cambodia			

The majority of households obtain electricity from sources such as diesel generators or car batteries; water comes from a mixture of wells, rivers and rainwater collection. However, more than one-third of households in Koh Andet have no electricity, compared with 11% in Koh Thom. Many households do not have latrines; they defecate in fields and other open spaces. The implications for the assessment of social vulnerability to flooding include the following:

(i) Due to inadequate supplies of safe drinking water and, particularly, poor sanitation conditions (defecation in the open and in paddy fields), there is a high risk of diarrhoea and dysentery.

(ii) The lack of firewood (flooded forests, flooded roads that make forest areas inaccessible) means that people are often unable to boil water to make it safer to drink.

(iii) Bathing and washing clothes in flood waters increases the incidence of skin rashes and infections due to contamination of the water.

2.5.7 Access to health care

Table 2.8 Access to health care

Access to Health Care West Bassac area			
Indicator	*Unit*	*Koh Andet*	*Koh Thom*
No. of HH	No.	9,975	27,250
No. of communes	No.	6	11
Hospital	No.	4	1
Number of beds	No.	36	80
HH per hospital bed	ratio	277	341
Health clinics	No.	5	11
HH per clinic	ratio	1,995	2,477
Dispensaries	No.	4	30
HH per clinic	ratio	2,494	908
Source: District Flood Vulnerability Baseline Database, Cambodia			

According to data provided by district health authorities, the health care facilities available to people living in the area are limited. Based on population, there is one hospital bed for every 275-340 households. On average, each clinic serves between 2,000 and 2,500 households; dispensaries serve from 900 to 2,500 households each.

People are vulnerable during floods for the following reasons:

(i) In the event of serious injuries or disease associated with floods, the health care facilities may not be sufficient to meet the needs of people living in the focal area.

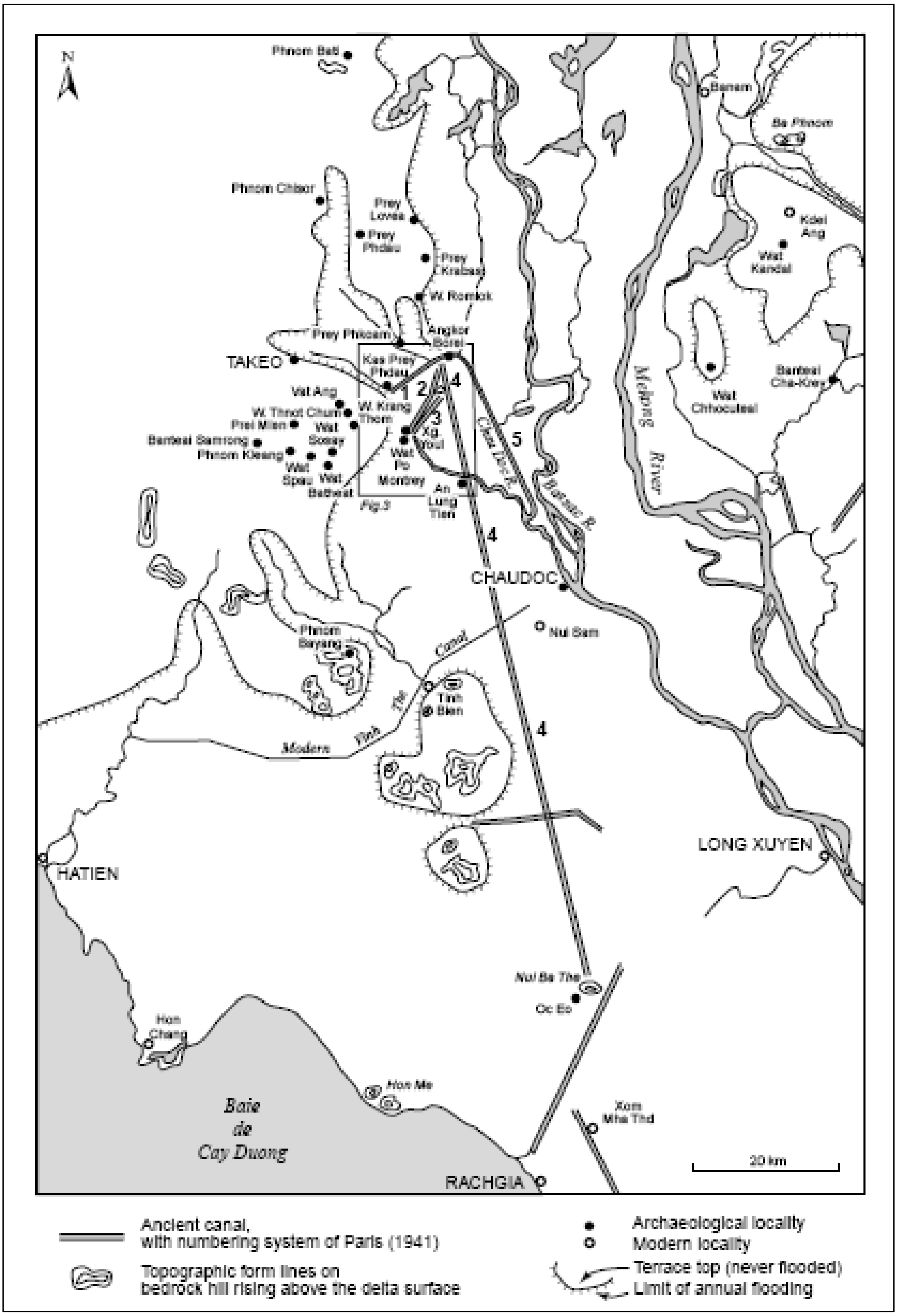
(ii) In the absence of adequate health care facilities, they tend to rely on buying drugs from petty traders who do not have any medical knowledge, or going to traditional healers and monks for help and advice.

(iii) The impacts are greatest on children and women. Children are easily injured or get sick because they drink unsafe floodwaters. Women, as noted, are most likely to forego meals if the household is experiencing a food shortage, thus reducing their overall health status. They also are unable to obtain reproductive health services during flood periods.

(iv) Due to the lack of adequate health care and/or the need to travel to obtain health care, there is a higher risk of extraordinary health care costs that strain the resources of households, particularly poor households. This may lead to distress sales and increased landlessness.

2.5.8 Cultural, historical, archaeological sites

In the area around Angkor Borei remains of pre-Angkorian canals have been found. The archeological evidence indicates a flourishing local economy early in the first millennium AD. It is also suggested that the area experienced major re-organization or re-structuring in the early fifth to early sixth centuries. This restructuring probably did not involve major de-population, but a change from rice cultivation in bunded fields with dry season burning, to flood recession cultivation of rice [7].



Source: Bishopa et al., 2003

Figure 2.3 Archeological sites and ancient canals in the area

2.6 Agriculture

The West Bassac area is characterized by a diversity of farming systems:

(i) the "Chamcar" along the right bank of the Bassac has a trend towards a more diversified cropping system following the annual flood cycle with high development potential,

(ii) the rain fed wet season rice crop dominates the non and shallow flooded area along the eastern side of the RN2, this area is relatively densely populated practicing subsistence rice cultivation in a relatively poor soil (ancient alluvium) and scarce of water sources has limited potential for crop intensification and diversification,

(iii) the deep flooded area extending from the Ta Khmao town to the Cambodian-Vietnamese border including the Stung Takeo flood plain is benefitting from regular sediment supplies from the Mekong floods spreading through some ninety colmatage canals. Part of this area closer to the villages, lakes and manmade reservoirs (Bat Rokar, Samrong, Boeung Krachap, Thammanon and Kanleng Chak, Boeung Choeung Luong, Boeung Uo Tom) are used for rice flood recession or dry season irrigated intensified crops.

Except for the small levee zone along the Bassac River, where cash crops are grown, rice is the main crop in the West Bassac area. Depending on soil type, elevation, flood frequency, flood depth and flood duration, different rice farming systems and rice varieties are used. The number of rice varieties is countless, but can be categorized into four main:

- wet season rainfed rice;
- wet season deep water rice;
- dry season recession rice and dry season irrigated rice; and
- upland rice (not present in the research area, not discussed any further).

With this rice ecosystem, farmers have cultivated thousands of varieties for many hundreds of years. While subject to environmental pressures – flooding, drought, adverse soils and insect pests – throughout a diverse history of cultivation, these traditional varieties provide not only grain for farmers, but also highly valuable genetic stocks for plant breeders. Variations in time to flowering mean that varieties from different groups are grown at different water levels in the fields.

The wet season rainfed rice can be classified into early, medium and late maturing varieties. Normally, early varieties are grown near villages where the water level is shallow and where the crop can be given supplementary irrigation. Intermediate maturing varieties are often grown on middle field terraces, and late-maturing varieties are grown in the lowest part of the fields where water is likely to be deeper and where submergence may frequently occur. Most rainfed rice varieties prefer floodwater depths between 0 to 0.25 m, but depths of 0.5 m or more can be tolerated for short periods. Some varieties of late maturing rainfed rice require rainwater during germination and early grow, while they require floodwater when they are taller.

Deepwater rice is grown in depressions that accumulate floodwater at a depth of 0.5 m or more for at least one month. Maximum water depth ranges to more than 3.0 m. Most varieties of deepwater rice are old traditional varieties. Ideally, these crops receive sufficient local rainfall to allow 6 or more weeks of growth before mid July. They are then at an advanced stage of maturity which allows them to grow fast enough to keep pace with the rising floodwater. Some of these rice varieties can grow 0.2 - 0.3 m per day and grow up to 4 m long. Deepwater rice is harvested in January or February. Deepwater rice cultivation is decreasing rapidly in favour of recession rice, double cropping or dry season rice. The risk of damage due to abnormal floods or droughts is high.

Low rainfall can result in drought for all three groups. Most rainfed lowland rice varieties have traits (such as time to flowering) that are adapted to local environments. Although only a few varieties are actually resistant to drought, a large proportion of traditional varieties are able to recover once the drought is over. The highly variable levels of recovery exemplify the different levels of drought tolerance.

Recession rice uses the floodwater as source of moisture. As the water begins to recede, the receding water is blocked off with barriers erected by farmers. Crops are planted along the edges of the flooded areas and as the water recedes during the dry season, water is pumped back onto the fields where possible. A succession of crops follows the edge of the lakes or floodplains as the water recedes, hence the term 'recession rice'.

Farmers normally have plots in at least two different rice ecosystems. In that way they spread the required labour force more evenly over the year and prevent the loss of the whole yield at once. Farmers can also adapt their sowing and transplanting dates to the actual circumstances. If the first rains are late, then nursery bed establishment and land preparation starts late. If a lack of rain in July or August delays transplanting, farmers can wait until the rain sets on and transplant older seedlings. Furthermore, if suddenly unexpected heavy rains occur farmers plant early maturing varieties in unused fields and enjoy an extra yield. Finally, when floods are extremely severe, fields in which the crops are destroyed are replanted with recession rice.

Since timing of agricultural activities depends on the rainfall and discharge pattern, and because rice is not equally sensitive to floods in all growth stages, comparable floods can result in different flood damages.

The area covers 227,000 ha of which 176,800 ha (78%) is (potential) agricultural land. There are limited irrigation facilities, a few small schemes extract water for irrigation from ponds/lakes and rivers. Besides, only a limited area is protected against early flooding. As a consequence a single cropping system is prevailing in the area.

Two crop seasons can be distinguished: in the wet season the cultivated area is about 69,000 ha, in the dry season about 84,000ha is cultivated. Wet season crop are (see also Figure 2.4):

- Early rice: planted in April and harvested in August (before the main flood);
- Medium rice: rice with long stem varieties is planted in May-June and harvested in November-December; and
- Late Rice: long stem and long duration varieties is planted in May-June and harvested in January-February.

The crops planting in the wet season are mainly rain-fed. Only 29% of wet season cropped area receives supplementary irrigation during dry spells.

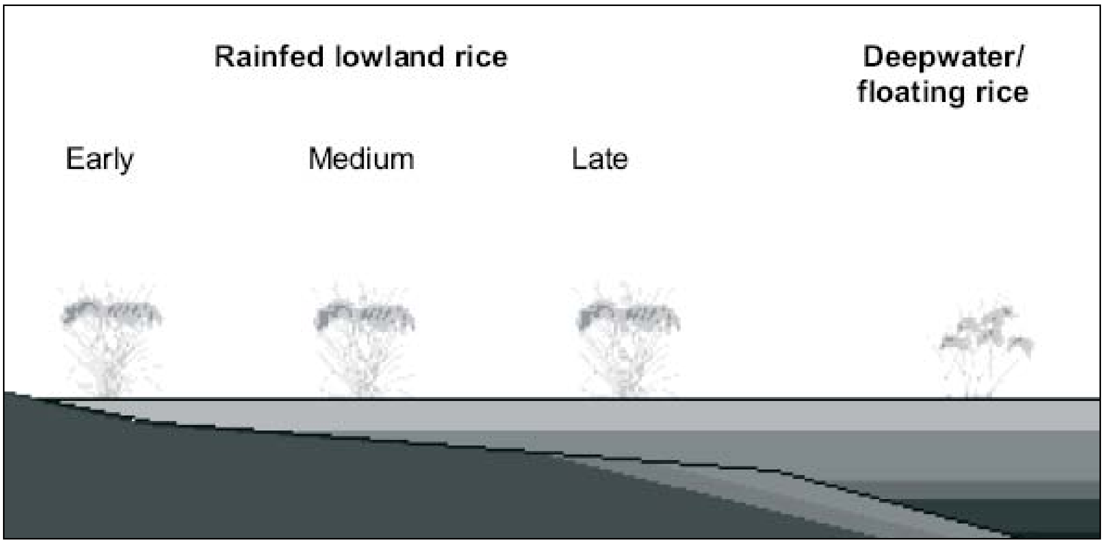


Figure 2.4 Rice varieties in the wet season

The dry season crop is planted after the flood recedes, especially on low-lying land. Depending on the progress of the flood recession, the crop is planted in November and harvested in late March for the early dry season rice, or planted in December and harvested in early May for the late dry season rice. According to the 2006 census data 78% of the cultivated area was fully irrigated in the dry season.

General speaking, crop cultivation in the area is very extensive with little use of fertilizers and pesticides, except crop in dry season with full irrigation. Yields are low at about 2.0-2.4 ton/ha in wet season and about 3.0-3.8 ton/ha in dry season. The total production amounts to about 208,000 ton/year in the dry season and 147.000 ton in the wet season.

Flood damage to agriculture is mainly for the wet season paddy. In the absence of August-flood protection as practised in Vietnam, the flood damages to agriculture (mainly paddy cultivation) depends more on the maximum annual level of the flood than on its timing.

Upland crops such as corn, mung beans, peanuts, vegetables and sweet potatoes are mainly grown on the higher grounds along the Bassac river.

At present cropping intensity in the area is 115%. Without the planthere is a small potential for developing commune irrigation schemes, this could increase the cropping intensity to 118%.

Agrochemical use

Rainfed lowland rice areas typically have sandy soils with low fertility. These are soils that respond poorly to fertilizer application. Nitrogen and phosphorus deficiencies and iron toxicity are common in most rice soils; some soils are also deficient in potassium and micro-elements. Low organic matter and poor water-holding capacity are also common. The productivity of rainfed lowland rice can be increased if the appropriate fertilizer is applied to overcome deficiencies in soil fertility (often associated with toxicities) (National Rice Programme, Mr. Sarom)

Within the framework of the Economy and Environment Program for Southeast Asia (EEPSEA) project a case study on the use of fertilizers and pesticides has been carried out in the Takeo province in 2001 [8]. Although the study is based on limited data, it indicated that more farmers (60 to over 90%) use chemical fertilizers in the dry season than in the wet season (less than 10%), when mixed and organic fertilizers are used by 30 to over 90% of the farmers.

The study also indicated that most farmers (15 to 50%) apply chemical fertilizers in amounts far exceeding the recommended levels, due to a lack of information on soil types and recommended application ranges, lack of agricultural training, and the inability of farmers to understand fertilizer product label instructions. Non of the farmers interviewed had ever received formal training in agro-chemical use.

Similar to chemical fertilizer use, pesticide application depends on the rice season, pesticide use is more common during dry season (70 to 100% of the farmers) than in the wet season (about 50%). The most frequently used pesticides were insecticides, followed by rodenticides and herbicides.

The World Health Organization (WHO) has classified pesticides by toxicity/hazard into Class I, II, and III with those in Class I considered the most toxic. Many countries including Cambodia have banned the use of pesticides classified as Ia or Ib. Nonetheless, the use of Class I pesticides remain common in Cambodia. The case study in the Takeo province indicated that 35 to 55% of the farmers use Class 1 pesticides in the dry season, in the wet season the figure drops to 15 to 30%.

Poor practices like smoking and eating while spraying, spraying against the wind, and not wearing protective clothing are commonplace. As a result, pesticide-related health problems appear widespread. Approximately 70% of the farmers surveyed sprayed pesticides during the wet and/or dry season, of which about 30% reported experiencing pesticide-related health problems. These problems, which occurred during or soon after spraying, included fatigue and dizziness, headaches, fever and chills, diarrhoea, stomach-aches and vomiting, coughing, and eye and skin irritation. The farmers lost workdays due to these health problems in the range of 2 to 14 days per year and some farmers continue to experience health problems that they believe are pesticide related.

Most farmers spray pesticides when they notice their crops damaged by pests or see a large number of insects in their rice field. Since very few farmers can distinguish between beneficial insects and actual pests, they may be spraying pesticides unnecessarily. Farmers also reported spraying pesticides when they see other farmers do so, even if there is no evidence of crop damage or insects in their field. Such indiscriminate pesticide spraying may result in increasing pest resistance. Regarding the disposal of pesticide residuals, over 90% of farmers in Prey Sva and Prey Tamao dispose cans, bottles and wash sprayers in their rice fields and/or irrigated canals.

The overuse of pesticides and poor disposal practices also has an impact on fish and other aquatic resources. Few, if any, aquatic resources live in rice paddies where pesticides have been sprayed and it is noted that fish and aquatic species tend to be more abundant in rice paddies where organic, rather than chemical, fertilizers have been applied.

2.7 Fisheries

The productivity of the floodplain is the highest worldwide and ranges between 139 and 230 kg/ha/year. This is due to 3 uniquely interconnected factors: high biodiversity, large accessible floodplains, and a very high exploitation rate.

Cambodian people in rural areas rely heavily on fisheries for their subsistence. Fish provide from 40-60% of animal protein intake for people in rural areas – even those living far from water. An average of 76 kg of fish is consumed per person/year [9]. The total value of fish catches in SA 10C is estimated at approximately US$ 45 million. The value of the river fish capture is estimated at about US$ 0.68 per kilogram, while the value of aquaculture is approximately US$ 1.05 per kilogram.

During the flood, fish are dispersed in a large volume of water. A large proportion of the fish has not yet grown to catchable size and the use of medium and large-scale gears is prohibited during the official closed season (1 July to 31 October). When water levels recede, fish are forced off the floodplain and become concentrated in channels, streams and rivers. Various kinds of traps and large stationary trawls (dais) set across flowing waters in the flood recession season catch many fish and other aquatic organisms.

Capture fisheries are categorized as small-scale or subsistence, as middle-scale, or as commercial scale. Small-scale fisheries are family fisheries, based on small gears such as cast nets, dip nets, small gill nets and traps. Anybody can fish, and a license is not needed, but it is illegal to fish in fishing lots during the open season (October-May). Most households in the area fish for some time each year on land they own, or in nearby water bodies, flooded forest and floodplain areas. Production from rice fields fisheries is very important to most rural families.

Middle-scale fisheries are based on larger gears, of at least 40 types, with the most popular being gill nets and seines. Anybody can fish, but a license is required. Middle-scale fisheries are not permitted inside commercial fishing lots.

Commercial-scale fishing is based on ‘lots’, fishing areas which are auctioned every two years. Large-scale fishing gears are only permitted in fishing lots, which can only be fished in the open season (October to May). Such gears include dais, fences with traps, and barrages. A dai is a stationary trawl or bag net, which filters the current, and is typically 25-45 m wide and 100 m long. Fences, up to several kilometers in length, are built across flooded areas or lakes to direct fish into traps. Barrages are smaller gears that block a stream and direct fish into traps.

The number of inland fishing lots in Takeo have been reduced considerably in the year 2000 (from 21 to 8) and the released commercial fishing lots have been transferred to community fisheries. Elimination of the commercial lots has provided an opportunity for villagers to better share the benefits of the fisheries. However, in the absence of management and enforcement of regulations such open access may lead to over fishing

Fisheries provide a possibility for income generation with very little capital investment and no land needed. In Cambodia as a whole 1995-96, 39% of households were involved in fishing and 77% of them were involved in farming as production and income-generating activities. More than 50% of the fishing households indicate that their supply of fish comes mainly from family fishing in rivers, lakes and in flooded rice fields. 10.5% of the households have fishing or a fishing related activity as the primary occupation while another 34.1% are engaged on a part-time basis.

More than 62,000 tons of fish are caught in natural water-bodies every year in SA 1OC, representing about 30% of the national total. In the Takeo Province 17,535 families in 62 communities (49% of all communities) are involved in fisheries, in Kandal province these figures are 3,190 and 17 respectively. Large companies are not operating in the area. Fish production in the Takeo province is reported to be 11,182 ton/year, in Kandal Province 32,769 ton/year [4].

2.8 Aquaculture

The capture fishery in Cambodia has been so productive that there has been little incentive for development of aquaculture. Moreover, until recently, poor infrastructure limited the distribution of fish feed, fingerlings and the produce of the industry. Nevertheless, aquaculture is a steadily increasing part of the economy. The Delta in Cambodia is considered to have huge aquaculture development potential. Pond culture and fish farming in rice fields have recently been introduced by the Department of Fisheries. An estimated 124,880 families in the Delta have their own fish ponds, which are increasingly contributing to water demand in the area. Consumption of water in Mekong Delta fish ponds for aquaculture is now estimated at 6,000 m3/ha/month.

At present about 4,900 tons of fish are produced yearly in SA 10C. Production in the Takeo Province is 808 ton/y, for Kandal Province no aquaculture production is reported by McKenny & Tola [4]. Fish ponds and cage nets are rarely developed in the Mekong River itself, but many can be found along the tributaries.

2.9 Industry

Industrial development in the area is very limited.

2.10 Other ecosystem services

River-based livelihoods involve a combination of many different linkages between people and their rivers. While rice fields, fisheries, livestock, and vegetable gardens are the most visible components of local livelihoods and economies, many other resources are perhaps less visible but no less important. Many of these less visible components of local livelihoods can only be appreciated and understood in the light of knowledge and experiences of local people living along, and with, the river. Together, aquatic and forest resources form the foundation of livelihood security for many of the people living in the West Bassac. This is particularly the case for Koh Thom district as nearly half of the district is flooded forest, although this is located between the Bassac and Mekong rivers outside of the area.

3 FLOODS AND FLOODING

3.1 Flood characteristics

Located in the Mekong delta part of Cambodia and under influence of the Mekong flow regime, major part of the West Bassac area is subject to regular annual flooding between July and October. Flood water affects large areas for several months where land elevation is no more than 2 to 6 m.

In addition to the Mekong flood, the northern part of the West Bassac area is partly affected by flood from the Stung Preik Thnot. The Preik Thnot flood water frequently threatens the southern suburb of Phnom Penh and surroundings when heavy rainfall occurs in the upper part of this sub-catchment (4,760km2 at Kampong Toul on the RN3) which mostly coincides with the peak water level of the Bassac from August to October. On such occasions two tributaries of the Preik Thnot, the Stung Touch and Stung Tonle Bati, experience backawater effect from the Bassac flood water and flooding extends over large areas of this part of the flood plain.

The national road RN2 is the western limit of the Mekong/Bassac flood plain stretching over 67 km from Ta Khmao to Takeo and another 60 km from Takeo to Phnom Den at the Cambodian-Vietnamese border. The RN2 runs through a terrain where land elevations vary between 8 and 10m amsl. It crosses some depressions with land elevations varying between 5 and 6m asml. In addition to Preik Thnot, the western side of the West Bassac is occasionally affected by a number of western tributaries of the Bassac which drain the hilly area to the west. The most important one is the Stung Sla Kou/Svay Prey with a drainage catchment area of 1,200 km2. This river crosses the RN2 near the Takeo town before joining the flood plain of the Stung Takeo.

After Takeo town, the RN2 runs through the same flat landscape extending over the area between the RN3 and RN2 with land elevation varying between 6 and 7m. A few spots are on higher ground near Takeo town: Cheung Chap, Prey Romiet villages and Phnom Pongro to the east of Prey Sandaek town on RN2 with a maximum altitude of only some 23 m. Further to the southwest a number of hills dominate the flat landscape namely the Phnom Den, Phnom Chua Halo, Phnom Tapok, KiriChong Kas, Veal Veng, Prey Rum Deng and Sanlong. During high flood the Mekong flood water crosses the RN2 at a few places: between Chi Khmar and Pech Sar to join the Stung Tuk Meas and Tan Han in Kampot Province.

The Bassac river

The Bassac River is heavily silted and is non navigable during the dry season and the RN 21 built on its right levee is flood free. The Bassac River receives its water from the Mekong (mainly during the beginning of the flood season) and from the Tonle Sap Great Lake during the flood recession period when water is flowing back from the lake. During the last months of the dry season (March-April), there is no or extremely low flow from the Great Lake. At the same time there is no or very limited flow in the Bassac River.

During the flood season (July-September) the water level of the Bassac River rises sharply and when reaching a level of approximately 5.0 m at Koh Khel station, part of the flood flow is diverted to the flood plain through some 90 colmatage canals. The relatively high lying natural levees directly bordering the river are in some places protected by embankments and are only affected by shallow flooding during relatively short periods. Throughout the years sediment steadily extends the western side of the RN21 causing land surface sloping down toward the flood plains. Similarly to the right bank, the left bank of the Bassac uses the same system but with only part of the levee/road embankment being flood free. The Preik Ho, a branch of the Preik Thnot (at Ta Khmao) joined by a number of natural lakes and depressions, and the Preik Ambel followed by the Moat Chhrouk canal form the current principal drainage channel of the West Bassac flood plain.

The areas most affected by the Mekong/Bassac flooding, classified as deep flooded area with respect to flood depth and duration, are located directly west of this shallow flooded area. Further from the river, land elevations rise and flooding is less deep. Typically the shallow flooded area is delimited by the 5.0 m contour line. Another deep flooded area extends from Takeo in southeastern direction, covering most of the Cambodia/Vietnam border area. Elevation in this area varies between 3-4 m amsl. The surface water distribution in the zone near the border is very complex, many interconnected canals and natural streams store or convey flood water across the border. Currently there is limited data available concerning the functioning and characteristics of these streams.

In addition to the Bassac water, the middle part of the West Bassac area receives also water from the Stung Takeo/Sla Kou sub catchments. The upper catchment of the Stung Takeo is drained by Preik Toul Lok to the south of the Phnom Chiso. This stream ends at the beginning of a flood plain which is some 3 km wide. At its confluence with the Stung Svay Prey (downstream part of the Stung Slakou), its average width is about 20 km extending from the RN2 to the road Prey Kabbas/Angkor Borei with an average elevation ranging between 3 to 4 m. The Bassac flood plain and the Stung Takeo flood plain form large flood water storages extending from Takeo to the Cambodian-Vietnamese border. Only an area extending from Prey Kabbas to Angkor Borei is on higher ground. It is a peninsula where the narrowest part is at Angkor Borei. All major drainage channels meet at Angkor Borei including the manmade Takeo canal, linking Takeo to the historical town of Angkor Borei. Flooding can last up to 6 months.

The most recent floods caused by high discharges in the Mekong/Bassac river system took place in the years 1961, 1966, 1978, 1991, 1996, 2000, 2001 and 2002, heavy flooding from the Stung Preik Thnot and other tributaries of the Bassac River is reported for the years 1922, 1991, 1994, 2000 and 2006.

During the 1991, 1994 and 2000 floods, heavy damages were caused to the railway line, National Roads 2 and 3 as well as other infrastructure (bridges, culverts) and crops.

From flood risk point of view, the West Bassac area could be subdivided into deep and shallow flooded area, the shallow flooded area extends from the western limit at RN 2 extending to the east following more or less the 10 m contour line; remaining area belongs to deep flood.

3.2 Social perception of flooding

Agriculture in the area is closely linked with the annual cycle of flooding. Normal floods improve soil moisture and fertility, restore ground and surface water resources, and replenish fisheries and forests. Normal floods likewise have no adverse physical impact on village settlements and only a limited effect on wet season rain-fed rice fields. Annual floods become disasters for rice farming only when they come too early or when they are too high or last too long. Floods that come too early in the crop growing cycle destroy the rice seedlings before transplanting. Too high floods or floods that last too long destroy established wet season rice crops.

In the area, the local population differentiate “good” and beneficial floods from “bad” and harmful floods. Table 3.1 summarizes the views of FG participants on what constitutes good and bad floods and the benefits and damages related to floods.

Table 3.1 Flood characteristics according to public perception

Flood Characteristics West Bassac Focal Area, Cambodia	
Good Floods / Flood Benefits	**Bad Floods / Flood Damages**
▪ During a good flood, water rises slowly at a normal pace to provide water for the rice crop and to control weeds. ▪ A good flood recedes quickly so that it does not rot the rice in the field. ▪ There are no strong winds, lightning strikes or waves that would make using boats and fishing dangerous. ▪ The flood brings fertile land and alluvial soils to rice fields, increasing yields by 25-33%. ▪ The flood increases fish production. ▪ Vegetables, perennial and fruit trees are not damaged.	▪ Flood waters rise rapidly and remain for a long time. Rice crops are damaged or lost. To lesser extent, there can be loss of vegetables. ▪ Fish cages damaged and fish escape from flooded natural ponds during bad floods. ▪ There are strong winds and waves that make navigation dangerous; people are at risk of drowning or being hit by lightning. ▪ Paths and roads are damaged, limited accessibility, people cannot travel to markets ▪ Small stores, outbuildings and houses of temporary materials are damaged/ destroyed. ▪ Water quality deteriorates and becomes smelly (particularly in upland areas); drinking water is unsafe and health risks increase; washing/bathing in flood waters causes skin rashes. ▪ Children are unable to attend school for up to 3 months due to damaged schools and roads.
Source: Focus Group Discussions, Cambodia	

3.3 Community preparedness to flooding

Throughout the area, there are no plans or strategies that have been prepared for flood warning or preparedness. Flood warnings consist of notices issued by provincial governments through district authorities, commune councils and/or village chiefs. Radio and TV are also used to warn people about flood conditions.

Similarly, there are no plans/strategies for emergency response or flood recovery. Provincial governors, the Cambodian Red Cross and other NGOs provide some assistance, as well as local pagodas and monks. In general, communities have to rely on traditional methods of restoring and reconstructing rice fields, dykes and drainage channels. The key weaknesses pointed out by FG participants include:

(i) Lack of financial resources and technical expertise.
(ii) Lack of organized, coordinated responses during and after flood emergencies.
(iii) Lack of transparency and accountability in assistance Programmes.
(iv) Focus on short-term relief without sufficient attention to long-term, sustainable strategies to assist communities.
(v) Poor households are unable to participate or take appropriate actions to restore livelihoods and living conditions because they lack labour as well as funds.

3.4 Flood hazards

Under the stage 1 of FMMP-C2 flood hazard maps have been produced based on the 97 years of records at Stung Treng for different frequencies, 1%, 5%, 10%, 20% and 30% and flood damage curves have been produced based on preliminary survey in two districts: Koh Andeth and Koh Thom [2] .

Figure 3.1 to Figure 3.2 represent flood hazard maps with respectively 2, 10, 25 and 100 year flood return period.

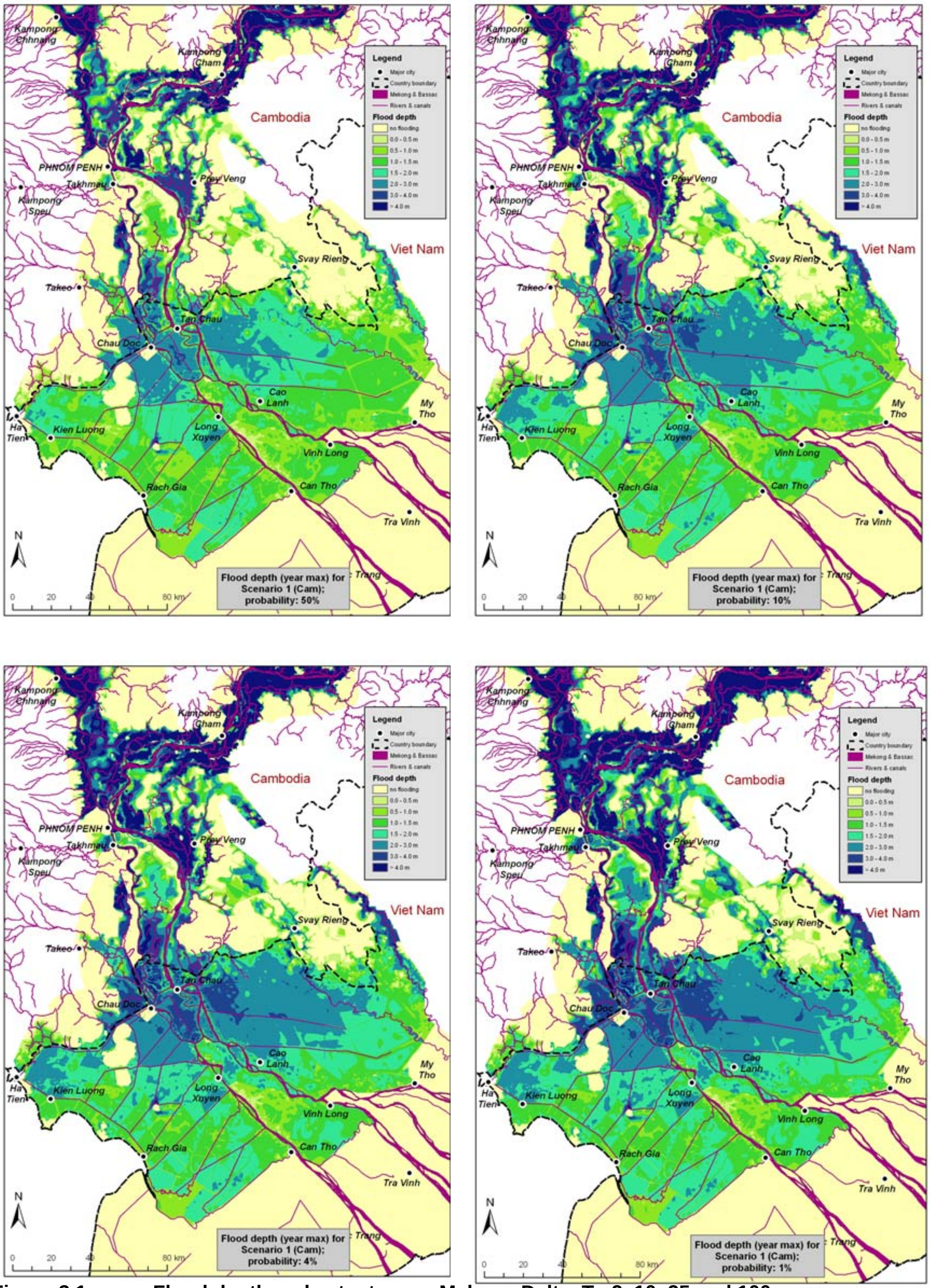


Figure 3.1 **Flood depth and extent maps Mekong Delta, T= 2, 10. 25 and 100 years**

3.5 Flood damages and annual flood risk

The ‘Best Practise Guidelines for Flood Risk Assessment in the Lower Mekong Basin’ [11] gives the methodology to produce maps of flood levels, flood depths, flood damages and flood risks with the ISIS model. These have been applied in stage 1 of the FMMP-C2 for 2 districts that are part of the demonstration area where assessed on flood damages and risk. They are Koh Andet district (Takeo province) and Koh Thom district (Kandal province).

The flood damages and annual risk have now been assessed for all districts in the West Bassac area (see Appendix 2). Following the absolute damages assessment approach for flooding damage figures for certain flood return periods have been produced.

Total flood risk

Total flood risk including infrastructure, housing and agriculture at probability of 1% in 13 districts of the West Bassac area varies from 92-788 thousand US$/year between districts. Highest flood risk was found in S'ang district, Kandal province and lowest flood risk was in Doun Kaev district, Takeo province. Figure 3.2 presents an example of total flood risk for all districts in the Mekong Delta.

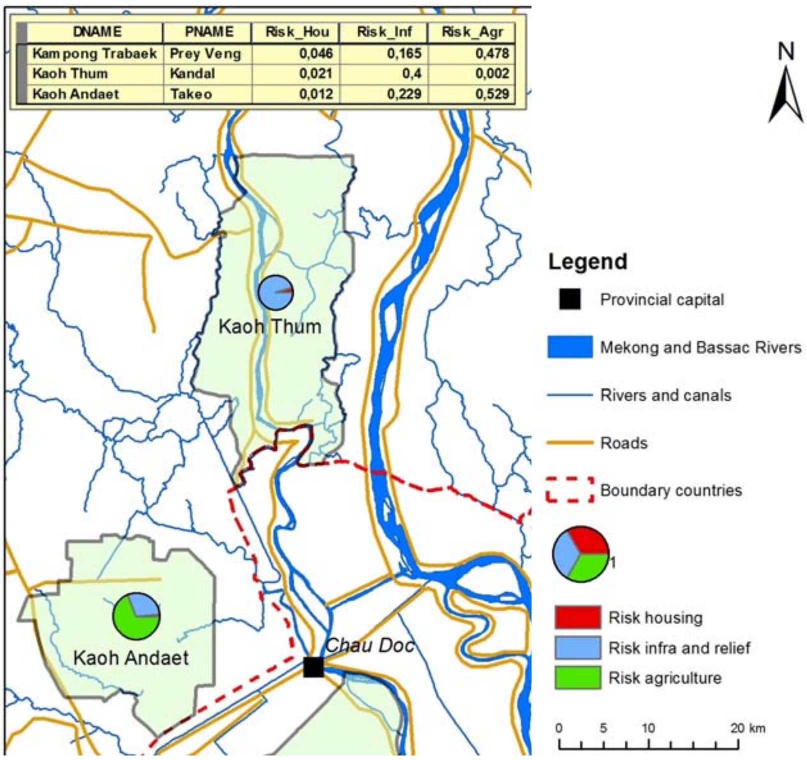


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Figure 3.2 Flood risk per district (million US$ per year)

4 STRATEGIC DIRECTIONS FOR FLOOD RISK MANAGEMENT

4.1 Strategic direction for the West Bassac area

During stage 1 a variety of flood risk management options have been considered and on the basis of a first evaluation of the impacts on risk reduction and potential loss of flood benefits, strategic directions for flood risk management have been formulated for the area.

The development of strategic directions for flood risk management in the unprotected flood plains in Cambodia is closely related with the envisaged land use scenarios:

1. single cropping in the deep flooded area (actual land use)
2. double cropping in the deep flooded area
3. double or triple cropping in the shallow flooded areas

The direct relation between the different land use scenarios and flood risk management strategies is as follows:

- Single cropping can be done without protection of the agricultural land. Structural measures can be restricted to protection and/or flood proofing of human settlements and public infrastructure.
- Double cropping in the deep flooded areas requires flood management to secure that sufficient flood free time is available between two floods. In practice, this comes down to early flood protection of the agricultural land and/or adequate drainage of flooded areas after the flood. Additional protection and/or flood proofing will be required for infrastructure and human settlements.
- Double or triple cropping in the shallow flooded areas requires a full protection of these areas. A differentiation of the protection levels in these areas is to be considered, in which human settlements and essential infrastructure is provided with a higher level of protection then the agricultural areas.

Current land use in the West Bassac areas is merely restricted to single rice cropping in the absence of adequate structural measures for flood management and irrigation. "Living with flood" is the leading concept. The existing flood risks in the West of Bassac area do not justify substantial investments in flood protection works to reduce agriculture related risks. In case no further agricultural development in this area is envisaged, flood risk management measures should focus on the reduction of flood risks related to business, housing and infrastructure. These risks can be reduced by:

- early warning
- relocation of houses and businesses
- flood proofing and/or protection of residential areas and infrastructure.

Relocation of houses and or business may be considered if the related costs are less than flood proofing and/or protection. This is not likely to be the case, but needs further investigation.

If, however, agricultural development is envisaged in these unprotected floodplains then such developments would create increased risks in the absence of adequate flood protection measures. Polder development would then be an obvious approach. Such development should go together with the provision of irrigation facilities. The loss of environmental benefits, especially fisheries related benefits, will play a crucial role in the planning and design of such polder schemes.

4.2 Impact of IFRM scenario's

The West Bassac area cannot be considered in isolation from the entire Delta. Flood management options at Delta level that aim at the reduction of the flood hazards for the entire Delta are very limited. Such options would have to consider the reduction of the flood discharges and volumes that enter the Delta or the creation of diversion and/or retention options in the Delta. Upstream retention as a flood mitigating measure for the Delta is not considered a realistic option.

Flood management at regional level within the Delta is the approach that is being followed in the Vietnamese part of the Delta. This approach refers to the different regions in the Delta with different levels of flooding (deep, shallow) and distinct boundary conditions requiring different flood control solutions. This regional approach is also suggested for the Cambodian part of the Delta. The development of cross boundary strategic directions is not considered appropriate, in view of the great difference between the development level and pace at the two sides of the border. Emphasis is to be given to the potential impacts that the separate regional strategic directions may have on neighbouring regions, rather than to try to come to common strategic directions.

The Vietnamese long term planning for the deep flooded areas in the Mekong Delta is essentially based on the "living with floods" concept and the management of floods to allow for a safe production of double rice Winter-Spring and Summer-Autumn crops, while human settlements and essential infrastructure will be flood proof throughout the year. The corresponding flood management infrastructure allows, though, for a management of the floods also beyond the early July-August floods. It will be the operation of this infrastructure that determines when and which area is allowed to be flooded.

For the Cambodian deep flooded areas in the Delta it is suggested to provide protection against the early floods only, allowing the safe harvest of a second crop. Human settlements and essential infrastructure are to be safeguarded also during the main floods, though. The shallow flooded areas in the Cambodian Delta areas could be provided with full protection.

It is recommended not to make (parts of) the areas completely flood free. A system of controlled flooding should be designed, which reduces the damages, but at the same time conserves the benefits of the flooding as much as possible. Special attention should be given to the remaining natural areas, they are not only threatened by changes in the flooding regime, but also, and probably even more so, by encroachment of local people.

From existing flood conditions and current land use, the West Bassac Integrated flood risk management zone could be sub-divided into three management zones.

5 THE WEST BASSAC IFRM PLAN

5.1 Structural measures for flood management, irrigation and drainage

Three flood risk management zones were identified based on present flood conditions, existing road and flood embankments, human settlements and land use. Subsequently, the type of structural components required for each area has been identified and preliminarily designed. The hypothetical scenario formulated above is based on the concept of living with flood and to take maximum advantage from flood and to reduce risk by avoiding the maximum flood period for agricultural activities in deep flooded areas. Due to the low level of infrastructure development in the area, flood risk reduction alone could not justify large investment for flood protection. On the other hand it would lead to an optimum use of the land use potential of the area by increasing the crop intensification and diversification. The West Bassac area could be sub-divided into three management zones (see Figure 5.1):

5.1.1 Zone 1

This zone is delimited to the east by the RN21, a flood free road built on existing river levees along the Bassac River. The RN21 runs from Phnom Penh to the Cambodian-Vietnamese border at Chhrey Thom. To the west zone 1 is partly delimited by the existing left embankment and the planned embankment of the flood plain main drain. The main drain will be built by connecting natural streams and dead river branches along the deepest part of the flood plain namely: The Preik Ho, a branch of Preik Thnot River, Stung Angkot, Preik koy, Preik Ambel, Preik Kbal Kmoach and Preik Moat Chhrouk (those rivers are interconnected by permanents lakes and depressions). Currently some 90 colmatage canals divert a large amount of the Bassac flood water across this zones extending 2 to 5 km into the flood plain. This happens when the water level at Koh Khel station stretches above 5.0m conveying and storing temporary through and in the flood plain. Behind the Bassac levees (RN 21), land elevation is about 3.5 to 4.0 m sloping towards the flood plain.

Currently only a few of the existing colmatage canals are gated providing water control capability. A small portion of this zone has been developed to be a polder (pilot stage). Under existing conditions, the “Chamcar” occupies higher ground near to the RN21 and the area near to the flood plain main drain is generally used for rice flood recession crop. With steady improvement of the road embankment of the left bank of the Preik Ambel, the area tends to develop itself as a series of polders. This can only be successful with a comprehensive integrated plan combining integrated flood risk management and integrated water resources development taking the whole flood plain into consideration. Major population settlement is concentrated along the RN21 road embankment and parts of the Preik Ambel embankment and a few higher road embankments around S’ang town. Land use intensification and diversification potential of this area is amongst the highest in the part of the Mekong delta in Cambodia.

It is proposed to conceive zone 1 as an area with full flood protection but with the benefits from flooding. This means that the infrastructural design and management should allow controlled flooding for re-supply of sediment and sanitation of farm conditions. Zone 1 will be sub-divided into five large polders using the flood free RN21 as a protection dike from the Bassac.

On the western side the embankments of the flood plain main drainage channel function as flood protection dikes. The number of colmatage canals will be reduced to only one per polder connecting between the Bassac and the flood plain main drain. Remaining colmatage canals will be closed but will be maintained and improved for drainage and irrigation water supply to each part of each polder. Existing lateral irrigation/drainage canals of each polder will be improved.

Each polder will be equipped with a pumping station equipped with a reversible pump installed at the lowest part of the polder (excess surface water retention pond) serving both for drainage and irrigation water supply.

The deep flooded area of the West Bassac has limited settlement space, the right bank of the flood plain main drain will be raised to a flood free level with a series of flood proof causeways of 100 m long at an interval of every 2km for flood passage with design crest above 10 year return period of July maximum water level. The crest of the embankment of the flood plain main drain on the left bank is designed for a 100 years annual maximum return period flood.

The main flood plain drain and main colmatage canals will be designed and operated in such a way that there will be no significant increase in water level at the left bank of the Bassac. The flood plain main drain will be dredged and improved for navigation with rural port facilities at Angkor Borei, head of Preik Ambel and S'ang. The hydraulic simulation model will be used for determination of appropriate canal dimensions following the Best Practice Guideline for Structural measure for Integrated Flood Risk Management. The order of measured maximum flood magnitude of Preik Ambel at Angkor Borei is in the order of 1,000 m3/s.

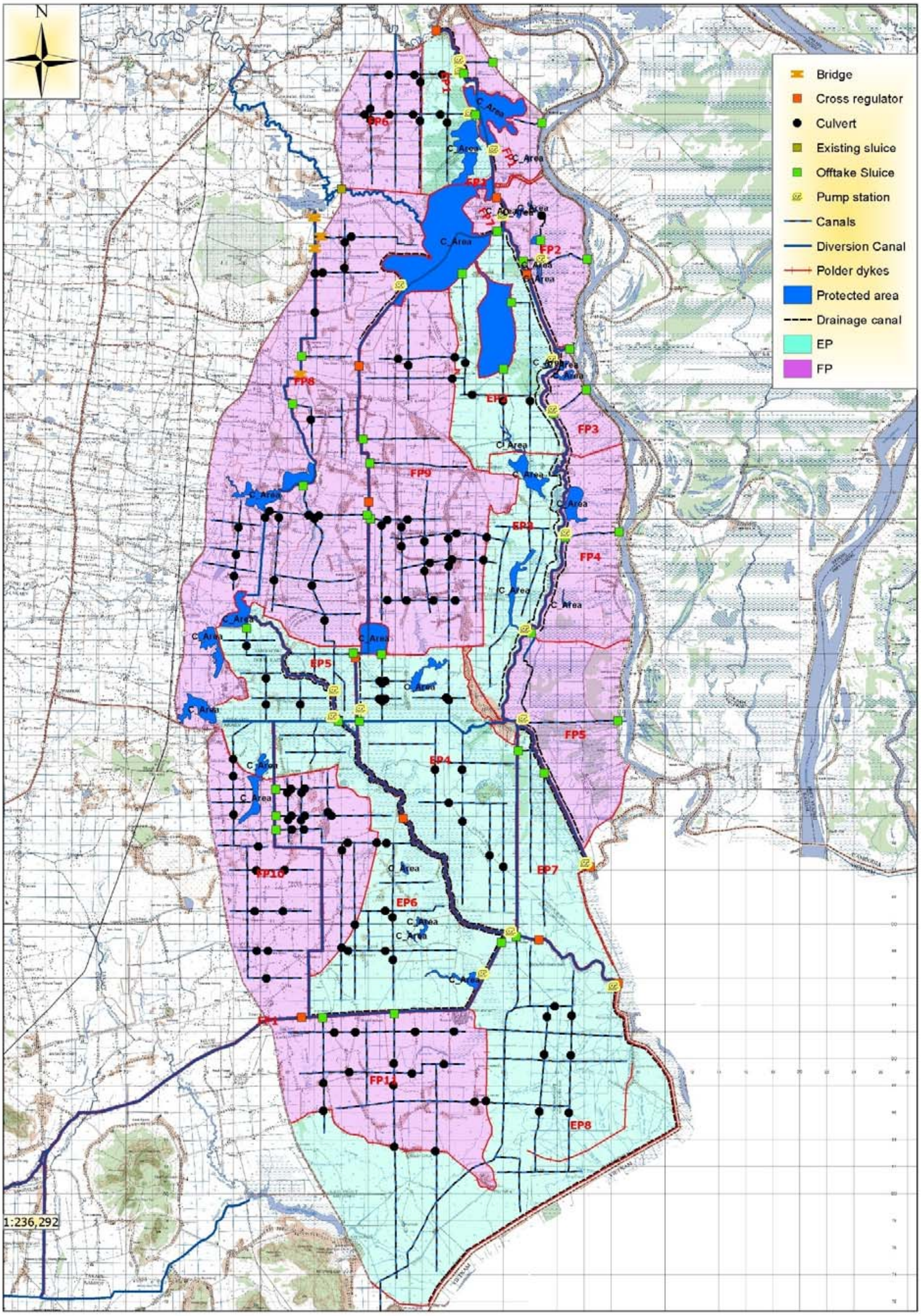

Figure 5.1 **Zoning of the West Bassac Area.**

The Preik Ambel is affected by tide, the operation of the diversion/drainage canal and the related water control infrastructure shall be the main focus during the operation phase to optimize the operation cost. The water management shall be the task of a specialized qualified government line agency. It is expected that water use communities will be established for the management of each polder. Farmer will use their own pumps to irrigate their field from the existing network of colmatage canals.

The design of Integrated Flood Risk Management and Integrated Water Resources Management in Zone 1 is based on existing and new infrastructure and local condition specific to each polder. The approach used is based on the maximum use of benefit from flooding which would rely mainly on the management capability and flexibility rather than on a full control by protecting against maximum design flood and assure timely drainage for different sets of crop calendars.
The following infrastructures are proposed:

10. The RN21 which is currently flood free will be reviewed according to standards developed by proposed Best Practice Guideline for development and design of structural and flood proofing measures;
11. A main flood plain drainage channel connecting the Preik Ho- Priek -Ambel-Preik Moat Chhrook to the border with Vietnam. The final drainage capacity will be based on modelling exercise in such a way that it could carry sufficient flow capacity without increasing water level in the Bassac. The left embankment of the flood plain main drain will be raised to 100 year return period protection level. The possibility for boat passage on top of the dike during flood season should be considered, depending on the future land use of the lowest part of each polder.
12. Five principal diversion/colmatage canals linking the Bassac with each of the five polders and the main flood plain drain/diversion canal. Each of the canals will be fully controlled by sluice gates in such a way that they could be used not only for flood diversion but also for water supply for irrigation taking advantage of tidal effects and the need for drainage of local rainfall;
13. Each principal diversion/colmatage canal is equipped with two control gates, one at the Bassac side and one at the flood plain main drain side.
14. Review and improved existing colmatage canals (disconnected with the Bassac) which will be used as irrigation/drainage canals connected with the main drain of each polder;
15. A main irrigation/drainage canal in the lowest part of each polder (improvement of existing canals linking with ponds and/or depressions and a pumping station equipped with reversible pumps capable for the polder drainage and polder irrigation water supply. This main drain is linked with the main colmatage canal with a control gate to allow flooding condition as might be required.
16. The left bank embankment of the main flood plain drainage canal will be upgraded to flood free level. It will be used to extend settlement areas from Ta Khmao town to the Cambodian-Vietnamese border and also functions as a flood free road with a crest at 100 years maximum flood return period.
17. An access road parallel to each of the main polder colmatage canals to the left embankment of the main flood plain drainage canal to ease canal maintenance and access road in addition to separation dike between each polder.
18. The main flood plain drainage/diversion canal will serve as a flood diversion canal during high flood periods and as drainage and irrigation canal during early flood and flood recession period. Access to water for supplementary irrigation is difficult for early crop and during the last period of recession crop. Depressions and deep lakes will be used as flood water storage for recession crop and as

excess rainfall collector for early crops. Their storage capacity will be improved by surrounding dikes including intake structures to the main drain. Maximum use of the tide will be made by controlling entrance and exit of water during low and high tide. This will reduce pumping costs for drainage and irrigation water.

5.1.2 Zone 2

The deep flooded area zone 2 is a large flood storage and conveyance area of 85,000 ha covering almost ¼ of the total provincial area extending from the Ta Khmao town to Phnom Den at the Cambodian-Vietnamese border, delimited to the east by the zone 1 and to the west by the non flooded and shallow flooded area zone 3. Almost all the surface runoff and rainfall in the province including the Mekong flood water are stored and conveyed in and through this area. Land elevation of this zone varies between somewhat less that 2.0m to 5.0m with some small hill and higher ground around S'ang district and Angkor Borei constituting as a natural screen hindering hydrological regime and alluvial deposition in the northern and southern part of the zone 2. Soil composition of this zone is relatively complex consisting mainly of:

- alluvium soil connecting with the Mekong system at higher elevation, about 56,000ha;
- alluvium soil with recent silt deposition "colmaté" about 13,000 ha, concentrating mainly along the river banks, creeks, cost line. Soil in deep depression mash land with deep flooding depth are of "Humiferes and Gleyifies ", 36,000 ha. These soils are rich in nutrient suitable for high yield rice variety.
- The acid sulphate soil: 11,000 ha and "grey soil humifers gleyifies" about 12,000 ha rich in organic matter, humus and nitrogen but acid and containing toxic substances harmful to plants root. Lime application of lime and good quality irrigation water could help to improve the soil production capacity, particularly in the area far away from water source such as Phnom Den, Kamnap etc. would face difficulties in putting these soil into cultivation. This area has been mostly used for floating rice.

A number of natural drainage channels, river branches and canals run into and through this zone: (Stung Sla Kou, Stung Takeo, Preik Moat Chhrouk, Preik Ho, Preik Ambel etc.) They supply this zone with the Mekong flood water and surface runoff from the western catchments and drain it across the Cambodian-Vietnamese border.
This zone is mainly occupied by flood recession rice area, waste land, flooded forest, protected areas for Cyrus Crane (Preik Lopeou, 9,000 ha) and deep lakes.

Fishery known to be one of the major natural resources of this zone has declined rapidly due to poor management and systematic destruction of habitat (encroachment of flooded forest and over fishing), the number of commercial fishing lot has dropped from 21 to 8 only now for the benefit of fishery community. Remaining commercial fishing lots are mainly concentrating around Angkor Borei area. Current total provincial average fish catch is about 10,700 t/year giving average consumption per habitat of only 13 Kg/person/year is very low as compared to national average 30kg per head per year. Aquaculture 430 tons/year has potential for growing with improvement of water resource management.

In contrast to deep and prolonged flooding of this area, flood recession cultivation far from water course suffers from shortage of water for supplementary irrigation due to insufficient and inadequate irrigation system. Only a limited number of reservoirs (flood water storage) can supply water for supplementary irrigation (Thnot Te, Thammanon ect.). Limited number of farms located near to the river and canals are able to produce

two crops per year making use of tidal effect (recession crop and fully irrigated dry season crop). Most existing irrigation/drainage canals in the zone are silted up quickly due to lack of maintenance.
Due to prolonged flood period only a few population settlement were established in this zone in some small villages along the higher levees of the Takeo River and Moat Chruok canal as well as on spots of higher ground namely: Prey Pdao, Kampong Yol, Kampong Ampil, Kampong Krasaing, Sangkum Mean Chey, Chey Chhok, Anh Chanh and Prey Yuthka, Phum Sre Khmonh, Tuol Tarik.

Based on the concept of living with flood and the above strategic direction for the Cambodian Mekong delta part, it is proposed to conceive for the protection of the zone 2 only against the early flood and for agriculture development only with consideration on the ecological balance in this zone.
Critical requirement for IFRM structural planning and IWRM in this zone are:

- the capacity for timely drain excess flood recession water for field preparation for recession crop (November-March);
- protect early crop (May-July) from early flooding and local excess rainfall;
- provide source of water for supplementary irrigation with least pumping cost
- provide adequate transport infrastructures for easy access to cropping areas
- propose a balance conservation areas for ecological balance
- propose new and improved settlement scheme for effective economic development of the area.

To achieve the above, following infrastructures are proposed:

8. Dike embankment along the flood plain main drain between the Zone 1 and zone 2, a dike with crest designed at 100 years return maximum flood for residential areas with causeway (spillway for maximum July flood at 10 year return period);
9. Dike embankment for maximum water level flood water storage around deep natural lakes for irrigation water supply (e.g Boeung Chhoeung Luong);
10. A dike embankment for early flood protection (Maximum July flood level at 10 years return period) along the border area preventing flood water from entering from the southern side of the area.
11. A drainage canal along the western side of the flood plain main drain/diversion canal for drainage of excess local rainfall for early crop harvest.
12. Dredging of the Stung Takeo from Samrong to Borei Chulsa with dike embankment and drainage.
13. Improvement of existing dike and canal between Angkor Borei and Stung Takeo as part of the flood plain main drain.
14. To take maximum benefit from investment for IFRM and IWRM in this zone, it is proposed also that existing settlement areas will be improved in terms of flood proofing and all year round accessibility to the market and other communities, for example flood proofing of the Angkor Borei historic town could be one of the priority, new settlement areas are also to be planned according to the future land use expansion.

For supplementary irrigation the source of water will be existing and new reservoir, the flood plain main drain, the Stung Takeo, the Takeo canal, the proposed canal linking the Boeung Chhoeung Luong with the Takeo flood plain and canal storage regulated according to tidal conditions. For the most southern part, south of Takeo Canal, existing main irrigation will be used as main irrigation canal.

5.1.3 Zone 3

The zone 3 extends along the RN 2 to the east and consisting of non-flooded and shallow flooded areas. Soil of this area is dominated by grey leached soil type on ancient alluvium terrace extending from the western foot hill until the north of Preik Ambel in northwest southeast direction with different characteristics from north to south, in north and northwest area at an elevation more than10 m, terrace with high content of sand and fine gravel, towards the south in terrace at elevation between 6 and 7m, consisting of silt and clay mineral, and interface with recent sediment of the Mekong system at elevation between 2 and 5m. In the shallow flooded area different type of recent alluvium soil stretches across the Bassac/Stung Takeo flood plain littoral in thin layer from Bati until Angkor Borei. The part of the shallow flooded area is affected by regular Mekong flood in spite the advantage of being closer to the water source. Existing flood protection dike system is not operational.

Rain fed subsistence rice occupies all the non flooded area covering highest percentage of cultivated rice area in the West Bassac area. Grey leached soil is known to be extremely poor.

The zone 3 is the most populated area of the West Bassac with large concentration along RN2 and rural roads. With population increase land plots are increasing dispersed and smaller and risks of agricultural drought are also increasing due to change in local hydrological conditions caused by extensive irrigation canals network but most of them functions as drainage canals instead due to lack of appropriate source of water and water control structures, surface runoff is drained rapidly into the flood plain leaving the field needed for water dried. Erratic rainfall regime (early, mid season or late season droughts) is another limiting factor for agricultural development of this area.

Major water source for supplementary irrigation of this area is non reliable depending on small western sub catchments and the Tonle Bati Lake which depend on the Preik Thnot flow regime. There is no storage reservoir in the Preik Thnot basin.

Potential for crop intensification and diversification is rather limited as compared to zone 1 and zone 2. Many farmers are now looking to expand their cultivated land into the zone 2 causing increasing number of land encroachment in protected areas in this zone damaging fishery resources of the region. Transportation and public facilities are extremely poor linking between the zone 3 and zone 2, many farmers has to travel long distance on daily basis with heavy equipment and supply far away from their village including drying of harvested paddy and transportation. Crop intensification need intensify capital and labour intensive such as weeding, pest management, water control etc. this can be optimized only when accessibility and travel distance and security are optimally met. There is a need for joint and integrated planning between the two zones especially for the establishment of new settlement areas and their accessibility.

The integrated flood risk management and integrated water resource management of the zone 3 is focusing on:

- securing full wet season crop in non flooded area by providing access to reliable and affordable water source for supplementary irrigation water;
- Reduce risk of flood damage from western catchment by diverting excess surface water from the cultivated area;
- Providing full flood protection of shallow flooded area along the Bassac flood plain;

- building and strengthening capacity in integrated water resource management to achieve optimum operation of structures for flood risk and water resource management.

Proposed infrastructure for integrated flood risk and integrated water resources management:

7. improvement of link irrigation/drainage canal between Boeung Tonle Bati and Samroung reservoir and Stung Takeo flood plain;
8. improvement of existing irrigation/drainage canal with appropriate water control structure;
9. surrounding dike around the Boeung Chhoeung Luong to be used as excess surface water collector for early crop protection and storage for supplementary irrigation for recession crop.
10. Dike embankment along the eastern part of the shallow flooded area, design at 100 years maximum flood level;
11. Main irrigation/drainage canal linking the Boeung Chhoeung Luong with the Takeo flood plain with related irrigation/drainage canal system (based on existing canals) and water control structures (off take, cross regulators etc) and main pumping station;
12. Main irrigation/drainage canal linking the Takeo canal with the Rominh canal including lateral irrigation canal system and a main pumping station.

5.2 Future agricultural development

Appendix 3 elaborates the socio-economics and agriculture in the area. The main aspects are discussed in this section.

5.2.1 Future without project

According to the commune database 2007, agriculture in the area had a low cropping intensity of 90% of total potential land (176,830ha) for agriculture. The cultivated crops were 158,576ha of which 79,378ha of cultivated dry season rice, 74,632ha of cultivated wet season rice, 788ha cultivated upland rice, and 3,770ha cultivated non-rice crops. There were 87% cultivated dry season rice being irrigated by different water sources: pond/lake, well, river/stream, and canal/reservoir. Supplementary irrigation for rice in wet season covered 12% of the cultivated area.

The land in area is flat and very suitable for agriculture, however main constrain for agricultural development in the area is availability of water in dry season and flooding. Crop field elevation is varied from 6 to 8m above MSL and water level in Bassac river in dry season in an order of 2 m, pumping irrigation would be required for the area from canal distribution net-work to the field. Possibility for gravity irrigation is limited except from some existing natural lake/pond.

There would certainly be a small-scale irrigation scheme development in future without the project. However, It is expected that an irrigated area from new irrigation schemes would be balanced the deteriorated rate of existing irrigation schemes. With this assumption, it is expected that future without plan would be more or less the same as existing agriculture.

5.2.2 Future with project

The plan provides irrigation facilities (canal, regulators, pumping stations), and flood control measures (ring dykes, compartment dykes, sluice-gates) for early flood protection in July to ensure the double cropping system in the deep flooded area and year around full flood protection for zone 1 and Zone 3 (shallow flooded area).

The first crop in the area would be planting in November-December and harvesting in March-April which is fully irrigated in dry season. The second crop would be planting in March-April and harvesting in June-July when early flood arrives in the area. The early flood protection (embankments and gates) would ensure the second crop safely harvested. Irrigation is also needed during April-June when no rain or insufficient rain compared to crop requirement. The third crop in full flood protection areas would be planted in August and harvested in November. This crop season would be rain-fed with provision of flood protection and local rain drainage.

For the purpose of FMMP_C2 to investigate preliminary assessment on economic feasible for flood control measures and irrigation development, it is assumed that:

1. Agricultural land in future with the plan would be reduced by 5% compared to future without plan for infrastructure development (canal systems, embankments, rural roads and on-farm development, etc)
2. Cultivated crops would cover at a maximum rate of 90% land availability;
3. Zone 1: In dry season crops planted mainly non-rice crops. In wet season 50% of area planted by rice and the remains for non-rice crops. There would be 10,000ha (48% of the area) that the third non-rice crop could be planted;
4. Zone 2: Crops are mainly rice for dry and wet seasons. There would be two crops per year. Triple crop land in the area would not be possible.
5. Zone 3: “Lowland” would be planted wet and dry rice crops (two crops/year). “Highland” would be planted wet and dry non-rice crops (two crops/year). There would be about 20,000ha (27% of the area) in the low land that third crop of non-rice could be planted.

With the above assumption, it is expected that:

- Cultivated dry season rice would be about 110,000ha with full irrigation of which more than 65,000ha in zone 2 and 45,000ha in zone 3. There would be no dry season rice in zone 1, since zone 1 in the dry season would be covered totally by non-rice crops;
- Cultivated wet season rice would be nearly 120,000ha with supplementary irrigation, of which about 9,000ha in zone 1, 65,000ha in zone 2, and 45,000ha in zone 3;
- There would be no upland rice in future with project, this land would be convert into non-rice crop area;
- Cultivated non-rice crops would be mainly covered by red corn in wet and dry seasons for animal feeds, there would be some other potential non-rice crops such as green bean, soy bean and peanut for domestic consumption. Total cultivated area of non-rice crops would be about 102,000ha of which 38,000ha in zone 1, 900ha in zone 2, and 63,000ha in zone 3.

Overall cropping intensity in 2007 and future *without* plan conditions was 90%, of which 95% in Zone 2, 90% in Zone 3 and 73% in Zone 1. With the plan it is expected that cropping intensity would be 228%, 180%, and 207% in zone 1, zone 2, and zone 3 respectively.

Even with full flood protection in zone 1 and zone 3 the expansion of third crop in the area would be limited due to limitation of irrigation water in dry season. It is noted that there would be significant needs for agricultural extension services in the area for supporting farmers in cultivation techniques, new crop varieties, proper application of fertilizers & pesticides, and marketing. Short-term credit would also be provided to farmer to cover their physical inputs required during crop cultivation.

5.3 Preliminary engineering design

For the preliminary engineering and the cost estimate a further division into *subzones* and *main structures* has been made:

Subzones
Each zone has been divided further into large management zones called *Subzones*. There are in total 19 subzones (see Figure 5.1).

Main structures
There are also main structures which are above subzone level.

Appendix 4 presents the preliminary design and cost estimate. The main structures and the structures per subzone are described. Maps of each subzone have been made indicating the structures within that particular subzone.

As an example Figure 5.2 shows the map of Subzone 1.

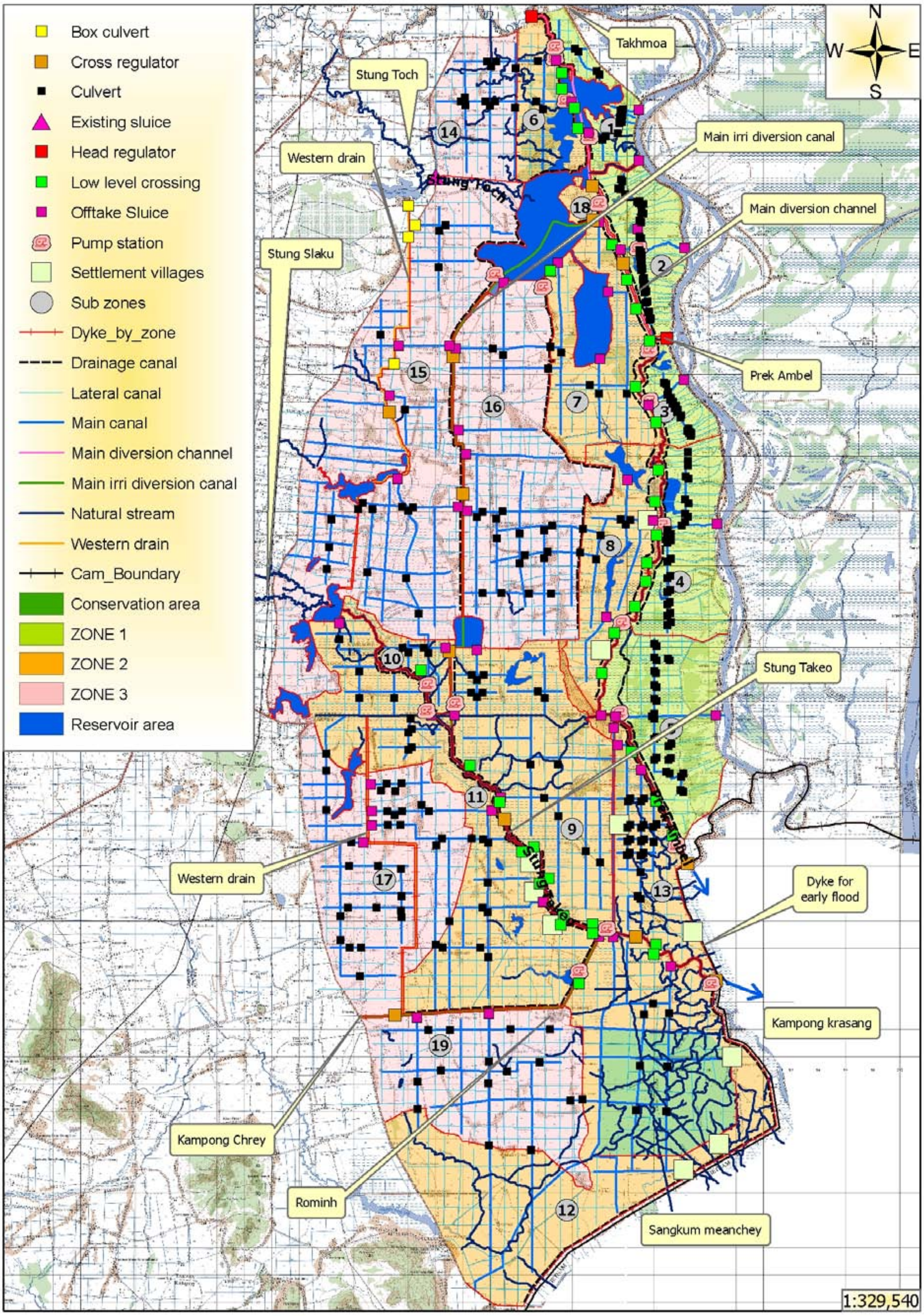

Figure 5.2 **Division of the West Bassac area into subzones**

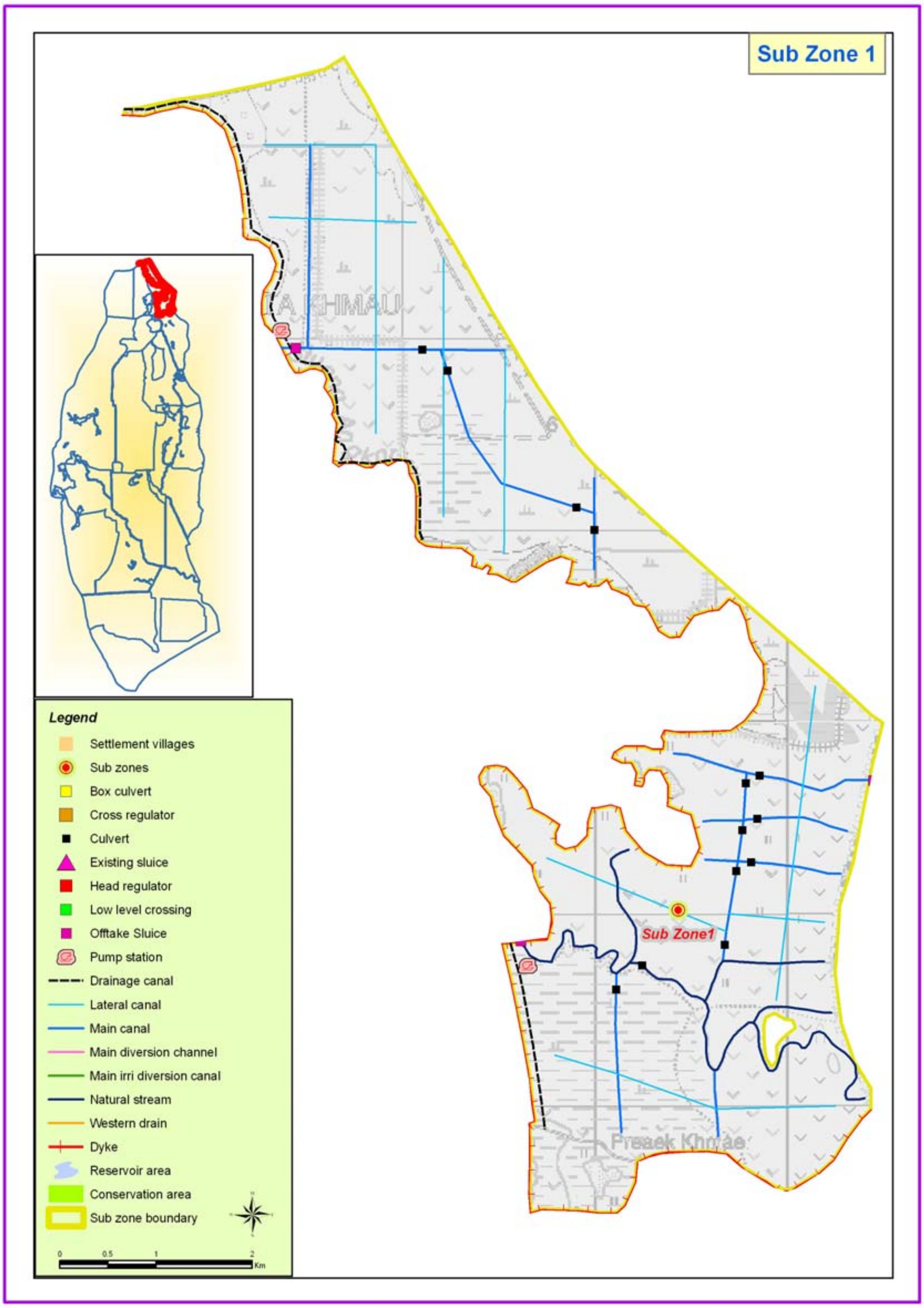

Figure 5.3 Map of Subzone 1

5.4 Cost estimate of works

Cost estimates were made for civil engineering works, like dykes, canals, pump stations, irrigation canals etc. The cost estimate figures in Appendix 4 together with plans for the works in the subzones.

The cost estimate was prepared but adjustment was needed based on the change in water level related to new ISIS model improvement. The ISIS run provides new set of water level at each node for different frequency and also dimension of proposed diversion canals. The run was based on the mixed flood protection measures in Cambodia (area with full flood protection and early flood protection).

The previous cost computation was made in excel format in such a way that any changes in water level and diversion canals dimension could be incorporated. In this computation review, estimated water levels are made by interpolation between nodes for points which are not at the simulation nodes. The results of the change are presented in the Appendix 4. Table 5.x summarizes the cost estimate which comes to a total of US$ 301 mln.

The height of earth dike for each zone was taken from the result of ISIS model run. The water level of 100 year recurrence interval maximum flood and 100 year recurrence interval for early flood (1st of August) from the ISIS model run in combination with the DEM were used in the computation of earth dike volume for full protection and early protection polders respectively. Some assumptions were made for determining the heights of dike because the ISIS water level nodes are not located along the planned dikes. So the water level nodes which are located closed to the dike are used for the determination the dike height. Water depth for determining the dike height is the difference between the water level node and the DEM (Digital elevation model).

Table 5.x Cost estimate for the West Bassac IFRM Plan

Descriptions	Unity	Qty	UnitPrice, USD	TotalPrice, USD
Main and latral and link canals	m3	48,334,868	2	96,669,736
Polder dyke	m3	15,659,603	2	31,319,206
Villages	m3	1,295,000	2	2,590,000
Irri diversion canals	m3	15,573,448	1.5	23,360,171
Prek Ambel	m3	13,041,300	2	26,082,600
Stung Takeo	m3	18,894,500	2	37,789,000
Tertiary canals	m3	3,188,073	2	6,376,146
Irrigation canals from Stung Takeo to Rominh	m3	2,043,680	2	4,087,360
			Subtotal for earth moving work volume =	**228,274,219**
Culvert	Unit	301	6,000	1,806,000
Offtake sluice	Unit	53	30,000	1,590,000
Head works	Unit	2	2,500,000	5,000,000
Cross regulators	Unit	12	50,000	600,000
Pump station	Unit	19	50,000	950,000
Box culverts	Unit	4	30,000	120,000
Gates for culverts	Unit	301	600	180,600
Gates for offtake	Unit	53	4,000	212,000
Gates for boxculverts	Unit	4	4,000	16,000
Gates for head-work structures	Unit	2	50,000	100,000
Low level crossings	Unit	35	20,000	700,000
			Subtotal for concrete works =	**11,274,600**
Land acquisition cost	m2	95,760,000	0.3	28,728,000
Resettlement cost 20% of Land acquisition cost				5,745,600
			Subtotal for land and resettlement impact =	**34,473,600**
			Total cost =	**274,022,419**
Detailed design consultancy cost 5% of total cost				13,701,121
Contigency cost 5% of total cost				13,701,121
			Grand total	**301,424,661**

5.5 Project phasing

The investment of some US$ 300 mln for the West Bassac area is likely not to come about as a single project. The cost estimates have been prepared for each subzone and the totals per zone are: zone 1: US$ 75 mln, zone 2: US$ 85 mln and zone 3: US$ 141 mln. These are more sizable to attract financing. Further phasing is very well possible, especially for the five polders in zone 1.

Which zone to start with is a matter for consideration by MOWRAM and the Government of Cambodia.

6 PUBLIC PARTICIPATION IN PLAN PREPARATION

6.1 Public Participation strategy

The objectives of the Public Participation strategy in stage 2 were:

1. Develop Public Participation Plan for the structural flood protection measures IFRM plan s to ensure inputs from stakeholders are incorporated in the design and that any potential negative impact on stakeholders is minimized;
2. Prepare Best Practice Guidelines to help the facilitators in conducting Public consultation exercises;
3. Training of NMC and Line Agencies in facilitating public participation during the implementation of the IFRM plan .

6.2 Public Participation Plan

A Public Participation Plan for West Bassac IFRM plan has been prepared (see Appendix 5). Internal and external stakeholders with an interest in the development of integrated flood risk management plans for the West Bassac area were identified. Besides the people from the communities the following key stakeholders from Line agencies and other organisations were to be consulted:

1. Provincial Department of Water Resources and Management (PDWRM), Takeo
2. Provincial Department of Agriculture (PDA), Takeo
3. Water User Association, Thnot Té village
4. Provincial Fisheries Administration, Takeo
5. Provincial Department of Water Resources and Management, Kandal
6. Water User Association, Prey Kabbas
7. Cambodia Centre for Study and Development in Agriculture (CEDAC), an NGO based in Phnom Penh

6.3 Best practice guideline

A best practice guideline for Integrated Flood Risk Management, Planning and Impact Evaluation was prepared [10] which discuss public participation and stakeholder consultation.

6.4 Training of NMC and Line Agencies in facilitating public participation

In West Bassac, representatives from CNMC and district Line agencies were trained to facilitate community consultation on getting feedback on structural measures for flood protection. A community consultation facilitation guide was also prepared and translated in Khmer language and the Line agencies representatives were trained to facilitate community consultation.

6.5 Stakeholder consultation

Based upon the Public Participation Plan a preliminary stakeholder analysis and consultation was conducted in March 2009 to identify the key stakeholders for consultation on structural flood protection measures in the West Bassac and understand the issues that the communities want to prioritize for dealing with floods. The stakeholder consultation schedule was prepared and implemented in the West Bassac in Takeo and Kandal province from June 1 to 4, 2009. Given the time and budget, the focus of public participation was on community consultation. Appendix 6 presents the report on the Implementation of the Public Participation Plan.

The consultation was done in two days time by six teams consisting of 3 to 4 members each from Line agencies. A total of 24 villages were selected; 16 villages in Takeo Province (Prey Kabbas and Koh Andet districts) and 8 villages in Kandal province (Koh Thom and S'ang district). The villages were selected based on the vulnerability characteristics. Takeo province being larger in area compared to Kandal province, more villages were selected in Takeo province. The consultation helped in validating the assumption regarding benefits and concerns of the communities when the plan is implemented.

The Line agencies representatives highlighted the following hazards and problems:

- Flood is the main hazard as it damages houses, crops, roads and infrastructure.
- The other important problems identified by the Line agencies are marketing agricultural produce, fishing, labour, water quality and diseases, health facilities during the floods.

The preferred solution according to the Line agencies representatives when the IFRM plan can be implemented is:

1. Construct flood protection dike, and improve or rehabilitate the existing irrigation system.
2. Move people living in the low lying area prone to flooding to safe shelters on higher grounds.
3. Provide seed to farmers, encourage farmers to cultivate dry season rice, provide health education and health facilities in the villages.

6.5.1 Feedback from Line agencies

At this stage, the idea of the plan is still abstract and hence a very detailed feedback cannot be expected. Despite this, people provided comprehensive feedback which demonstrates their understanding of the problem in the area and a feel for priorities.

The West Bassac IFRM PLan was explained. The feedback of the Line agencies representative is that the structural measures with flood protection dikes and polder system will make the area flood free and with 2 to 3 crops per year will bring in economic benefits.

On the negative side, the concern of the line agencies representatives is that there might conflict on ownership of land for fishing and agriculture between villages. The villages on higher ground might find it difficult to get water during the dry season for cultivation. They believe that flood is required because it deposits silt, which contributes to improving soil structure and hence soil fertility. With increased cropping intensity from one to two or three crops per year, pest problem will increase. There might be impact on fish in the flooded forest and also impact on fish migration as the water flow through the flood plain will be cut off or change. This can have negative impact on fishing. The plan will require pumping and maintenance of these structures can become an issue in the future and can get more expensive. Fisheries opinion: improving economic conditions can help to relieve pressure on flooded forest by landless and poorest group, possibly improving route for fish migration in terms of management.

Suggestion to minimize impact:

1. Conflict with drainage and irrigation (upstream and downstream). Study the drainage and irrigation system.
2. When constructing dike, provide access to water on both side of the dike – otherwise farmers will break the dike to access water??
3. Compensation for land acquisition and resettlement policy should be incorporated
4. Multiple benefits – road, navigation etc. should be considered.
5. Promote Aquaculture.
6. Fish sanctuaries – protected area
7. Respect fishing period regulation

6.5.2 Feedback from communities

The feedback of all the groups in the 24 villages was that the IFRM Plan of controlling the flood with dikes, water gates and drainage channels will be very beneficial to them.

The communities recognize the benefits of the IFRM Plan in terms of agriculture production, increased cropping intensity, ease of transportation, no damage to houses and properties, less disease and overall increase in economic benefits. However, they also recognize that there will be some negative impact like conflict between upstream and downstream farmers, especially water use for fishing & agriculture, land acquisition for construction of dike, reduction in fish possibly due to reduction of fish migration and also negative environmental impacts such as reduction in bird population, especially along the Vietnam – Cambodia border in Koh Andeat, increase in pest and disease incidence due to continuous cropping, loss of fertilization effect of silt which happens in case of floods and flushing of toxic elements from the soil may not happen, which may further deteriorate soil quality.

The communities also proposed some of the solutions to minimize the negative impact of the IFRM plan . The conflict between upstream and downstream farmers or neighbouring villages could be solved by forming water users committee when the plan is implemented so that through their participation, the issue can be addressed right at the initial stage. They are willing to contribute land or willing to lose some trees to construction of dikes and roads. However, if the loss is high, they expect compensation. They also expect to participate in the Operation & Maintenance of the structures. The communities in Koh Andeat also propose dike around the village to protect the villages from flooding in the event of bigger floods.

The results of the consultation presents the vulnerability analysis, existing coping mechanism against floods, existing structures such as dikes and canals and their length, their proposed solution to overcome the problem of floods apart from the feedback on the IFRM plan .

7 INITIAL ENVIRONMENTAL EXAMINATION

Sensitive and valuable ecosystems that are encountered in the Cambodian Delta are seasonally-inundated riparian forests; seasonal wetlands, including marshes, small pools and pools; and seasonally inundated grasslands. These ecosystems are important as a habitat of a variety of fish and water birds and for the sustenance of the inland fisheries.

Population density in the plan area is fairly low. Locally, densities in the more protected, higher areas along river banks and dikes, are fairly high. There are no regions subject to heavy development where conflicts over resource use are to be expected. Water courses in the area, rivers and canals, but also ponds and lakes are used as a source for drinking water by the majority of the rural population.

As far as resources are concerned, the area is primarily an agricultural, rice producing area. Of importance as a source for food and income for the rural population is also the inland fishery. An initial environmental examination for the West Bassac IFRM plan has been executed (see Appendix 7).

The following potential environmental impacts have been identified:

1. Destruction of natural habitats, valuable resources
    - The sensitive and valuable ecosystems encountered in the Cambodian Delta are all dependent on the seasonal flood. Protection against early flooding will mean an average delay of the onset of the flooding with about one month. Area and depth of flooding during the main flood are not expected to change. Direct impacts on the riparian forests, seasonal wetlands and seasonally inundated grasslands are probably limited, although species composition may change: some species will simply not be able to survive the prolonged drought. When also provisions for quicker drainage after the flood are made, the total period of flooding may become so short that wetlands dry out or change so much in species composition that they lose their ecological value.
    - The indirect impact of the project on the natural areas may be significant as well. Increased protection against the early flood will encourage people to extent their agricultural activities to areas that are presently not used for rice growing. Encroachment into forest/scrublands, wetlands and natural grasslands will be the result.

2. Loss of biodiversity, rare and endangered species
    - As stated above prolonged drought and more floodplain lakes and ponds drying out completely may have an impact on the biodiversity in the area. Species composition of aquatic flora may change and the diversity and extent of marshes may reduce. In the dry season ‘Black fish’ species remain in lakes and swamps on the floodplain, where they are able to tolerate acidic and low oxygen conditions.
    - Eighty-five to 95% of the freshwater fish populations in the Mekong basin have an inundation spawning pattern and undertake lateral migrations from the mainstream and tributaries into the inundation zones to spawn and rear young between July and September. Late access to the floodplain or blockage of migration routes will have an impact on the standing stocks of these migrating species.
    - Apart from fish, the wetland areas support a high diversity of other aquatic animals including vertebrates - reptiles, birds, mammals and amphibians, and invertebrates, such as insects, crustaceans and mollusks, all of which depend

upon maintenance of aquatic ecosystems and could be affected if the total area of the wetlands reduces or when wetlands dry out completely during part of the year.

- Desiccation could also lead to loss of seasonally-inundated riparian forest along the banks of lakes and rivers and the loss of some of the over 200 species of plants that are known to occur in these forests. The woody species of this forest are bearing fruits and seeds at the time of inundation, providing food for the 34 species of fruit-eating fish of the Lower Mekong Basin. Delay of the flooding could imply that the fruit is already fallen and decomposed before the fish arrive.
- Loss of wetland areas could also affect the number and diversity of water birds.
- Late inundation of the seasonally inundated grasslands might reduce the feeding areas of a number of birds.

3. Loss of environmental services.
    - Flooding and the related sustenance of wetlands are known to have a number of benefits; some of these benefits will be affected by later and shorter flooding as discussed below.
    - The importance of deposition of fertilizing sediment is illustrated by the results of the Focal Group discussions. It turned out that after a year with a good flood rice yields are about 1 ton/ha higher than in years after a year with a bad flood. In some areas and increase of 1.5 ton/ha was mentioned. Production costs were estimated to be the same in years after a year with a good flood as compared to years after a year with a normal flood. Overall benefit of the flood for agricultural production is estimated at 620,000 to 920,000 Riel/ha. Not only the fertilizing of the soil with sediments is important, also the flushing of toxic materials and pollutants by the floodwaters, the sanitation of the soil (killing of pests and bugs) and possibly the good replenishment of ground and surface waters. Impacts of delaying the flood on this benefit are not thought to be very significant, the highest sediment concentrations are observed during the main flood. The delayed replenishment of groundwater and surface water bodies will not affect the quantities of water available in the next season. However, shortages for human and ecosystem use (flora and fauna) will increase, since the dry season is prolonged. Water quality at the end of the dry season will deteriorate with delayed flooding. Not only may the available quantity be affected, but also the quality of the water. Pollutant concentrations become higher and the flushing/diluting effect of the flood is delayed. Finally the flow regulation effect of the flooding will be less, meaning that early flood levels downstream will increase.

4. Impact on Protected Areas
    - The Boeung Preik Lapouv IBA (Important Bird Area) forms one of the largest areas of adjoining natural habitats remaining in the Mekong Delta. Although not (yet) officially a protected area, the area has a high conservation value. Changing flood patterns or canal/dike construction could have a negative impact on the area and reduce the number of aquatic vegetation species and the area's importance in providing critical wetland habitat to 25% of the world's population of endangered, non-breeding Eastern Sarus Cranes (Grus antigone sharpii). In total 58 bird species including 34 water birds have been observed in the area.

5. Impact on Fisheries
    - People in rural areas rely heavily on fisheries for their subsistence. With an average of 76 kg of fish is consumed per person/year, fish provide from 40 - 60% of animal protein intake. The productivity of the Lower Mekong Floodplains

ranges between 139 and 230 fish kg/ha/year, which is very high compared with other river systems in the world. Fish productivity depends amongst others on accessibility of the floodplain for fish, the availability of food and the length of the period that the fish stay on the floodplain to grow. All these three factors could be influenced negatively by the project. Dispersal of ‘White fish’ fry over the floodplain with the flood water will be delayed. At the time of flooding the amount of fry in the floodwater may have diminished somewhat resulting in lesser stocks. At the same time the survival rate of ‘Black fish’ in the floodplain habitats will be reduced.

- Deterioration of the floodplain vegetation results in a lower food availability and the growth period of the fish during their stay on the floodplain is reduced with one month. This impact may have an effect on an area larger than the project area, downstream river fisheries might be affected as well.

6. Land acquisition and resettlement
   - Project implementation will entail quite a length of canals and dikes to be constructed. Partly these canals and dikes will follow existing alignments. In other words, a fairly large percentage of the works will be carried out at places where the population is concentrated and land acquisition and resettlement may be unavoidable.

7. Human health and safety impacts
   - Overall the project will have a positive impact on human health and safety. People will be better protected against flooding, floods will last shorter and food (rice) production, and so food security, will increase. This is not necessarily the case for the amount of fish available in the flood season. Reduced water availability and poor water quality at the end of the (prolonged) flood free period may pose a threat to human health.
   - Construction activities are another threat to health and safety for a variety of reasons: emission of dust, fumes, noise and vibration from construction sites and access roads, increased traffic and workers accidents. Inflow of workers from other areas increases the risk of a spread of HIV/AIDS.

8. Impact on cultural, historic and archaeological sites
   - Large scale construction of canals and dikes will partly destroy the remains of the pre-Angkorian canals that have been found in the area around Angkor Borei.

8 COST BENEFIT ANALYSIS

8.1 Costs

The costs of the civil engineering works have been required for the IFRM Plan have been estimated at US$ 301 mln.

No attempt was made to estimate costs related to project implementation, and programmes that would be required in support of realizing the expected benefits, like extension services, aquaculture development, farmer credit schemes.

8.2 Project benefits

8.2.1 Flood risk reduction

Flood risk assessment was carried out for three main flood damage categories in each districts as presented in the Chapter 5. It provides an annual expected flood damage ($/year) which is referred to as the risk: the sum of expected damage at certain probabilities of exceedance. The IFRM Plan reduces the risk, by providing flood protection, taken at 1% for infrastructure and housing and agriculture in the full protection areas and 10% in the areas protected against early floods.

The West Bassac area covers 9 districts in Takeo with an area of 181,160 ha and 4 districts in Kandal with an area of 45,959 ha. One could argue that the flood risk reduction that has been worked out at the level of whole districts should be corrected for the part of the protected area in each district within the IFRM Plan area. However, that should not be done because impact of flood protection for the plan area spreads over a larger area and is a result of the plan. Therefore total flood risk reduction is to be taken into account.

The West Bassac area is proposed to be full flood protection in zone 1 and zone 3 at 1% probability for infrastructure, housing and agriculture. Meanwhile early flood protection is provided for zone 2 to protect only crops from the annual flood at 10% probability. For those districts (almost all) where parts are fully protected and parts only receive early flood protection, the calculations have been done with the weighted average risk for the two types of protection. Total flood risk reduction by the proposed measures would be 1.814 mln US$/year of which 0.746 mln US$/year for infrastructure and housing and 1.069 mln for agriculture. Details on flood damages in the districts for the two categories of damages and for various probabilities of exceedance are presented in Appendix 2.

8.2.2 Agricultural benefits

The possible agricultural development with and without the project has been described in section 5.2. In order to estimate the benefits the following assumptions were made:

1. Construction of the project for main elements (flood control dykes, primary canal system and regulators, primary pumping stations) would be in 5 years. During construction of main structures, secondary and tertiary canals/structures which proposed to be funded by local governments would be started and it is assumed to be fully completed after 10 years. The potential maximum net benefits from cultivation can be reached since the year 10 of the project;

2. There would be higher crop yield in the future due to new high-yielding and good quality varieties developed by agricultural department and/or researches. This factor of future higher yield would not be claimed as result of the project;
3. The benefit from agriculture would be realized in year 5 and being reached at potential maximum in year 10 of the project time frame;
4. Agricultural net benefit of the project is an incremental NB due to higher crop intensity. It is estimated by crop NBs with project deducted by those without project. Thus beside the crop NBs, the project has to claim for benefit of flood reduction by protection measures.

Economic net benefit from crops

Crop-budget analysis was done for financial and economic perspective for different zones in the project area (see Appendix 3). Red corn is now cultivated in zone 1 and it is proposed to be expanded to other zones in future with project, and it is expected the economic NB of corn would be the same as in zone 1. Economic NB of peanut, sesame, soy bean are assumed to be the same in the 3 zones. Table 8.1 presents a summary of the results.

The individual crop-budgets would be investigated in more detail during preparation of feasibility study of the West Bassac in a coming phase.

Table 8.1 Economic net benefit of selected crops (US$/ha)

No	Crops	Zone 1	Zone 2	Zone 3
1	Rice (Wet-rainfed)	210	109	228
2	Rive (Wet-irrigated)	368	281	252
a	Early Rice (Wet)	210	281	252
b	Medium Rice (Wet)	285	194	228
c	Late Rice (Wet)	368	227	233
3	Early Rice (Dry irrigated)	507	553	312
4	Early Rice (Dry recession)	406	442	250
5	Red Corn (Dry)	648	(648)	(648)
6	White Corn (Wet)	318	319	(318)
7	Green Bean	325	(325)	(325)
8	Soy bean	(330)	330	(330)
9	Peanuts	(330)	(330)	(330)
10	Cassava	(821)	(821)	821
11	Sesame	(330)	(330)	(330)

Source: From section 2. The value in bracket is assumed to be the same as other zone

Economic benefits from cultivation

Given the agricultural land-use and economic net benefit of crops in the project area, the economic net benefits would be 129.65 million US$/year and 54.76 million US$/year for future with project and future without project respectively. It would result in an incremental NB of the project at a level of 74,886,000 US$/year. It would be contributed from cultivation from zone 1 by 15,111,000 US$/year, from zone 2 by 24,877,000 US$/year, and from zone 3 by 34,898,000 US$/year. Details are presented in Table 2.1.

Table 8.2 Potential economic net benefit of agriculture by zone (1000 US$/year)

		Future without Project				Future with Project			
	ITEMS	**Project**	Zone 1	Zone 2	Zone 3	**Project**	Zone 1	Zone 2	Zone 3
1	**Cultivated dry-season rice**	**37,871**	**5,337**	**26,781**	**5,752**	**50,115**	**0**	**36,075**	**14,040**
	Recession dry season	3,494	292	2,075	1,127	-	-	-	-
	Full-irrigated dry season	34,377	5,045	24,707	4,626	50,115	-	36,075	14,040
2	**Cultivated wet-season rice**	**15,468**	**556**	**3,011**	**11,901**	**33,157**	**3,486**	**18,331**	**11,340**
	Rain fed rice	13,041	335	2,130	10,576	-	-	-	-
	Supplemental irrigated	2,427	221	880	1,325	33,157	3,486	18,331	11,340
3	**Cultivated upland rice**	162	2	22	138	**-**	-	-	-
4	**Cultivated non-rice crops**	**1,263**	**1,043**	**153**	**67**	**46,378**	**18,563**	**438**	**27,377**
	Corn 1 (Dry)	-	-	-	-	26,538	12,276	292	13,971
	Corn 2 (Wet)	569	532	37	-	9,868	3,012	-	6,856
	Soy bean	56	47	9	-	4,290	990	-	3,300
	Green bean	430	367	46	17	5,021	1,625	146	3,250
	Peanut	45	25	20	-	660	660	-	-
	Cassava	79	4	28	47	-	-	-	-
	Sweet potatoes	78	62	14	2	-	-	-	-
	Sesame	7	6	-	-	-	-	-	-
5	**Total net benefits**	**54,764**	**6,938**	**29,967**	**17,859**	**129,650**	**22,049**	**54,844**	**52,757**
6	**Incremental NB**					**74,886**	**15,111**	**24,877**	**34,898**

Source: Consultant estimates

8.3 Reduction of flood benefits

8.3.1 Impact on fisheries

Natural fish lost is considered as negative “benefit” for the proposed flood control measures due to reduction of flooded/inundated flood plain. In the Focus Group Discussion in the six surveyed communes local people mentioned that floods have significant benefits for local community as providing protein source.

Depending on the district, 30-100% of families in the deep flooded area are fishing during the flood season. Duration for fishing is reported as 2-3 months in five communes; in the Prek Thmey commune fishing lasts for 7 months. The benefit of flood for capture fisheries of people in deep flooded areas are 0.32–3.78 million Riel/fishing household (about 80 – 945 US$) in most communes and much higher in the Prek Thmey commune as they also fish outside the flood season.

According to MRC[2]-Technical Paper, average amount of fish catch from rice field in Mekong Delta Flood Plain (deep flooded areas) would be 80-119 kg/ha resulting in the value of 30-40 US$/ha. Therefore, 35 US$/ha is taken in the economic analysis. The IFRM Plan would reduce the total area of water bodies suitable for fishing with about 57,000 ha.

8.3.2 Impact on soils

Other benefits of flooding is leaching toxicity substances cumulated during crop cultivation, improving soil texture, reducing rat/pest population, and soil fertility as results of sedimentation. It will be treated as negative 'benefits' in the flood control measures.

In the Focus Group Discussion in the six surveyed communes farmers mentioned that floods have significant benefits for crop cultivation. After a big flood, the crop yield would be 1.5-2 ton higher than after a normal flood. The application of fertilizers and pesticides, however, is almost the same. Flood benefits for agriculture would be 0.62-0.93 million Riel[3]/ha (about 150-230 US$/ha). Assuming big flood frequency of one third, the annual flood benefit for agriculture would be 50-80 US$/ha.

The intensive study on the impact of soil fertility was carried out in North Vam Nao water control project funded by AusAID in two flood seasons in 1999 and 2002. The two studies have the same conclusions that the amount of fertilizers contained in sediment would be insignificant compared with the amount of fertilizers applied by farmers to their crops.

The studies show that positive impacts of flooding to agriculture would be (i) Reducing insects and germs; (ii) Neutralizing and flushing soil toxicants; (iii) Speeding up the process of plant residue disintegration; (iv) Improving soil texture; and (v) Fertilizing soil.

8.4 Economic analysis

The economic analysis is based on the assumption that the works will be implemented ovewr a period of nine years and that benefits will gradually accrrue and will start from year five since flood protection benefits can only be counted for when entire dykerings have been completed.

The annual benefits of flood risk reduction, agricultural development and losses due to reduced fisheries area and loss of soil fertility, and project costs for investment and operation and maintenance have been discounted over a period of 30 years.

The Net Present Value at 12% amounts to US$ 71 mln. The Economic Internal Rate of Return would be 16%.

In view of the many uncertainties and the level of detail of the plan preparation, these figures are to be taken with great caution

[2] MRC-Technical Paper, No:16, October 2007:Consumption and the yield of fish and other aquatic animals from the Lower Mekong Basin

[3] 1 US$ = 4,000 Riel

9 TRANSBOUNDARY IMPACTS

The flood risk management options that consider protection of areas go hand in hand with the reduction of the storage of flood waters in these areas until the design level of protection works have been reached. This reduction of floodplain storage results in the increase of the river discharges at and downstream of the protected area and, consequently in the increase of the river water levels.

The impact of the IFRM Plan for the West Bassac area can therefore not be seen in isolation, it is intricately linked also to flood protection developments elsewhere in the Mekong Delta. Such impacts have been investigated in the Flood Risk Management in the Border Zone between Cambodia and Vietnam, also a Demonstration Project under FMMP-C2. That project has been reported in Volume 6F.

10 INSTITUTIONAL DEVELOPMENT

10.1 Institutions involved

As water resources development and utilization is a cross-cutting issue several agencies are invariably involved in the water sector management, including:

- (i) Cambodia National Mekong Committee (CNMC);
- (ii) The Ministry of Water Resources and Meteorology (MOWRAM);
- (iii) Ministry of Industry, Mining and Energy (MIME);
- (iv) Ministry of Rural Development (MDR);
- (v) Ministry of Public Works and Transport (MPWT);
- (vi) Ministry of Environment (MOE);
- (vii) Ministry of Agriculture, Forestry and Fisheries (MAFF).

Table 10.1 summarizes responsibilities of the various ministries involved in the water sector management. In general, the relations of the ministries in Cambodia are complicated, as on national level the division of labour between ministries and departments is not clear cut.

Table 10.1 Roles and Responsibilities of Various Government Agencies

Functions	MOWRAM	MAFF	MOE	MRD	MIME	MPWT	MOH	PPWSA	CNMC
Policy and planning for the sector	●	❍	❍	❍	❍		❍		❑
Policy and planning for each subsector	●	❍							❑
Water capital development and control	●								
-watershed management	●	❍							❑
-flood control	●								❑
-drought control	●								❑
-ground water control	●			❍					❑
Water utilization									
-irrigation and farm drainage	●	❍							❑
-fisheries and aquaculture	❍	●							❑
-hydropower	❍				●				❑
-urban water supply	❑							●	
-rural water supply	❍			●			❑		
-urban drainage	❑					●			
Water pollution control									
-urban wastewater control			●			❍			
-industrial waste control			●			❍			
-agricultural waste control		❍	●						
Operations and maintenance of water management infrastructure									
-hydrological and meteorological network	●								
-water quality surveillance			●				❍		
People participation									
-irrigation and agriculture (FWUCs)	●	❍							
-rural water supply				●					

Notes: ● = key responsibility, ❍ =support and ❑ = cooperation

At the policy level, MOWRAM is the apex body for water resources management responsible for formulating national policies and laws and irrigation systems. MOWRAM has a key interest in irrigation and drainage. As water and agriculture are related, MAFF and MRD are MOWRAM's strategic partners responsible for efficient and effective use of water in agriculture to support rural development. MAFF is also responsible for protecting forest conditions of the watersheds.

At the implementation level, authorities are being delegated to provincial, district and commune levels in line with the Government's policy on decentralization.

At the community level, the Farmer Water User Community (FWUC) is the community organization to take over the responsibility of operations and maintenance (O&M) expenses. As the end of 2008, about 250 FWUC's have been established of which 180 have been registered and the remaining are in the process for registration.

A FWUC is led by an elected committee consisting of the following members: Chairperson, two vice-chairpersons, a treasurer and all chiefs of farmer water user groups. FWUCs have the following functions and responsibilities:

(i) manage and operate the irrigation schemes handed over from PDWRAM, including preparing work plan and prepare statutes, contracts and internal regulations of communities, and distribute water to all members,
(ii) collect irrigation service fee;
(iii) (iii) bring together farmers who have farming land in an irrigated area and form a group for facilitating the supply of irrigation water to them;
(iv) acquire knowledge of management, O&M of irrigation system and financial affairs;
(v) increase the yields and seasonal cropping;
(vi) facilitate support from the government;
(vii) strengthen the use, management and improvement of the irrigation system in an efficient manner; and (
(viii) resolve conflicts and problems occurring within the community.

In general, the capacity of most FWUCs is still inadequate to perform the assigned functions. Their institutional capacity is constrained by low educational levels of their members and lack of financial resources.

10.2 `The Ministry of Water Resources and Meteorology

10.2.1 Origin

MOWRAM is a rather new ministry, created only in 1999 by upgrading the then Directorate General of Irrigation, Meteorology and Hydrology (DGIMH) under the Ministry of Agriculture, Forestry and Fisheries (MAFF). As the ministry builds on the existing institutional capacity of DGIMH, it had a certain strength and capacity to implement the various projects and Programmes almost immediately after its formation. MOWRAM has a broad mandate related to the planning and development of water resources in the country. During this short period of its establishment, MOWRAM has received already a large amount of external assistance in capital investment and TA (in the form of both grant and loan), with the total of more than US$132 million and US$20 million respectively. By its nature, the work of MOWRAM has to involve with many other ministries and agencies to ensure the success of its projects and Programmes. Efficient coordination at ministerial level is still a key issue that the present project has to observe.

It has been recently noted that Water law of Cambodia has already been enacted (May 2007), although some of the related policies and sub-decree as the flood management policy, irrigation sector policy (ISP), the participatory management and development (PIMD), the irrigation management transfer (IMT), etc. are yet to be finalized and enforced.

10.2.2 Organization

MOWRAM is organized into General Directorate of technical Affairs (GDTA) and General Directorate of Administrative Affairs (GDAA) directly under the Ministry and Secretary of State (MOWRAM) organization structure is presented in Figure 10.1. Under GDTA, there are six departments: Water Resources Management and Conservation; Hydrology and River Works (DHRW); Meteorology (DM); Irrigation and Drainage (IDD);

Water Supply and Sanitation (WSSD); and Engineering (ED). Similarly, GDAA has International Cooperation (PICD); and Finance (FD). It was also noted that these departments have corresponding offices in the provincial department (PDRAM). Organizationally, MOWRAM has therefore undergone changes but, most of the institutional arrangements are only recent and, may not yet fully operational.

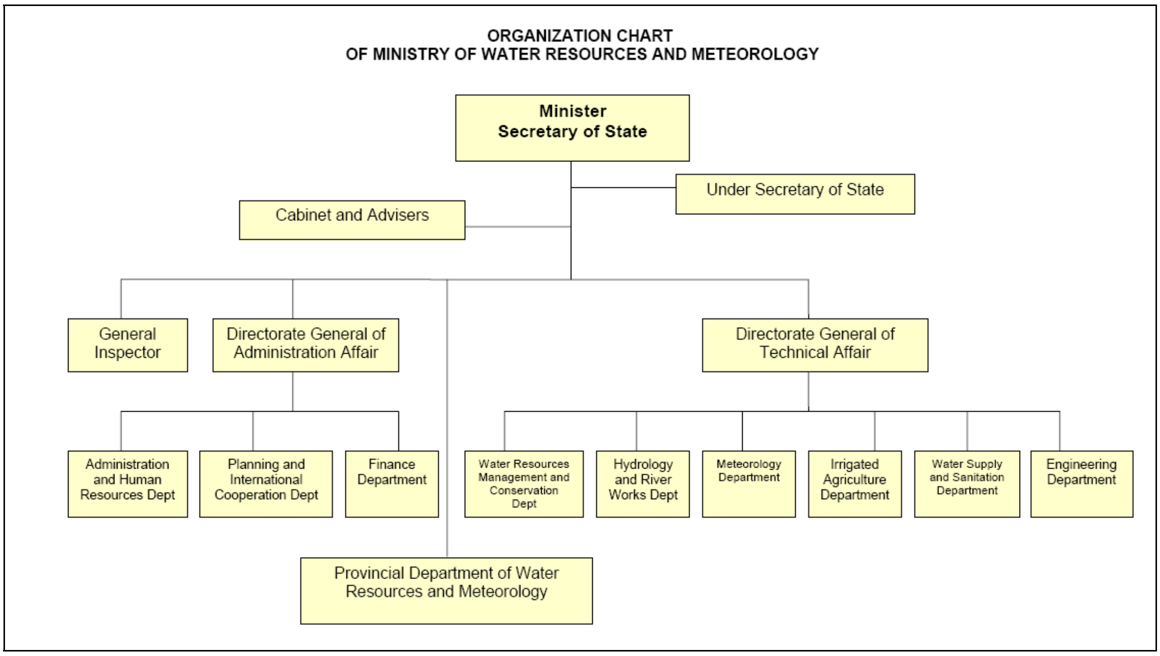

Figure 10.1 Organization charts of Ministry of Water Resources and Meteorology

10.2.3 Staffing

According to information obtained, currently, MOWRAM has more than 700 staff at the head office. Most of them are water engineers and technicians. Of these about 230 are engineers with bachelor's or master's degree. Nearly 70% of the staff is attached to IDD and ED. MOWRAM maintains a large fleet of plant and equipment-basically could be seen as a construction-oriented organization. However, following the government policy, there was an opinion that MOWRAM should be strengthened in many ways for effective management of the water resources development in the country. Its staffs, system, procedures and practices, etc. should be re-oriented towards a user-friendly organization that can operate effectively in collaboration with other related government agencies and other external development partners.

ADB and AFD, as an example, are among the key development partners of MOWRAM who have been and still are active in providing various supports to this ministry, aiming at building, their supports include financial and technical resources for rehabilitation and/or re-construction of a large number of irrigation infrastructures in the country.

During a relatively short period of its association, the consultant team already felt that several of their counterpart staff from MOWRAM is highly devoted to their duties, but overloaded. Problem related to staff at MOWRAM is more pronounced with a right mix of skills and making the skilled staff use their knowledge and skill for organizational purposes. More staff of social science background, e.g. rural development specialists, irrigation/farmers institution specialists (such as FWUC development officer whom should be required many more in view of its mandate on the matter) should need to be recruited and put on board. Various positions should be strengthened to enable them to perform project management and related matters of a larger scale. At the provincial and district levels, in addition to social development/institutional specialists, requirement for more experienced engineers is generally high. In this connection, MOWRAM should therefore reconfigure itself by acquiring new skills and capacity in a manner that enable it to act as an overall manager of the water resources development and reorient its staffs, systems, procedures and practices to meet with the new requirements. Long term HRD planning aiming at a highly efficient and modernization should be required for MOWRAM.

It must be added, however, that since 2001, MOWRAM has been receiving assistance from Japan (JICA) in operating its Technical Services Center (TSC), serving as an in-house technical institution providing various training courses to MOWRAM staff. TSC is now in its second phase operation, although the Japanese assistance is to be ended in 2009. The role of TSC in HRD, particularly capacity building of MOWRAM staff, has been and still is highly recognized. Movement to have it upgraded to be a kind of permanent “institution” could also be observed, but problems remain.

In a longer term perspective, MOWRAM should continue to work towards this direction of modernization.

10.2.4 Salary Issues

Another aspect to be noted is on the salary of the staff which is relatively low. As a matter of fact, incentive problem is all pervasive in the Cambodia’s government bureaucracy, including MOWRAM. As also generally recognized, this partly explains the bureaucratic inefficiency and associated distortions including the lack of transparency and accountability in the system. It was noted however that at the project level, staffs assigned to work on external funded projects (i.e. staff at NPMO, PIU, etc) are being provided with salary supplement of allowances. This practice could be a transient and expedient measure, serving a limited and immediate purpose. The measure is effective in helping maintain the government staff working for a definite project. However, the measure may not be adequate to secure and/or maintain competent staff in some certain fields. Usually the performance of the staff concerned was not up to expectation due basically to lack of job descriptions (per staff) and their limited knowledge on the project and requirement they are working with. These are some of the areas that need to be improved largely to be effective.

10.3 Provincial Department for water Resources and management (PDRAM)

PDRAM is the provincial office of MOWRAM. Its typical structure broadly mirrors the one at the central level with some minor modifications. The main PDRAM organizational divisions are irrigated agriculture, water supply and sanitation, water resources management and conservation, hydrology and meteorology, and administration, personnel management and conservation and planning office. Normally, PDWRAM s do not have district offices but could have some staff (district agents) working in selected districts/sites to collect hydrological and meteorological data and operate gates of irrigation systems. Staff of PDRAM varies from province to province, depending on sizes of area under their responsibility and others. Current numbers of the staff of PDRAM at Takeo and Kandal are 85 and 45 respectively. The common character of these offices is the lack of senior engineers (only 2-3 staff per PDRAM). Middle class staff represents about 20%, and the remainder is lower grade staff, including general workers. Some of existing staff have received formal training in different disciplines including water management from donor assistance.

10.4 Institutional Capacity of MOWRAM and PDWRAM

Institutional capacity of MOWRAM is hampered by inadequate number of qualified and experienced personnel. This caused by the driven out of most professionals by the civil war and by low level of official remuneration of government officials. The lack of personnel is a problem in the planning, project management and in PDRAM.

Takeo and Kandal
The PDRAM in Takeo and Kandal do not have adequate number of engineers (for example in Takeo PDRAM has a total number of staff of 82, of which only 9 engineers and 30 technicians, and Kandal among the total staffs of 45, only five engineers and fourteen technicians) as these provincial offices could not compete with the private sector in attracting engineers. The shortage of engineers in PDRAM would have adverse impacts on large scale project studies, implementation and operation and furthermore quality of the supporting service provided to FWUCs. To cope with personnel shortage of MOWRAM and PDRAM, MOWRAM should find ways to train and educate more staffs in water sector than focusing on construction works.

10.5 Policy and strategy development

At the sector level, water resource development in Cambodia is guided by the following key national policies and strategies:

(i) **NSDP**: The national Strategic Development Plan (NSDP) covers, among others, Rectangular Strategy, the National Water Resources Policy, and in particular, the Strategic Development Plan of the Ministry of water Resources and meteorology (MOWRAM) which reflects MOWRAM's emphasis on feasible investment in irrigation.

(ii) **Rectangular Strategy**. The Rectangular Strategy promotes the development of agriculture sector to alleviate rural poverty and food insecurity.

(iii) **Strategy for Agriculture and Water (SAW)** 2006-2010. SAW sets a long term development goal of the Water Resources, Irrigation and Land Management Program as follows "sustainable and pro-poor management of water resources, water management facilities, water related hazards and land resources that is integrated, efficient, and carried out in river basin context". This goal will be realized through
   a. institutional capacity building and management support programme,
   b. food security support programme,
   c. agriculture and agri-business (value chain) support programme
   d. water resources, irrigation and land management programme, and,
   e. agricultural and water resources research, education and extension programme.

(iv) **National Irrigation and Drainage Strategy**: This strategy supports the joint formulation of multi-stakeholder river basin plans with Ministry of Agriculture, Forestry and Fisheries (MAFF), Ministry of Rural Development and Ministry of Environment.

Figure 10.2 is MOWRAM's rectangular strategy. It covers five Strategic areas;

(i) water resources information;
(ii) flood and droughts management;

(iii) legislation and sustainability;
(iv) water resources management and development; and
(v) management improvement.

The management improvement is the core Strategic area that has impacts on other four strategic areas.

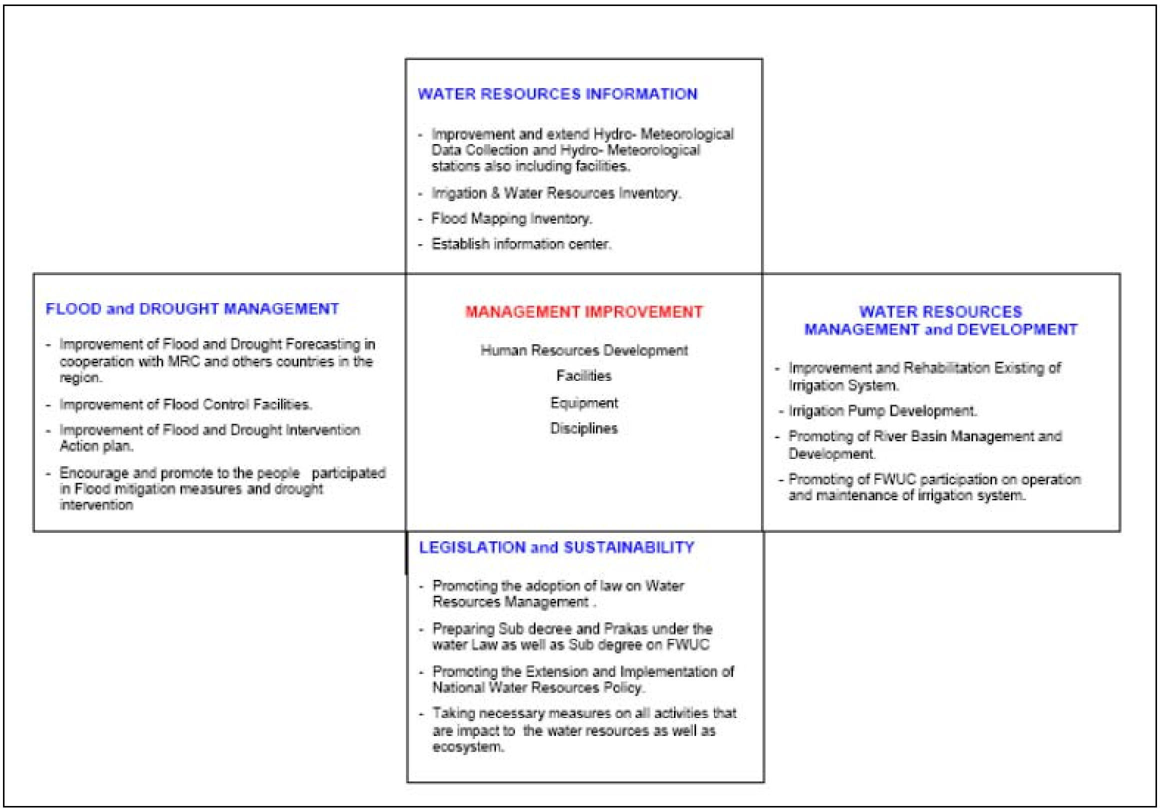

Figure 10.2 Rectangular Strategy on Water Resources and meteorology

10.6 Legal Framework

The Water Law was adopted by National Assembly on 22 May, 2007. A number of sub-decrees have been drafted and will be preceded to inter-ministerial meeting for comments and discussion prior to submitting to the Council of Ministers for approval. Circular and declarations have been prepared and enforced for the purpose of proper management, operation and maintenance of irrigation systems.

For irrigation use of water, a legal basis will have to be established to institutionalize and provide details on the participatory irrigation management and development (PIMD), or irrigation management transfer (IMT), and farmer water user communities (FWUCs) which serve as the tool for achieving the decentralization of responsibility for operations and maintenance (O&M) of irrigation facilities to users. A Sub-decree to this effect will be drafted and issued by Prime Minister. Until this Sub-decree is issued the circular no 1 would be referred to in project implementation.

11 TERMS OF REFERENCE FEASIBILITY STUDY FOR PHASE 1

PM

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Appendix 1 Flood hazard assessment

Appendix 2 Flood damage and Flood Risk Assessment

Appendix 3 Socio economics and agriculture

Appendix 4 Preliminary engineering design and cost estimate

Appendix 5 Public Participation Plan

Appendix 6 Implementation Public Participation Plan

Appendix 7 Initial Environmental Examination

Flood hazard assessment for Mekong Delta

Appendix 1

November 2009

final Report

Contents

1 Introduction

In the Mekong Delta four Focal Areas have been selected by the CNMC and the VNMC concentrated along the border between Cambodia and Vietnam, including:

1. Takeo, west of Bassac in Cambodia
2. Prey Veng, east of Mekong in Cambodia
3. Long Xuyen Quadrangle, west of Bassac in Vietnam, and
4. Plain of Reeds, east of Mekong in Vietnam

Flood hazard assessment in these Focal Areas involves the determination of flood levels for distinct return period from 2 to 100 years with the duration and time of occurrence of the flood. The latter is particularly of importance in relation to the timing of harvest of the crop. For this purpose simulation runs with the ISIS-model of the delta, a one-dimensional hydraulic model, have been carried out, covering 97 years of historical floods from 1910 to 2006.

The set up of this Appendix 1 is as follows. In Chapter 2 the flood hazard assessment procedure for the Mekong Delta floods is presented followed by a description of the Focal Areas and hydrological characteristics of the Mekong Delta in Chapter 3. The hydraulic model of the Mekong delta is presented in Chapter 4 with the applied boundary conditions. In Chapter 5 the flood hazard in the Mekong Delta is discussed for the above mentioned scenarios, whereas in Chapter 6 the effect of sea level rise on the water levels in the Mekong and Bassac is estimated. Finally, in Chapter 7 conclusions and recommendations are made.

Reference is made to Appendix 7 to 11 to Annex 1 of the Stage 1 Report for details of the applied hydraulic model (Appendix 7), applied boundary conditions in the hydraulic model (Appendix 8 and 9), probabilistic computations (Appendix 10) and modelling of the flow diversion to Tonle Sap River (Appendix 11). These appendices give a detailed description of the data used and procedures applied.

The flood hazard assessment for the West Bassac area cannot be done in isolation, the area is part of the larger Mekong Delta, effects of measures taken to reduce flood hazard in one part of the delta impact on other areas. Reason why this Appendix deals with flood hazard in the Mekong Delta as a whole, as far as related to river floods and flooding.

This Appendix is being used for three Demonstration Projects, the West Bassac Integrated Flood Risk Management Plan, the Flood Protection Criteria for the Vietnamese part of the Mekong Delta, and the Flood Risk Management in the Border Zone between Cambodia and Vietnam.

2 Flood hazard assessment procedure

2.1 General

The floods in the Mekong Delta are classified as a special type of flood in the Lower Mekong Basin due to their special external and internal boundary conditions and the delta's unique hydraulic infrastructure. The flood levels in the Mekong Delta in its downstream part are essentially the result of upstream and lateral inflow, local rainfall and downstream water levels at sea. The flood in the Mekong delta is conveyed via the Mekong and Bassac Rivers and via their flood plains, including the colmatage canal system which diverts and controls the flow from and to the River. In the delta the river regime is modified by to the temporary storage in Great Lake and in the Mekong flood plains, creating slowly rising and falling water levels.

2.2 Determination of the flood hazard

For the Mekong delta downstream of Kratie for flood hazard assessment use is made of the fact that a relatively long historical discharge series at Stung Treng just upstream of Kratie is available. Furthermore, for the tributary inflow further downstream and to the Great Lake long representative series have been created preserving the serial and cross-correlation with the Mekong flow. The series, which cover the period 1910-2006, are used as boundary conditions for a hydrodynamic model (based on ISIS-modelling package) to derive a 97-year series of water levels in the flood-prone areas. Further input to the model is formed by local rainfall, evaporation, water use and the year 2000 tidal conditions at the Gulf of Thailand and the South China Sea.

The relevant statistics including the probabilities of flooding and related damages for return periods from 2 to 100 years can be derived directly from the series of water levels and depths computed with the model. From the model results for each year maximum water levels are derived for all model nodes to estimate the exceedance probabilities. The probability estimates are obtained with Gringortens formula:

$$p_i = \frac{r_i - 0.44}{N + 0.12} \tag{2.1}$$

where:
p_i = probability of exceedance of the annual maximum water level in year *i*
N = total number of years
r_i = rank number of the maximum water in year *i* (1 = highest, n = lowest)

Since the series of annual maxima is close to 100 years, the estimated 100-year water level is by definition approximately the same as the maximum observed water level.

3 Description of focal areas

3.1 General

The Mekong Delta comprises the BDP-Sub-areas 9 and 10, see Figure 3.1 and Figure 3.2, and covers the Mekong river basin from Kratie to the river mouth in the South China Sea. The total area amounts about 144,500 km^2 of which 105,100 km^2 is in Cambodia, 4,200 km^2 in Thailand and 35,200 km^2, the Cuu Long Delta, is located in the southern part of Vietnam. A number of river reaches can be distinguished:

1. From Kratie via Kampong Cham to Chroy Changvar (Phnom Penh), just upstream where the Tonle Sap River joins the Mekong and the Bassac branches off at Chaktomouk Junction to discharge part of the total Mekong flow to the sea;
2. The Tonle Sap River and Lake with its large number of tributaries covering a drainage area of nearly 86,000 km^2.
3. Mekong from Phnom Penh to the North Vam Nao River junction, with discharge stations Neak Luong in Cambodia and Tan Chau in Vietnam. The North Vam Nao River diverts part of the Mekong flow to the Bassac;
4. Mekong downstream of North Vam Nao River, discharging its water to the South China Sea via a number of branches: Co Chien, Ham Luong, Cua Dai, and Cua Tieu. The total Mekong flow is measured in this reach at My Thuan;
5. Bassac from Chaktomouk Junction to the junction with North Vam Nao River, with stream gauging stations Chaktomouk in Cambodia and Chau Doc in Vietnam. Downstream of Chaktomouk the basin of the Prek Thnot discharges to the Bassac;
6. Bassac downstream of the junction with North Vam Nao River to the South China Sea with the flow measured at Can Tho. Part of the flow from the right bank of the Bassac drains via the Cai Lon River to the Gulf of Thailand.

The Great Lake, the flood plains and the road infrastructure play an important role in storing and conveying the floodwaters.

Apart from the fringes of the basins of the Tonle Sap and the Prek Thnot basin the areas is very flat. In general, the delta has a deep hollow shape: high along the riverbanks and low toward the inland. Regarding land use, the area around Tonle Sap is predominantly covered with forest of which a small part is flooded forest forming an important habitat for fish reproduction and refuge. Here some 25% of the land cover is agricultural land. The land use in the delta is heavily dominated by paddy land, with some forest in the upper parts. Soils in the delta are the most fertile of the LMB, brought in by the floods. Large quantities of gleysols exist suitable for rice farming. In the lower part of the delta intrusion of saline water affects the quality of the soils. Infertile acid sulphate soils are found in the Plain of Reeds.

Reference is made to Annex 1 of Volume 2 of the Inception Report for a full description of the characteristics of the Mekong Delta included in the Sub-Areas 9 and 10.

Figure 3.1 Layout of Tonle Sap River and Lake basin

Figure 3.2 Layout of Mekong Delta in Sub-Area 10, comprising the Focal Areas

3.2 Focal areas

In the Mekong Delta 4 Focal Areas have been selected by the CNMC and the VNMC concentrated along the border between Cambodia and Vietnam, including:

1. Takeo, west of Bassac in Cambodia
2. Prey Veng, east of Mekong in Cambodia
3. Long Xuyen Quadrangle, west of Bassac in Vietnam, and
4. Plain of Reeds, east of Mekong in Vietnam

The location of the Focal Areas in the Mekong Delta is as follows:

1. Focal Area Takeo is located in Takeo and Kandal Provinces west of the Bassac, enclosed by the right bank of the Bassac , Road Nr 2 from Takmau to the Cambodian-Vietnamese border.
2. Focal Area Prey Veng is located in Prey Veng Province between the left bank of the Mekong, Road Nr 1, border of the Prey Veng and Svay Rieng Provinces and the Cambodian-Vietnamese border.
3. Long Xuyen Quadrangle boundaries are formed by the right bank of Bassac River from Chau Doc to Kenh Cai San off-take of Bassac d/s of Long Xuyen, the Cambodian-Vietnamese border from Chau Doc to Ha Tien, the Rach Gia-Ha Tien Canal from Hat Tien to Rach Soi via Kien Luong, Hon Dat and Rach Gia and the Kenh Cai San from Rach Soi to the Bassac via Tan Hiep. Most of this area is located in the An Giang and Kien giang Provinces and a small part in Hau Giang Province
4. The Plain of Reeds is bordered by the left bank of the Mekong from Hong Ngu near Tan Chau to Thanh Binh, in the south by the Nguyen Van Tiep canal via My An to My Phuoc, the Tong Doc Loc, crossing the West Vaico, Thu Thua canal, west of Road 1A from My Tho to Ben Luc via Tan An, the Bo Bo canal parallel to the East Vaico river in the west and in the north by the Cambodian-Vietnamese border up to the Mekong River at Hong Ngu. The area is in the provinces Dong Thap, Long An and Tien Giang.

3.3 Hydrological network and data availability

The Mekong Delta encloses the BDP-Sub-areas 9 and 10. The hydro-meteorological monitoring network and data availability has been described in detail in Annex 1 to Volume 2 of the Inception Report to which reference is made.

3.4 Hydrological characteristics

3.4.1 Rainfall

The Mekong delta has a monsoon climate. The average annual rainfall varies from 1,200 to 2,000 mm and around Tonle Sap from 1,300 to 1,600 mm. The seasonal distribution of the rainfall for Kampong Cham, Battambang and Tra Cu in Vietnam is shown in respectively Figure 3.3 to Figure 3.5. The rainfall is seen to be distributed into two seasons:

- the dry season from November to April receives some 10% of the annual rainfall, while
- the rainy season from May to November receives the remaining 90%.

From the graphs it is observed that - different from the upper part of the Mekong basin - in the delta also October is a wet month.

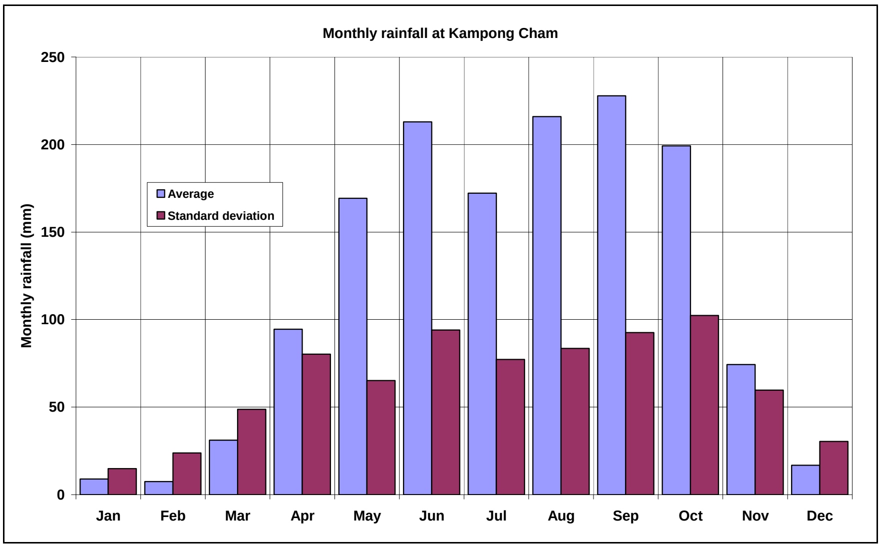


Figure 3.3 Monthly rainfall characteristics of Kampong Cham (Cambodia)

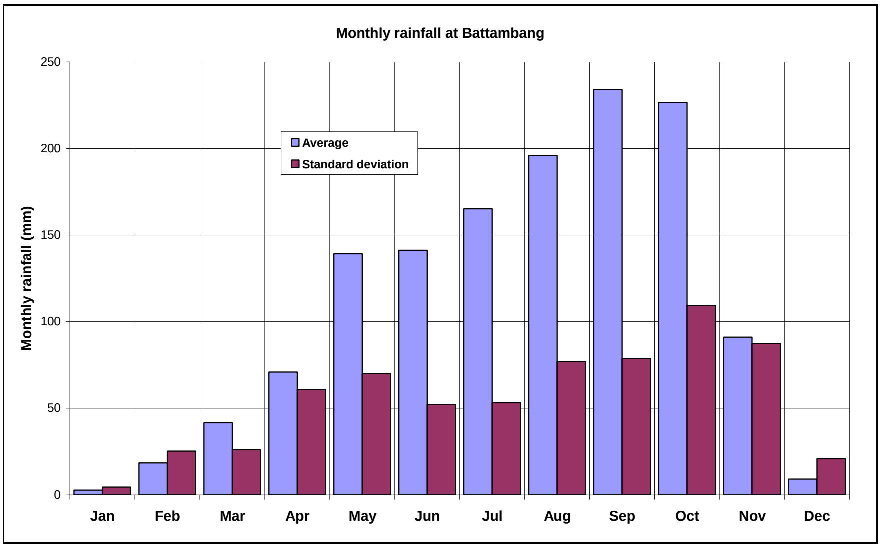


Figure 3.4 Monthly rainfall characteristics of Battambang (Cambodia)

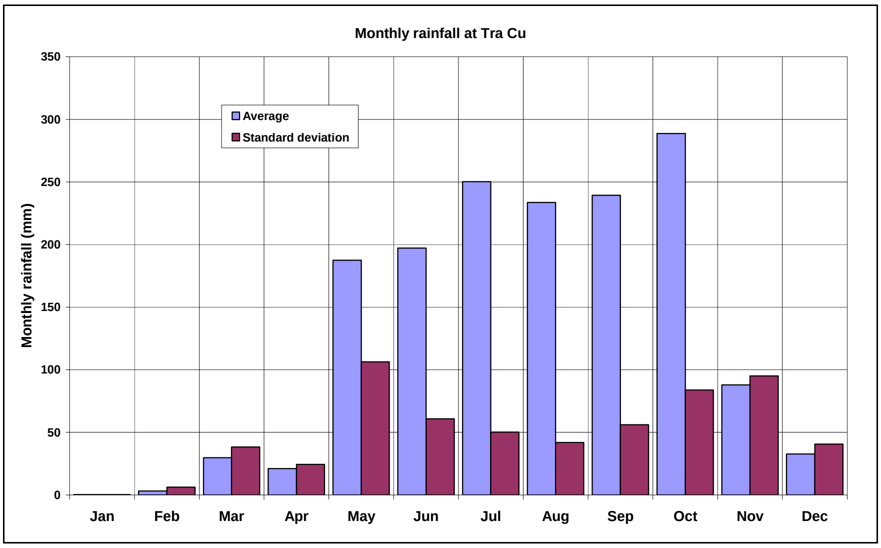


Figure 3.5 Monthly rainfall characteristics of Tra Cu (Vietnam)

3.4.2 Evaporation

Annual (pan)-evaporation in the Mekong basin in Cambodia varies between 1300 and 1900 mm. For the Mekong Delta in Vietnam annual total between 900 and 1300 mm are reported. Monthly pan-evaporation data generally are highest in the March-April and lowest in July-September/October.

3.4.3 River flows

Upstream inflows

The inflow to the delta is to a large extent determined by the discharge in the Mekong at Kratie. In Phase 1 an analysis has been made of the water level record and discharge measurements at Kratie and of the stations Pakse and Stung Treng. Since the discharge at Stung Treng is apart from a time shift of one day approximately equal to the flow at Kratie and because this series was considered to be more reliable and available for a longer period it was taken as the inflow to the Mekong Delta instead of the series of Kratie. Reference is made to Appendix 8 for the details.

The monthly flow statistics of the Mekong at Stung Treng for the Period 1910-2006 is presented in Table 3.1 and Figure 3.6. Largest flows are observed in the months August and September and lowest in March-April.

Table 3.1 Monthly flow statistics (MCM) of the Mekong at Stung Treng, Period 1910-2006

Var	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
mean	10,879	7,315	6,114	5,573	10,131	28,918	61,130	99,625	100,254	61,855	29,066	16,622	437,480
stdev	1,779	1,155	1,097	1,368	3,407	11,029	16,277	21,651	18,043	14,036	6,564	3,186	60,258
cv	0.164	0.158	0.179	0.245	0.336	0.381	0.266	0.217	0.180	0.227	0.226	0.192	0.138
min	7,205	4,780	3,426	1,931	3,391	9,922	26,355	52,390	51,462	31,474	16,788	9,945	285,292
max	15,596	9,740	8,957	9,329	23,141	67,019	102,090	160,875	147,218	101,193	46,386	23,618	553,923

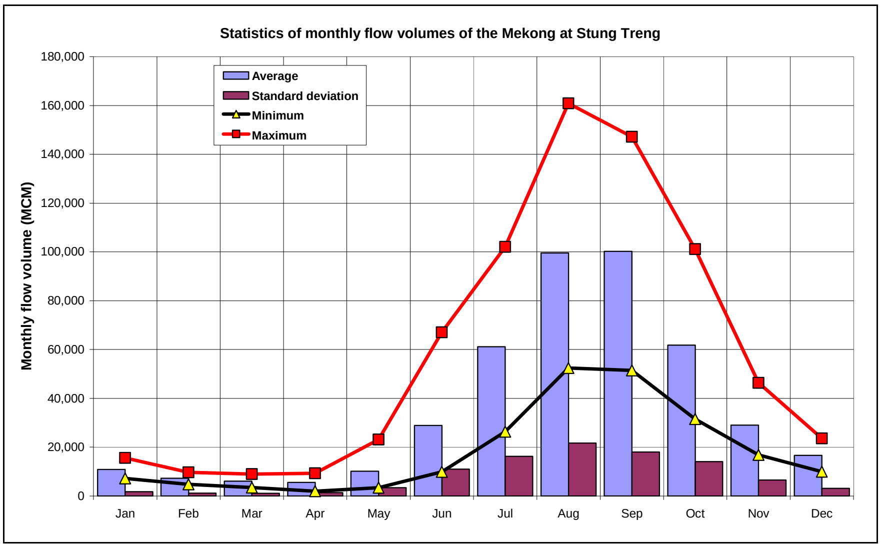


Figure 3.6 Monthly flow statistics of the Mekong at Stung Treng, Period 1910-2006

Lateral inflow

Downstream of Kratie the inflow to the Mekong is from the 13 Stungs draining to the Great Lake and the Mekong tributaries Prek Te, Prek Chhlong, Prek Thnot. Their monthly averages are presented in Table 3.2.

Table 3.2 Average monthly tributary inflow (in MCM) to the Great Lake (observations of years 1997-2004) and to the Mekong downstream of Kratie (SWAT series 1985-2006)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Tonle Sap	487	271	271	312	783	1,616	2,783	4,740	5,581	6,638	2,947	926	27,354
Prek Te	114	60	34	27	42	87	160	369	633	587	358	201	2,671
P. Chhlong	84	44	32	26	43	79	84	163	278	340	228	133	1,533
P. Thnot	77	58	40	88	192	236	337	395	505	675	299	153	3,054

The statistics of the tributary inflow to the Tonle Sap are shown also in Figure 3.7. It is observed that on average the inflow is largest in October, in response to the rainfall, see Figure 3.4, In comparison with the Mekong, as shown in Figure 3.6, it follows that the inflow regime to the Tonle Sap is shifted by about one month. This gives excellent opportunities to use the Great Lake for temporary storage of the early flood of the Mekong to reshape the regime downstream of Phnom Penh for harvesting in late August. On the other hand, during the year 2000, when the flood volume of the Mekong was large, the inflow to Great Lake from its tributaries was also large. The annual inflows to the Tonle Sap are correlated with the flow volume in the Mekong upstream of the Delta; more than half of the variance on the inflow is explained by the Mekong flow volume.

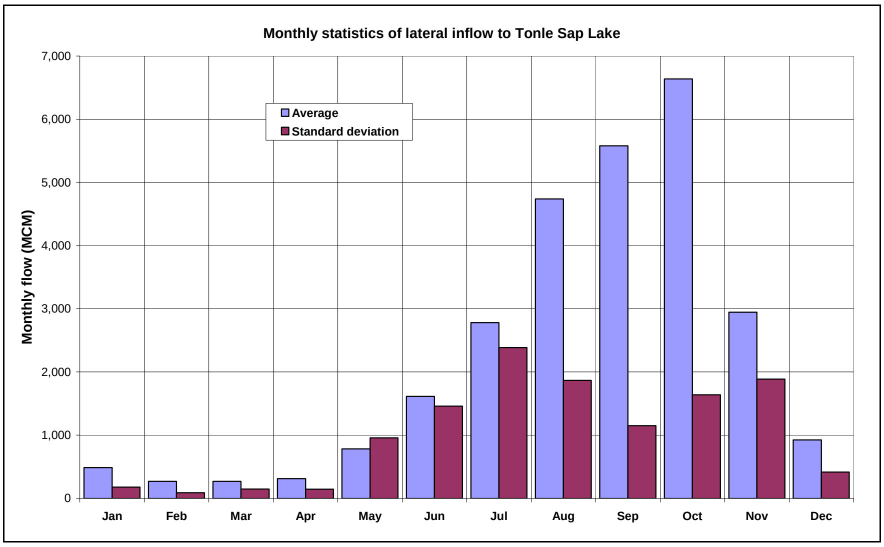


Figure 3.7 Average and standard deviation of monthly inflows to Great Lake, Period 1997-2004

3.4.4 Tidal boundaries

The downstream boundary of the Mekong Delta is formed by the Gulf of Thailand in the west and the South China Sea in the south:

- The tide in the Gulf of Thailand varies from semi-diurnal to diurnal. The tidal range is in the order of 1.5 m. Levels are highest in October and November.
- In the South China Sea the tide is basically semi-diurnal, but becomes at times almost diurnal. The daily range is generally in the order of 1.5 to 2.5m; the maximum range is about 4 m, see Figure 3.8. The tidal averages show a sharp increase in September-October coinciding with highest flows in the Mekong as shown for 4 coastal stations in Figure 3.9.

The annual maximum water levels of station Tra Vinh near the coast, which is available from 1985 till 2006 does not show clear effects of wind set up in the mouth of the Mekong. The annual maximum values during the available 22 years only varied from 1.58 to 1.82 masl.

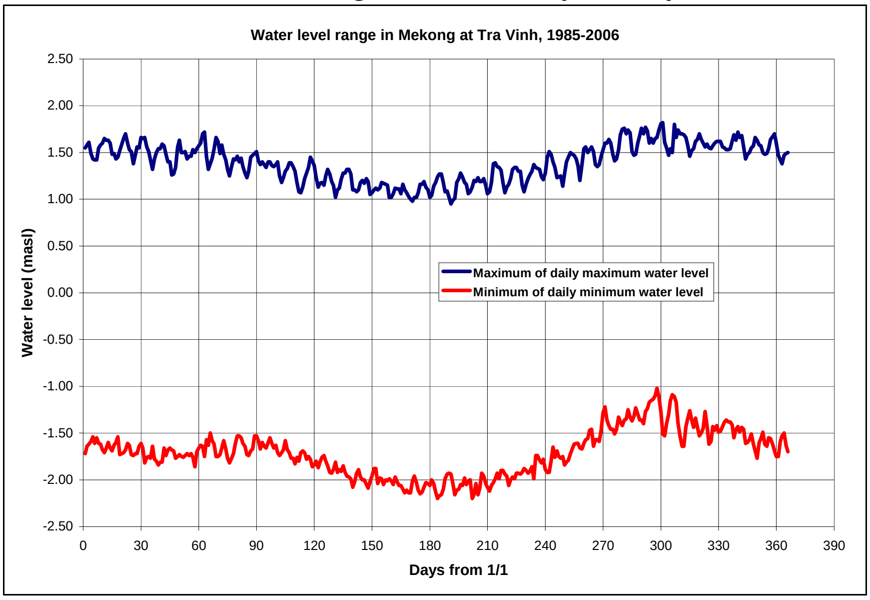


Figure 3.8 Water level range in Mekong at Tra Vinh near the coast, Period 1985-2006

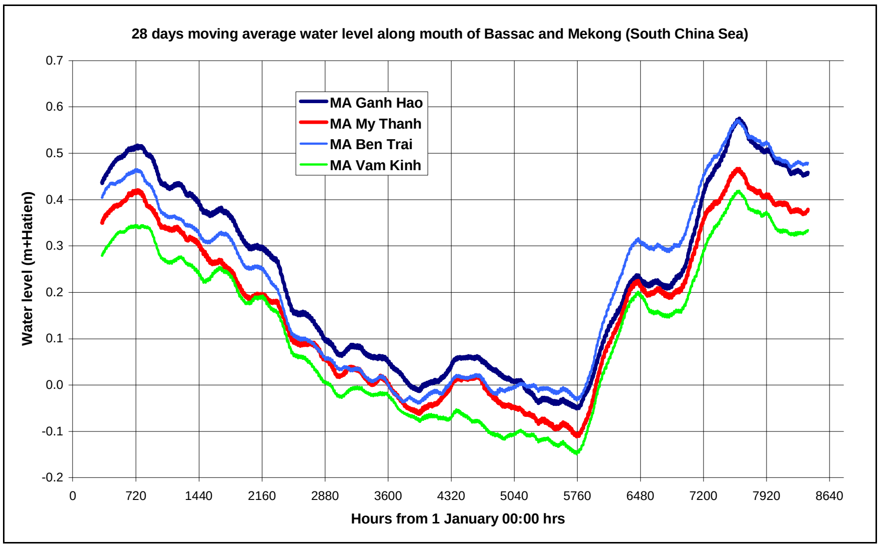


Figure 3.9 28 days moving average of water level at Ganh Hao, My Thanh, Ben Trai and Vam Kinh

4 Hydraulic model of the Delta

4.1 General

In this chapter an overview is given of the hydraulic model of the Mekong Delta and its boundary conditions as for flood hazard assessment. The model is used to compute flood levels for distinct return period from 2 to 100 years with the duration and time of occurrence of the flood, based on 97 years of historical floods from 1910 to 2006. First the model layout is shortly discussed and subsequently the boundary conditions, including:

- upstream boundary condition at Kratie,
- tributary inflow to Great Lake,
- tributary inflow to Mekong,
- rainfall,
- evaporation,
- water use, and
- downstream boundary condition at Gulf of Thailand and South China Sea.

4.2 Model layout

The hydraulic model of the Mekong Delta is based on the ISIS modelling system for the simulation of unsteady flow in channel networks. It provides an implicit numerical solver for the de Saint Venant equations for 1 dimensional flow. At selected intervals it computes water levels and discharges on a non-staggered grid. The system was introduced to the MRC under the WUP-A programme and now serves as part of the Decision Support Framework (DSF). The model covers the Mekong Basin from Kratie to the South China Sea, including the Great Lake and Floodplain, the Cambodian floodplains and the Vietnamese Mekong Delta. At the delivery of the model by Halcrow, it was decided that further improvements had to be made in the model schematization and calibration. Significant improvements were indeed made in 2006 by Mr To Quang Toan of the Southern Institute for Water Resources Research (SIWRR) in Ho Chi Minh City. Adaptations and recalibration were made in the first half of 2008 by JBA Consulting. Also, significant improvements were made in Aug and September 2009 by the MRC IKMP-Modelling Team following the discovery of numerous and severe numerical instabilities in the results of the simulation outputs. The performance of the model has been reviewed by Consultants (see Appendix 7 to Annex 1). It was concluded, that:

- the current ISIS model still has to be improved with regards to the number of extended river sections and reservoirs in the Weat Bassac and Eat Mekong area in Cambodia, the initial boundary conditions at the onset of the flood season of reservoirs in deep flooded areas and the levels of spillways in the coastal plains.
- the error in the celerity of flood wave propagation pose a serious problem, leading to an approximately one week late arrival of the flood wave in the Plain of Reeds and the Long Xuyen Quadrangle.

- for the simulation of structural measures to change the nature of the floods in the project areas, adaptations in the model schematization are required. As the current model serves as a reference, any changes in the schematization and its associated parameter settings must be introduced in a way consistent with the procedures applied in the development of the reference model.

The schematisation of the Cambodian and Vietnamese Focal Areas in ISIS is shown in Figure 4.1.

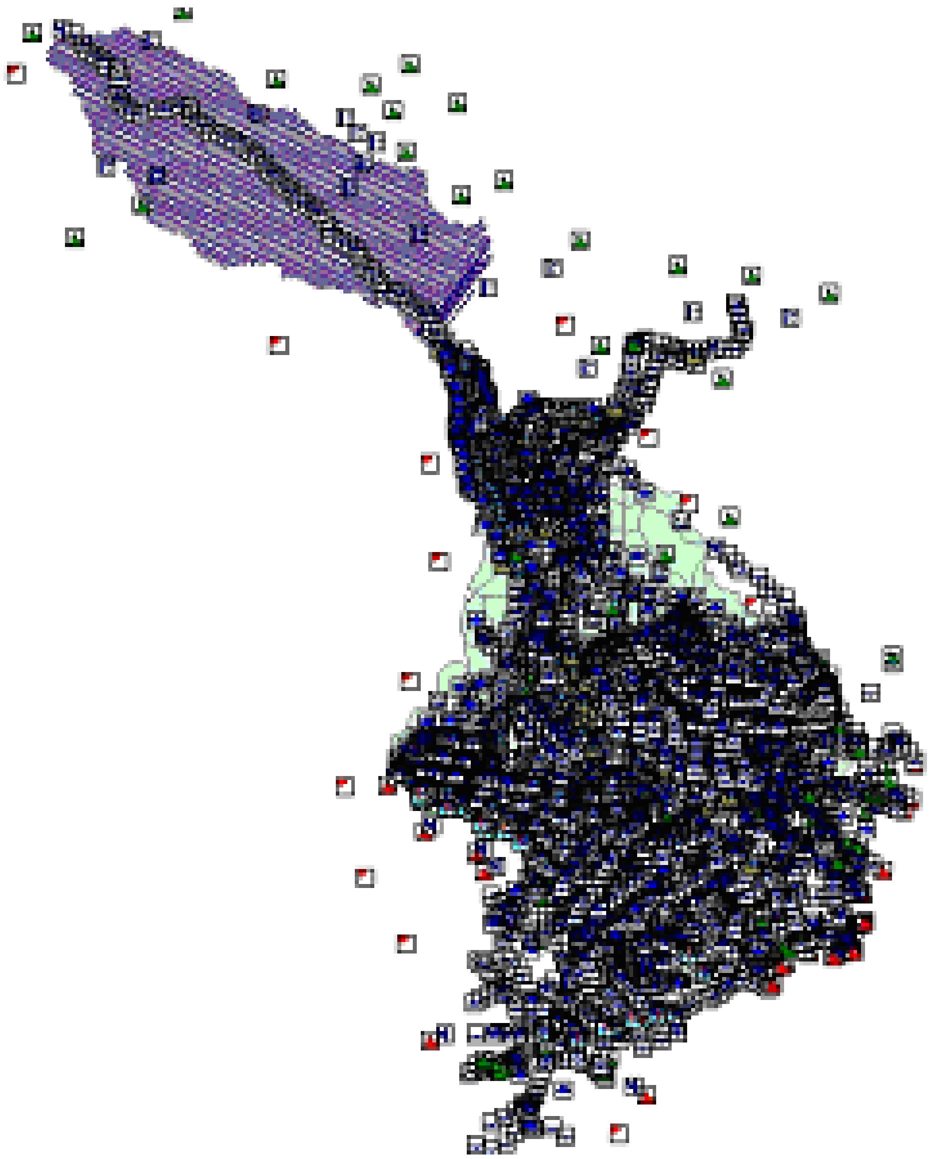


Figure 4.1 ISIS-schematisation of the Mekong delta

The Focal Areas in Vietnam have been treated in far more detail than the areas in Cambodia. To reliably simulate the effect of flood management measures in the Cambodian part of the delta a more detailed network to be implemented has been requested for. This has been done late 2008 and early 2009 but further extension of nodes is still needed, requiring surveys. Hence the effect of the alternatives for the Focal Areas in Cambodia on the flood hazard can only schematically be assessed.

4.3 Mekong at Kratie

The water level series, stage-discharge measurements and discharge series of the Mekong at Kratie have been reviewed in Annex 8. Water levels at Kratie are available since 1933. It appears that at several occasions gauge shifts have taken place and that a number of periods are of doubtful quality. Furthermore, stages at Kratie have gradually changed in the course of time, due to developments downstream. This implies that the stage-discharge relation will have changed with time. Unfortunately, between 1969 and 2002 no discharge measurements were carried out at Kratie and those carried out since 2002 with ADCP appear to be biased relative to the current meter measurements in the past. Also, the hydraulic control at Kratie is complicated and difficult to describe with shifted type power relations. This makes extrapolation beyond the measured range cumbersome. Finally, the stage-discharge relation for Kratie is affected by backwater from the Tonle Sap: for a particular water level at Kratie during rising stages when water is flowing into the Tonle Sap the discharge at Kratie is higher then during falling stages when water is flow out of the Tonle Sap. So, summing up, though the sensitivity of the gauge at Kratie is small (small dQ/dh), a number of factors make the conversion of stages into discharge uncertain.

In view of these difficulties and because for Stung Treng a longer series is available (since 1910 up to and inclusive 2006), preference has been given to the discharge series of Stung Treng. The basin area at Stung Treng measures 635,000 km^2, whereas at Kratie the upstream area is 646,000 km^2, i.e. only 1.7% larger than at Stung Treng. In the flows measured at both locations this difference is not visible. Regarding peak flows, differences are even further diminished by attenuation between Stung Treng and Kratie. For a correct reproduction of the flow at Kratie, the flow at Stung Treng has to be shifted with 1 day to account for travel time between the two sites. Still, the discontinuity in the recent series based on ADCP-measurements at Kratie remain and should be further analysed on basis of concurrent current meter and ADCP discharge measurements at Kratie.

The frequency curves of daily Mekong discharges at Stung Treng are presented in Figure 4.2. The flows are highest in August and September, with the peak value occurring around 1 September, and lowest discharges in April and early May. Note that from these graphs no information is obtained about the true shape of the hydrographs in a particular year as sequential information is not contained in the frequency curves.

Extreme value analysis has been carried out on the annual maximum peak flows and flood volumes at Stung Treng using GEV-distributions. Particularly the flood volumes are of importance for the Mekong Delta as these create the highest water levels and flood damages. The results of the extreme value analyses are shown in Table 4.1 and Figure 4.3. The correlation between the peak flows and flood volumes is included in the bivariate extreme value distribution on peak flows and flood volume. For its establishment reference is made to Appendix 9 for the details.

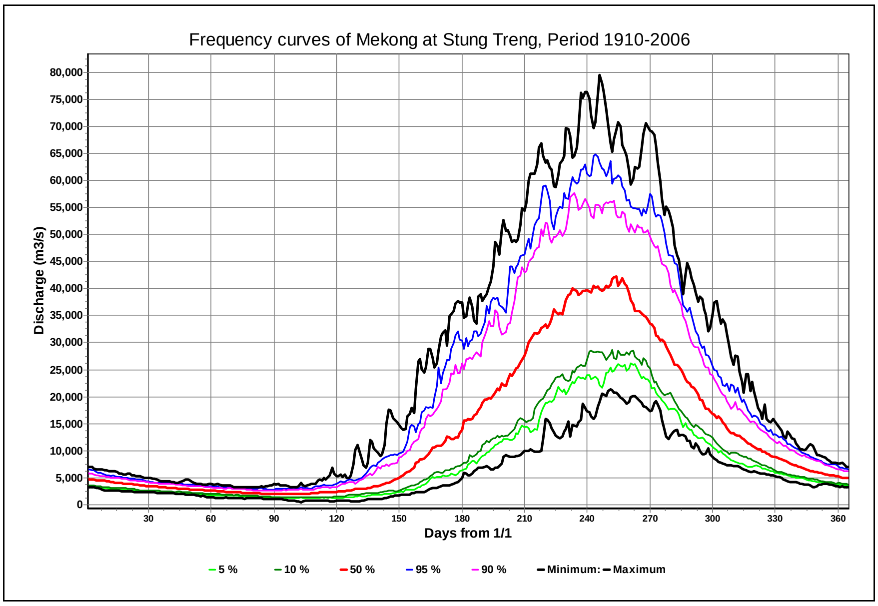


Figure 4.2 Frequency curves of the Mekong discharge at Stung Treng, Period 1910-2006

Table 4.1 Annual maximum discharge and flood volume in the Mekong at Stung Treng, period 1910-2006

T	Peak flow (m^3/s)	Flood volume (MCM)
2	54,400	331,000
5	62,600	389,000
10	66,600	416,000
25	70,600	440,000
50	72,900	453,000
100	74,800	463,000

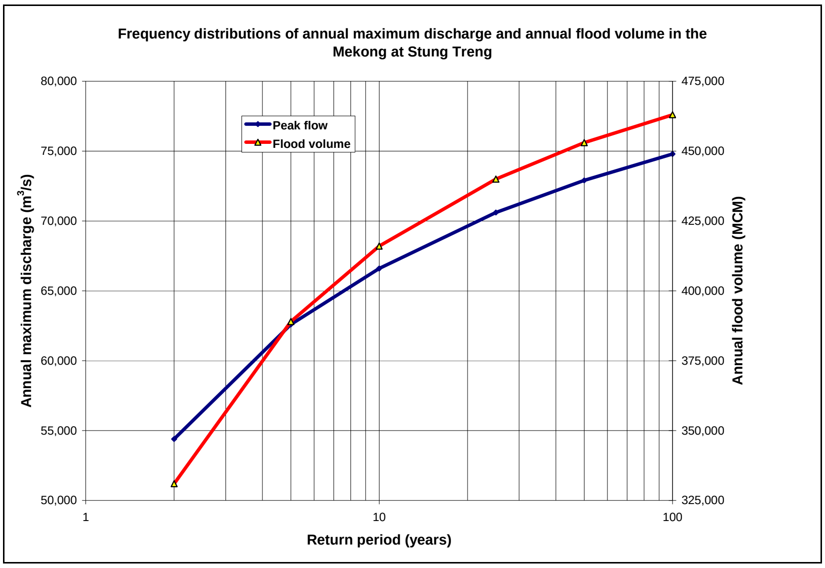


Figure 4.3 Frequency distributions of annual maximum discharge and flood volume in the Mekong at Stung Treng, Period 1910-2006

4.4 Tributary inflow to Great Lake

The area draining to Tonle Sap up to the highways 5 and 6 amounts 68,830 km^2. It comprises the drainage areas of 13 Stungs shown in Figure 4.4. Inflow series of daily discharges are available for the years 1997-2004. A multiple regression equation has been used for the generation of monthly tributary flow of month *i* as a function of the tributary flow in month i-1 (to preserve the serial correlation) and the flow at Stung Treng in the same month (to preserve the cross-correlation). A normally distributed random number was added to preserve the variance. Unlikely numbers beyond observed values for a month were eliminated. The frequency distribution of the generated flows (aggregated to annual flows) is shown in Figure 4.5. The monthly flows were next disaggregated to daily values based on their degree of resemblance with the observed years: daily values of observed years were scaled per month to the required generated value.

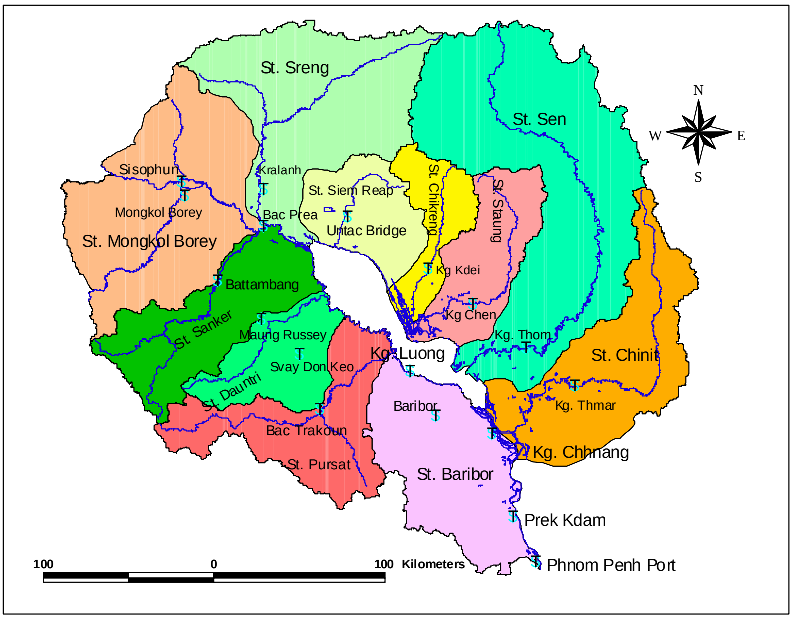


Figure 4.4 Tributaries draining to Great Lake

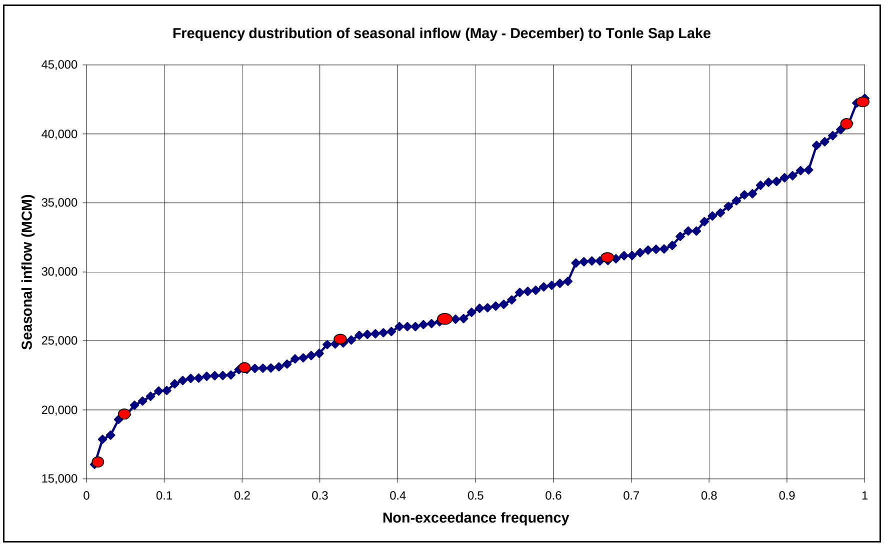


Figure 4.5 Frequency distribution of generated and observed (red dots) inflow to Great Lake

Figure 4.6 Ton Le Sap Lake as seen from the plane, looking in south-westerly direction. The lower part of the picture shows the Siem Reap river. On the upper right side the inflow of the combined Stung Sanker/Stung Sisophun/Stung Sreng is visible.

4.5 Tributary inflow to Mekong

Apart from the inflow to the Great Lake the Delta Model also requires inflow series for the tributaries Prek Te, Prek Chhlong, Prek Thnot, East Vaico River, and West Vaico River. The daily flow series for the period 1985-2006 are available from the DSF files created by the SWAT model. Since the SWAT-series show no correlation with the flow in the Mekong a pragmatic approach was used to extend the series by applying a block-wise repetition of the series 1985-2006 for the years 1910-1984.

4.6 Rainfall

Daily series of 9 locations in Cambodia and of 5 locations in Vietnam are required as input to the hydraulic model of the Mekong Delta. Data is available for the locations for the period 1985-2006. The annual maximum daily values generally are in the order of 100 to 150 mm, occasionally with larger values up to 400 mm in Can Tho in 1985. Analysis showed that seasonal rainfall at the selected locations hardly correlated with Tonle Sap inflow and not at all with the flow in the Mekong. Hence, a block-wise repetition of the series 1985-2006 was applied for the period 1910-1984.

4.7 Evaporation

For the same locations as rainfall is input into the model also evaporation data is required. For the locations in Vietnam daily series is available from 1985 onward with the exception of 2002. The series available for Cambodia are shorter. In case data is not available monthly averages have been applied, in view of the limited variability from year to year of potential evaporation in a particular month.

4.8 Water use

At 128 nodes in the network of the Delta model water is abstracted for agriculture, domestic and industrial use. The variation in the total abstraction varies from about 1400 m3/s in January till almost 0 m3/s at the end of September. The total annual abstraction amounts 16.5 BCM. During the flood season the demand is about 4.4 BCM in total, i.e an abstraction of less than 300 m^3/s, which is smaller then the error margin in the computed discharge from the Mekong.

4.9 Sea boundary

In total at 19 nodes water level boundaries are defined in the Delta Model. These boundaries are taken from hourly observations made at the 6 stations listed in Table 4.2.

Table 4.2 Overview of water level stations at sea boundaries

Station	River	Province	Remark
Rach Gia	Cai Lon	Kien Giang	Draining to Gulf of Thailand
Song Doc	Song Ong Doc	Ca Mau	-do-
Ganh Hao	Ganh Hao	Ca Mau/Bac Lieu	Draining to South China Sea
My Thanh	Bassac	Soc Trang/Tra Vinh	Draining to South China Sea
Ben Trai	Cua Cung Hau	Tra Vinh/Ben Tre	Southern Mekong outlet, draining to South China Sea
Vam Kinh	Cua Dai	Ben Tre/Tien Giang	Northern Mekong outlet, draining to South China Sea

The hourly observations used in the Delta Model are records of the year 2000. The characteristics of the series have been discussed in the previous chapter. This series is applied to all historical years from 1910 onward. It appears that the year 2000 slightly underestimates the range of water levels at the sea boundary. It was shown that the annual maximum daily maximum water levels are not correlated with the annual flood volume flowing into the delta. It implies that in the area influenced by the downstream boundary addition of the backwater difference between the year 2000 maximum and the long term average of the annual maximum will be sufficient. This difference at Tra Vinh is 1.69-1.62 = 0.07 m. This effect though has practically vanished in the river reaches bordering the Focal Areas.

5 Flood hazard assessment

5.1 General

5.1.1 Description of scenarios

For the management of floods and related risks in the Focal Areas in the Mekong Delta the following development scenarios have been considered:

[1] Base Case
The existing condition of land use and flood control levels in Cambodia and Vietnam.

[2] Scenario Cam0: flood protection in Cambodia
This scenario comprises of early flood protection and full flood protection in Cambodia according to recommendation in Stage 1, while no further development in Vietnam is assumed. The protection in Cambodia is as follows:

- Takeo (West Bassac)
  - Zones 1 and 3: full protection
  - Zone 2: early flood protection
- Prey Veng (East Mekong)
  - Zone 1: early flood protection
  - Zones 2 and 3: 1: 10 year flood protection (+free board)
  - Zone 4: no protection.

Early flood protection is defined as follows: based on the model simulation of the base case the annual maximum water level of the early flood season, which ends on August 1, is derived for the series of 97 years (1910-2006). Subsequently, the water level with a return period of 10 years, $h_{1Aug;\ 10}$, is derived from this series. So $h_{1Aug;\ 10}$, is the water level that is exceeded on average once in every 10 early flood seasons (1 May – 1 August). Early flood protection means that the crest height of the dikes are raised to the level of $h_{1Aug;\ 10}$. This means the probability of flooding in the early flood season is equal to 1/10 (10%).

[3] Scenario VNa flood protection in Vietnam, variant a
This scenario comprises of early flood protection and full flood protection in Vietnam.

- Long Xuyen Quidrangle
  - enlargement of canals,
  - no sluices along Bassac,
  - rubber dams open on the 1st of August
- Trans Bassac: full protection as at present
- Plain of Reeds: Canal enlargement

[4] Scenario Cam0VNa: flood protection in Cambodia and Vietnam
This is the combination of scenarios Cam0 and VNa

[5] Scenario diversion:
This is the scenario in which a Diversion to the Great Lake is built for early flood control

5.1.2 Outline

Section 5.2 describes the probabilistic method that has been applied to derive probabilities of exceedance for water levels for the various scenarios. The results for the base case are presented in Sub-section 5.3. The outcomes for the development scenarios [2] – [5] are dealt with in Sub-section 5.4 and are compared with the base case, to assess the effect of the measures. Subsection 5.5 describes the effects of scenario [6]. Finally, in Sub-section 5.6 the effect of sea level rise is analysed.

5.2 Probabilistic analysis

5.2.1 Annual maximum water levels

For the probabilistic analysis for the Mekong delta downstream of Kratie we make use of the fact that a relatively long series of observed and reconstructed discharges is available for the Mekong at location Stung Treng and also for the tributaries of the Mekong downstream and the tributaries of the Great Lake, see Appendix 9. The series, which cover the period 1910-2006, are used as boundary conditions for a hydrodynamic model (Isis) to derive a 97-year series of water levels in the flood-prone areas. The relevant statistics like probabilities of flooding and related damages can be derived directly from these series of water depths as will be demonstrated in this section.

This approach can be considered as a special case of the crude Monte Carlo simulation technique (see appendix 10). Generally, in Monte Carlo analysis a long series of all random variables is generated by taking samples from their respective distribution functions. In this case (reconstructions of) actual observations are used. Then, as in crude Monte Carlo analysis, for each sample (year) maximum water levels and flood damages are derived. From these series, exceedance probabilities of maximum water levels and flood damages are derived, using Gringortens formula:

$$p_i = \frac{r_i - 0.44}{N + 0.12} \tag{5.1}$$

where:
p_i = probability of exceedance of the annual maximum water level in year *i*
N = total number of years
r_i = rank number of the maximum water in year *i* (1 = highest, n = lowest)

The annual maximum level in a large number of model output nodes (3445) was derived and analysed. Figure 5.1 shows an example of the results for a single node. It shows annual maximum water levels plotted against year of occurrence (above) and estimated probability of exceedance (below).

The observations in Figure 5.1 are connected by a red dotted line, which assumes the relation between the logarithm of the exceedance probability and the water level to be linear in between observations. This line is used to derive the water level for return periods of 2, 5, 25 and 100 years.

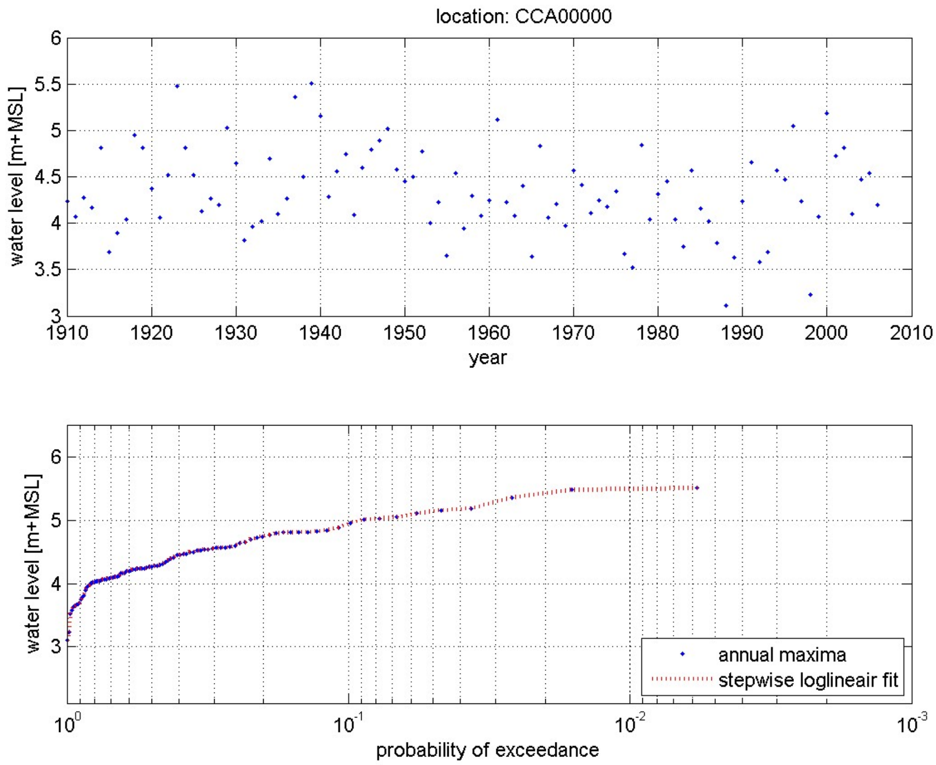


Figure 5.1 Derived annual maximum water levels at output node CCA0000 plotted against year of occurrence (above) and estimated probability of exceedance (below).

Since the series of annual maxima is close to 100 years, the estimated 100-year water level is by definition approximately the same as the maximum observed water level. This can be seen in Figure 5.1, where the red line crosses the 10^{-2} – probability line at approximately the same level as the blue dot to the far right (the maximum observed water level). The estimated 100-year water level in this case is equal to MSL+5.49 m, the maximum observed water level is equal to MSL+5.51. Figure 5.2 compares the estimated 100-year water level with the observed maximum water level for all 3445 locations. All locations are very close to the line x=y, showing the difference between the 100-year water level and the observed maximum water level is small. For 7 locations the difference is more than 20 cm, which may be suspicious. A closer look, however, revealed that there seems to be nothing wrong with these locations. These are just examples of cases where the highest annual maximum water level differs significantly from the second highest annual maximum water level. These 7 locations are all in the same area and the years of occurrence of the highest and second highest annual maximum are the same for all locations.

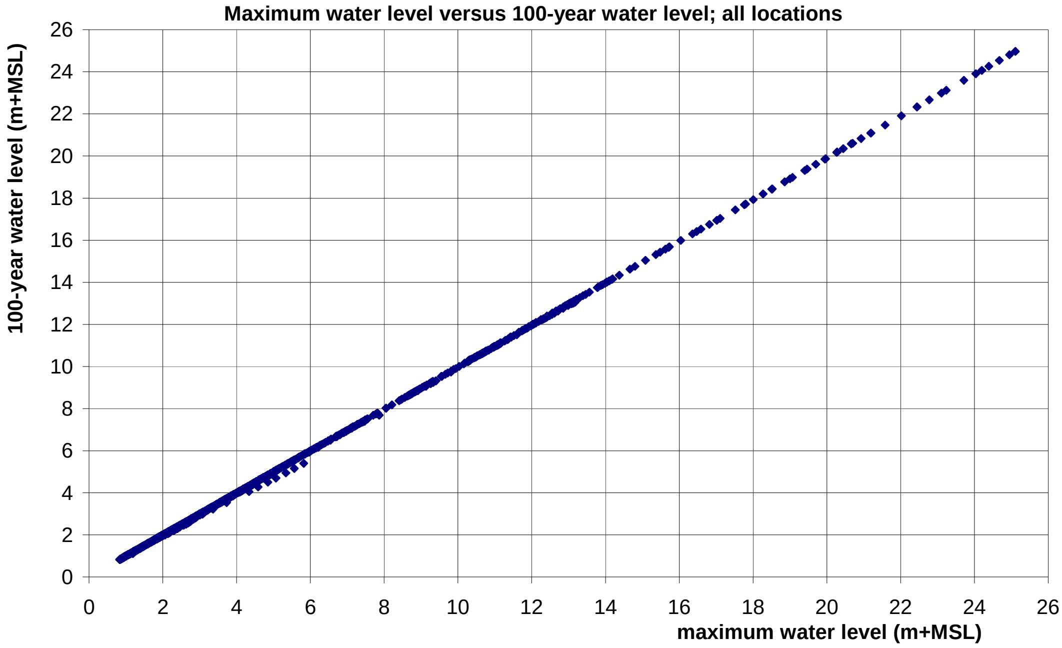


Figure 5.2 Comparison of the derived 100-year water level (horizontal axis) and the maximum water level in the period 1910 – 2006 at 3445 locations all over the lower Mekong basin.

For the remainder of the analysis it is relevant to know what causes the highest water levels to occur at the various locations. Of course, in this area the discharge of the Mekong river is the main driving force, but we need to identify the years and the corresponding flow conditions that lead to high water levels. Furthermore, it is relevant to know whether or not this varies from location to location, i.e. at some locations the peak discharge may be most relevant, whereas for other locations high flow volume might be the number 1 cause of high flood levels.

Table 5.1 shows the years in the period of 1910-2006 in which extremely high water levels occurred at a relatively large amount of locations (model nodes). The table shows years that are ranked highest, second highest or third highest at a relatively large amount of many locations. The numbers should be interpreted as follows: e.g. in 1228 model nodes the maximum water level was highest over the period 1910-2006 in the year 1939. And in 1068 model nodes the water level was third highest over the period 1910-2006 in the year 1937.

Table 5.1 Years with highest, second highest or third highest water levels over the period 1910-2006 in a relatively large amount of locations. E,g in 1228 model nodes the maximum water level was highest over the period 1910-2006 in the year 1939.

highest peak		second highest peak		third highest peak	
year	# locations	year	# locations	year	# locations
1939	1228	1923	833	1937	1068
1937	834	1937	458	1961	383
1952	372	1996	410	1923	324
1996	293	1939	378	2000	316

For each year in the period 1910-2006 the annual peak discharge and annual flow volume of the Mekong river at Stung Treng was derived. The flow volume in this analysis is defined as the total flow above a threshold discharge of 25.000 m^3/s, the latter being approximately the flow capacity of the Mekong river near Phnom Penh. Figure 5.3 shows a scatter plot of volumes vs. peak discharges. It shows, not surprisingly, there is a positive correlation between volume and peak discharge.

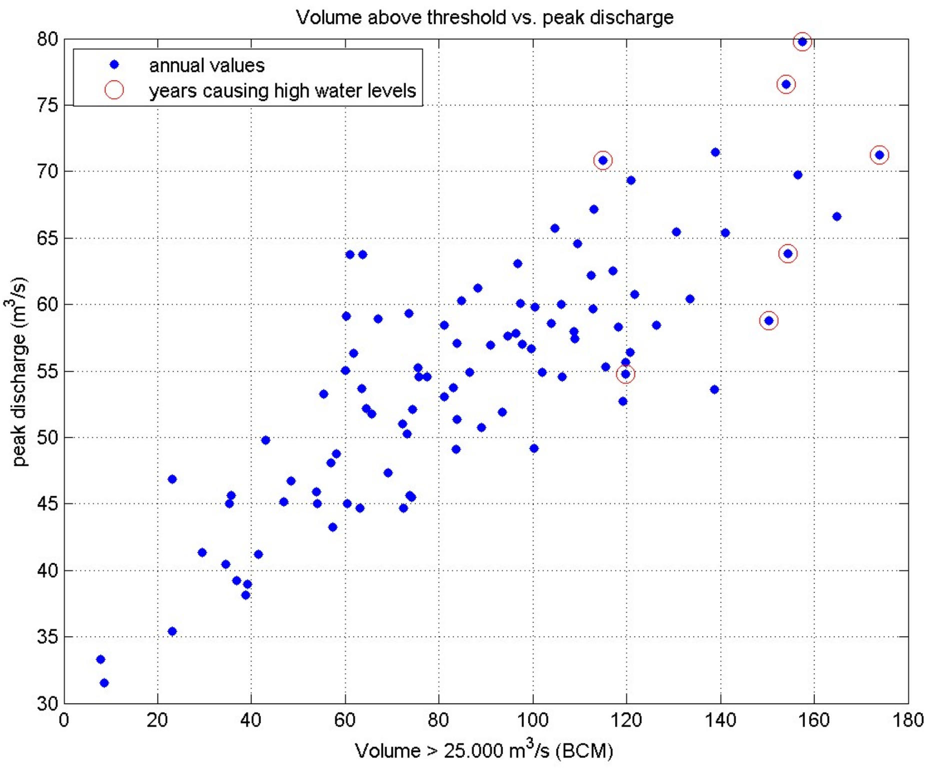


Figure 5.3 Volume of flow above the threshold of 25.000 m^3/s versus peak discharge

The seven years of Table 5.1 (1923, 1937, 1939, 1952, 1961, 1996 and 2000) are circled in red in Figure 5.3. These red circles are generally in the upper right corner of the figure, confirming the fact that a combination of high flow volume and high peak discharge in the Mekong River leads to high water levels in the flood-prone areas. In order to find out which one of those two is the most relevant variable, scatter plots were produced in which both variables were plotted against water levels in the flood-prone areas. Figure 5.4 shows the scatter plot of the annual flow volume in the Mekong versus the annual maximum water level at model node BAT39000. Figure 5.5 shows a similar plot for the peak discharge. Both figures clearly show a positive correlation as can be expected. The correlation for the flow volume is significantly stronger than for the peak discharge. This is a very typical example, correlations like these are found at many model nodes. This indicates that the flow volume is more relevant than the peak discharge with respect to generation of high water levels in the flood prone areas.

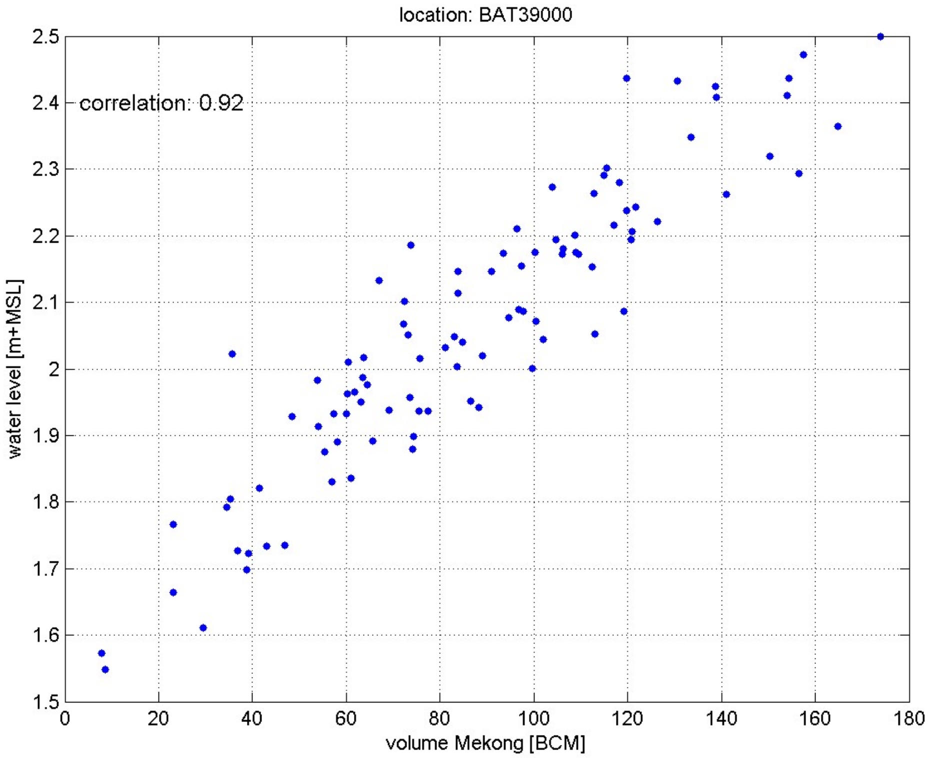


Figure 5.4 Annual flow volumes (BCM) in the Mekong river at Stung Treng above a threshold discharge of 25,000 m^3/s versus annual maximum water level at model node BAT39000.

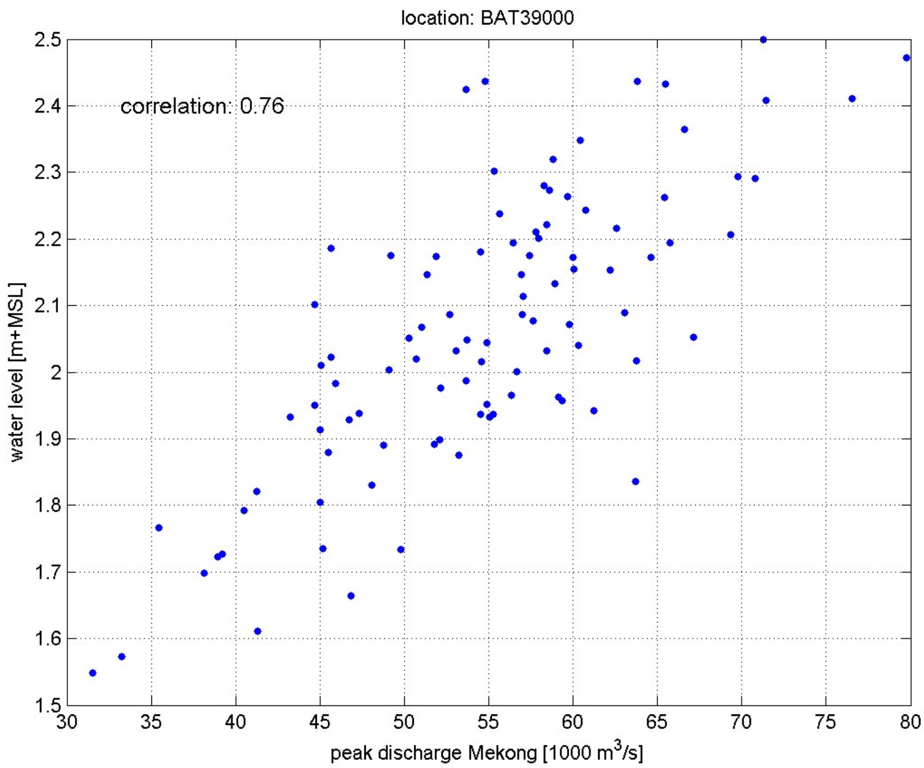


Figure 5.5 Annual peak discharges (1000 m^3/s) in the Mekong river at Stung Treng versus annual maximum water level at model node BAT39000.

5.2.2 Maximum water levels in the early flood season

The previous pages describe the probabilistic analysis for the annual maximum water level in flood plain areas. For agriculture, the maximum water level during the early flood season (1 May - 1 August) is generally more relevant than the annual maximum water level. If the area is flood free during the early flood season, the crops can be safely harvested. For agriculture, a flood hazard assessment for the early flood season is required as well. The procedure for this is similar to the procedure of section 5.2.1. The only difference is that the maximum water level in the period (1 may – 1 August) is derived for each year in the period 1910-2006, instead of the annual maximum water level.

5.2.3 Fitted function

For practical purposes it is convenient to derive a fit for the relation between water level and its corresponding probability of exceedance. These fitted functions are used to derive the annual expected damage (Appendix 2). Analysis showed that the shifted exponential function is generally a good description of this relation:

$$h(p) = ae^{bp} + c \qquad (5.2)$$

where:

h	= water level
p	= probability of exceedance
a,b,c	= fit parameters
e	= 2.718282 …

The parameters a,b,c, are location specific and based on fits of the available data from simulations with Isis. Figure 5.6 shows an example of a fitted function.

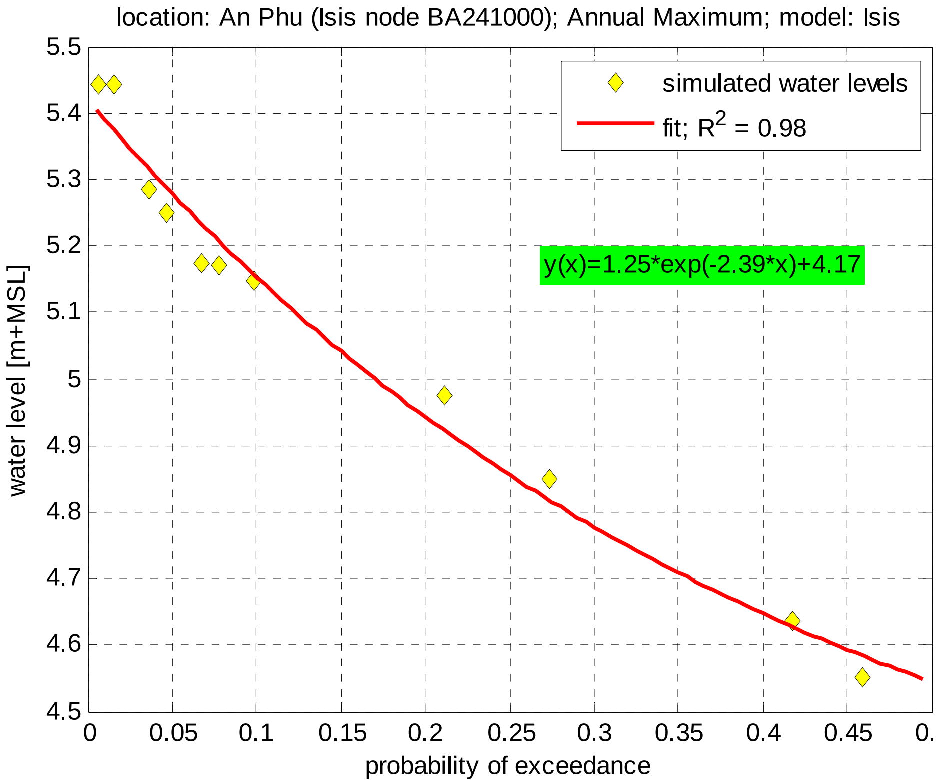


Figure 5.6 Fitted function of probability of exceedance for water levels for location An Phu; Base case.

In some cases the shifted exponential function is not good description of the relation between water level and probability of exceedance. This is mainly the case for locations for which water levels with low probabilities of exceedance are much higher than the more regularly occurring water levels. In these cases the power function is a very good alternative:

$$h(p) = ap^b + c \qquad (5.3)$$

5.3 Resulting flood maps for the Base Case

Flood frequency curves like Figure 5.1 were derived for all 3445 output nodes of the hydraulic model. The water levels for 2, 5, 10, 25 and 100 years were subsequently compared with ground elevation to determine flood depth and extent. Flood hazard maps for the base case and te scenarion for Cambodia for flood protection in the West Bassac area andd East Mekiong area are included in Attachment 1. The Attachment show shows maps for various probabilities, for example the 100-year water level, for the entire Mekong delta, based on analysis for the *entire* flood season, as well as for the *early* flood season. Annual maximum water levels generally occur in the period August – November, so the maximum water level in the early flood season is generally significantly lower than the annual maximum water level.

It is very important to realise that the maps do not show the water levels that occur during a single extreme event and are therefore made up of highest water levels from several years combined.

5.4 Results for development scenarios [2]-[4]

5.4.1 Hydraulic model output

Each scenario as described in section 5.1.1 is simulated with the Isis Delta model to compare resulting water depths and water levels with those derived for the base case. The effects of the scenarios on water levels are analysed in detail for 59 locations, each representative of one of the 59 districts in the Delta area. Of these 59 districts, 34 are located in Vietnam and 25 in Cambodia. Furthermore, also the effect on water levels along the Mekong and Bassac will be described in the remainder of this report.

It is noted that in the available hydraulic model of the Mekong Delta the density of the network is insufficient for detailed simulation of flooding under the Scenarios 2 and 3 in Takeo and to a lesser extent in Prey Veng. Consultants requested in April 2008 for a denser network in those areas to the modelling team responsible for the recalibration (see Appendix 7). This adaptation was carried out late 2008 and early 2009 but the number of extended cross sections and reservoirs remain by far insufficient. As a consequence, we were unable to find proper representative locations for a number of districts in the West Bassac and East Mekong, particularly in the flood plains of the northern part Takeo Area and to a lesser extent in Prey Veng.

5.4.2 Estimating flood hazards from 11 simulated years

Instead of running the hydraulic model for the above scenarios for the full 97 flood seasons, only 11 selected years (1918, 1923, 1927, 1929, 1939, 1940, 1971, 1994, 1996, 2000 and 2001) were simulated in order to save valuable computation time. The years were selected in such a way that they represent the range from moderate to extreme years in terms of Mekong flows and, consequently, flood depths. However, the ranking of years in terms of high water levels differs for different locations, so it is not possible to award a specific exceedance frequency to a specific year without knowing which location is involved. Therefore, for each location separately the following procedure was applied:

1. For each of the 11 years the water level in the base case (scenario [1]) is derived (either annual maximum water level or maximum water level up to August 1)

2. The frequency of exceedance of the 11 years for the specific location is derived, based on the water level of step 1.
3. Water levels of the base case and the scenario are compared for the selected 11 years (see e.g. Figure 5.7). The water levels are plotted against the derived frequencies of step 2 to see if the change in water level is different for floods of different magnitudes.
4. The water levels with probability of exceedance of 50%, 20%, 10%, 4%, 2% and 1% (i.e. return periods of 100, 50, 25, 10, 5 and 2 years) are derived from the water levels of the 11 simulated years through interpolation.
5. A fit of the relation between water level and corresponding probability of exceedance is derived (see e.g. Figure 5.8), which can be used to derive expected annual damages.

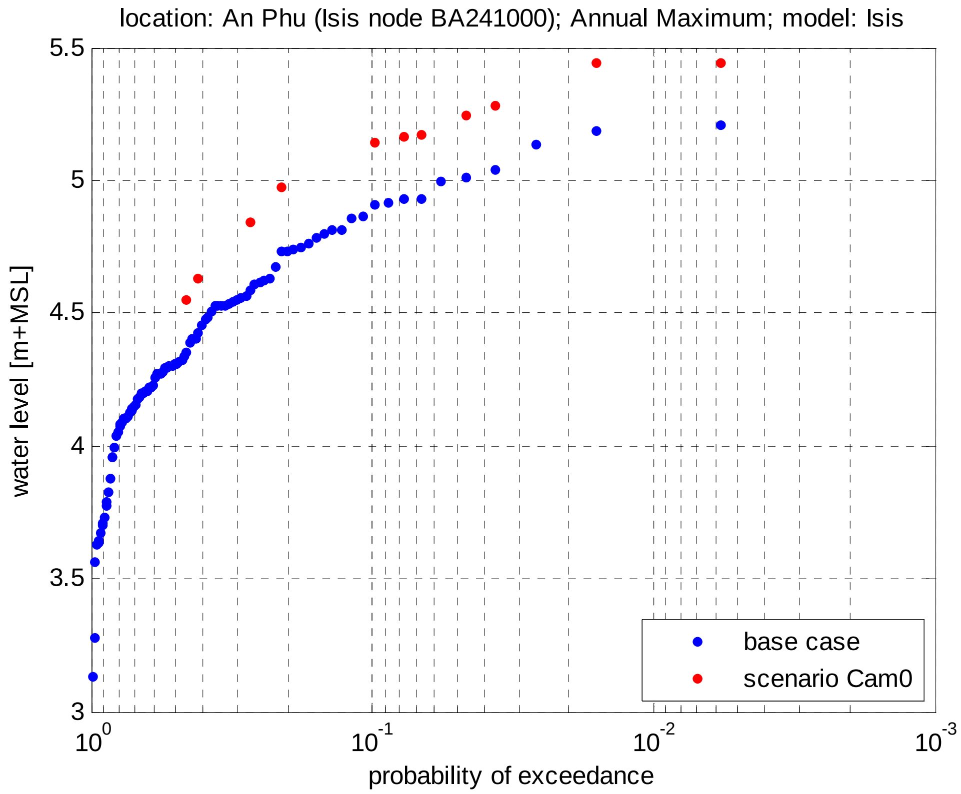


Figure 5.7 Exceedance frequencies of annual maximum water levels of 97 in the base case (blue dots) compared to water levels in 11 selected years.

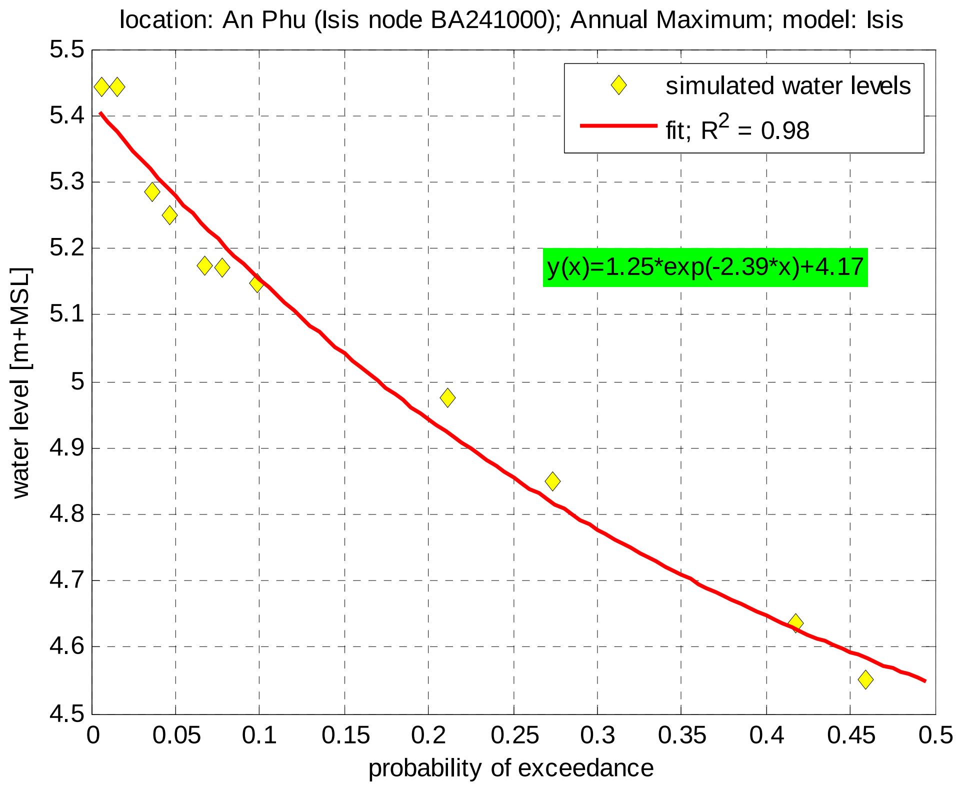


Figure 5.8 Fitted function of probability of exceedance for water levels for location An Phu; scenario Cam0

The fact that for the scenario's the results of only 11 simulation years are used may means that the derived water levels for a given probability of exceedance are less accurate than for the base case for which 97 years have been simulated. In other words; the outcome based on 11 years is an approximation of the outcome that would have been obtained if the full 97 years would have been simulated. In order to find out what the magnitude is of the error which is introduced by this approximation, a comparison is made between the results based on 97 years and 11 years respectively. This comparison is executed for the base case, since that is the only scenario for which the full set of 97 years have been simulated. Figure 5.9 compares the resulting 100-year water levels for 59 locations. For all locations the approximation (vertical axis) is very close to the initial result based on 97 years (horizontal axis), because all points are close to the line y=x. The maximum difference between the two is 0.12 m. This means the error introduced with the approximation method is small.

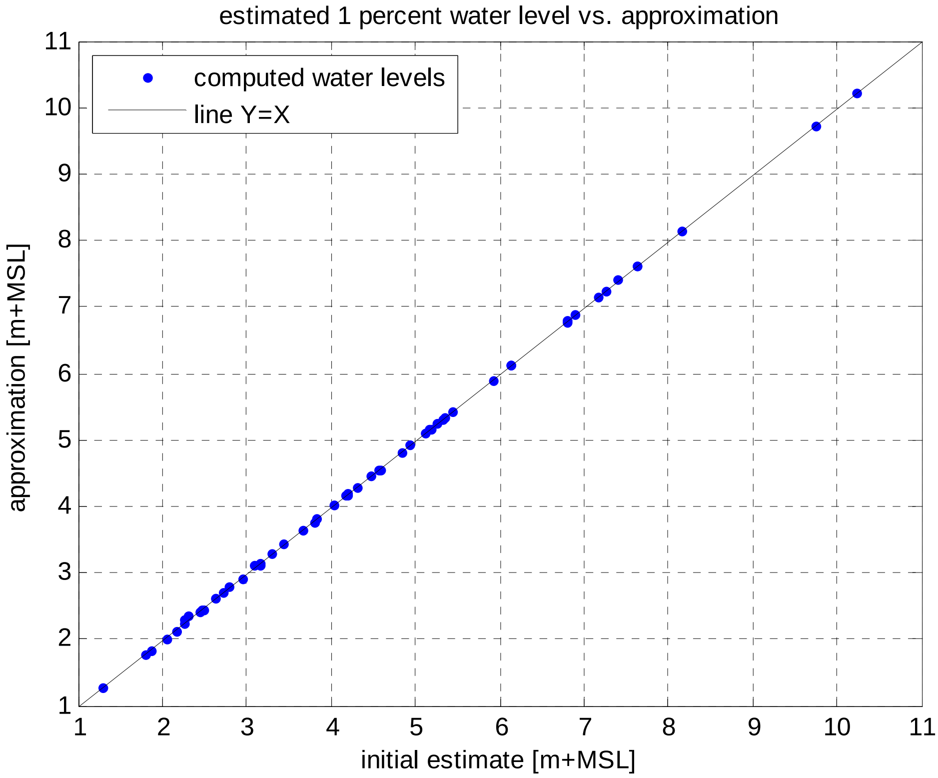


Figure 5.9 Comparison of the estimated 1%-water level (i.e. the 100 year water level) based on 97 simulated years (horizontal axis) and the approximated estimate based on 11 simulated years (vertical axis). The comparison is made for the 59 selected locations.

5.4.3 Results for scenario [2] – Cam0

The water levels with probability of exceedance of 50%, 20%, 10%, 4%, 2% and 1% for this scenario are compared with the corresponding water levels for the base case. Figure 5.10 and Figure 5.11 show the differences with the base case for the 25 locations in Cambodia and 34 locations in Vietnam respectively. As can be seen there is no consistent pattern. For 16 out of 25 locations in Cambodia the water level decreases as a result of the measures of scenario Cam0, for 8 locations the water levels increases and for one location (Preah Sdech) both increases and decreases are observed. Of the 34 Vietnamese locations, 11 show an increase in water levels, 13 show a decrease in water levels and 10 show hardly any change at all. So for some locations the annual expected damages will increase as a result of the measures of scenario Cam0 and for some locations the water levels will decrease. This will be quantified in Appendix 2.

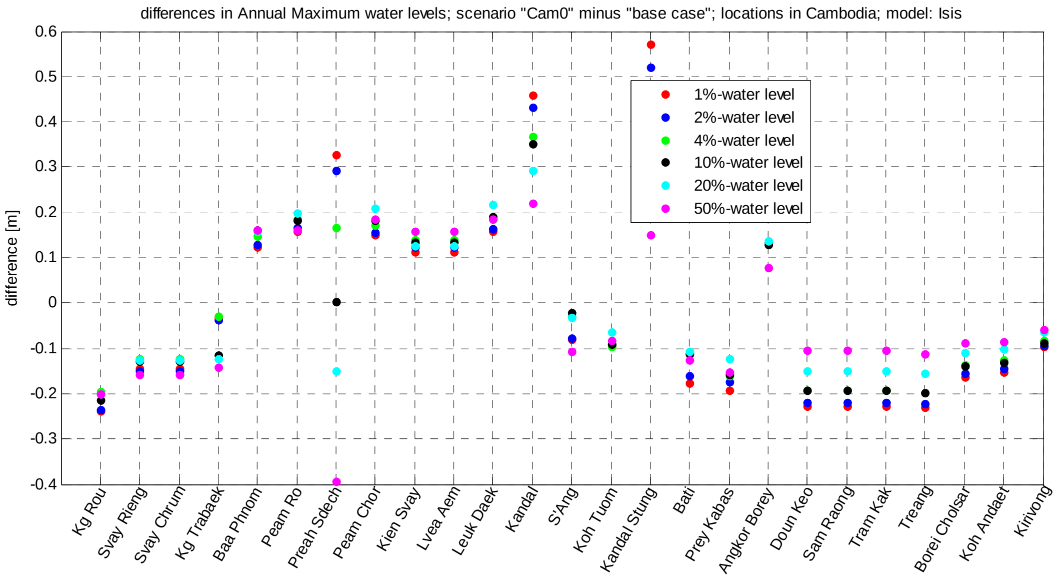


Figure 5.10 Change in the p-percent annual maximum water level (p=1, 2, 4, 10, 20 and 50) for 25 locations in **Cambodia**; comparison of scenario **Cam0** with the base case. Positive values indicate an increase in water level.

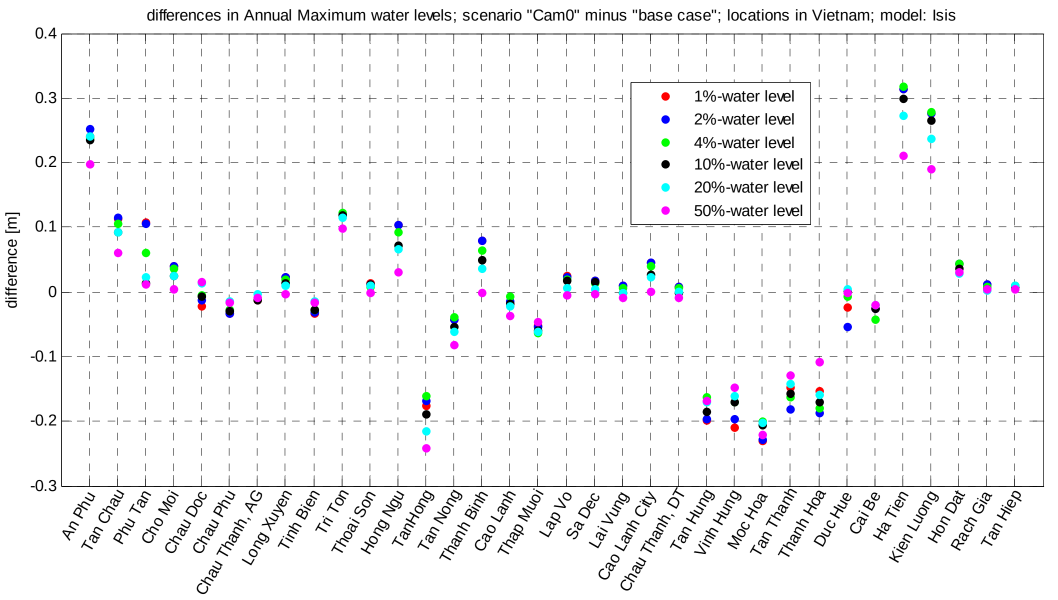


Figure 5.11 Change in the p-percent annual maximum water level (p=1, 2, 4, 10, 20 and 50) for 34 locations in **Vietnam**; comparison of scenario **Cam0** with the base case. Positive values indicate an increase in water level.

Figure 5.12 - Figure 5.15 compare water levels in the Mekong and Bassac rivers for the base case and scenario Cam0. Most noteworthy is the fact that the scenario leads to a reduction in water levels over some stretches of the Bassac river.

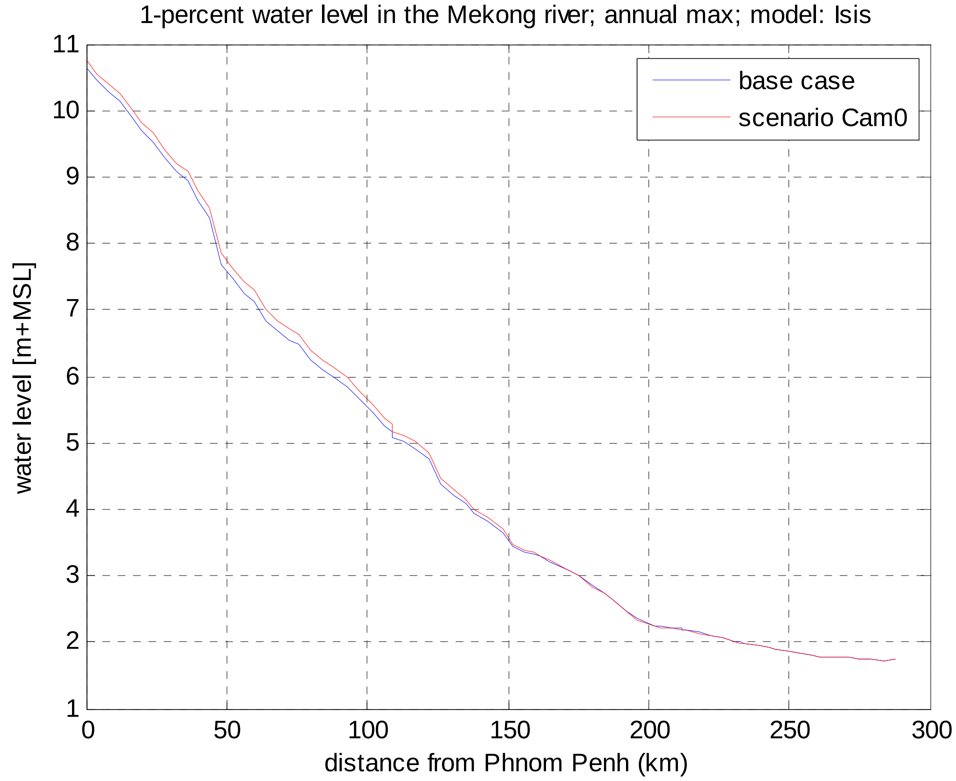


Figure 5.12 Water levels in the **Mekong** river downstream of Phnom Penh; comparison between the base case and scenario **Cam0**.

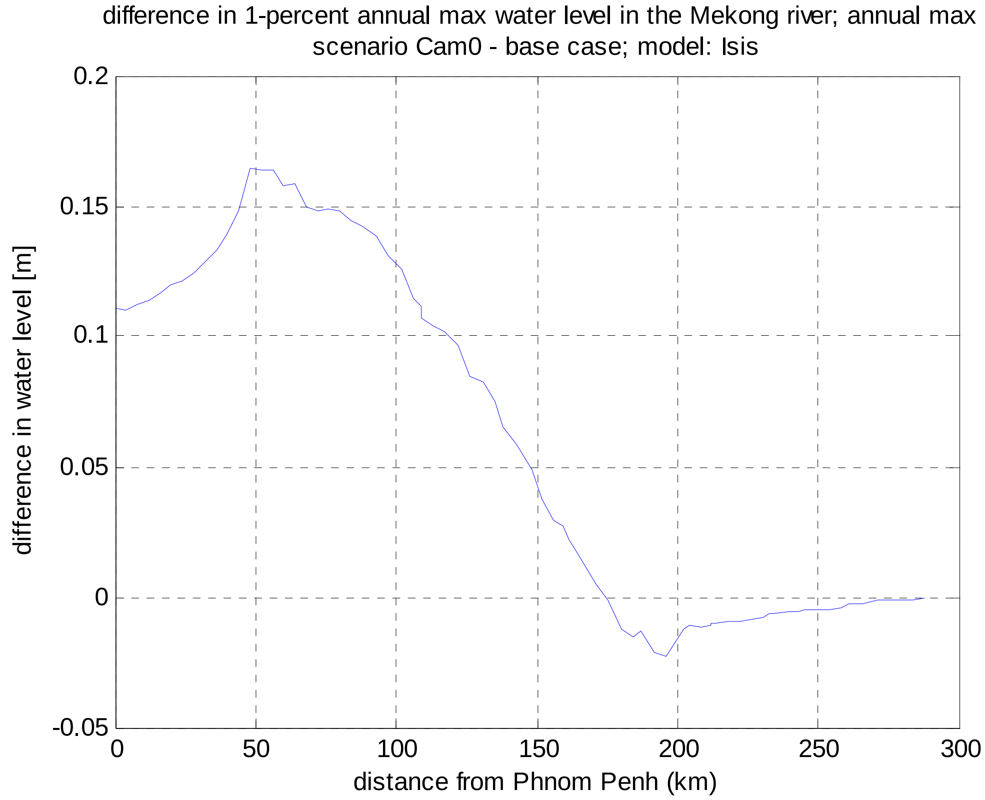


Figure 5.13 Increase in water level in the **Mekong** river downstream of Phnom Penh as a result of scenario **Cam0** (differences between the two cases of Figure 5.12).

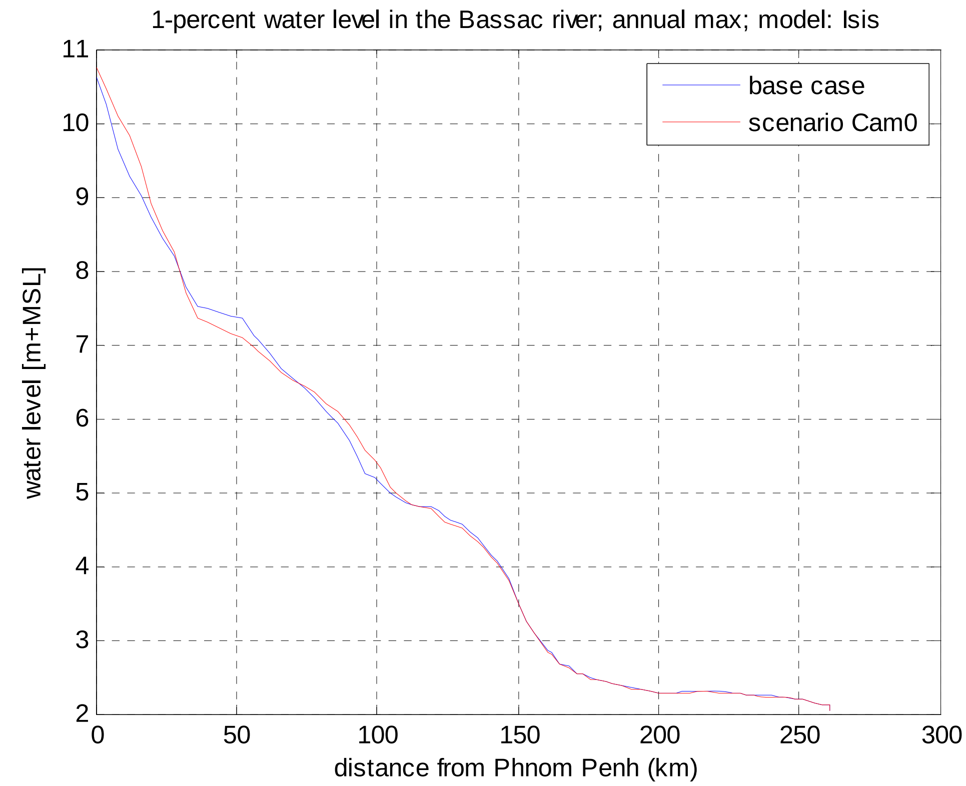


Figure 5.14 Water levels in the **Bassac** river downstream of Phnom Penh; comparison between the base case and scenario **Cam0**.

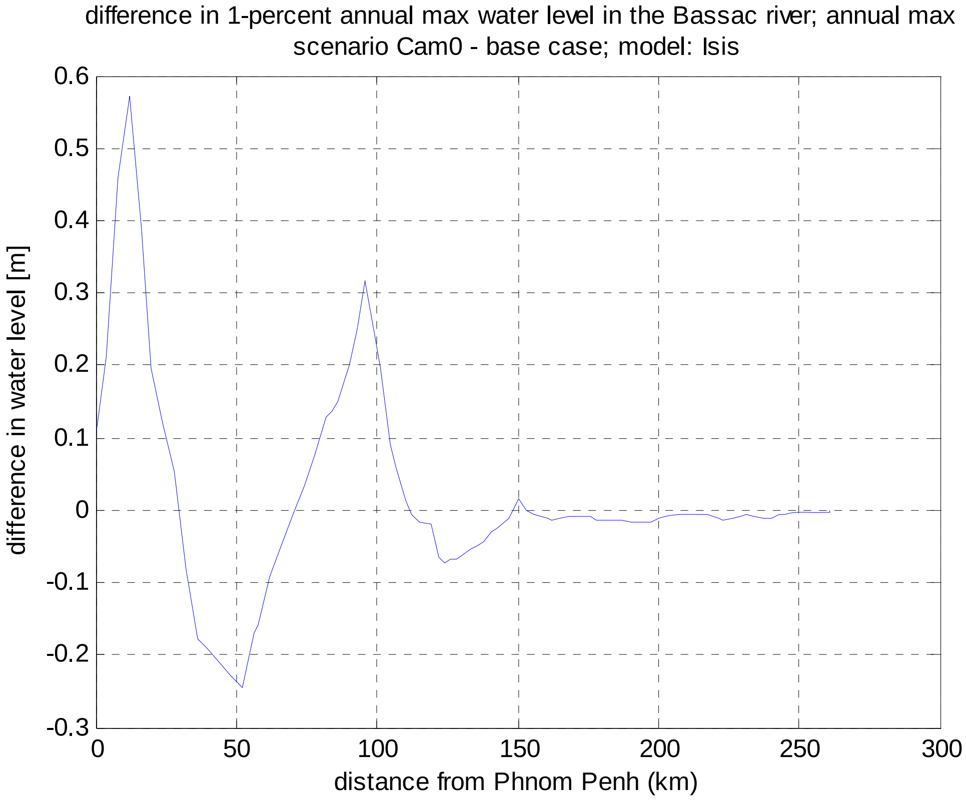


Figure 5.15 Increase in water level in the **Bassac** river downstream of Phnom Penh as a result of scenario **Cam0** (differences between the two cases of Figure 5.14).

5.4.4 Results for Scenario [3] – VNa

Figure 5.16 and Figure 5.17 show the differences in water levels between scenario VNa and base case for the 25 locations in Cambodia and 34 locations in Vietnam respectively. Again, for some locations the water levels increase as a result of the measures of scenario VNa, while for other locations the water levels decrease. All Cmabodian locations show an increase in water level. Figure 5.18 - Figure 5.21. compare water levels with probabilities of exceedance of 1% in the Mekong and Bassac rivers for the base case and scenario VNa

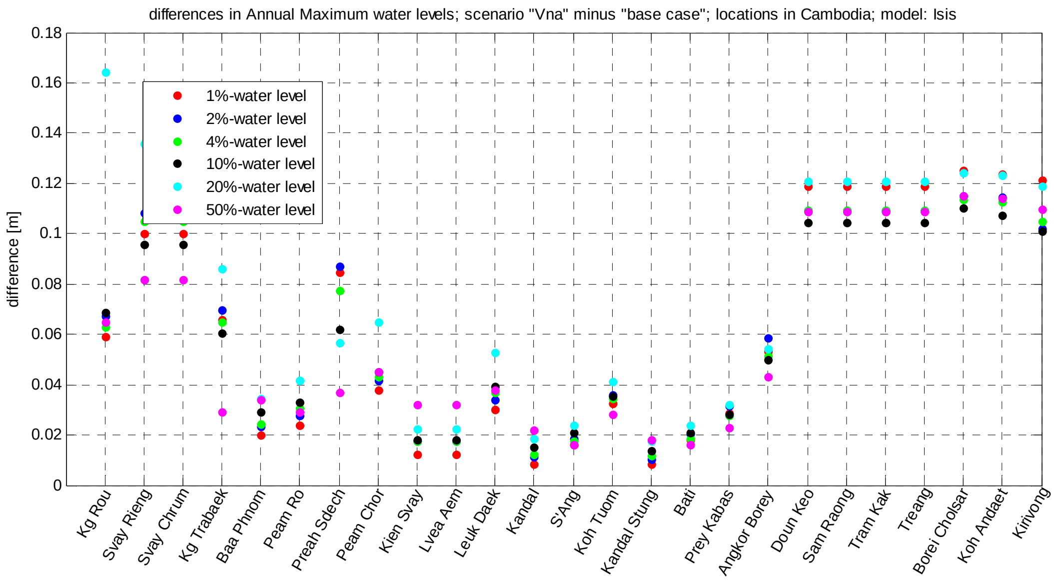


Figure 5.16 Change in the p-percent annual maximum water level (p=1, 2, 4, 10, 20 and 50) for 25 locations in **Cambodia**; comparison of scenario **VNa** with the base case. Positive values indicate an increase in water level.

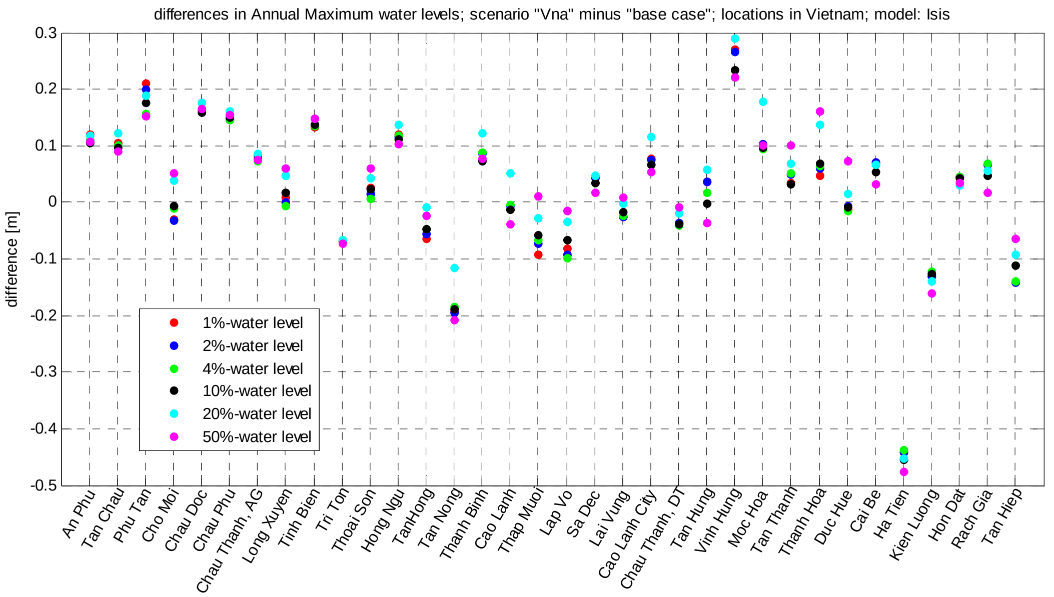


Figure 5.17 Change in the p-percent annual maximum water level (p=1, 2, 4, 10, 20 and 50) for 34 locations in **Vietnam**; comparison of scenario **VNa** with the base case. Positive values indicate an increase in water level.

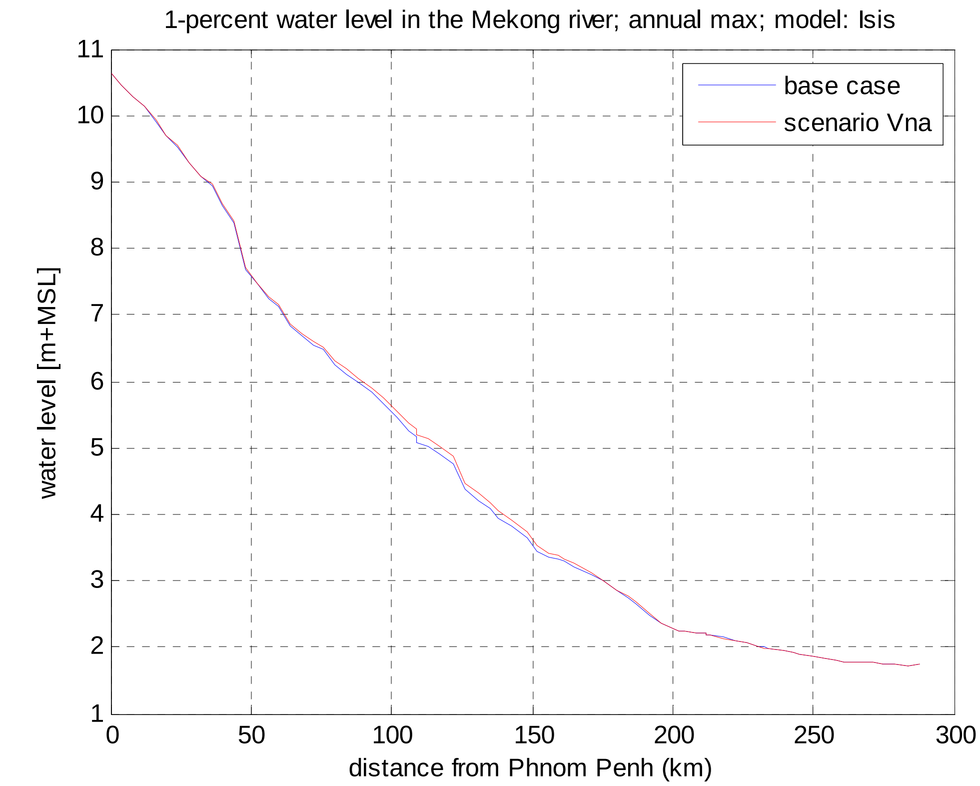


Figure 5.18 Water levels in the **Mekong** river downstream of Phnom Penh; comparison between the base case and scenario **VNa**.

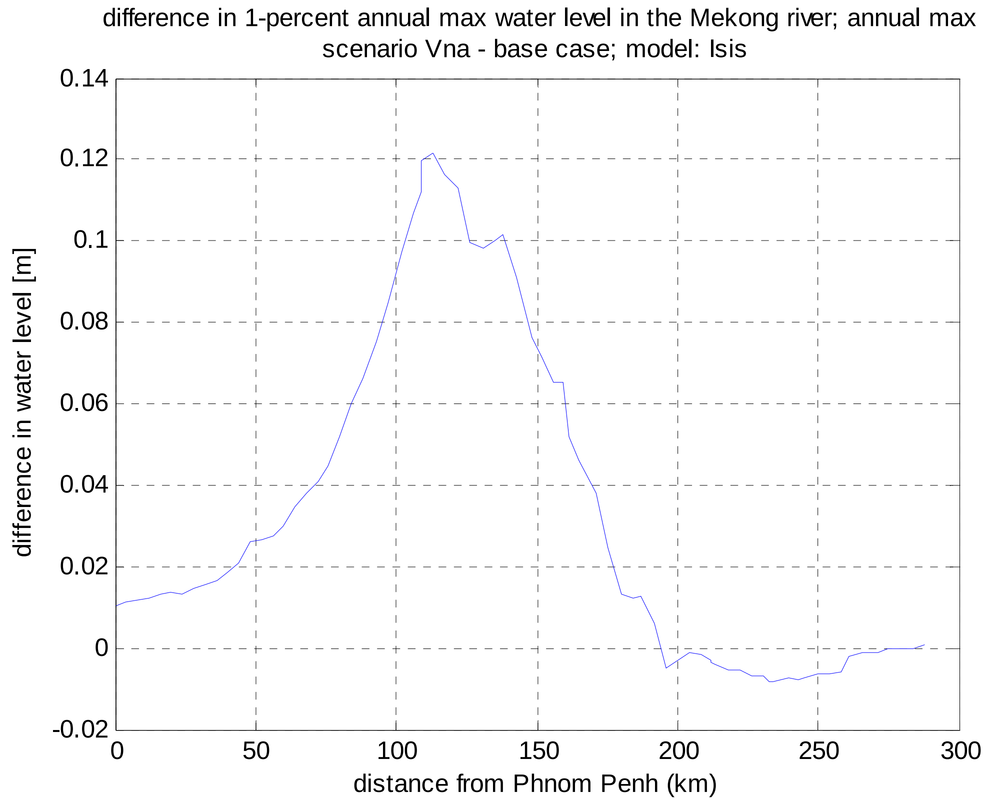


Figure 5.19 Increase in water level in the **Mekong** river downstream of Phnom Penh as a result of scenario **VNa**.

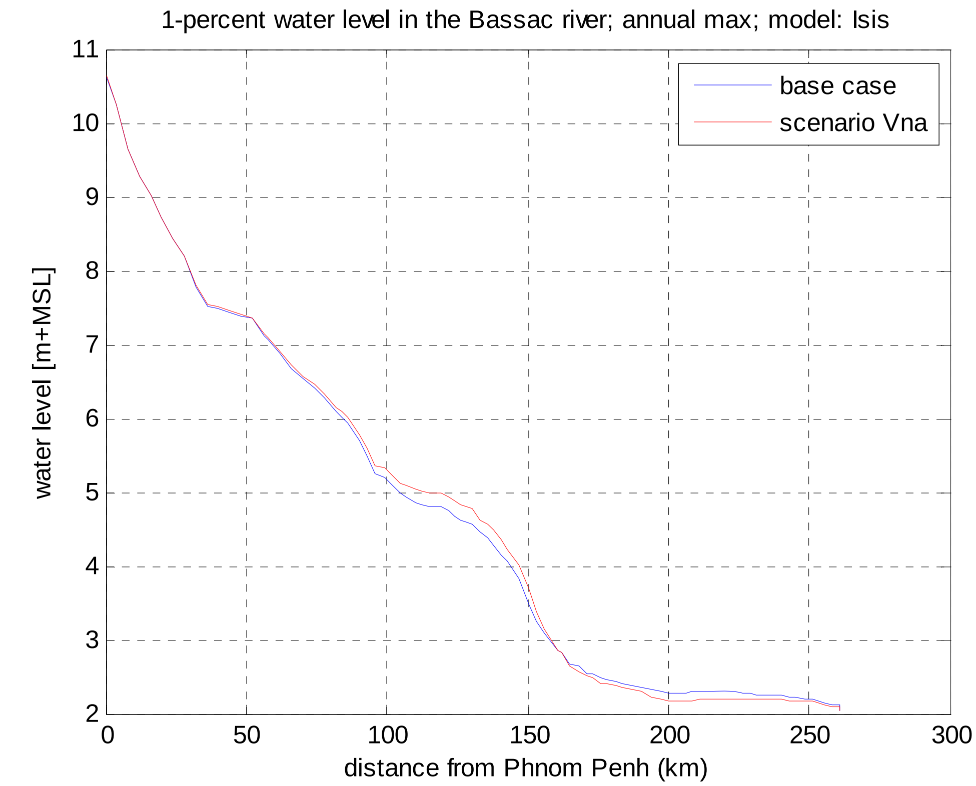


Figure 5.20 Water levels in the **Bassac** river downstream of Phnom Penh; comparison between the base case and scenario **VNa**.

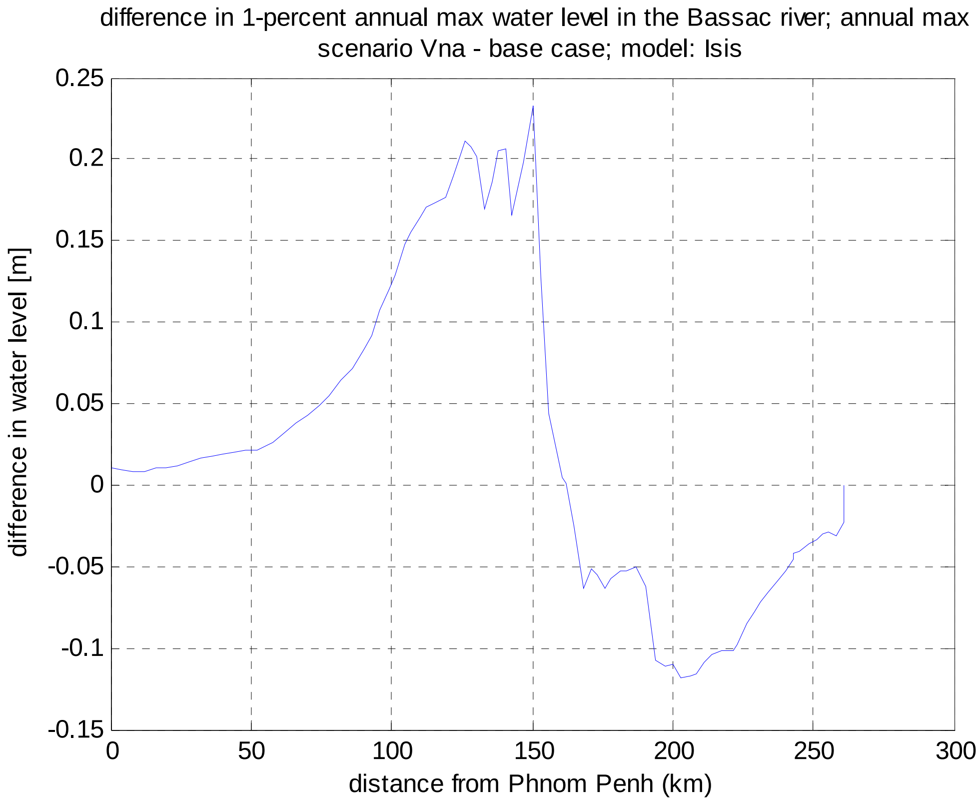


Figure 5.21 Increase in water level in the **Bassac** river downstream of Phnom Penh as a result of scenario **VNa**.

5.4.5 Results for Scenario [4] – Cam0VNa

Figure 5.22 and Figure 5.23 show the differences in water levels between scenario Cam0VNa and base case for the 25 locations in Cambodia and 34 locations in Vietnam respectively. Again, for some locations the water levels increase as a result of the measures of scenario Cam0VNa, while for other locations the water levels decrease. Figure 5.24 - Figure 5.27 compare water levels with probabilities of exceedance of 1% in the Mekong and Bassac rivers for the base case and scenario Cam0VNa.

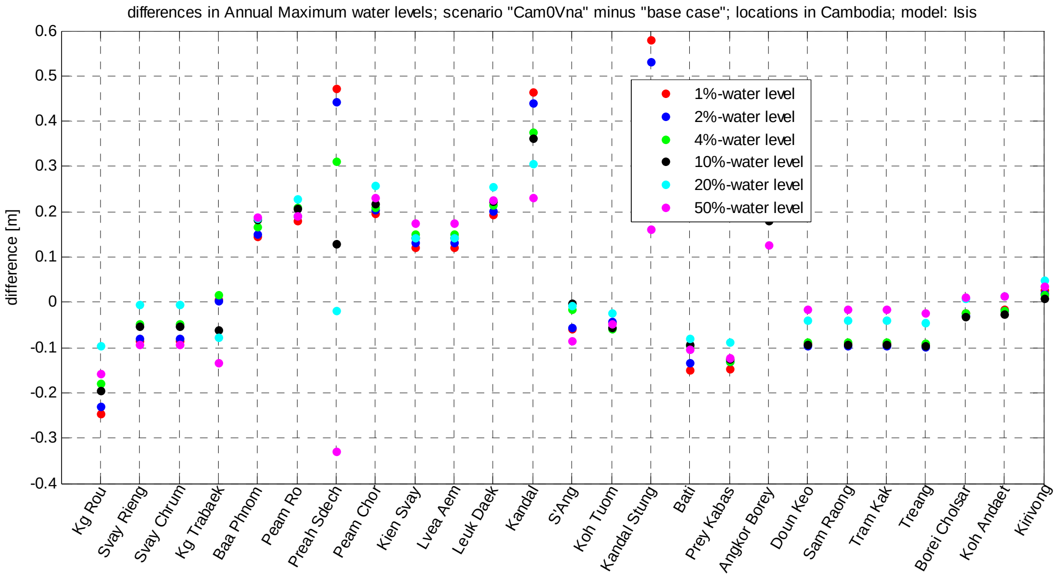


Figure 5.22 Change in the p-percent annual maximum water level (p=1, 2, 4, 10, 20 and 50) for 25 locations in **Cambodia**; comparison of scenario **Cam0VNa** with the base case. Positive values indicate an increase in water level.

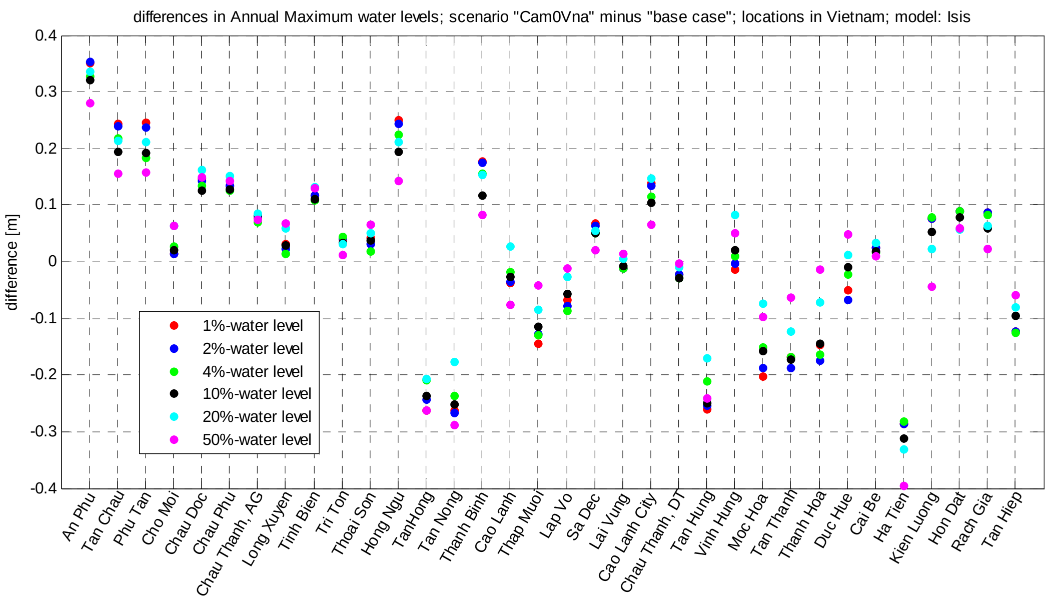


Figure 5.23 Change in the p-percent annual maximum water level (p=1, 2, 4, 10, 20 and 50) for 34 locations in **Vietnam**; comparison of scenario **Cam0VNa** with the base case. Positive values indicate an increase in water level.

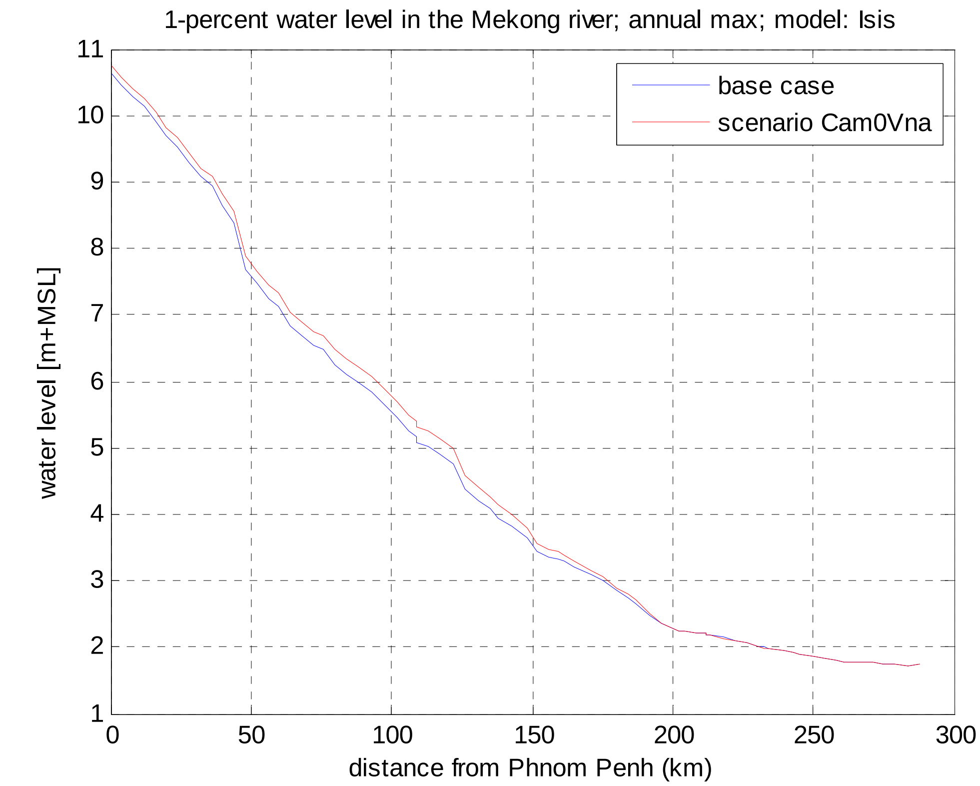


Figure 5.24 Water levels in the **Mekong** river downstream of Phnom Penh; comparison between the base case and scenario **Cam0VNa**.

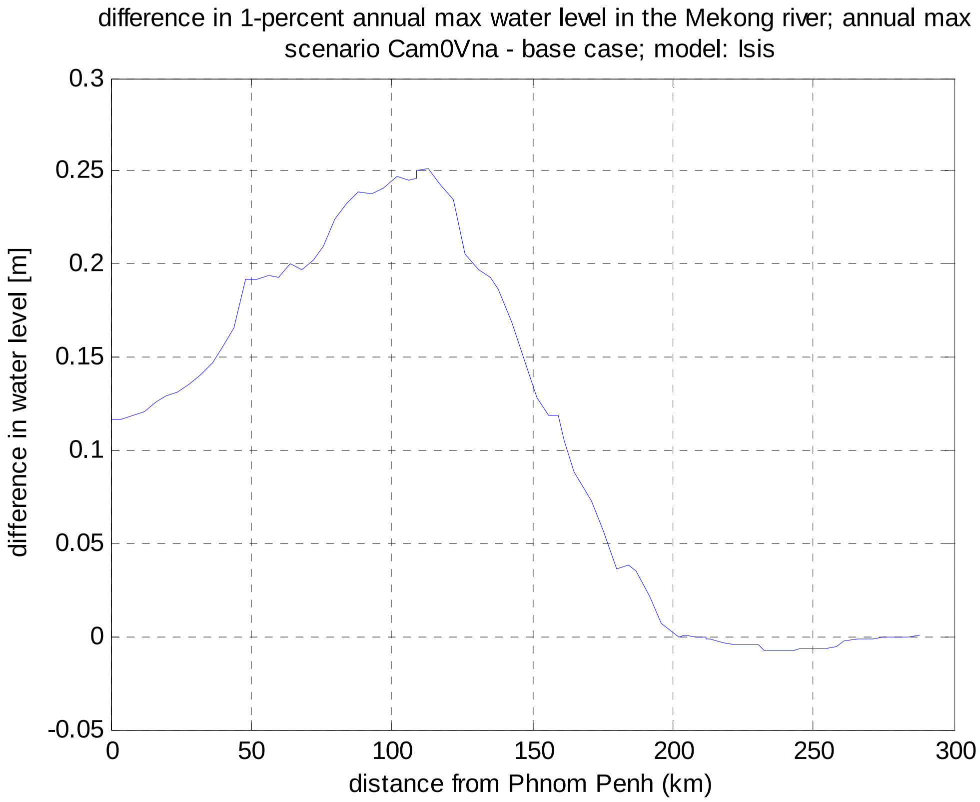


Figure 5.25 Increase in water level in the **Mekong** river downstream of Phnom Penh as a result of scenario **Cam0VNa**.

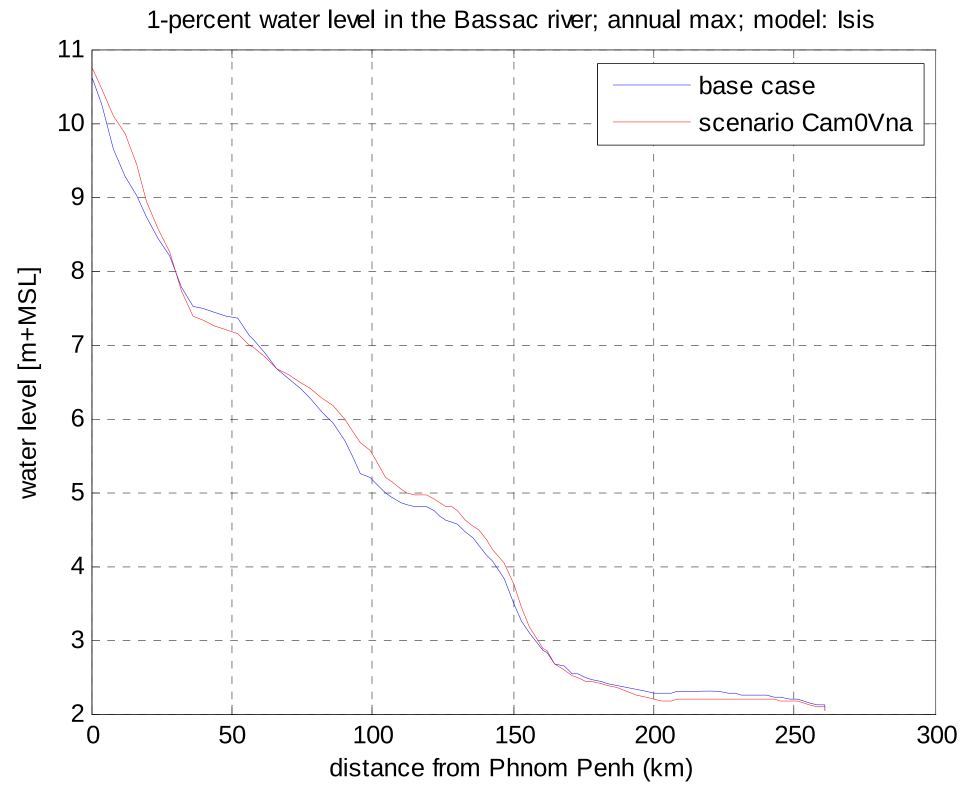


Figure 5.26 Water levels in the **Bassac** river downstream of Phnom Penh; comparison between the base case and scenario **Cam0VNa**.

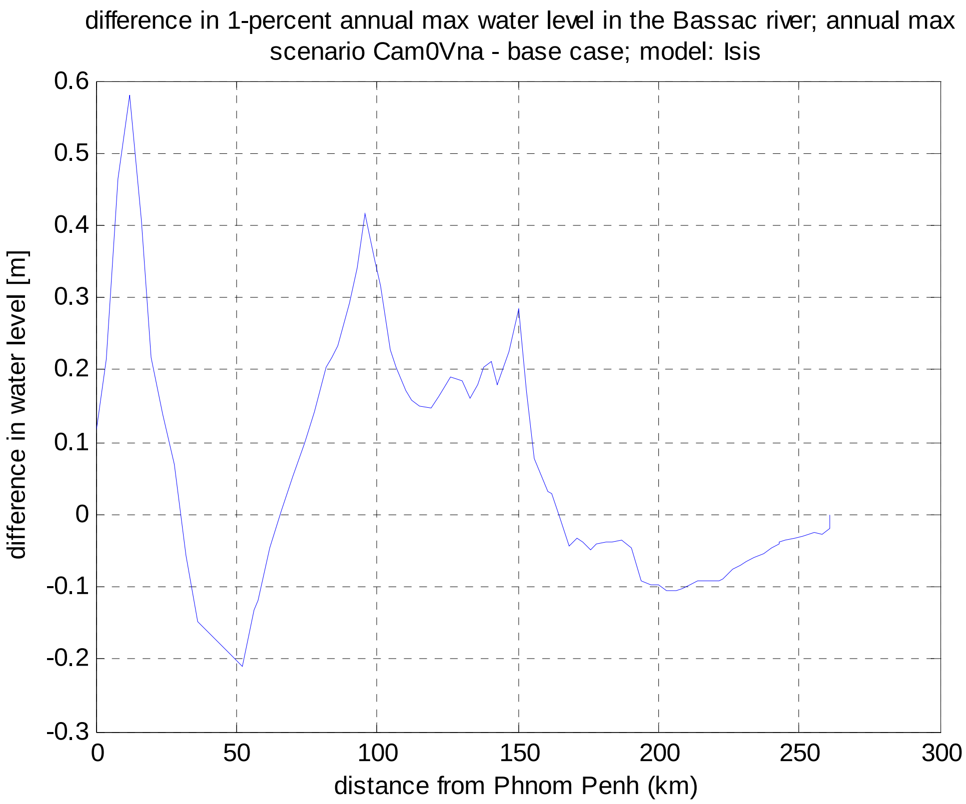


Figure 5.27 Increase in water level in the **Bassac** river downstream of Phnom Penh as a result of scenario **Cam0VNa**.

5.5 Scenario [6] – flood diversion to the Great Lake

In Cambodia the paddy is harvested before 1 August each year according to the crop calendar. In Vietnam the crop is harvested before the third week of August. When floods occur before the date of harvest it will create damage to the crop. Hence, if the floods can be limited till after the date of harvest up to the capacity of the Mekong and Bassac downstream of Phnom Penh, then benefits are generated for the farmers. In Scenario_4 this is achieved by diversion of flood water to the Tonle Sap for early flood control. Additional benefits of such option is generated for fish farming in the Lake as the Great Lake level will be higher than normal. Furthermore, if the outflow from the Lake is controlled the water availability for the dry season increases, which provides options to reduce salinity problems in the delta.

The effectiveness of flow diversion to Tonle Sap from midway Kampong Cham-Phnom Penh to the Lake has been investigated for two variants:

1. a fully controlled diversion, and
2. an uncontrolled diversion.

For this a water balance model of the Mekong between Kampong Cham and Phnom Penh has been developed, including Tonle sap River and Lake and a diversion canal from the Mekong to the Lake, see Figure 5.28. In the controlled mode, the diversion is operated such that the flow downstream of Phnom Penh does not exceed the capacity of the rivers Mekong and Bassac, set to 30,000 m3/s. Limits are further set to the diversion capacity, and Tonle Sap River capacity (10,000 m3/s) and Great Lake volume (85.86 BCM i.e. equivalent to a Lake level of 11.0 masl). The model is run for the 97 historical flood seasons, see Chapter 4.

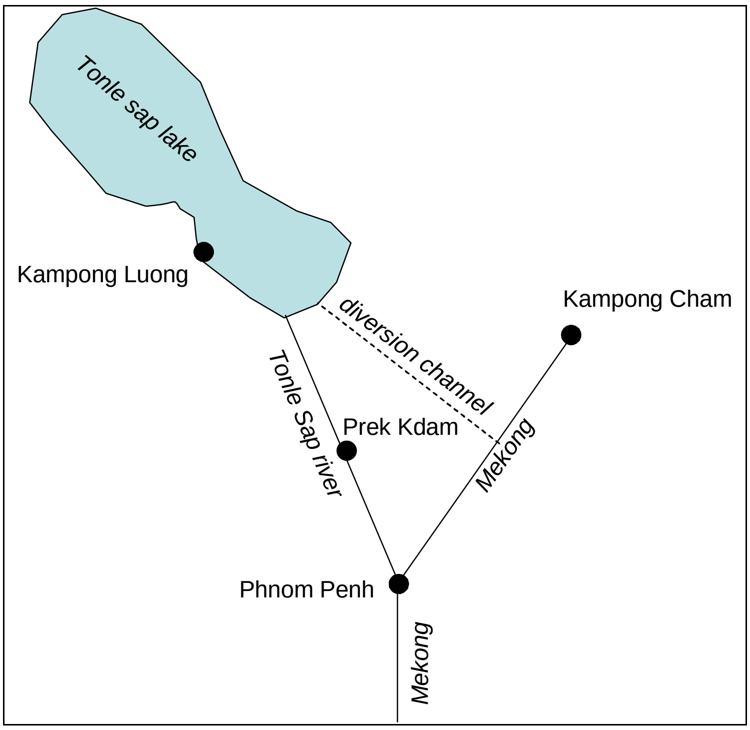


Figure 5.28 Structure of water balance model of Mekong and Tonle Sap

Controlled diversion

For the controlled diversion the effectiveness of the measure for different diversion capacities can be read from Figure 5.29.

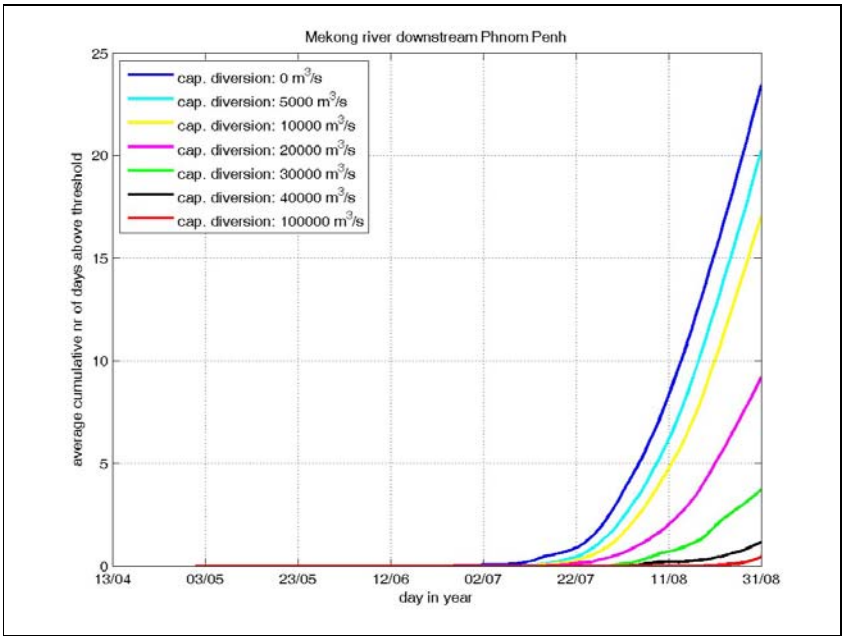


Figure 5.29 Average cumulative number of days (up to the date shown on the horizontal axis) in the simulated period 1910-2006 during which the flow downstream of Phnom Penh exceeded 30,000 m^3/s; depending on the available flow capacity of the diversion channel

The graph shows that under present conditions the number of days that flooding takes place downstream of Phnom Penh before 1 August is about 3 days on average each year. This would reduce to 1 day with a diversion canal with a capacity of 20,000 m^3/s. before the third week of August on average during 16 days flooding occurs, whereas with a diversion canal of the same capacity this would reduce to about 5. Figure 5.30 shows the mean wet surface area of the lake for different values of the flow capacity of the diversion channel. It shows the area increases with increasing capacity. Generally, an increase in the wet surface area has a positive effect on the fish population.

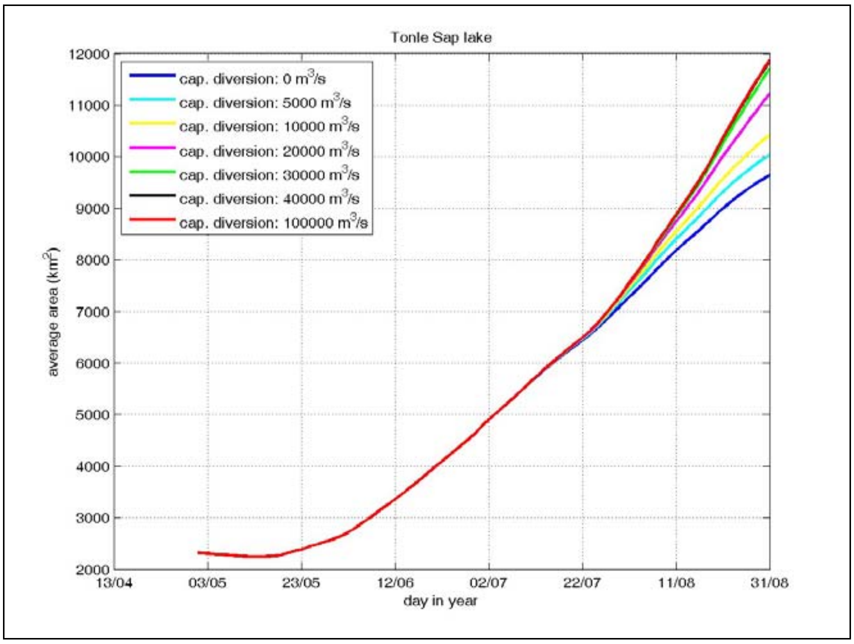


Figure 5.30 Mean wet surface area of the lake for different values of the flow capacity of the diversion.

Uncontrolled diversion

For the uncontrolled diversion a 2,500 m wide diversion canal is assumed with a weir at the off-take having a fixed level of 8.0 masl. The effectiveness of this measure seems to be limited as is observed from Figure 5.31 at first glance. However, this is mainly due to the fact that this option cannot control the flow downstream of Phnom Penh not to exceed exactly 30,000 m^3/s. The flood volume, though, will reduce substantially.

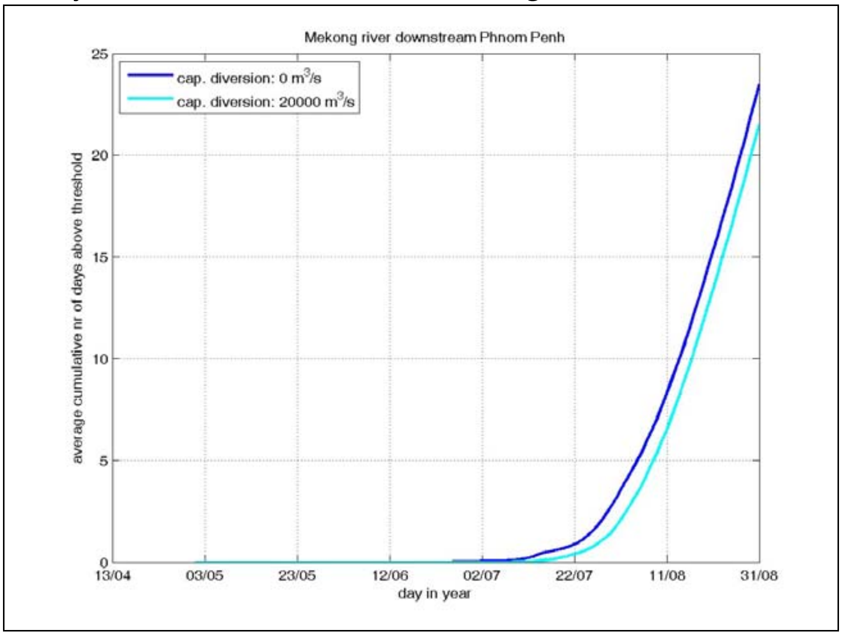


Figure 5.31 Average cumulative number of days (up to the date shown on the horizontal axis) in the simulated period 1910-2006 during which the flow downstream of Phnom Penh exceeded 30,000 m^3/s; depending on the available flow capacity of the diversion channel.

So the benefit of the uncontrolled channel can be found in the volume of water that fills the flood plain. This volume will be reduced each year the water flows into the diversion channel. For each year in the simulation period 1910-2006 the volume above the threshold of 30,000 m^3/s was derived. Figure 5.32 and Figure 5.33 show the frequency distributions of these volumes as derived on August 1st and August 21st each year. It shows that especially at August 1 there is a large percentage-wise reduction of flood volume, indicating that the diversion channel prevents significant areas of farmland from flooding before the end of the growing season.

The uncontrolled diversion has also been simulated with the hydraulic model for the same flood seasons as selected for the Scenarios_1 to 3. An unregulated diversion canal diverting Mekong water into the Lake from an off-take at Khchau village was implemented. It turned out the maximum flood water levels are only slightly reduced by this Scenario, as its function has finished before the peak passes. The reduction on the early flood levels is somewhat larger but still very limited. By blocking the early return flow from the Tonle Sap the diversion channel option can be made more effective.

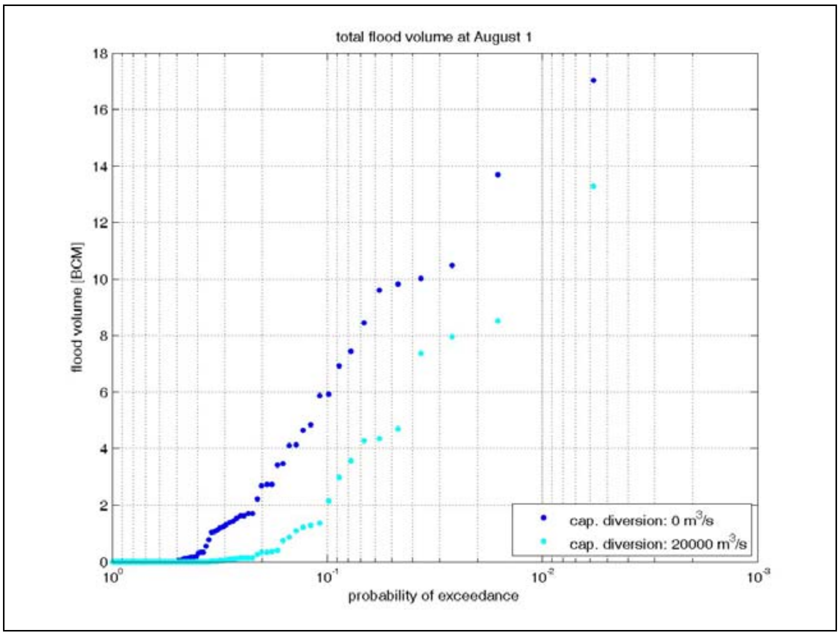


Figure 5.32 Frequency distribution of the total volume above a threshold of 30,000 m^3/s in the Mekong downstream of Phnom Penh until August 1, depending on the available flow capacity of the diversion channel.

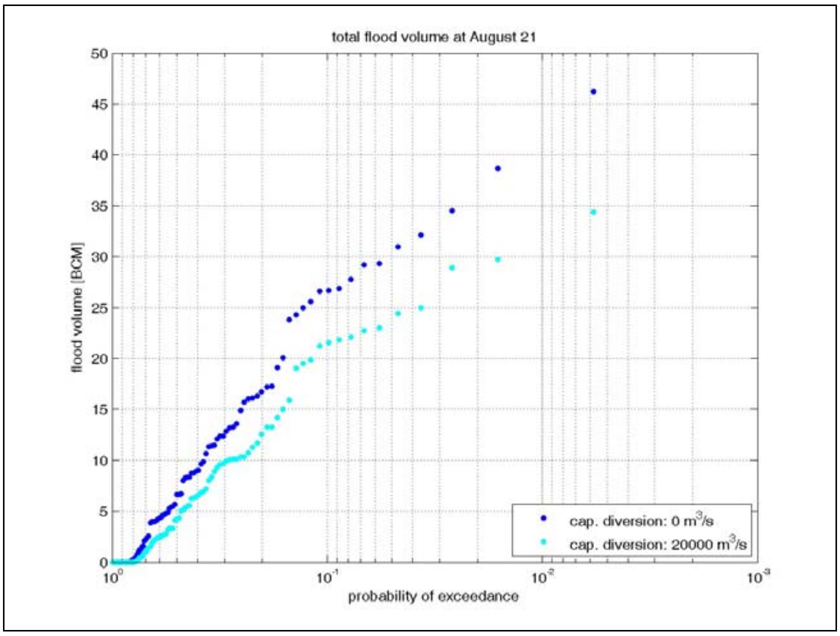


Figure 5.33 Frequency distribution of the total volume above a threshold of 30,000 m^3/s in the Mekong downstream of Phnom Penh until August 21, depending on the available flow capacity of the diversion channel.

5.6 Sea level rise

The following section is based on simulations with ISIS before the major improvements of August - September 2009 were carried out. In fact, the analysis of impact of see level rise should be done again. However, since impacts are essentially in the coastal zone of the delta, we see no need to re-simulate the case.

Due to climate change (melting of ice and particularly thermal expansion of water) the levels at sea at the mouth of the Mekong will rise in the next century with some 0.25 to 0.50 m (IPCC, 2007). This will affect the flood risk in the Mekong Delta. To get an impression of the effect of sea level rise on the water levels in the delta (size and extent) the Mekong Delta hydraulic model was run for two cases:

1. the Base Case: the year 2000 flood conditions using the observed sea level boundary and current hydraulic infrastructure
2. the Sea Level Rise Case; the year 2000 flood conditions using a 1 m higher sea level as boundary and the current hydraulic infrastructure.

The results of the computations are presented in Figure 5.34 to Figure 5.37 and Table 5.2.

Table 5.2 Effect of 1 m sea level rise on maximum water levels along Bassac and Mekong

Location	Distance, m	Maximum stage with	Maximum stage without	Diff.	Location	Distance, m	Maximum stage with	Maximum stage without	Diff.
Bassac					**Mekong**				
Phnom Penh	0.0	10.12	10.09	0.03	Phnom Penh	0.0	10.12	10.09	0.03
Koh Khel	48,000.0	6.99	6.95	0.04	Neak Luong	64,000.0	6.88	6.83	0.04
Chau Doc	119,003.1	4.82	4.66	0.15	Tan Chau	106,000.0	5.25	5.12	0.12

Long Xuyen	168,203.1	3.12	2.37	0.76	Cao Lanh	156,000.0	3.67	3.26	0.40
Can Tho	217,203.1	2.94	2.07	0.88	My Thuan	202,137.5	2.97	2.13	0.84
Dai Ngai	258,203.1	2.97	2.09	0.88	My Tho	243,297.5	2.75	1.86	0.89
					Ha Binh	265,969.0	2.72	1.76	0.96

Though exact linear interpolation on the differences for other seas level rises by multiplying the table values with the expected rise in meters will not be fully correct, as a first estimate it will be sufficient. Effects reduce on Bassac rapidly upstream of Long Xuyen. Along the Mekong the effect reduced strongly between My Thuan and Than Chau. The effect of the sea level rise has reduced to 12 to 15% at the Cambodian-Vietnamese border.

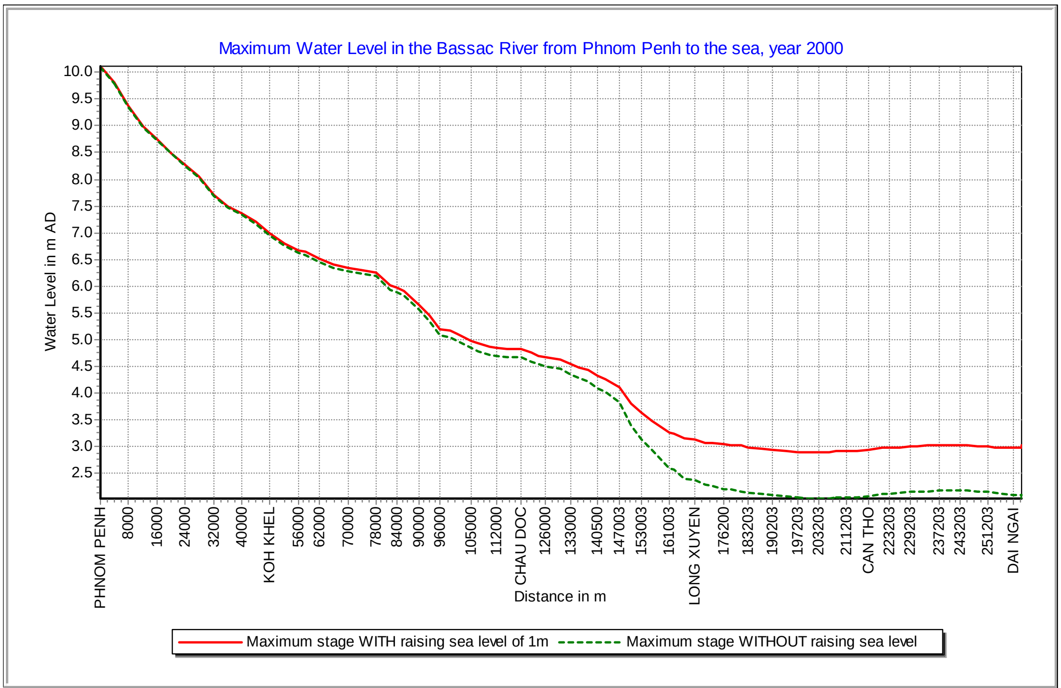


Figure 5.34 Effect of 1 m sea level rise on the maximum water level in Bassac, conditions of year 2000

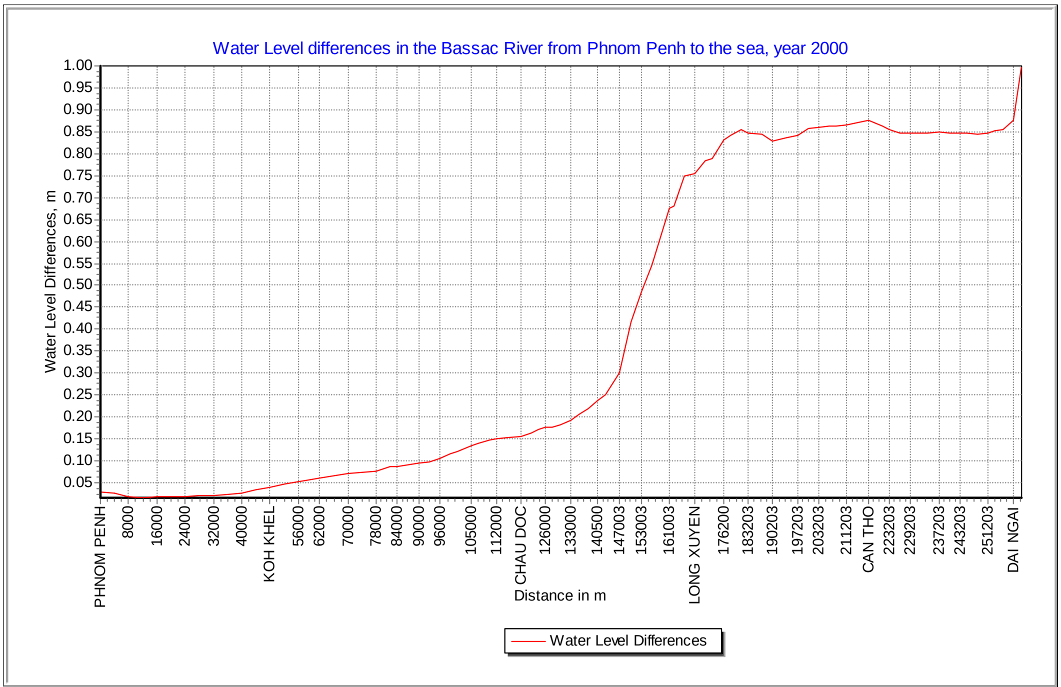


Figure 5.35 Net effect of 1 m sea level rise on the maximum water levels in Bassac, conditions of year 2000

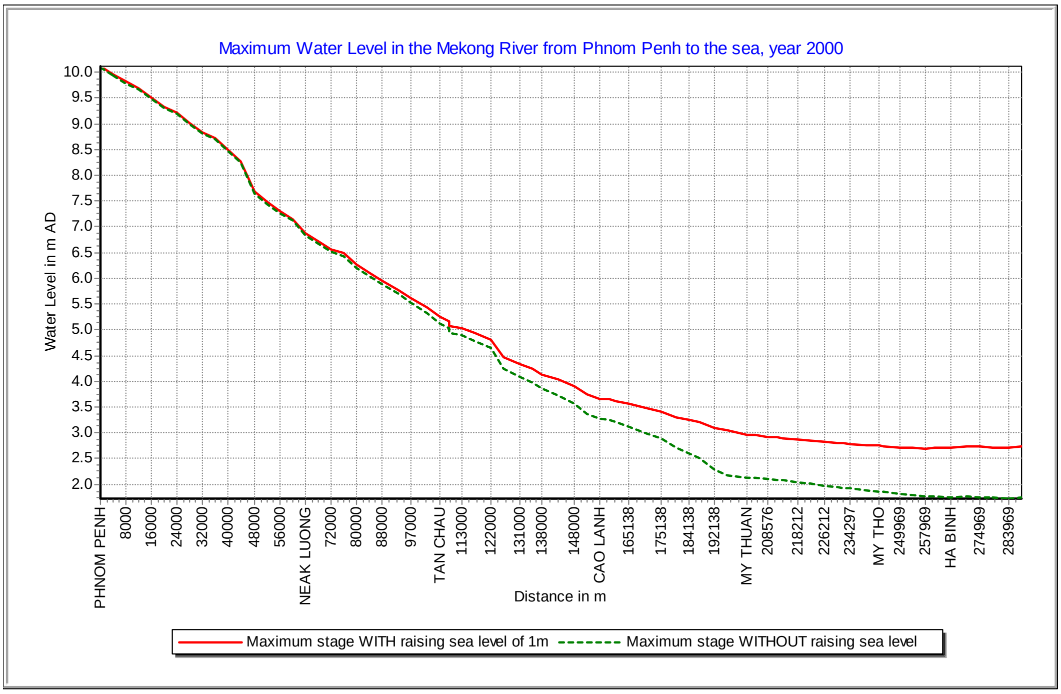


Figure 5.36 Effect of 1 m sea level rise on the maximum water level in Mekong, conditions of year 2000

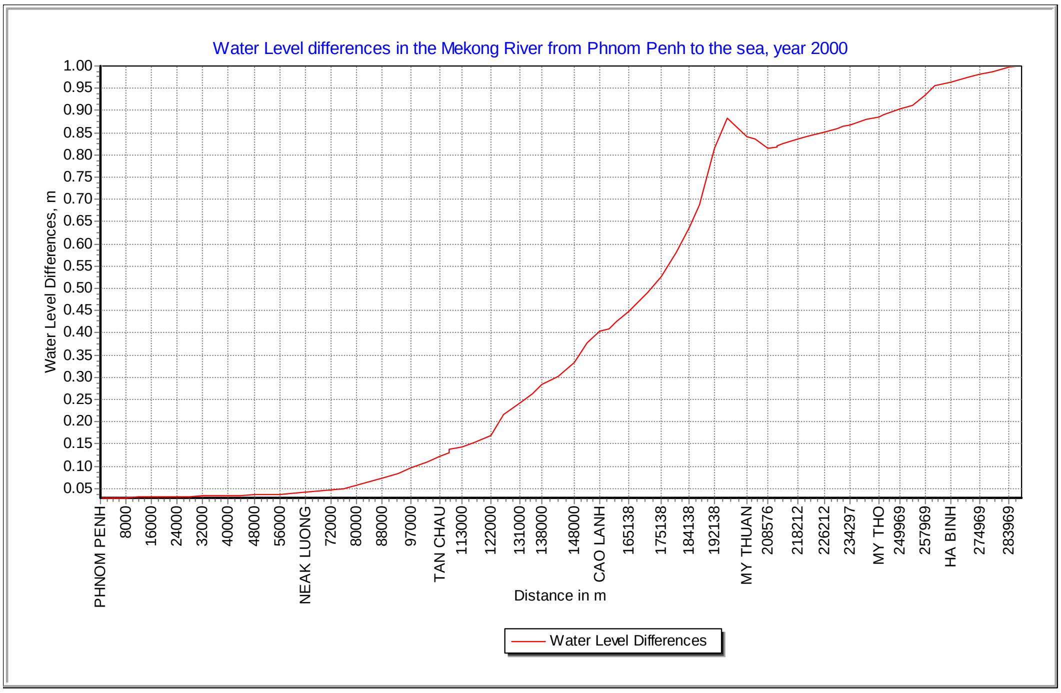


Figure 5.37 Net effect of 1 m sea level rise on the maximum water level in Mekong, conditions of year 2000

6 Conclusions and recommendations

6.1 Conclusions

Flood hazard assessment procedures

- Flood hazard in the Mekong delta up to return period of 100 years is determined from frequency analysis of 97 years of flood hydrographs derived with the Mekong Delta hydraulic model for the historical flow from 1910 to 2006.
- The Mekong Delta hydraulic model needs recalibration and refinement of the schematization of the Focal Areas in Cambodia. At present the model output is acceptable for demonstration purposes but unsuitable for planning or design.
- The inflow series to the Mekong delta can at present best be taken from the discharge series of the Mekong at Stung Treng. This series was considered to be more reliable and also available for a longer period. The use of the series of Kratie is not recommended because it is unreliable. The flow at Stung Treng is, apart from a time shift of one day, approximately equal to the flow at Kratie.
- The discharge series both at Stung Treng and Kratie contain a discontinuity caused by change in use of discharge measuring equipment. For a particular water level the current meter method leads to higher discharges then an ADCP.
- The combined flow of the tributaries to Great Lake (Tonle Sap river not included) is correlated with the flow of the Mekong river at stung Treng. To correctly generate monthly inflow series the serial correlation with the flow in the previous month and the cross-correlation with the inflow to the delta in the same month should be taken into account.
- The seasonal rainfall in the Mekong Delta shows no significant correlation with the inflow to Tonle Sap nor the Mekong flow at Kratie.
- The hydraulic model of the Mekong Delta uses in its simulations the observed water levels in the Gulf of Thailand and in the South China Sea as boundary condition. This series slightly underestimates the average conditions along the coast (0.07 m at Tra Vinh).
- A realistic 97 year long set of boundary conditions has been created for the Mekong Delta model.

Development scenarios

- The various scenarios of flood control measures (Cam0, VNa, and Cam0VNa) result in reduced water level at several locations, but at the same time cause an increase at other locations. Analysis of expected damage (Appendix 2) will show whether these measures have a net benefit when all 59 district are taken taken into account.
- The scenario of development in Vietnam (VNa) cause rising water levels in all 25 locations in Cambodia.
- The regime of the Mekong is about 1 month ahead of the Tonle Sap local inflow regime, which provides opportunities to use the lake for storage of early Mekong floodwater to reduce damage to crop.

- Diversion of flow to the Tonle Sap may have mutual benefits, including early flood volume reduction, which reduces damage to unharvested crop, extended surface area of Tonle Sap, which benefits fish farming and larger volume of water stored in Tonle Sap, which when the outflow is controlled, can be used to reduce the salt intrusion in the delta.
- Controlled diversion of Mekong flood water to Great Lake is an effective tool to reduce early floods downstream of Phnom Penh up to a discharge of 30,000 m^3/s and leads to larger volumes of water stored in Great Lake.
- Uncontrolled diversion of Mekong flood water to Great Lake hardly reduces the exceedance frequency of a discharge of 30,000 m^3/s downstream of Phnom Penh up till 31 August. Its effect on reducing early flood volumes is substantial.
- Despite the latter, the effect of uncontrolled flooding on reduction of early flood levels in the Focal Areas is only 1 to 2 dm and proved to be far less effective then local flood protection measures.

6.2 Recommendations

Based on the analyses made in the frame of flood hazard assessment for the Mekong delta it is strongly recommended to improve on the computational tools available at the MRC. The recalibration of the Mekong Delta hydraulic model is to be undertaken with priority including an extension of the computational network in the Focal Areas in Cambodia. Prior to the recalibration, during the 2010 flood season concurrent current meter and ADCP discharge measurements have to be made at Kratie to resolve in-homogeneities in the inflow series of the Mekong Delta.

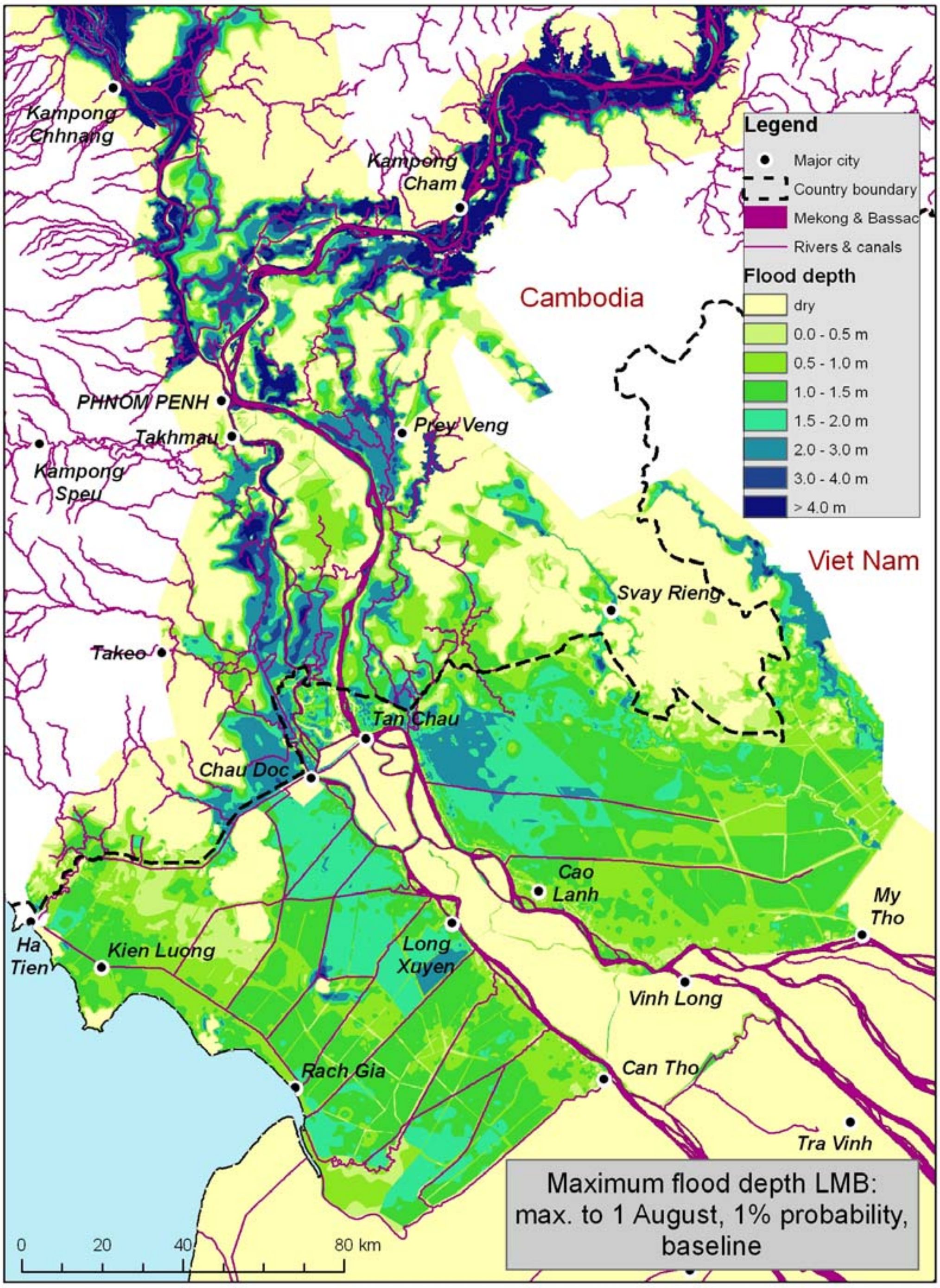
The effects of the development alternatives are recommended to be repeated with the hydraulic model using the updated schematisation of the Focal Areas in Cambodia. Then also controlled diversion of flood water to the Tonle Sap, including an outflow control structure in the Tonle Sap River, to maximise the benefits of extra storage of water within the basin is recommended to be evaluated.

7 Literature

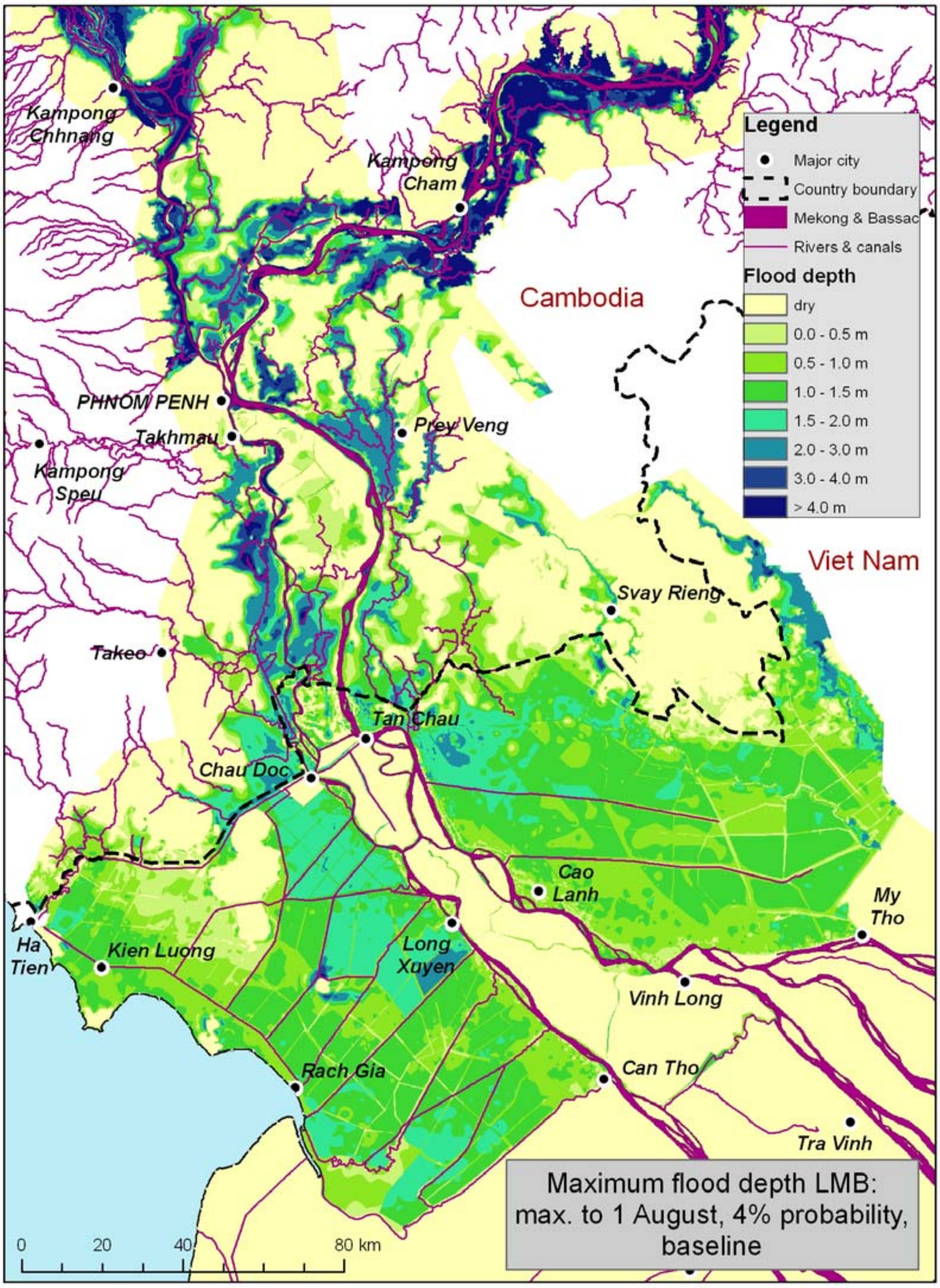
IPCC (2007)
Climate Change 2007.
IPCC Fourth Assessment Report

Royal Haskoning, Delft Hydraulics and IHE (2008)
Character and Nature of Flooding in the Lower Mekong Basin.
Volume 2: Appendix 1 of Inception Report of the Flood Management and Mitigation Program, Component 2: Structural Measures and Flood Proofing

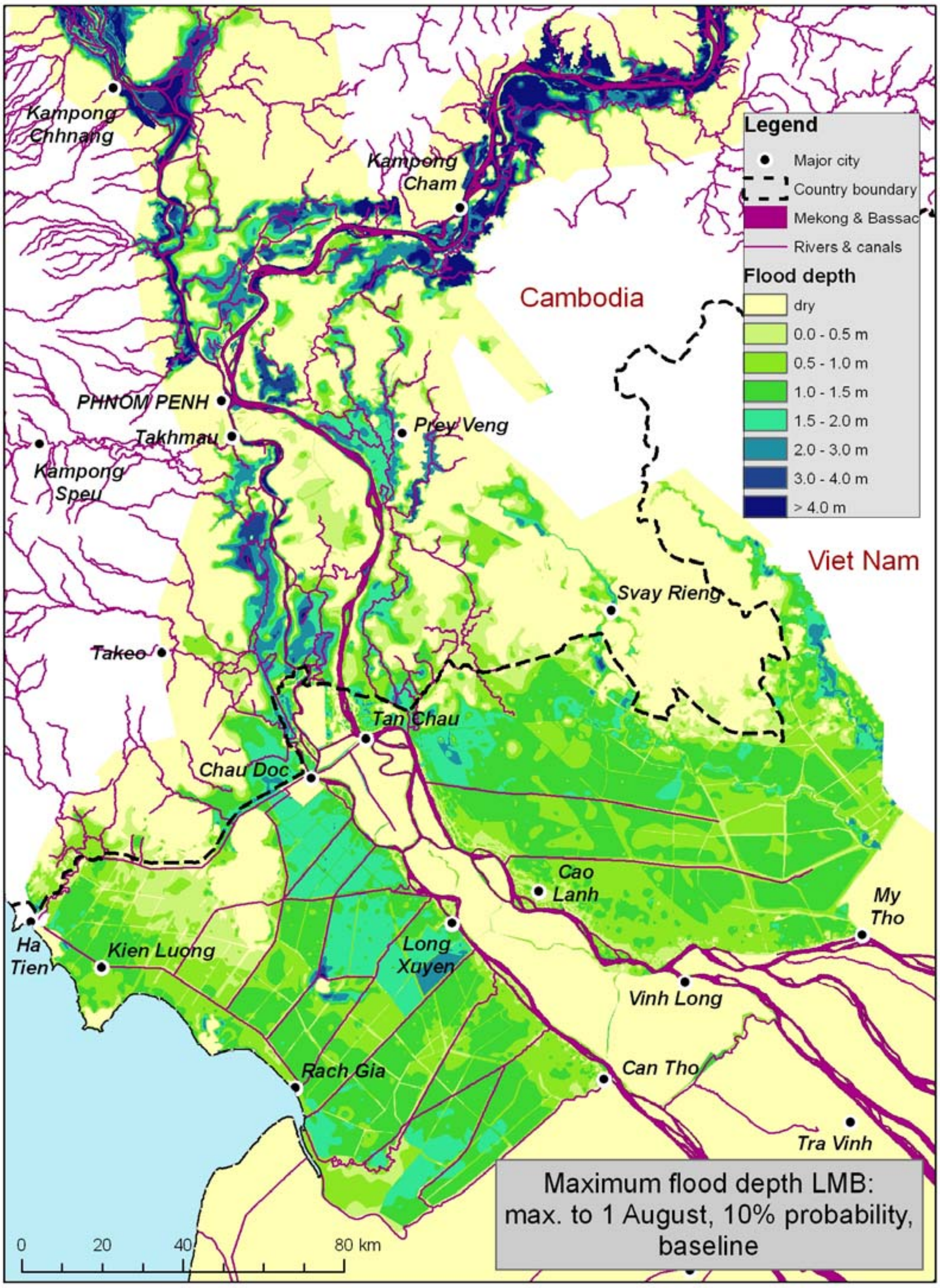
Attachment 1.1: Flood Hazard map at p=1%, Base case, Before 1st of August



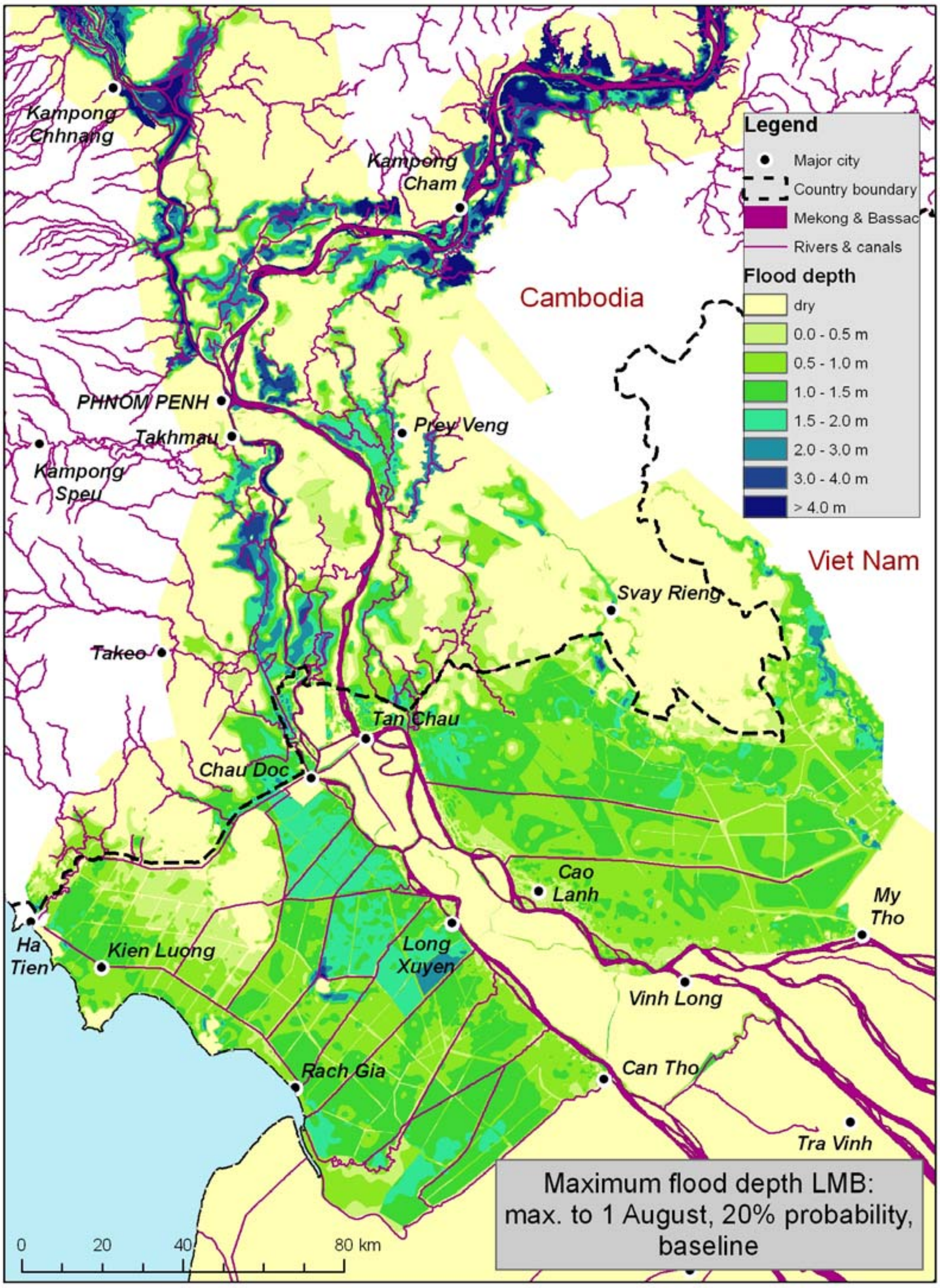
Attachment 1.2: Flood Hazard map at p=4%, Base case, Before 1st of August



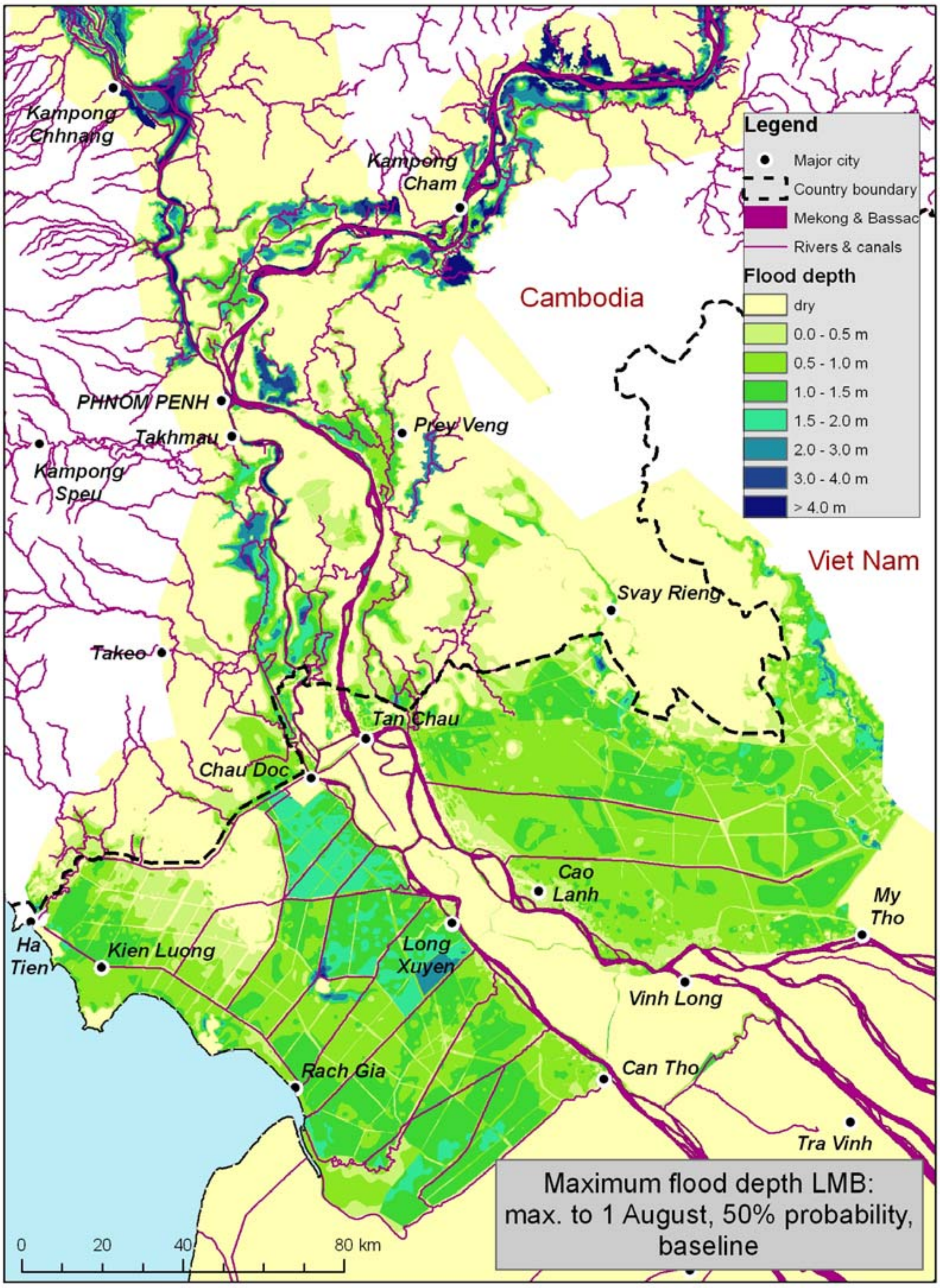
Attachment 1.3: Flood Hazard map at p=10%, Base case, Before 1st of August



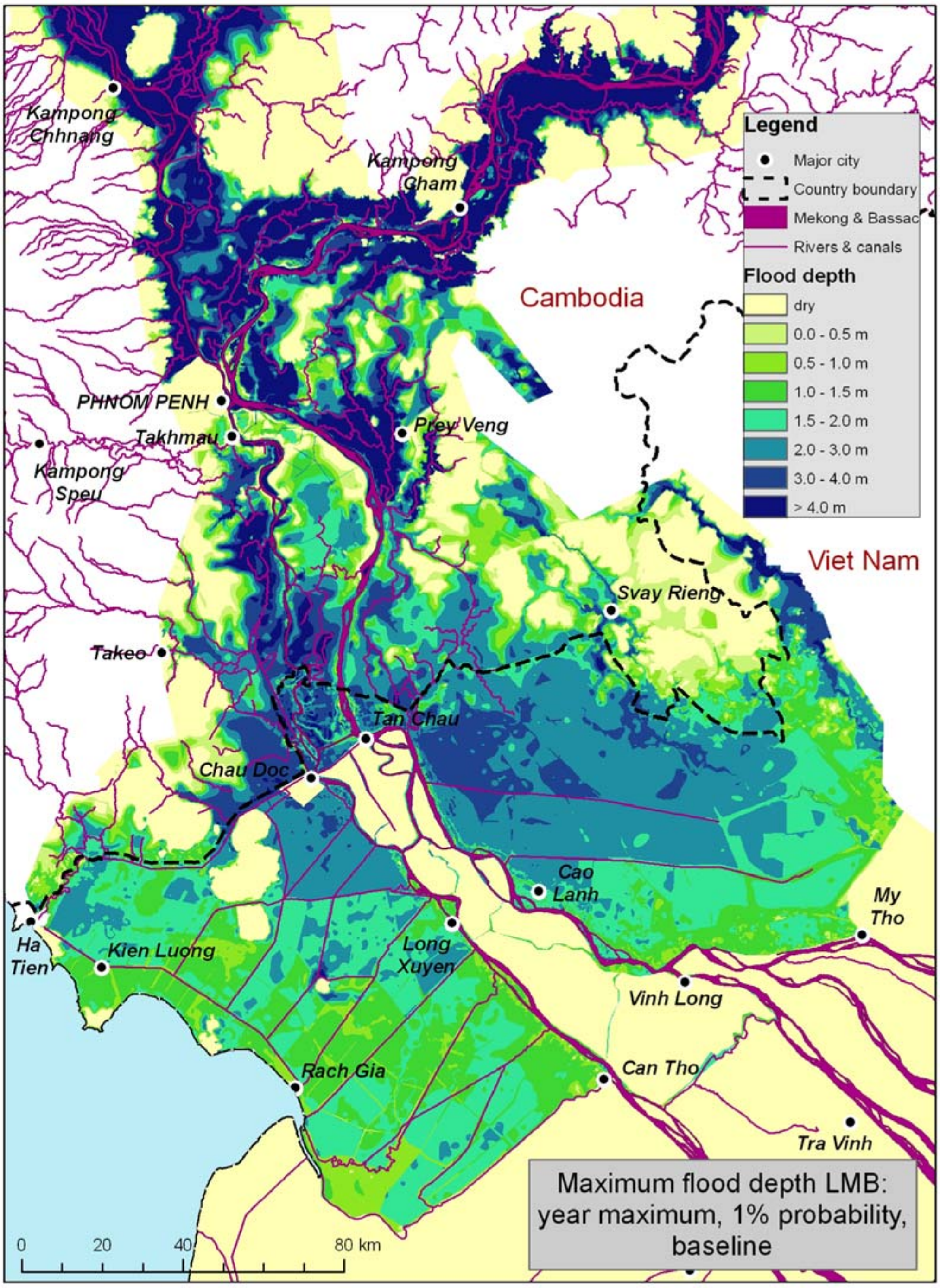
Attachment 1.4: Flood Hazard map at p=20%, Base case, Before 1st of August



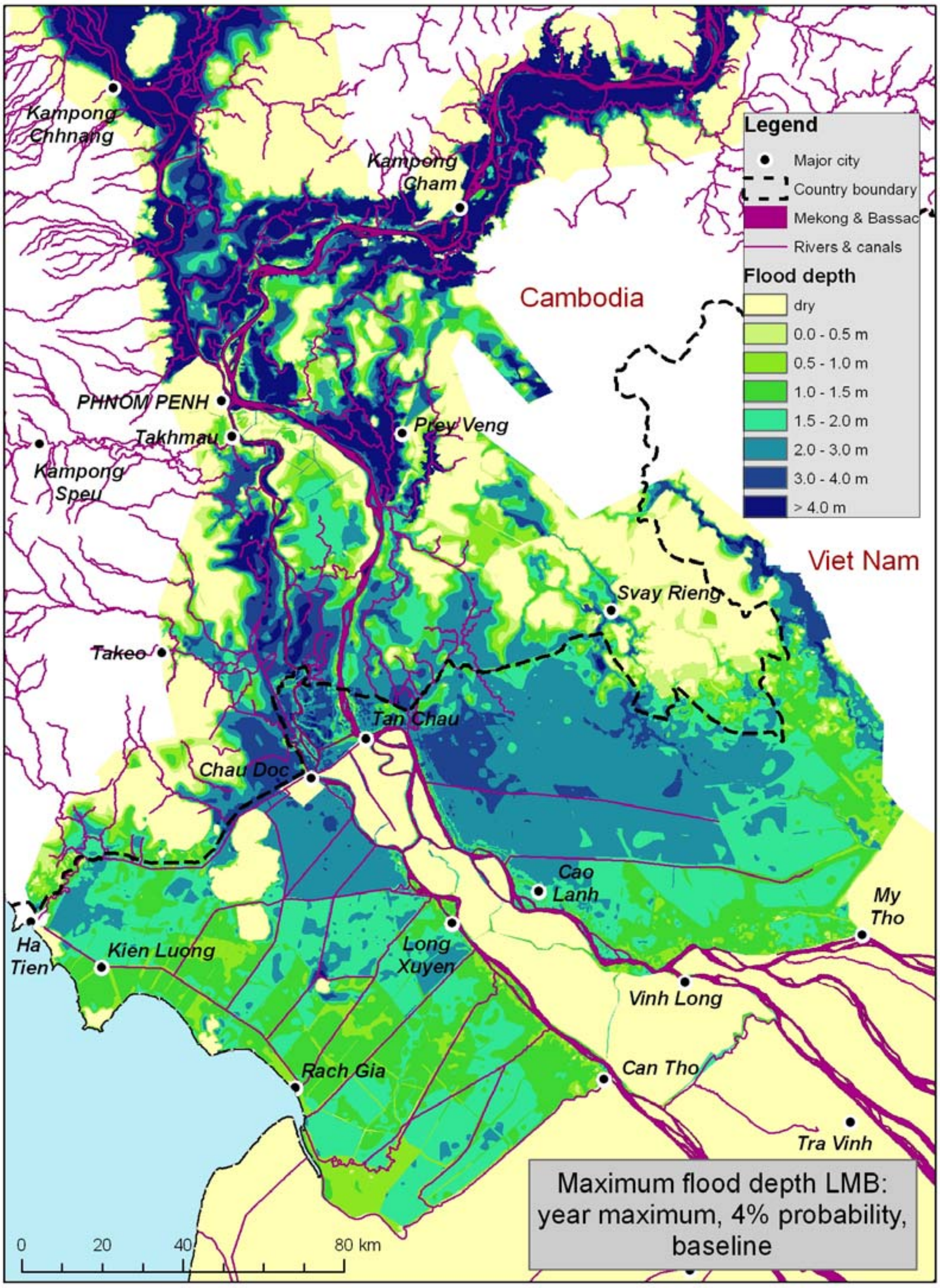
Attachment 1.5: Flood Hazard map at p=50%, Base case, Before 1st of August



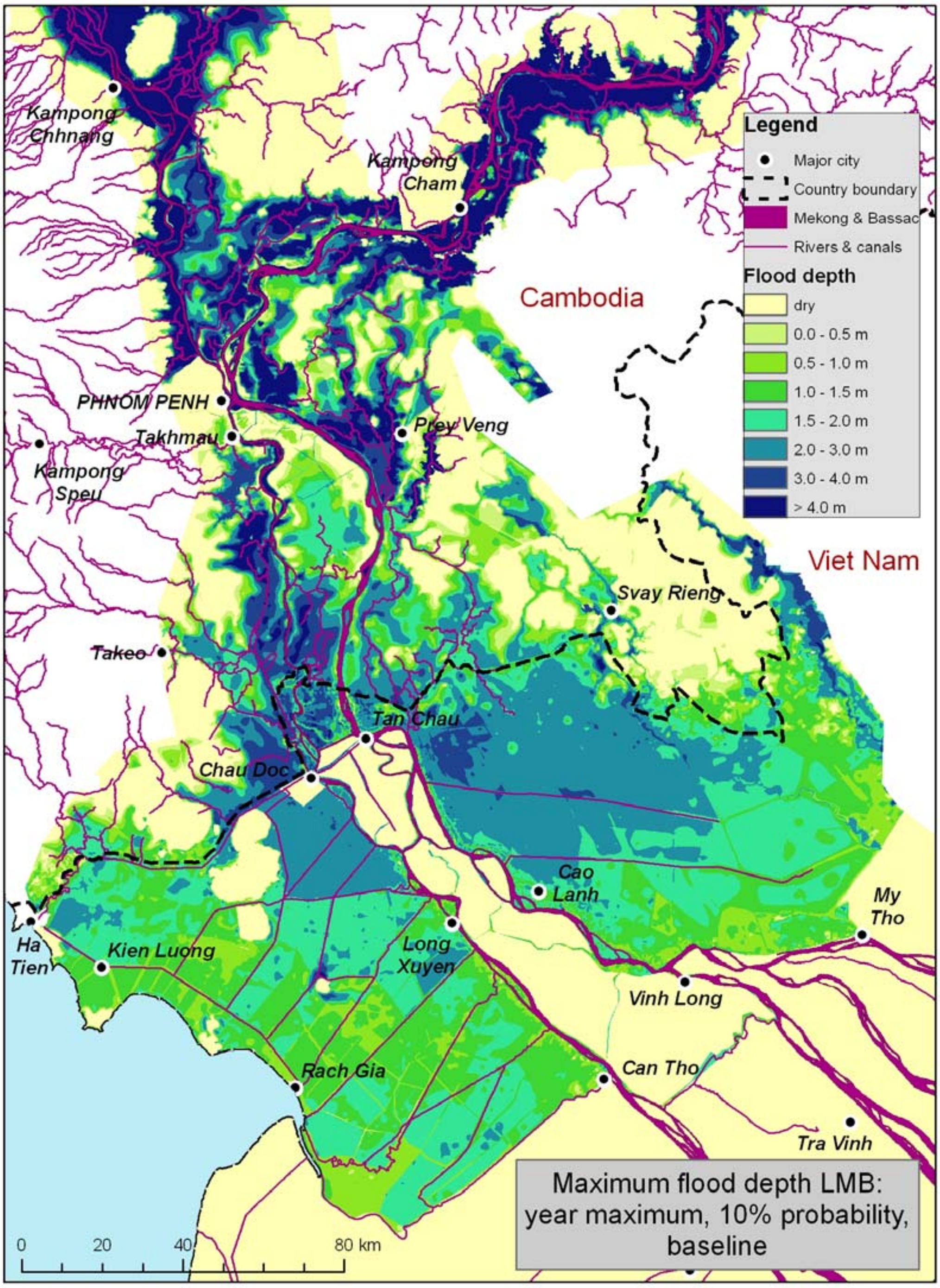
Attachment 1.6: Flood Hazard map at p=1%, Base case, Year Maximum



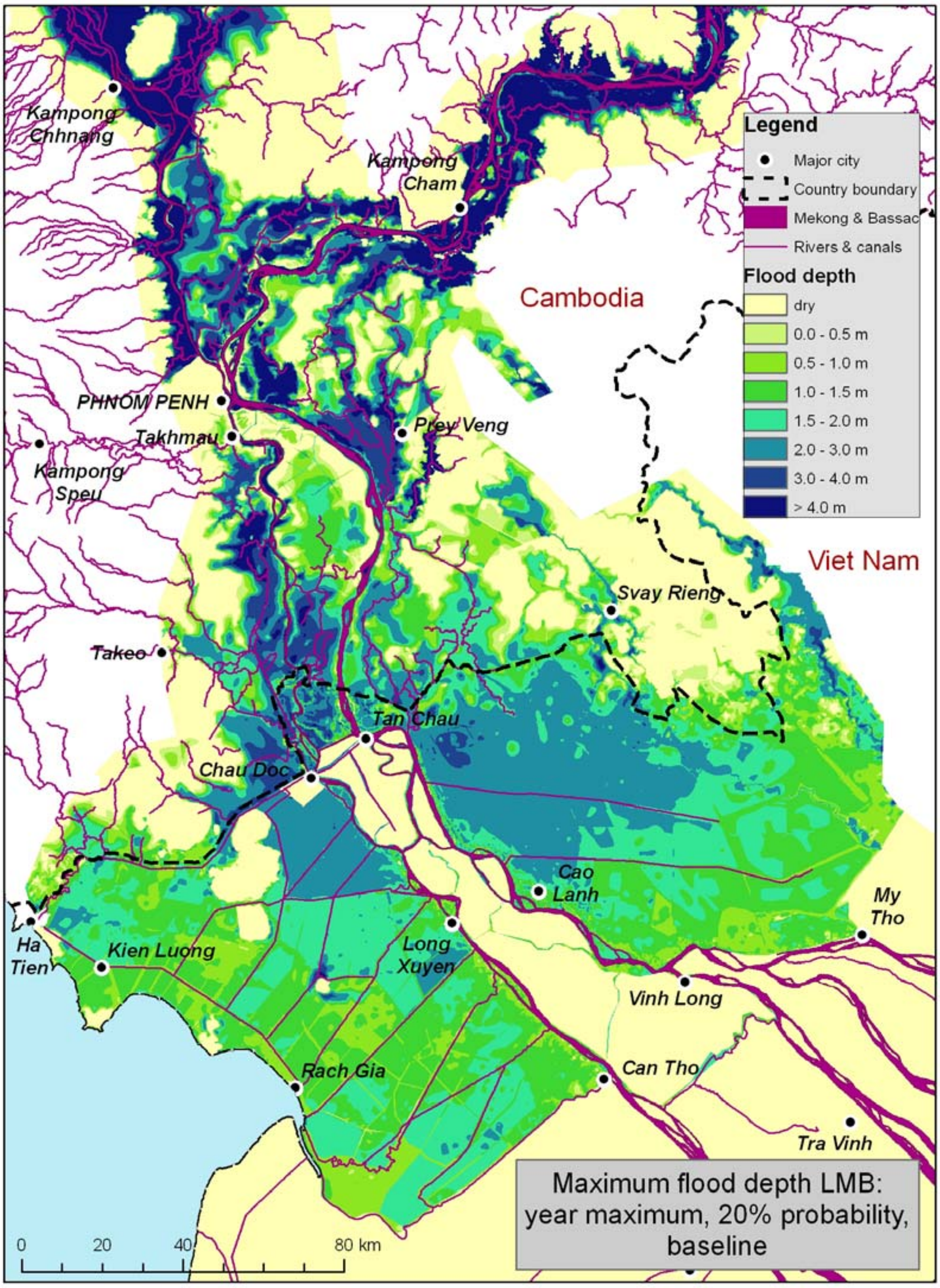
Attachment 1.7: Flood Hazard map at p=4%, Base case, Year Maximum



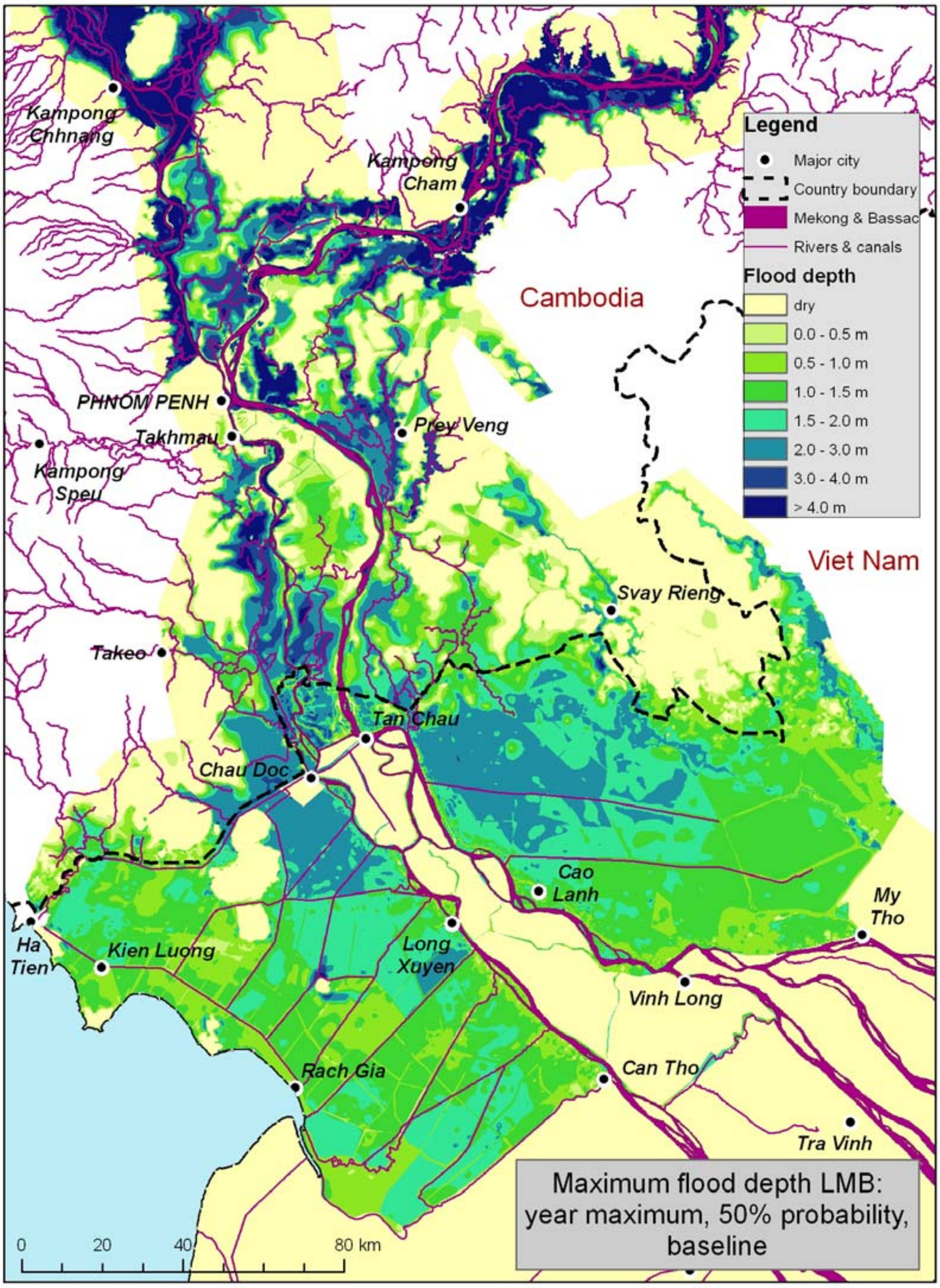
Attachment 1.8: Flood Hazard map at p=10%, Base case, Year Maximum



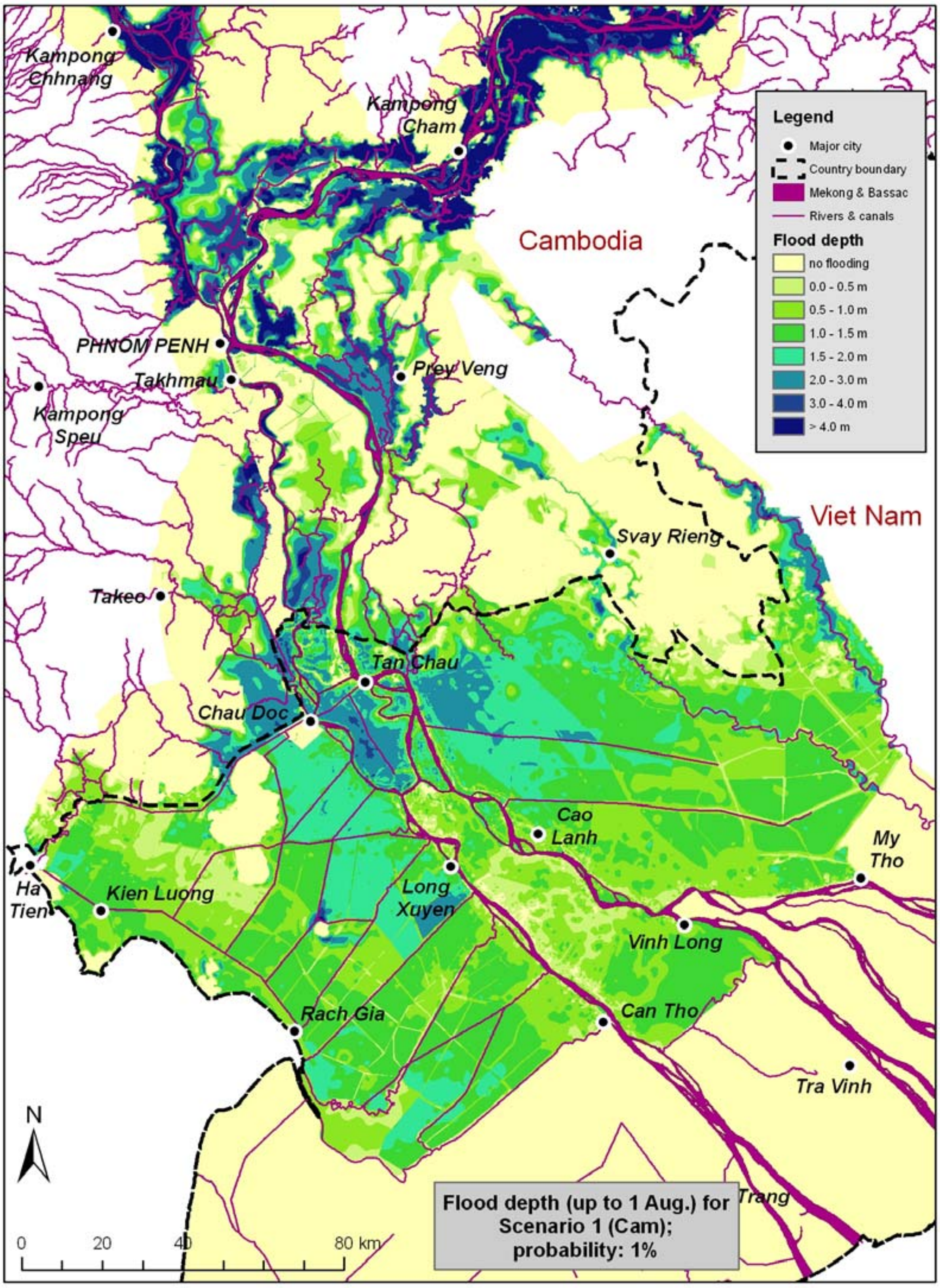
Attachment 1.9: Flood Hazard map at p=20%, Base case, Year Maximum



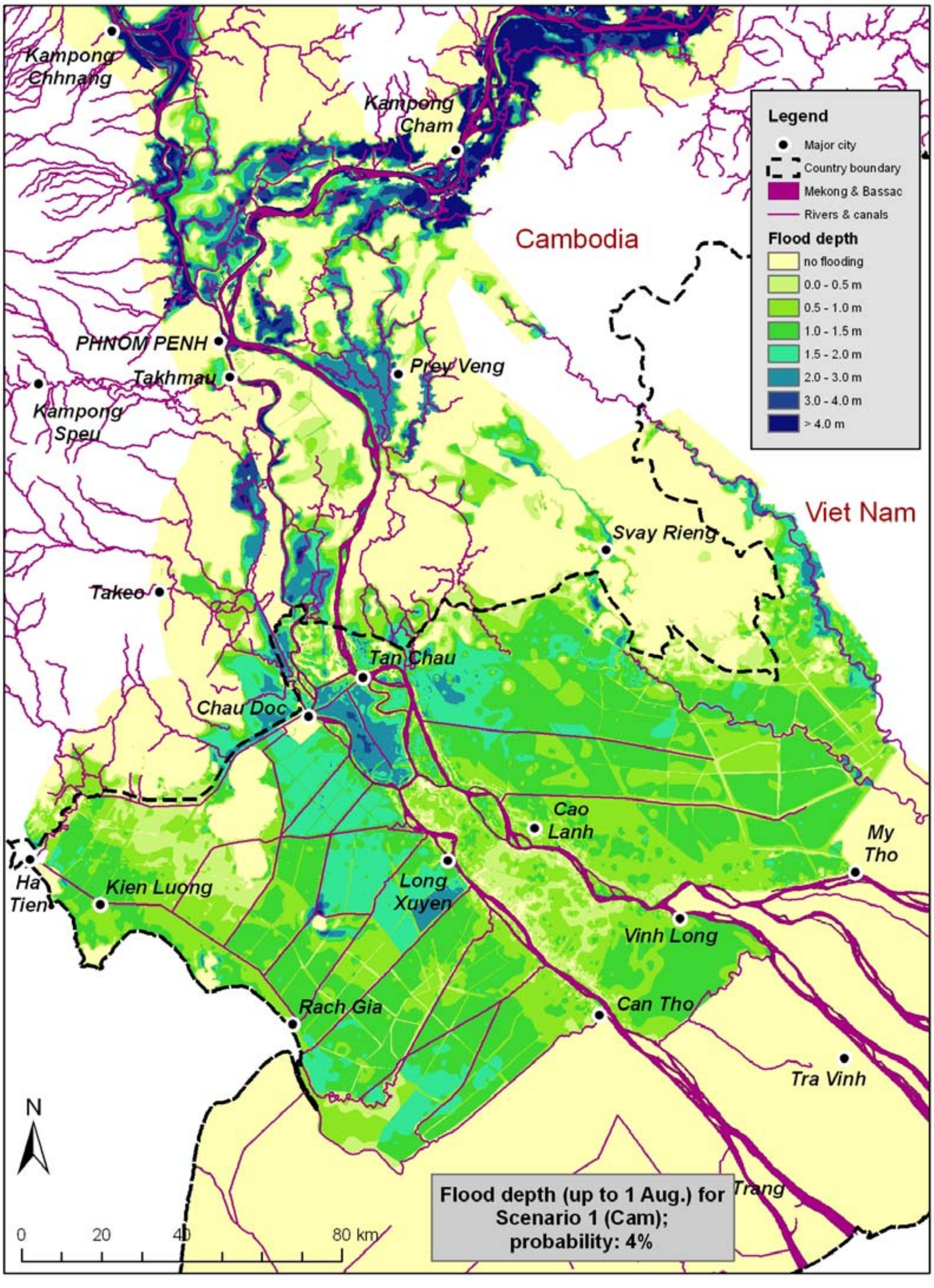
Attachment 1.10: Flood Hazard map at p=50%, Year Maximum



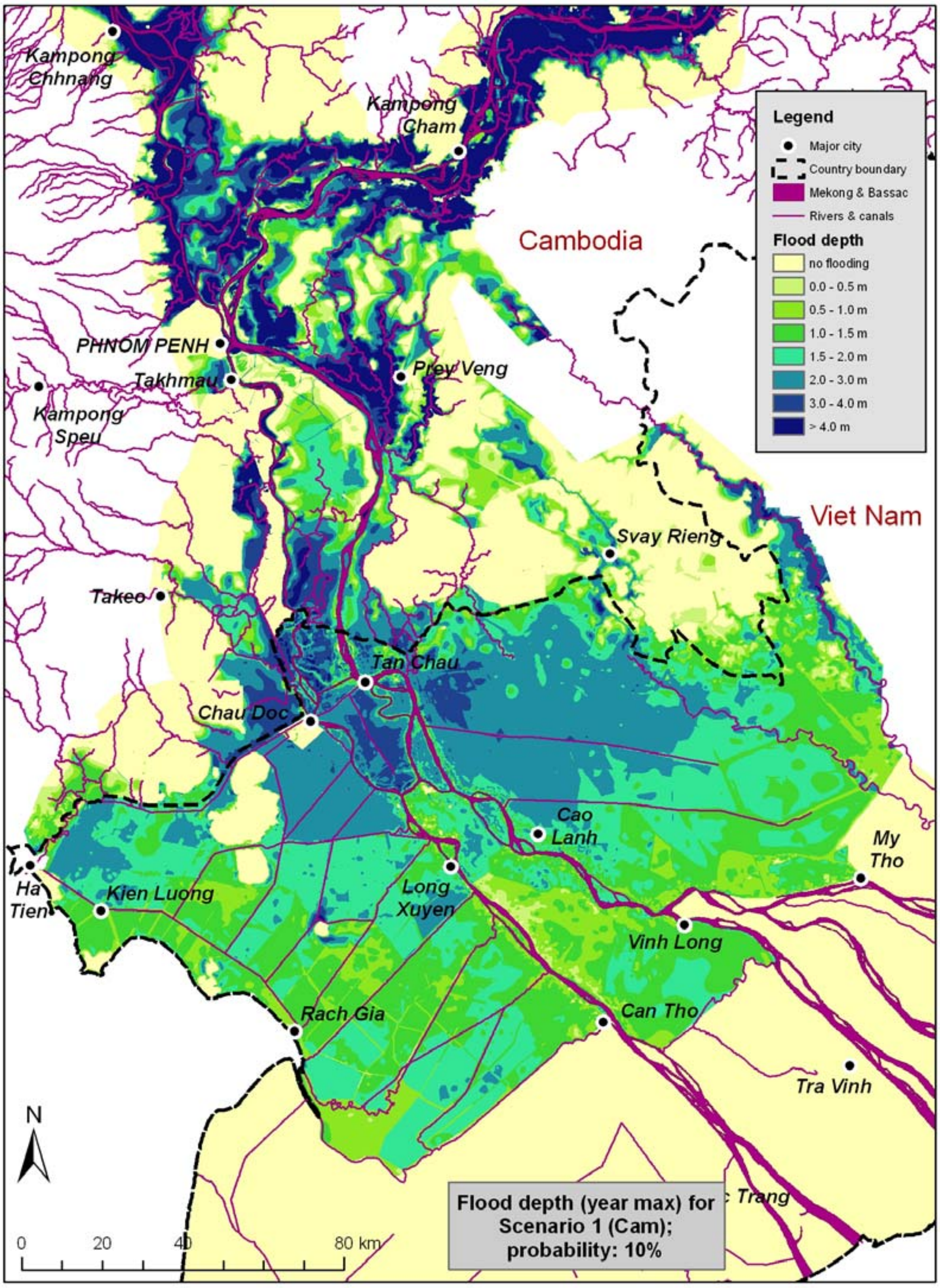
Attachment 1.11: Flood Hazard map at p=1%, Scenario Cam0, Before 1st of August



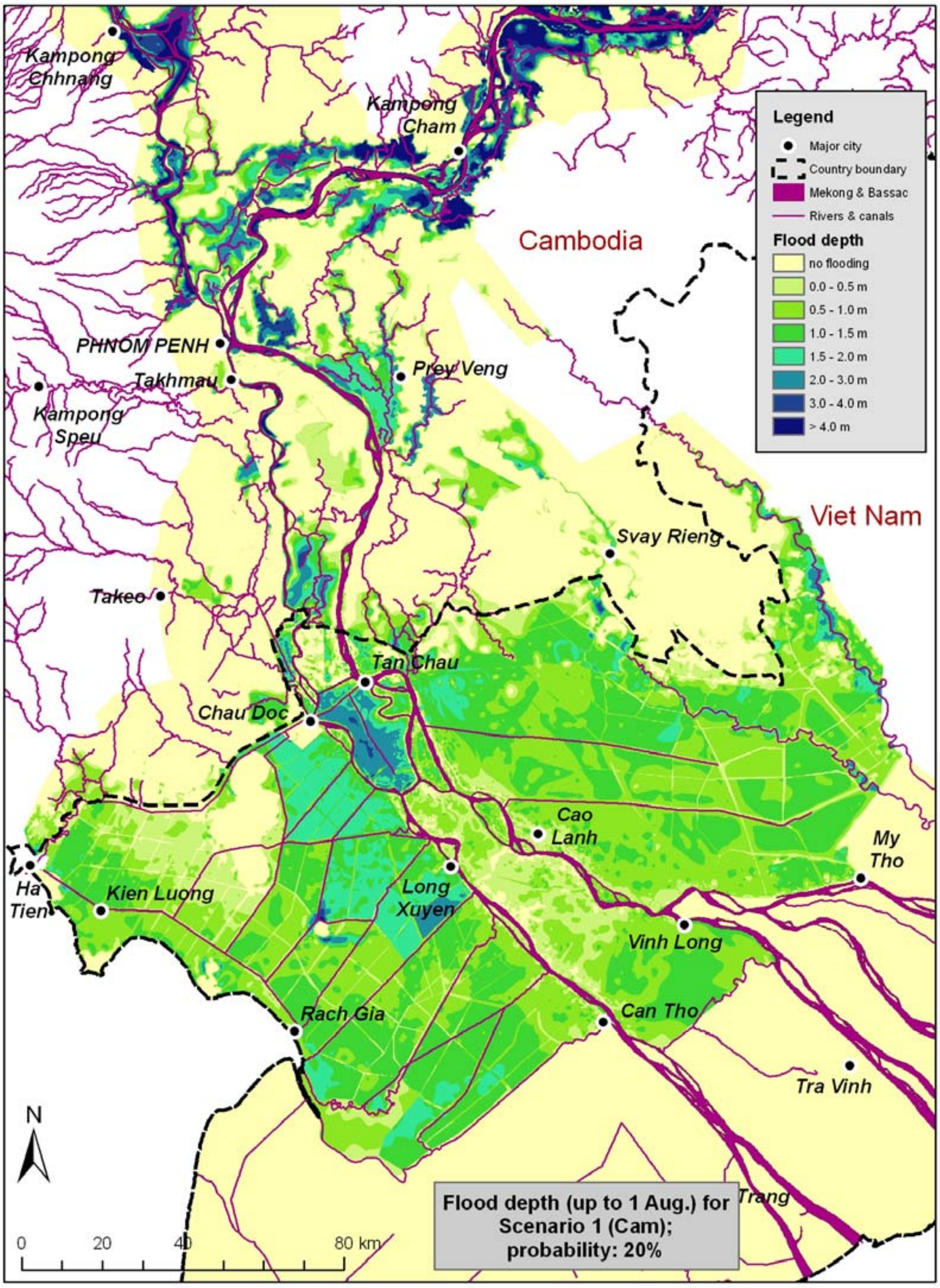
Attachment 1.12: Flood Hazard map at p=4%, Scenario Cam0, Before 1st of August



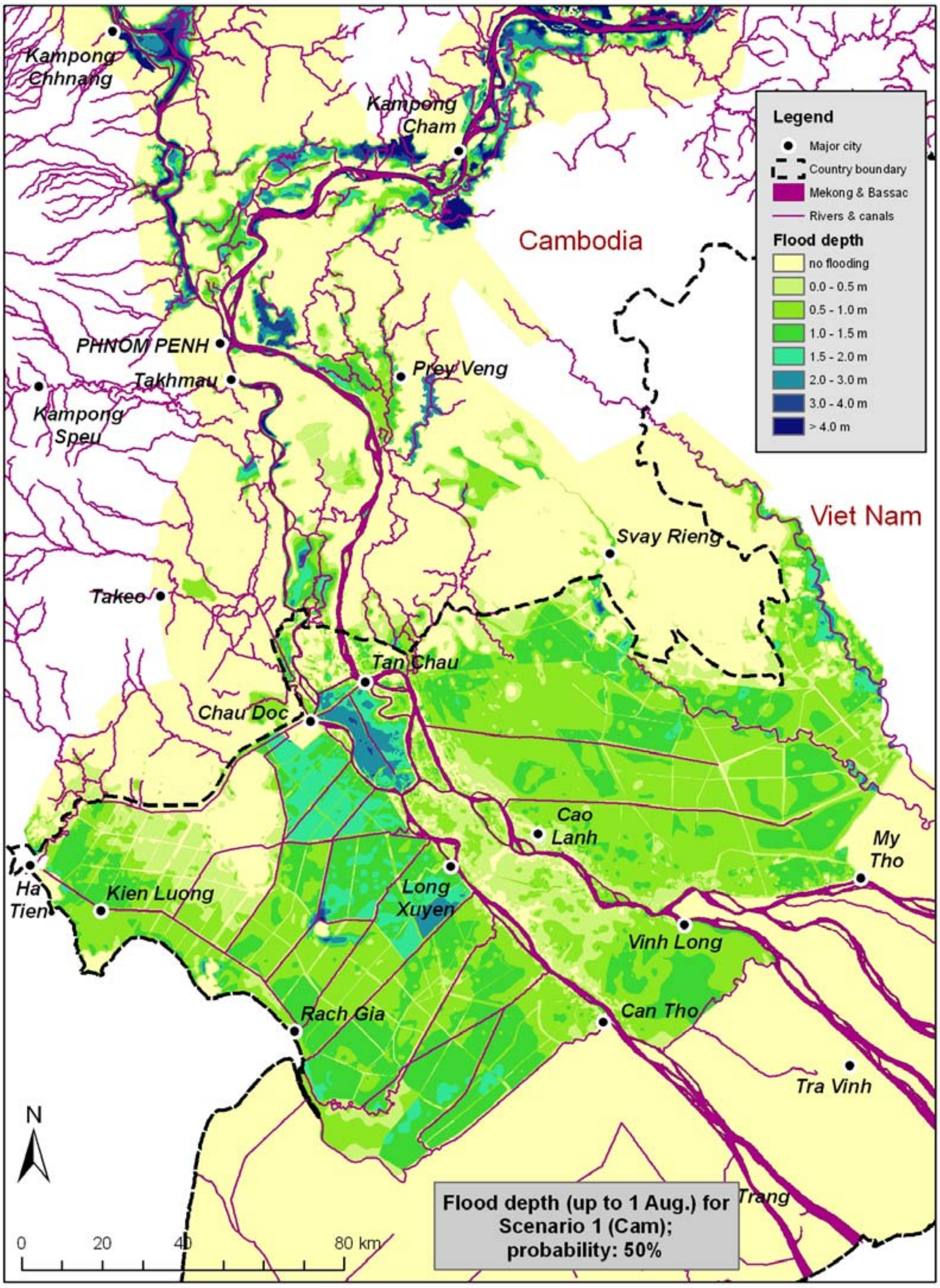
Attachment 1.13: Flood Hazard map at p=10%, Scenario Cam0, Before 1st of August



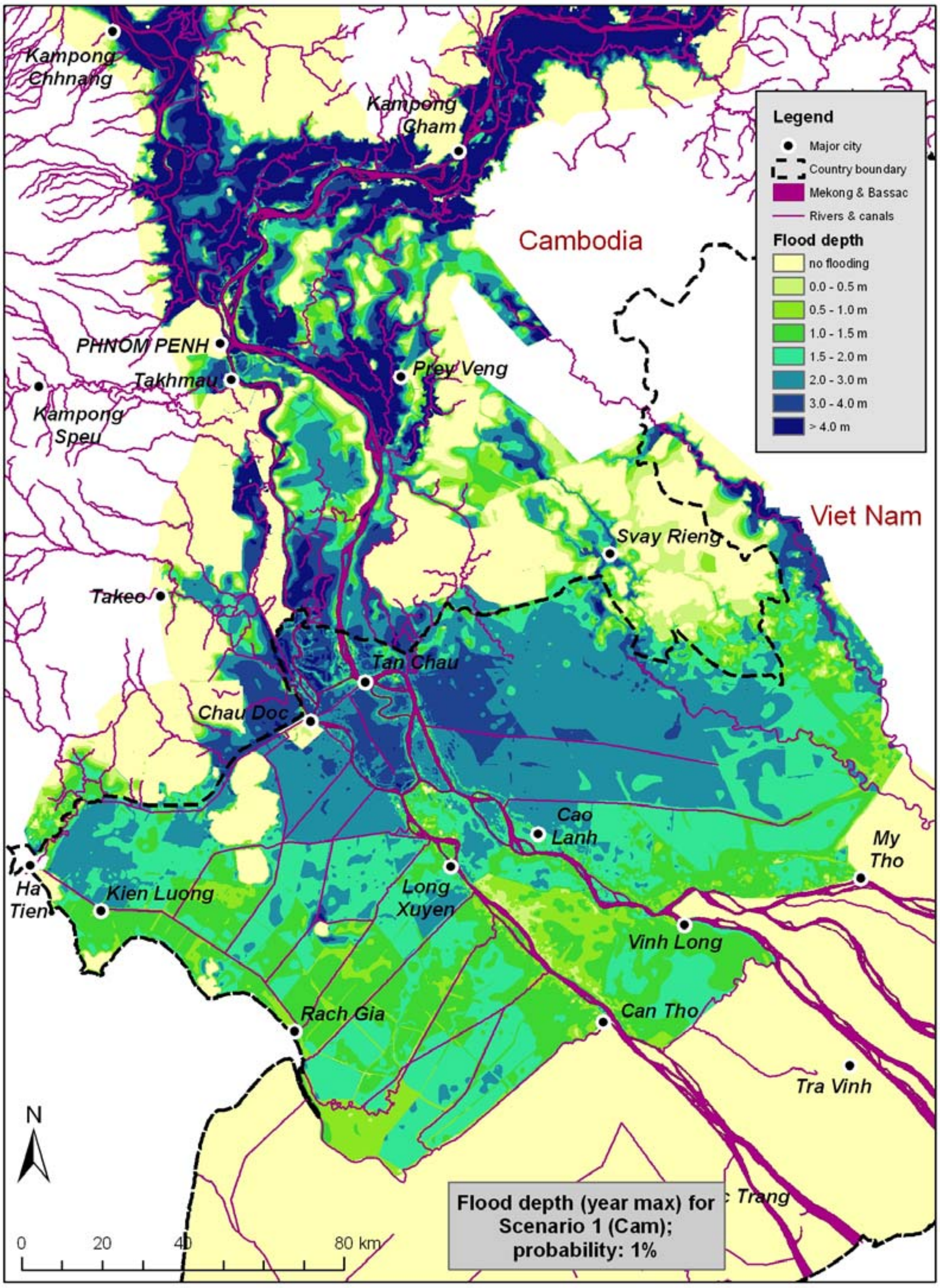
Attachment 1.14: Flood Hazard map at p=20%, Scenario Cam0, Before 1st of August



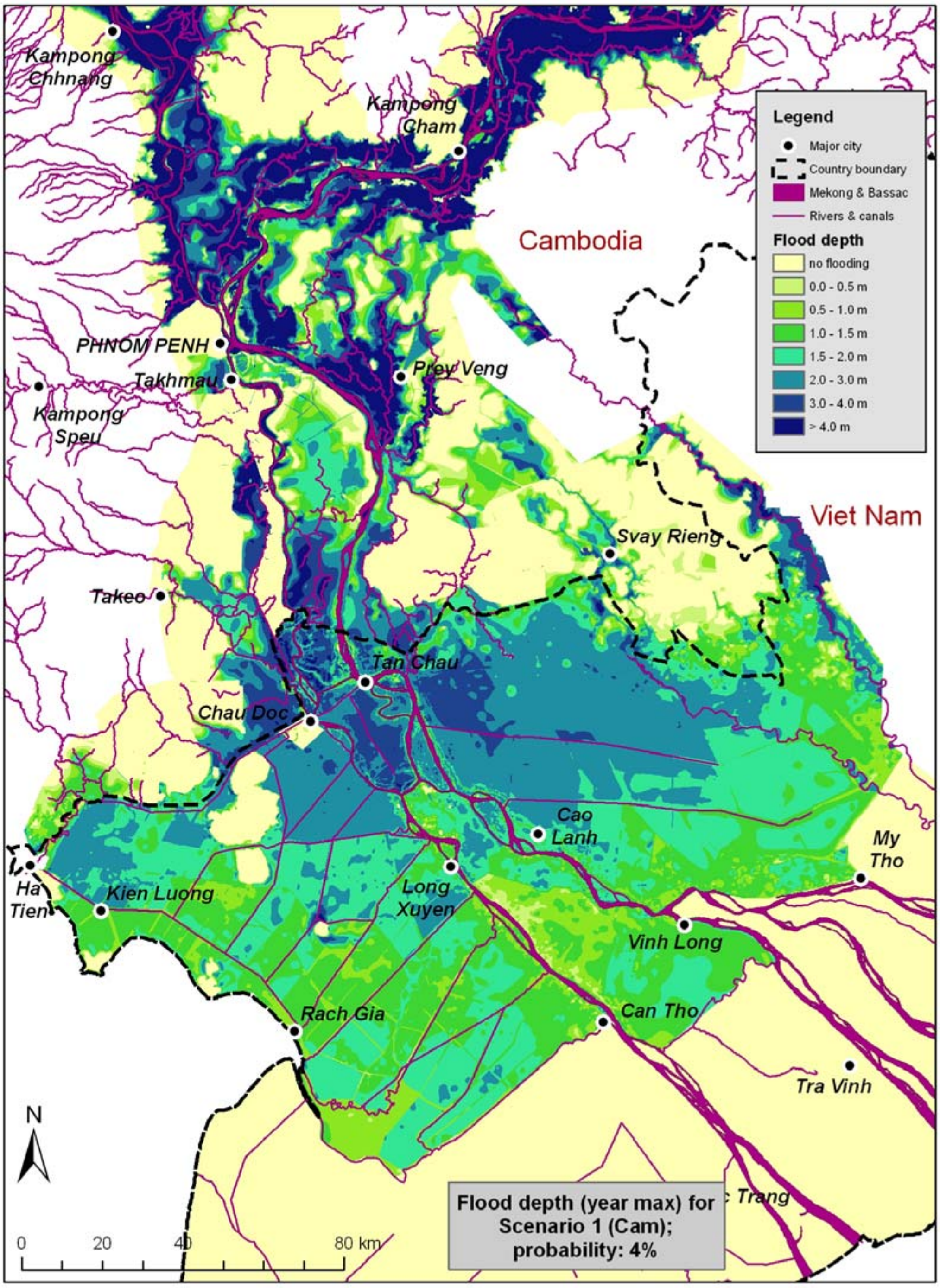
Attachment 1.15: Flood Hazard map at p=50%, Scenario Cam0, Before 1st of August



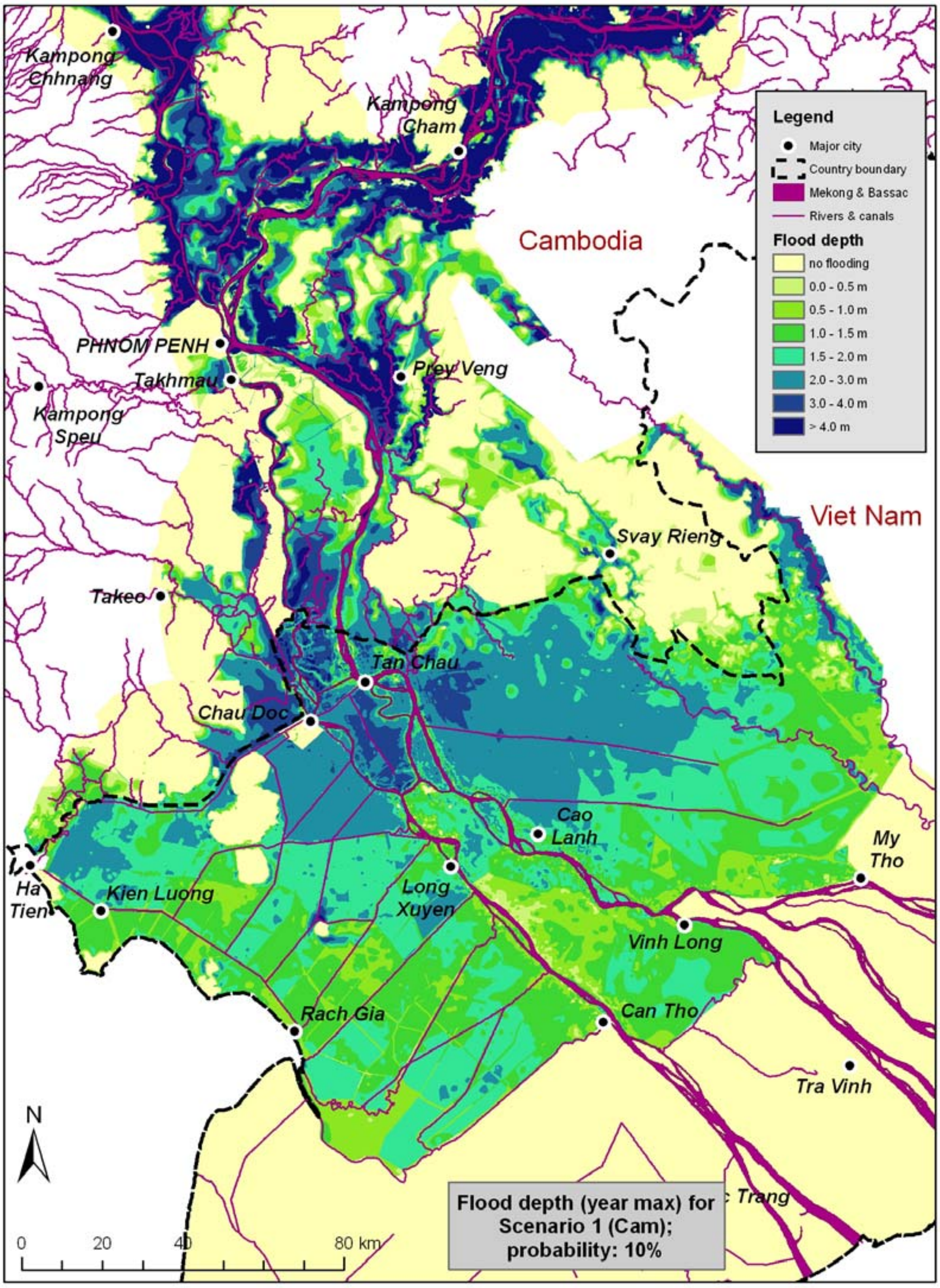
Attachment 1.16: Flood Hazard map at p=1%, Scenario Cam0, Year Maximum



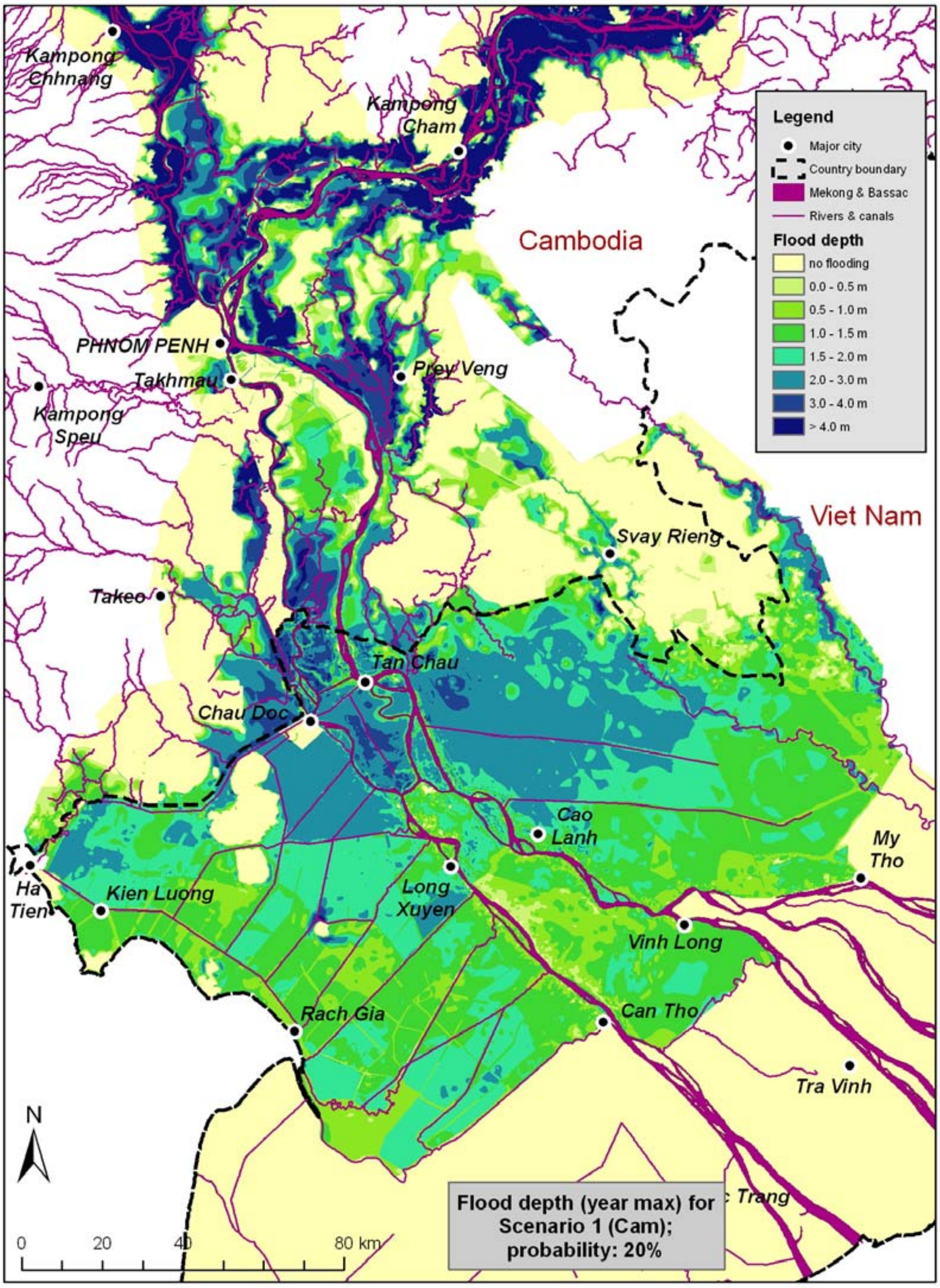
Attachment 1.17: Flood Hazard map at p=4%, Scenario Cam0, Year Maximum



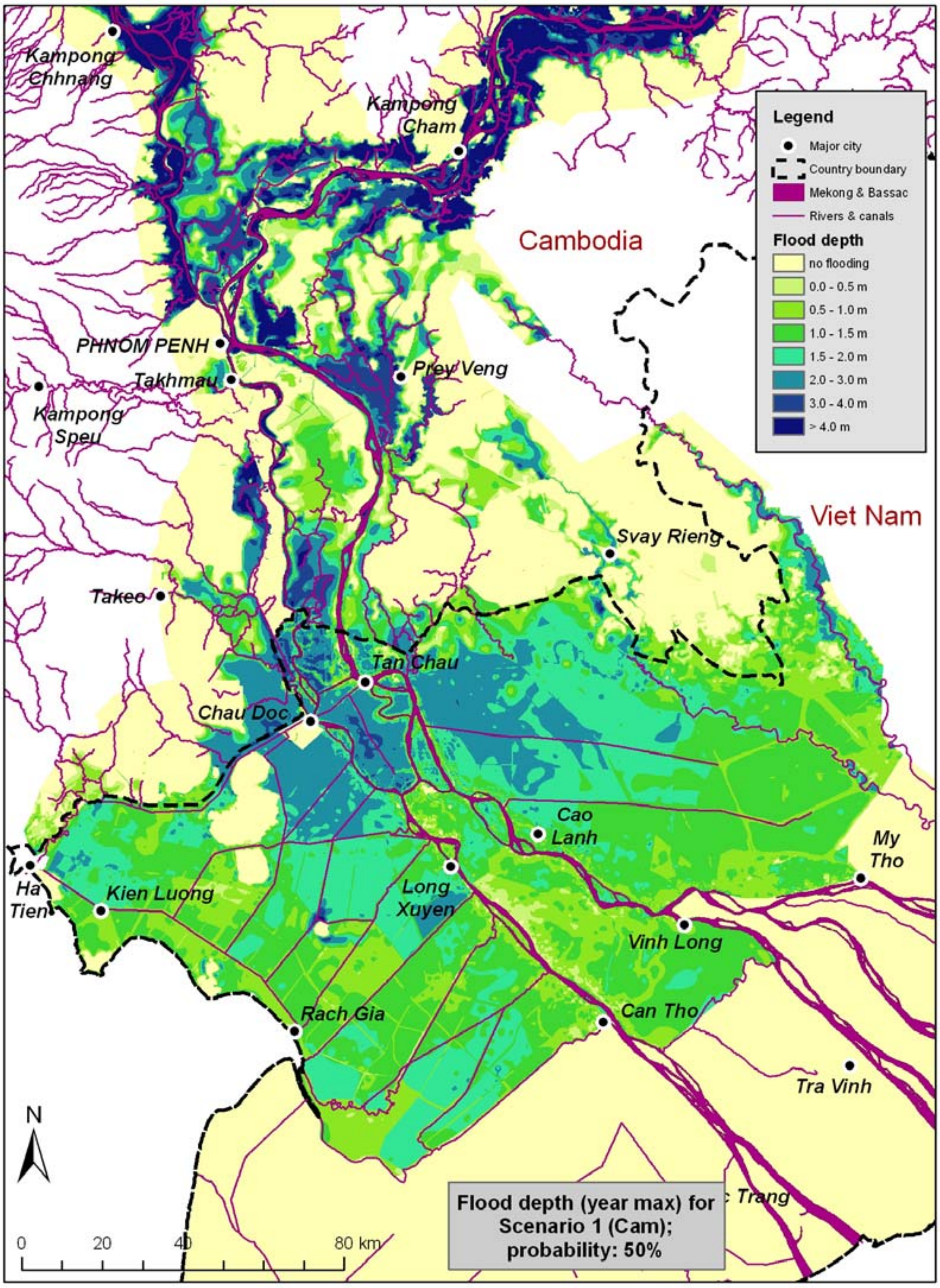
Attachment 1.18: Flood Hazard map at p=10%, Scenario Cam0, Year Maximum



Attachment 1.19: Flood Hazard map at p=20%, Scenario Cam0, Year Maximum



Attachment 1.20: Flood Hazard map at p=50%, Scenario Cam0, Year Maximum



Appendix 2 Flood Damage Assessment and Flood Risk Assessment

CONTENTS

ATTACHMENTS

1 INTRODUCTION

1.1 Scope of the Demonstration Project (DP)

The Project area is delimited to the north and the west by RN2, to the east by the RN21 and to the south by the Vietnam-Cambodian border. Based on annual flooding conditions (deep and shallow flooded area), existing infrastructures and actual land and water use conditions (road as flood protection dike embankment, existing natural and man made drainage network), the West Bassac area could be subdivided into three zones for effective flood risk management:

-Zone 1: Deep flooded currently cash crop area immediately left to the RN21 and the deepest part of the flood plain to the west following the same alignment of the Prek Ambel. This zone is conceived to be a full flood protection area consisting of four large polder systems. The Prek Ambel will be improved and managed as a bypass canal to mitigate water level increase in the eastern area of the Bassac River that might be impacted by the proposed infrastructure.

-Zone 3: Shallow flooded area immediately to the east of the RN2 will be protected against peak flood from the Mekong flood by a dike system and from the western catchment by a drainage/irrigation canal along the RN2.

-Zone 2: Deep flooded area in between of the Zone 3 and Zone 1, this zone is proposed to be protected against the early flood up to 31 of July. The area will be flooded after this date. See Figure 1.1 Project location map.

The socio-economic survey and flood damage data collection for the two districts Koah Andeth in Takeo province and Kaoh Thum in Kandal province were carried out during the phase 1 and additional data collection on socio-economic indicators and flood damages for remaining districts in the West Bassac area were collected. In short, district socio-economic indicators and land-use in 2007, district direct flood damages from 2000-2008 were available for the study.

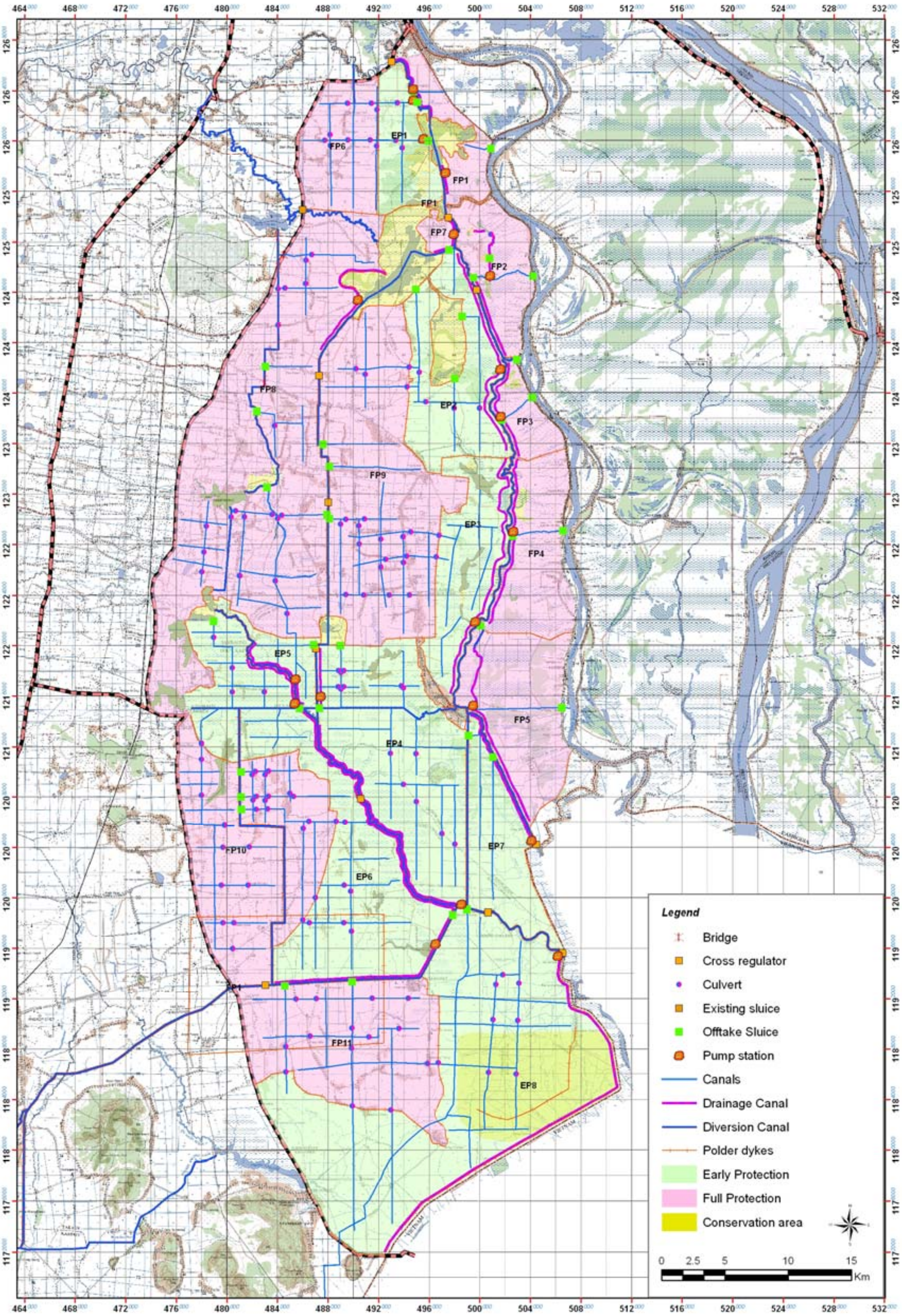


Figure 1.1 **Project Location Map**

1.2 Methodology and approach for flood damage assessments

There are basically two approaches for flood risk assessment[1]: Absolute approach (a top-down) and relative approach (a bottom-up). In the absolute approach historical damage data for an (administrative) area are used to assess the flood damage risk in that area. In the relative approach inundation-damage relationships are developed on a per unit (ha, % of house value) basis, and the flood damage risk is assessed by applying the per unit risk to the number of units in the concerned area.

In this study, considering resource, time and data availability, absolute approach has been applied for flood damage assessment to Housing, Agriculture, and Infrastructure. As defined in phase #1 of the program, housing damage covers individual house, structure and properties of flood affected families, agriculture damage covers crops and aquaculture which is an important in lower Mekong Delta, infrastructure damage covers all remaining items such as public infrastructure and utilities, industries, institutions etc.

The grand total of damages caused by a flood in a certain district is the total of direct damages plus the total of indirect damages. Direct damages are obtained from local authorities at provincial and district levels from 2000-2008. It covers loss of life, damages to housing, crops, aquaculture, and infrastructure broken down into irrigation, transportation, power and water supply, education, health etc. The indirect-direct damage ratios were taken from results of the detail survey during the phase 1 for the focal areas to estimate the grand total of damages.

A first step in this approach is the proper assessment of the flood hazard, i.e. the flood levels with different exceedance probabilities with the help of the MRC ISIS model (see Appendix 1).

The second step is to establish damage functions for three damage group categories with maximum flood water level for individual district.

The third step is to develop flood damage probability curves and hence calculating expected damage at selected flood return period of 100, 50, 25, 10 and 2 years.

[1] The Guidelines for Flood Risk Assessment, April 2009

2 DATA COLLECTION AND PROCESSING

The West Bassac project area covers 9 districts in Takeo province and 4 districts in Kandal province. During the phase #1 of the FMMP_C2, intensive socio-economic survey (household and business) and district data collection were carried out in the two selected districts in focal area, Cambodia: Koah Andeth district in Takeo and Kaoh Thum district in Kandal. Additional data collection on socio-economic indicators and direct flood damages for the remaining districts in the project area was implemented in Mar-April 2009, during the phase #2 of the FMMP_C2.

A dataset was obtained at district level from phase #1 and phase #2 covering (i) direct flood damages for a period 2000-2008; (ii) district socio-economic indicators and land-use 2007; (iii) survey on the 2006 flood damage for household/business; (iv) indirect costs spent in the 2006 flood by district departments; and (v) Focus group discussions.

2.1 Flood damages

Direct flood damages data were collected from provincial and/or district departments from annual reports. It covers damages for housing and properties, crops, aquaculture, infrastructure (roads, irrigation, power and water supply, schools, industry and commercial centres, public service utilities etc.), and emergency rescue and relief. Details are presented in Attachment 2. The flood direct damages were grouped into 3 main categories as housing, infrastructure, and agriculture.

Total direct and indirect flood damages were estimated based on indirect-direct damage ratios which were taken from the Household and Business surveys for the selected districts in the focal area of Cambodia. A relation between indirect and direct damages was derived for 2006 flood at a level of 68% for the Housing category[2]. From the secondary data collection at district level on indirect flood damage data, a relation between indirect and direct damages for the Infrastructure & Relief category was derived for the 2006 flood. This relation was used to increase the direct damages as reported for the provincial level for infrastructure with 30% to obtain the total damages for this category.

The total flood damages were deflated to the 2007 constant price by using deflation index (2007=100). See the Table 2.1, Table 2.2 and Table 2.3

Table 2.1 Deflation index (2007=100)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008
Deflation	110%	109%	108%	107%	105%	104%	102%	100%	98%

Source: http://www.photius.com/

[2] Details are presented in Annex 2: Flood Damages and Flood Risks in the Focal Areas, August 2008

Table 2.2 Direct & Indirect flood damages (1000 US$ at 2007 price), Kandal province

District	2000	2001	2002	2003	2004	2005	2006	2007	2008
Kandal Stung	**2,265.3**	**1,020.2**	**228.1**	**359.6**	**317.4**	**0.0**	**43.4**	**0.0**	**0.0**
Housing	106.2	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0
Agriculture	1,564.5	918.5	205.6	347.5	0.0	0.0	0.0	0.0	0.0
Infrastructure	594.6	101.8	22.4	12.0	317.4	0.0	41.3	0.0	0.0
S'ang	**4,767.0**	**1,574.7**	**1,009.3**	**113.6**	**384.4**	**143.3**	**106.6**	**39.4**	**12.7**
Housing	179.4	15.9	127.4	0.4	111.5	3.1	0.0	0.0	0.0
Agriculture	2,122.5	1,214.7	554.1	0.0	0.0	0.0	0.0	0.0	0.0
Infrastructure	2,465.1	344.1	327.8	113.1	272.8	140.2	106.6	39.4	12.7
Kaoh Thum	**1,407.2**	**550.2**	**333.4**	**145.8**	**131.3**	**427.3**	**143.4**	**135.9**	
Housing	52.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Agriculture	459.7	240.0	121.1	0.0	0.0	279.8	10.1	5.9	
Infrastructure	895.4	310.2	212.3	145.8	131.3	147.5	133.3	130.0	
Ta Khmau	**853.2**	**228.5**	**124.2**	**11.7**	**0.0**	**0.0**	**34.5**	**1.3**	**0.0**
Housing	8.0	11.3	10.2	0.0	0.0	0.0	2.6	1.3	0.0
Agriculture	139.4	99.3	0.0	0.0	0.0	0.0	31.2	0.0	0.0
Infrastructure	705.9	117.9	114.0	11.7	0.0	0.0	0.7	0.0	0.0

Source: District/province data and consultant estimates

Table 2.3 Direct & Indirect flood damages (1000 US$ at 2007 price), Takeo province

District	2000	2001	2002	2003	2004	2005	2006	2007	2008
Angkor Borei	**2,651**	**622**	**695**	**8**	**45**	**76**	**25**	**4**	**7**
Housing	1,368.0	7.8	6.1	3.4	0.6	0.3	0.2	0.2	0.0
Agriculture	805.7	553.5	224.9	0.0	21.0	70.7	0.0	0.0	0.0
Infrastructure	477.3	60.4	464.3	4.4	23.0	4.6	24.3	3.5	7.1
Daun Keo	**406.7**	**197.6**	**71.7**	**41.1**	**30.7**	**34.0**	**59.4**	**36.9**	**29.1**
Housing	61.8	48.1	50.9	28.2	18.6	20.7	46.3	21.8	20.2
Agriculture	204.2	100.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Infrastructure	140.6	49.4	20.8	12.8	12.1	13.3	13.1	15.1	8.9
Prey Kabbas	**1,372.0**	**552.4**	**465.0**	**276.9**	**363.2**	**323.1**	**300.7**	**361.1**	**239.5**
Housing	56.5	42.6	31.4	37.7	40.7	34.7	40.7	43.9	35.2
Agriculture	479.9	366.7	96.0	1.5	94.0	88.2	90.8	137.5	57.4
Infrastructure	835.5	143.1	337.6	237.8	228.4	200.2	169.1	179.7	146.9
Samroang	**1,026.5**	**589.2**	**372.1**	**183.2**	**87.0**	**50.6**	**90.6**	**39.5**	**12.2**
Housing	111.3	25.7	32.2	93.0	11.2	7.8	66.7	13.0	1.3
Agriculture	304.1	244.7	28.1	45.0	53.5	1.2	1.1	0.8	1.0
Infrastructure	611.1	318.7	311.8	45.3	22.3	41.5	22.8	25.6	9.8
Traing	**2,269.9**	**541.3**	**116.2**	**43.3**	**6.3**	**2.4**	**0.0**	**0.0**	**0.0**
Housing	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	1,880.4	505.4	96.0	15.4	6.3	2.4	0.0	0.0	0.0
Infrastructure	384.0	35.9	20.1	27.9	0.0	0.0	0.0	0.0	0.0
Borei Cholsar	**1,676.7**	**1,298.7**	**495.9**	**212.5**	**103.5**	**93.3**	**16.0**	**38.3**	**34.0**
Housing	239.2	70.4	25.3	0.0	1.9	14.1	0.0	2.9	3.3
Agriculture	1,347.3	1,167.0	376.3	196.8	28.1	20.3	2.3	2.6	3.1
Infrastructure	90.1	61.4	94.3	15.7	73.6	58.8	13.7	32.9	27.7
Bati	**437.7**	**309.0**	**32.2**	**63.8**	**0.0**	**0.0**	**4.4**	**0.0**	**0.0**
Housing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	244.7	306.7	29.1	58.0	0.0	0.0	0.0	0.0	0.0
Infrastructure	193.0	2.3	3.2	5.8	0.0	0.0	4.4	0.0	0.0
Kiri Vong	**2,157.1**	**1,816.3**	**258.9**	**81.3**	**120.6**	**55.8**	**4.9**	**67.1**	**1.7**
Housing	42.6	0.0	0.0	0.0	0.0	0.0	0.0	25.3	0.0
Agriculture	1,622.2	1,748.2	166.8	81.3	119.8	38.5	4.9	0.7	1.2
Infrastructure	492.3	68.1	92.1	0.0	0.8	17.3	0.0	41.0	0.5
Kaoh Andeth	**1,846.3**	**1,594.8**	**524.9**	**540.2**	**261.6**	**175.2**	**80.5**	**1,846.3**	
Housing	29.0	18.6	9.8	4.3	3.9	4.5	2.7	29.0	
Agriculture	1,303.0	1,306.2	376.0	430.6	164.1	84.0	0.0	1,303.0	
Infrastructure	514.3	270.0	139.2	105.3	93.7	86.6	77.8	514.3	

Source: District/province data and consultant estimates

3 FLOOD WATER LEVELS

ISIS hydraulic model was used to simulate flood water level in entire Mekong Delta of Cambodia and Vietnam. The output of daily water level from 1910-2006 at representative locations for each districts located in the West Bassac project area was used for flooding hazard analysis. For the Flood Hazard Assessment, reference is made to Appendix 1.

4 FLOOD DAMAGE ASSESSMENT

The method used for flood damage assessment is specified in the Guidelines for Flood Risk Assessment. Considering data availability, resources, and study objectives the absolute damage assessment methodology is used for the demonstration projects in generally and for the West Bassac particularly.

Flood damage curves or damage functions would be established by relationship between yearly maximum flood water levels at representative location of the district and yearly flood damages in the district by three main categories: Infrastructure, Housing, and Agriculture.

Combining the damage functions and the fit functions of the flood water levels (see Appendix 1), flood damages are obtained and hence damage probability curves are developed.

Table 4.1 summarizes the flood damages for each district (corrected to account for only the West Bassac side of two districts that are partly also in the Trans Bassac area).

Attachments 2.1 to 2.13 show the damage graphs for each district for the combined damage categories for infrastructure and housing, and for agriculture (together with the flood damage graphs and the flood risk probability graphs).

Table 4.1 Estimate of flood damage without and with the IFRM Plan

District	Area (ha)	Base Case: Damage to Infrastructure and Housing (USD 1,000)						Cam0: Damage to Infrastructure and Housing (USD 1,000)					
		1%	2%	4%	10%	20%	50%	1%	2%	4%	10%	20%	50%
Kandal Stueng	26,343	2,040	1,932	1,725	1,174	453	-	3,550	3,364	3,015	2,129	-	-
Kaoh Thum	14,162	361	339	298	190	54	43	308	286	245	136	52	-
Ta Khmau	3,144	957	894	775	454	26	-	1,652	1,552	1,366	895	-	-
Angkor Borei	30,079	2,539	2,366	2,035	1,160	25	-	3,346	3,160	2,803	-	-	-
Bati	37,358	301	279	235	119	1	1	-	-	-	-	-	-
Bourei Cholsar	24,437	331	319	295	232	145	16	271	259	236	-	-	-
Doun Kaev	9,458	235	224	202	145	67	41	159	148	127	-	-	-
Kaoh Andaet	35,019	691	648	566	344	162	125	496	453	371	-	-	-
Kiri Vong	59,276	681	636	552	320	1	-	551	504	415	178	-	-
Prey Kabbas	26,585	1,170	1,104	979	651	246	233	845	786	-	-	-	-
Samraong	29,738	840	803	732	541	280	74	-	-	-	-	-	-
Tram Kak	56,074	18	17	14	8	1	1	9	8	6	1	1	0
S'ang	16,173	1,194	1,118	973	586	80	61	1,125	1,049	903	506	74	-
Treang	41,030	539	496	414	191	16	12	240	-	-	-	-	-
Total Kandal	**408,875**	**11,895**	**11,174**	**9,795**	**6,114**	**1,558**	**607**	**12,553**	**11,569**	**9,485**	**3,846**	**126**	**0**
		Base Case: Damage to Agriculture (USD 1,000)						**Cam0: Damage to Agriculture (USD 1,000)**					
Kandal Stueng	26,343	1,885	1,788	1,604	1,113	469	-	3,232	3,066	2,754	1,965	-	-
Kaoh Thum	34,092	136	131	122	97	66	15	124	119	110	85	54	-
Ta Khmau	3,144	155	148	134	95	44	5	239	227	204	148	-	-
Angkor Borei	30,079	936	895	817	611	343	-	1,126	1,082	998	-	-	-
Bati	37,358	322	309	284	217	130	22	-	-	-	-	-	-
Bourei Cholsar	24,437	1,602	1,535	1,407	1,058	585	-	1,275	1,208	1,080	-	-	-
Doun Kaev	9,458	195	186	168	120	55	-	132	123	105	-	-	-
Kaoh Andaet	35,019	1,268	1,216	1,116	846	478	164	1,030	978	878	-	-	-
Kiri Vong	59,276	1,830	1,759	1,623	1,250	737	-	1,621	1,546	1,403	1,022	-	-
Prey Kabbas	26,585	477	460	429	348	245	82	396	382	-	-	-	-
Samraong	29,738	254	246	230	187	129	22	-	-	-	-	-	-
Tram Kak	56,074	-	-	-	-	-	-	-	-	-	-	-	-
S'ang	35,683	834	795	719	519	257	-	798	759	683	478	196	-
Treang	41,030	2,298	2,152	1,871	1,108	70	6	1,276	-	-	-	-	-
Total Takeo	**448,315**	**12,191**	**11,620**	**10,523**	**7,570**	**3,608**	**315**	**11,250**	**9,490**	**8,216**	**3,698**	**250**	**-**
Total	**857,190**	**24,087**	**22,794**	**20,318**	**13,684**	**5,167**	**922**	**23,803**	**21,059**	**17,701**	**7,544**	**376**	**0**

5 FLOOD RISK

Flood risk can be calculated as the flood damage times its probability of exceedance, an integral of the flood damage probability curve; it is the area below the flood damage probability curve from p=0% up to the given probability P (say 20%, 10%, 4%, 2%, 1% etc.). The area represents annual expected risk caused by floods which are equal or higher than the flood at the specified probability p. The unit of measurement is $/year.

Flood risk reduction, when flood protection measures are provided to control the flood at certain probability p is an area below the flood damage probability curve from p to p=100%. The unit of measurement is $/year.

Table 5.1 summarizes the flood risk for each district (corrected to account for only the West Bassac side of two districts that are partly also in the Trans Bassac area).

Attachments 2.1 to 2.13 show the flood risk graphs for each district for the combined damage categories for infrastructure and housing, and for agriculture (together with the flood damage graphs and the flood damage probability graphs).

Flood risk maps for various probability of exceedance are presented in Attachment 3. It is noted that the graphs represent the analysis of the 59 districts as undertaken in the demonstration project on Flood Risk Management in the Brder Zone between Cambodia and Vietnam.

Table 5.1 Estimate of flood risk without and with the IFRM Plan, and risk reduction

District	Area (ha)	RISK REDUCTION	Base Case: Risk to Infrastructure and Housing (USD 1,000 per year)							Cam0: Risk to Infrastructure and Housing (USD 1,000 per year)					
			1%	2%	4%	10%	20%	50%	90%	1%	2%	4%	10%	20%	50%
Kandal Stueng	26,343	(133)	21	41	77	164	243	261	261	36	71	135	288	394	394
Kaoh Thum	14,162	28	4	7	14	28	40	54	70	3	6	11	23	30	42
Ta Khmau	3,144	(47)	10	19	36	72	95	95	95	17	33	62	129	142	142
Angkor Borei	30,079	55	26	51	95	190	246	246	246	34	67	127	191	191	191
Bati	37,358	26	3	6	11	22	26	26	27	1	1	1	1	1	1
Bourei Cholsar	24,437	54	3	7	13	29	47	65	71	3	5	10	17	17	17
Doun Kaev	9,458	53	2	5	9	19	30	43	58	2	3	6	6	6	6
Kaoh Andaet	35,019	141	7	14	26	53	75	117	162	5	10	18	22	22	22
Kiri Vong	59,276	24	7	14	25	51	67	67	67	6	11	20	38	42	42
Prey Kabbas	26,585	276	12	23	44	93	136	207	299	9	17	24	24	24	24
Samraong	29,738	167	9	17	32	70	111	144	172	5	5	5	5	5	5
Tram Kak	56,074	1	0	0	1	1	2	2	2	0	0	0	0	1	1
S'ang	16,173	51	12	24	45	91	123	143	166	12	22	42	84	108	115
Treang	41,030	49	6	11	20	38	44	48	53	3	3	3	3	3	3
Total Kandal	**408,875**	**746**	**123**	**238**	**447**	**921**	**1,284**	**1,520**	**1,749**	**135**	**255**	**465**	**831**	**986**	**1,005**
			Base Case: Risk to Agriculture (USD 1,000 per year)							**Cam0: Risk to Agriculture (USD 1,000 per year)**					
Kandal Stueng	26,343	(110)	19	38	72	153	230	252	252	33	65	123	263	362	362
Kaoh Thum	34,092	8	1	3	5	12	20	31	33	1	2	5	11	17	24
Ta Khmau	3,144	3	2	3	6	13	20	23	25	2	5	9	20	22	22
Angkor Borei	30,079	90	10	19	36	78	125	157	157	11	23	43	67	67	67
Bati	37,358	68	3	6	12	27	45	61	69	1	1	1	1	1	1
Bourei Cholsar	24,437	186	16	32	61	135	216	264	264	13	25	48	78	78	78
Doun Kaev	9,458	23	2	4	7	16	25	28	28	1	3	5	5	5	5
Kaoh Andaet	35,019	253	13	25	49	107	173	241	300	11	21	39	48	48	48
Kiri Vong	59,276	132	19	37	70	156	255	324	324	17	32	62	134	193	193
Prey Kabbas	26,585	121	5	10	18	42	71	116	132	4	8	11	11	11	11
Samraong	29,738	60	3	5	10	22	38	59	62	2	2	2	2	2	2
Tram Kak	56,074	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S'ang	35,683	17	9	17	32	69	107	124	124	8	16	30	65	98	106
Treang	41,030	219	24	46	86	175	232	234	235	14	17	17	17	17	17
Total Takeo	**448,315**	**1,069**	**125**	**244**	**465**	**1,005**	**1,555**	**1,912**	**2,003**	**118**	**219**	**395**	**721**	**920**	**936**
Total	**857,190**	**1,814**	**247**	**482**	**912**	**1,927**	**2,840**	**3,432**	**3,752**	**254**	**474**	**860**	**1,552**	**1,906**	**1,941**

6 BENEFITS OF FLOOD CONTROL MEASURE

6.1 Flood risk reduction

Flood risk assessment was carried out for three main flood damage categories in each districts as presented in the Chapter 5. It provides an annual expected flood damage ($/year) which is referred to as the risk: the sum of expected damage at certain probabilities of exceedance. The IFRM Plan reduces the risk, by providing flood protection, taken at 1% for infrastructure and housing and agriculture in the full protection areas and 10% in the areas protected against early floods.

The West Bassac project covers 9 districts in Takeo with an area of 181,160 ha and 4 districts in Kandal with an area of 45,959 ha. One could argue that the flood risk reduction that has been worked out at the level of whole districts should be corrected for the part of the protected area in each district within the IFRM Plan area. However, that should not be done because impact of flood protection for the plan area spreads over a larger area and is a result of the plan. Therefore total flood risk reduction is to be taken into account.

The West Bassac project proposed to be full flood protection in zone 1 and zone 3 at 1% probability for infrastructure, housing and agriculture. Meanwhile early flood protection is provided for zone 2 to protect only crops from the annual flood at 10% probability. For those districts (almost all) where parts are fully protected and parts only receive early flood protection, the calculations have been done with the weighted average risk for the two types of protection. Total flood risk reduction by the proposed measures would be **1.814 mln US$/year** of which 0.746 mln US$/year for infrastructure and housing and 1.069 mln for agriculture. Details on flood damages in the districts for the two categories of damages and for various probabilities of exceedance are presented in Table 5.1; summarizes the Risk and the risk reduction.

6.2 Natural fish lost

Natural fish lost is considered as negative “benefit” for the proposed flood control measures due to reduction of flooded/inundated flood plain. In the Focus Group Discussion in the six surveyed communes local people mentioned that floods have significant benefits for local community as providing protein source.

Depending on the district, 30-100% of families in the deep flooded area are fishing during the flood season. Duration for fishing is reported as 2-3 months in five communes; in the Prek Thmey commune fishing lasts for 7 months. The benefit of flood for capture fisheries of people in deep flooded areas are 0.32–3.78 million Riel/fishing household (about 80 – 945 US$) in most communes and much higher in the Prek Thmey commune as they also fish outside the flood season.

According to MRC[3]-Technical Paper, average amount of fish catch from rice field in Mekong Delta Flood Plain (deep flooded areas) would be 80-119 kg/ha resulting in the value of 30-40 US$/ha.

[3] MRC-Technical Paper, No:16, October 2007:Consumption and the yield of fish and other aquatic animals from the Lower Mekong Basin

6.3 Reduction of soil fertility

Other benefits of flooding is leaching toxicity substances cumulated during crop cultivation, improving soil texture, reducing rat/pest population, and soil fertility as results of sedimentation. It will be treated as negative 'benefits' in the flood control measures.

In the Focus Group Discussion in the six surveyed communes farmers mentioned that floods have significant benefits for crop cultivation. After a big flood, the crop yield would be 1.5-2 ton higher than after a normal flood. The application of fertilizers and pesticides, however, is almost the same. Flood benefits for agriculture would be 0.62-0.93 million Riel[4]/ha (about 150-230 US$/ha). Assuming big flood frequency of one third, the annual flood benefit for agriculture would be 50-80 US$/ha.

The intensive study on the impact of soil fertility was carried out in North Vam Nao water control project funded by AusAID in two flood seasons in 1999 and 2002. The two studies have the same conclusions that the amount of fertilizers contained in sediment would be insignificant compared with the amount of fertilizers applied by farmers to their crops. Findings of the study in 2002 show that composition of sediment includes 199.kg total nitrogen, 146kg total phosphorus and 279kg calcium. It was equivalent to available nitrogen in NO_3 compound (0.005kg/ha), available phosphorus in P_2O_5 compound (9.66kg/ha), and K_2O (5.52kg/ha).

The studies show that positive impacts of flooding to agriculture would be (i) Reducing insects and germs; (ii) Neutralizing and flushing soil toxicants; (iii) Speeding up the process of plant residue disintegration; (iv) Improving soil texture; and (v) Fertilizing soil.

[4] 1 USD = 4,000 Riel

Attachment 1: Direct Flood damage data of 13 Distrticts

Attachment 1.1: Flood damage data (current price in Riel)

Inventory of Direct Flood Damages at District Level from 2000 to 2008

Country: Cambodia
Province: Takeo **CURRENCY:** Riel
District: Ankor Borey

Types	No	Items	Unit	Year: 2000		Year: 2001		Year: 2002		Year: 2003		Year: 2004		Year: 2005		Year: 2006		Year: 2007		Year: 2008	
				Quant	Cost	Quant	Cost	Quant	Cost	Quant	Cost	Quant	Cost	Quant	Cost	Quant	Cost	Quant	Cost	Quant	Cost
Human	HU1	Number of causalities	Person	5		2		5		1		0		0		0		0		0	
	HU2	Number of missing people	Person	0		0		0		0		0		0		0		0		0	
	HU3	Number of injured people	Person	2,417		156		395		15		0		9		0		0		0	
	HU4	Number of affected households	Family	7,519		582		1,696		380		490		495		490		480		450	
	HU5	Number of affected people	Person	40,219		3,129		7,853		2,044		2,636		2,665		2,636		2,582		2,421	
Housing	HO1	Collapsed/swept away houses	Nos	360	1,160,000,000	6	8,600,000	4	6,400,000	2	6,000,000	0		0		0		0		0	
	HO2	houses	Nos	6,695	1,339,000,000	10	2,000,000	9	1,800,000	2	800,000	4	800,000	2	400,000	2	400,000	1	300,000	0	
	HO3	Damaged properties	Riel		465,600,000		6,400,000		5,200,000		750,000		600,000		300,000		150,000		93,000	0	
Education	ED1	Number of affected schools	Nos	4	4,000,000	4	4,000,000	4	4,000,000	4	4,000,000	4	4,000,000	4	4,000,000	4	4,000,000	4	4,000,000	4	4,000,000
	ED2	Damaged classrooms	Nos	13	21,542,000	3	3,625,000	13	21,542,000	0	0	10	17,917,000	0	0	10	17,917,000	0	0	7	14,292,000
	ED3	Damaged houses	Nos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ED4	Damaged desks & chairs	Set	401	19,275,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ED5	Damaged books	Nos	474	2,049,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ED6	Damaged education equipment	Set	11	1,440,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Health care	HE1	Number of affected clinics	Nos	3		1		0		0		1		0		0		0		0	
	HE2	Damaged rooms	Nos	6	78,400,000	3	30,000,000	0		0		2	25,000,000	0		0		0		0	
	HE3	Medicine damaged	Riel	LS	20,000,000	LS	10,000,000	0		0		LS	5,000,000	0		0		0		0	
	HE4	Medical equipment damaged	Riel	LS	9,600,000	LS	15,000,000	0		0			0	0		0		0		0	
	HE5	Other assets damaged	Riel	1	4,000,000		5,000,000	0		0			10,000,000	0		0		0		0	
Structures	ST1	Cultural/historical structures	Nos	0		0		0		0		0		0		0		0		0	
	ST2	Head offices	Nos	6	12,000,000	4	4,000,000	4	4,000,000	4	4,000,000	4	4,000,000	4	4,000,000	4	2,000,000	4	2,000,000	4	2,000,000
	ST3	Market/commercial centers	Nos	0		0		0		0		0		0		0		0		0	
	ST4	Warehouses	Nos	0		0		0		0		0		0		0		0		0	
	ST5	Other works	Nos	0		0		0		0		0		0		0		0		0	
Agro-forest	AG1	Damaged rice area	Ha	2,805	2,134,360,000	1,946	1,583,020,000	537	410,400,000	0	0	80	64,500,000	263	209,475,000	0	0	0	0	0	0
		+Lost completely	Ha	2,634	2,107,000,000	1,898	1,575,340,000	507	405,600,000	NA		80	64,500,000	263	209,475,000	0		0		0	
		+Seed lost (just sown)	Ha	171	27,360,000	48	7,680,000	30	4,800,000	NA		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		NA		0		0		0		0		0	
	AG2	Damaged flowers/vegetables	Ha	226	135,600,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		+Lost completely	Ha	0		NA		NA		NA		NA		NA		0		0		0	
		+Productivity decreased	Ha	226	135,600,000	NA		NA		NA		NA		NA		0		0		0	
	AG3	Damaged field crops	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
		+Lost completely	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
		+Seed lost (just sown)	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
		+Productivity decreased	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
	AG4	Damaged perennial trees	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
		+Dead	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
		+Productivity decreased	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
	AG5	Damaged fruit trees	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
		+Dead	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
		+Productivity decreased	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
	AG6	Damaged seeds	Ton	365	171,385,000	247	118,435,000	66	326,625,000	NA		6	3,577,000	17	11,584,000	0		0		0	
	AG7	Damaged food	Ton	561	224,400,000	379	157,534,000	101	44,616,000	NA		11	6,450,000	33	20,947,000	0		0		0	
	AG8	Number of dead big livestock	Nos	NA		NA		2	1,200,000	NA		NA		NA		0		0		0	
	AG9	Number of dead little livestock	Nos	NA		NA		10	2,200,000	NA		NA		NA		0		0		0	
	AG10	Dead poultry	Nos	NA		NA		NA		NA		NA		NA		0		0		0	
	AG11	Damaged fertilizers	Ton	NA		NA		NA		NA		NA		NA		0		0		0	
	AG12	Damaged agro-chemicals	Ton	280	252,450,000	190	170,820,000	51	45,630,000	NA		4	5,160,000	20	29,925,000	0		0		0	
	AG13	Farm land eroded w/o recovery	Ha	0		0		0		0		0		0		0		0		0	
	AG14	Housing land eroded/lost	Ha	0		0		0		0		0		0		0		0		0	
Irrigation	IR1	Dyke damaged	Meter	4,000	160,000,000	0		0		0		0		0		0		0		0	
	IR2	Embankment damaged	Meter	0		0		0		0		0		0		0		0		0	
	IR3	Canal & Ditch damaged	Meter	7,600	280,000,000	0		5,000	200,000,000	0		0		0		0		0		0	
	IR4	Water reservoir and dam	Nos	2		0		0		0		0		0		0		0		0	
	IR5	Pumping station damaged	Nos	1	60,000,000	0		1	12,000,000	0		0		0		0		0		0	
	IR6	Other irrigation facilities	Nos	0		0		0		0		0		0		0		0		0	
Fishery	FI1	Aquaculture pond damages	Ha	0.05	3,600,000	0		0		0		0		0		0		0		0	
	FI2	Fish/shrimp lost from ponds	Ton	2	6,000,000	0		0		0		0		0		0		0		0	
	FI3	Fish cage, raft, trap damaged	No.	0		0		0		0		0		0		0		0		0	
	FI4	Other fishing tools damaged	Set.	20	800,000	0		0		0		0		0		0		0		0	
	FI5	Boats and ships lost	Nos	5	5,000,000	0		0		0		0		0		0		0		0	
Transport	TR1	Damaged national/provincial roads	Meter	7,000	140,000,000	0	0	3,000	60,000,000	0		0		0		0		0		0	
	TR2	Damaged rural roads	Meter	35,000	175,000,000	590	5,900,000	10,600	##########	0		0		0		0		0		0	
	TR3	Damaged railways	Meter	0	0	0	0	0	0	0		0		0		0		0		0	
	TR4	Damaged bridges/culverts	Nos	5	2,000,000	2	800,000	4	6,200,000	0		0		0		0		0		0	
	TR5	Damaged ports	Nos	0	0	0	0	0	0	0		0		0		0		0		0	
	TR6	Damaged airports	Nos	0	0	0	0	0	0	0		0		0		0		0		0	
	TR7	Damaged boats/vehicles	Nos	42	21,000,000	10	5,000,000	25	12,500,000	0		0		0		0		0		0	
	TR8	Other damages	Riel		15,000,000		6,000,000		10,500,000	0		0		0		0		0		0	
Communication	CO1	Damaged houses/stations	Nos	0		0		0		0		0		0		0		0		0	
	CO2	Damaged equipment/assets	Riel	0		0		0		0		0		0		0		0		0	
	CO3	Communication poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	CO4	Communication wires cut	Meter	0		0		0		0		0		0		0		0		0	
	CO5	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Industry	IN1	High tension poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	IN2	Electric wires cut	Meter	0		0		0		0		0		0		0		0		0	
	IN3	Damaged transformer stations	Nos	0		0		0		0		0		0		0		0		0	
	IN4	Damaged power plants	Nos	0		0		0		0		0		0		0		0		0	
	IN5	Damaged factories & plants	Nos	0		0		0		0		0		0		0		0		0	
	IN6	Damaged mines	Nos	0		0		0		0		0		0		0		0		0	
	IN7	Damaged machines, equipment	Nos	5	6,000,000	2	2,400,000	0		0		0		0		0		0		0	
	IN8	Damaged industrial products	Ton	4	8,000,000	3	7,000,000	0		0		0		0		0		0		0	
	IN9	Other industrial damages	Riel	LS	4,000,000		6,000,000	0		0		0		0		0		0		0	
Construction	CS1	Construction instrument damaged	Nos		21,000,000	0			630,000	0		0			560,000	0		0		0	
	CS2	Unfinished works swept away	M3		0	0			0	0		0			0	0		0		0	
	CS3	Construction material damaged	Riel		12,000,000	0			450,000	0		0			200,000	0		0		0	
	CS4	Other damages	Riel		5,000,000	0			220,000	0		0			150,000	0		0		0	
Water & Envi-ronment	WE1	Number of damaged wells	Nos	89	127,630,000	38	54,492,000	0		0		0		0		30	50,092,000	0		0	
	WE2	Water supply stations damaged	Nos	0		0		0		0		0		0		0		0		0	
	WE3	Drainage system damaged	Meter	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	WE4	Number of people without water	Person	0		0		0		0		0		0		0		0		0	
	WE5	area	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Prevention & Rescue (Gov +NGOs)	PR1	Flood prevention costs	Riel	0		0		0		0		0		0		0		0		0	
	PR2	Temporary relocation sites	Riel		131,400,000		11,600,000		17,600,000		4,000,000		4,000,000		4,000,000		4,000,000		4,000,000		3,000,000
	PR3	Foods & medicine etc. supplied	Riel	LS	120,000,000	LS	15,200,000	LS	32,000,000	LS	2,000,000	LS	3,500,000	LS	2,000,000	LS	2,000,000	LS	1,600,000	LS	1,000,000
	PR4	Costs for rescue	Riel	0		0		0		0		0		0		0		0		0	
	PR5	Others	Riel	0		0		0		0		0		0		0		0		0	
Other costs	OT1	?	???																		
	OT2	?	???																		
	OT3	?	???																		
			1000 US$		1,840		558		571		5		39		72		20		3		6
		Grand Total	Mil Riel		**7,358.53**		**2,232.83**		**2,285.21**		**21.55**		**154.50**		**287.54**		**80.56**		**11.99**		**24.29**
		Direct damages Housing	Mil Riel		2,964.60		17.00		13.40		7.55		1.40		0.70		0.55		0.39		0.00
		Direct Damages Agriculture	Mil Riel		2,933.60		2,029.81		830.67		0.00		79.69		271.93		0.00		0.00		0.00
		Relief&emergency	Mil Riel		251.40		26.80		49.60		6.00		7.50		6.00		6.00		5.60		4.00
		Infrastructures	Mil Riel		1,208.94		159.22		1,391.54		8.00		65.92		8.91		74.01		6.00		20.29

Attachment 1.2: Flood damage data (current price in Riel)

Inventory of Direct Flood Damages at District Level from 2000 to 2008

Country: Cambodia
Province: Takeo **CURRENCY:** Riel
District: Daun Keo

Types	No	Items	Unit	Year: 2000 Quant	Year: 2000 Cost	Year: 2001 Quant	Year: 2001 Cost	Year: 2002 Quant	Year: 2002 Cost	Year: 2003 Quant	Year: 2003 Cost	Year: 2004 Quant	Year: 2004 Cost	Year: 2005 Quant	Year: 2005 Cost	Year: 2006 Quant	Year: 2006 Cost	Year: 2007 Quant	Year: 2007 Cost	Year: 2008 Quant	Year: 2008 Cost
Human	HU1	Number of causalities	Person	0		0		0		0		0		0		0		0		0	
	HU2	Number of missing people	Person	0		0		0		0		0		0		0		0		0	
	HU3	Number of injured people	Person	0		0		0		0		0		0		0		0		0	
	HU4	Number of affected households	Family	58		42		50		18		0		0		16		0		0	
	HU5	Number of affected people	Person	240		210		225		90		0		0		80		0		0	
Housing	HO1	Collapsed/swept away houses	Nos	6	30,000,000	7	35,000,000	4	20,000,000	12	60,000,000	8	40,000,000	9	45,000,000	9	80,000,000	0		9	45,000,000
	HO2	houses	Nos	52	78,000,000	35	52,500,000	46	69,000,000	6	3,000,000	4	2,000,000	5	2,500,000	8	28,000,000	13	52,000,000	8	4,000,000
	HO3	Damaged properties	Riel	LS	26,000,000	LS	17,500,000	LS	23,000,000	0		0		0		0		0		0	
Education	ED1	Number of affected schools	Nos	2	1,000,000	2	1,000,000	0		0		0		0		0		0		0	
	ED2	Damaged classrooms	Nos	18	6,480,000	2	4,000,000	0		0		0		0		0		0		0	
	ED3	Damaged houses	Nos	0	0	0	0	0		0		0		0		0		0		0	
	ED4	Damaged desks & chairs	Set	80	320,000	0	0	0		0		0		0		0		0		0	
	ED5	Damaged books	Nos	300	120,000	0	0	0		0		0		0		0		0		0	
	ED6	Damaged education equipment	Set	4	80,000	0	0	0		0		0		0		0		0		0	
Health care	HE1	Number of affected clinics	Nos	0		0		0		0		0		0		0		0		0	
	HE2	Damaged rooms	Nos	0		0		0		0		0		0		0		0		0	
	HE3	Medicine damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE4	Medical equipment damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE5	Other assets damaged	Riel		1,400,000		3,000,000		150,000		100,000		20,000		40,000		800,000		600,000		738,000
Structures	ST1	Cultural/historical structures	Nos	0		0		0		0		0		0		0		0		0	
	ST2	Head offices	Nos	0		0		0		0		0		0		0		0		0	
	ST3	Market/commercial centers	Nos	0		0		0		0		0		0		0		0		0	
	ST4	Warehouses	Nos	0		0		0		0		0		0		0		0		0	
	ST5	Other works	Nos	0		0		0		0		0		0		0		0		0	
Agro-forest	AG1	Damaged rice area	Ha	1,785	743,400,000	864	366,956,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		+Lost completely	Ha	882	635,040,000	332	303,116,000	0		0		0		0		0		0		0	
		+Seed lost (just sown)	Ha	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	903	108,360,000	532	63,840,000	0		0		0		0		0		0		0	
	AG2	Damaged flowers/vegetables	Ha	0		0		0		0		0		0		0		0		0	
		+Lost completely	Ha	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG3	Damaged field crops	Ha	0		0		0		0		0		0		0		0		0	
		+Lost completely	Ha	0		0		0		0		0		0		0		0		0	
		+Seed lost (just sown)	Ha	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG4	Damaged perennial trees	Ha	0		0		0		0		0		0		0		0		0	
		+Dead	*Ha*	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG5	Damaged fruit trees	Ha	0		0		0		0		0		0		0		0		0	
		+Dead	*Ha*	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	*Ha*	0		0		0		0		0		0		0		0		0	
	AG6	Damaged seeds	Ton	0		0		0		0		0		0		0		0		0	
	AG7	Damaged food	Ton	0		0		0		0		0		0		0		0		0	
	AG8	Number of dead big livestock	Nos	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG9	Number of dead little livestock	Nos	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	0	Dead poultry	Nos	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	1	Damaged fertilizers	Ton	0		0		0		0		0		0		0		0		0	
	2	Damaged agro-chemicals	Ton	0		0		0		0		0		0		0		0		0	
	3	Farm land eroded w/o recovery	Ha	0		0		0		0		0		0		0		0		0	
	4	Housing land eroded/lost	Ha	0		0		0		0		0		0		0		0		0	
Irrigation	IR1	Dyke damaged	Meter	2,000	80,000,000	8,000	32,000,000		7,000,000	129	6,450,000	168	5,675,000	188	4,750,000	1,900	3,000,000	430	2,150,000	270	1,350,000
	IR2	Embankment damaged	Meter	0		0		0		0			31,000,000		20,000,000	0		0		0	
	IR3	Canal & Ditch damaged	Meter	5,000	200,000,000	1,500	60,000,000	0		0		0		0		0		0		0	
	IR4	Water reservoir and dam	Nos	1		0		0		0		0		0		0		0		0	
	IR5	Pumping station damaged	Nos	0		0		0		0		0		0		0		0		0	
	IR6	Other irrigation facilities	Nos	0		0		1	4,000,000	0		0		0		0		0		0	
Fishery	FI1	Aquaculture pond damages	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI2	Fish/shrimp lost from ponds	Ton	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI3	Fish cage, raft, trap damaged	No.	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI4	Other fishing tools damaged	Set.	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI5	Boats and ships lost	Nos	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Transport	TR1	roads	Meter	0		0		0		0		0		0		0		0		0	
	TR2	Damaged rural roads	Meter	0		0		0		0		0		0		0		0		0	
	TR3	Damaged railways	Meter	0		0		0		0		0		0		0		0		0	
	TR4	Damaged bridges/culverts	Nos	1	400,000	0		0		0		0		0		0		0		0	
	TR5	Damaged ports	Nos	0		0		0		0		0		0		0		0		0	
	TR6	Damaged airports	Nos	0		0		0		0		0		0		0		0		0	
	TR7	Damaged boats/vehicles	Nos	0		0		0		0		0		0		0		0		0	
	TR8	Other damages	Riel	0		0		0		0		0		0		0		0		0	
n	CO1	Damaged houses/stations	Nos	0		0		0		0		0		0		0		0		0	
	CO2	Damaged equipment/assets	Riel	0		0		0		0		0		0		0		0		0	
	CO3	Communication poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	CO4	Communication wires cut	Meter	0		0		0		0		0		0		0		0		0	
	CO5	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Industry	IN1	High tension poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	IN2	Electric wires cut	Meter	0		0		0		0		0		0		0		0		0	
	IN3	Damaged transformer stations	Nos	0		0		0		0		0		0		0		0		0	
	IN4	Damaged power plants	Nos	0		0		0		0		0		0		0		0		0	
	IN5	Damaged factories & plants	Nos	0		0		0		0		0		0		0		0		0	
	IN6	Damaged mines	Nos	0		0		0		0		0		0		0		0		0	
	IN7	Damaged machines, equipment	Nos	5	20,000,000	0		0		0		0		0		0		0		0	
	IN8	Damaged industrial products	Ton	0		0		0		0		0		0		0		0		0	
	IN9	Other industrial damages	Riel	0		0		0		0		0		0		0		0		0	
Construction	CS1	damaged	Nos	0		0		0		0		0		0		0		0		0	
	CS2	Unfinished works swept away	M3	0		0		0		0		0		0		0		0		0	
	CS3	Construction material damaged	Riel	0		0		0		0		0		0		0		0		0	
	CS4	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Water & Envi-ronment	WE1	Number of damaged wells	Nos	75	107,550,000	30	43,020,000	30	43,020,000	20	28,680,000	0		10	14,340,000	20	28,680,000	30	43,020,000	17	24,378,000
	WE2	Water supply stations damaged	Nos	0		0		0		0		0		0		0		0		0	
	WE3	Drainage system damaged	Meter	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	WE4	Number of people without water	Person	1,500	4,500,000	1,000	3,000,000	1,000	3,000,000	750	2,250,000	0		500	1,500,000	760	2,280,000	920	2,760,000	500	1,500,000
	WE5	area	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Prevention & Rescue (Gov +NGOs)	PR1	Flood prevention costs	Riel	0		0		0		0		0		0		0		0		0	
	PR2	Temporary relocation sites	Riel	LS	315,000	LS	340,000	LS	342,000	LS	350,000	LS	354,000	LS	359,000	LS	365,000	LS	370,000	LS	350,000
	PR3	Foods & medicine etc. supplied	Riel	LS	8,120,000	LS	5,880,000	LS	7,000,000	LS	2,520,000	LS	1,680,000	LS	1,960,000	LS	8,032,000	LS	1,820,000	LS	2,380,000
	PR4	Costs for rescue	Riel	0		0		0		0		0		0		0		0		0	
	PR5	Others	Riel	0		0		0		0		0		0		0		0		0	
Other costs	OT1	?	???																		
	OT2	?	???																		
	OT3	?	???																		
			1000 US	4,000	327		156		44		26		20		23		38		26		20
Grand Total			Mil Riel		**1,308**		**624**		**177**		**103**		**81**		**90**		**151**		**103**		**80**
Direct damages Housing			Mil Riel		134		105		112		63		42		48		108		52		49
Direct Damages Agriculture			Mil Riel		743		367		0		0		0		0		0		0		0
Relief&emergency			Mil Riel		8		6		7		3		2		2		8		2		3
Direct Damages Infrastructure			Mil Riel		422		146		57		37		37		41		35		49		28

Attachment 1.3: Flood damage data (current price in Riel)

Inventory of Direct Flood Damages at District Level from 2000 to 2008

Country: Cambodia
Province: Takeo **CURRENCY:** Riel
District: Prey Kabas

				Year: 2000		Year: 2001		Year: 2002		Year: 2003		Year: 2004		Year: 2005		Year: 2006		Year: 2007		Year: 2008	
Types	**No**	**Items**	**Unit**	**Quant**	**Cost**	**Quant**	**Cost**	**Quant**	**Cost**	**Quant**	**Cost**	**Quant**	**Cost**	**Quant**	**Cost**	**Quant**	**Cost**	**Quant**	**Cost**	**Quant**	**Cost**
Human	HU1	Number of causalities	Person	4		3		5		2		3		6		4		3		5	
	HU2	Number of missing people	Person	1		0		0		0		0		0		0		0		0	
	HU3	Number of injured people	Person	1		0		1		4		2		3		8		4		6	
	HU4	Number of affected households	Family	8,210		8,712		5,125		8,711		8,915		8,872		8,715		8,975		8,869	
	HU5	Number of affected people	Person	41,050		43,560		25,625		43,555		44,575		44,360		43,575		44,875		44,345	
Housing	HO1	Collapsed/swept away houses	Nos	10	100,000,000	8	80,000,000	6	60,000,000	7	70,000,000	8	80,000,000	7	70,000,000	8	80,000,000	9	90,000,000	7	70,000,000
	HO2	houses	Nos	15	7,500,000	12	6,000,000	8	4,000,000	12	6,000,000	14	7,000,000	13	6,500,000	12	6,000,000	13	6,500,000	14	7,000,000
	HO3	Damaged properties	Riel	LS	15,000,000	LS	7,000,000	LS	5,000,000	LS	8,000,000	LS	5,000,000	LS	3,000,000	LS	9,000,000	LS	8,000,000	LS	8,500,000
Education	ED1	Number of affected schools	Nos	1	500,000	1	370,000	2	1,000,000	4	950,000	2	600,000	2	600,000	3	850,000	4	1,175,000	4	780,000
	ED2	Damaged classrooms	Nos	2	2,300,000	2	2,300,000	3	550,000	5	530,000	4	600,000	3	200,000	3	250,000	2	250,000	0	
	ED3	Damaged houses	Nos	0		0		0		0		0		0		0		0		0	
	ED4	Damaged desks & chairs	Set	68	450,000	20	150,000	0		0		0		0		0		0		0	
	ED5	Damaged books	Nos	550	1,300,000	0		0		0		0		0		0		0		0	
	ED6	Damaged education equipment	Set	5	200,000	0		0		0		0		0		0		0		0	
Health care	HE1	Number of affected clinics	Nos	0		0		0		0		1	60,000,000	2	120,000,000	0		0		0	
	HE2	Damaged rooms	Nos	0		0		0		0		0		0		0		0		0	
	HE3	Medicine damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE4	Medical equipment damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE5	Other assets damaged	Riel	0		0		0		0		0		3 boats	30,000,000	0		0		0	
Structures	ST1	Cultural/historical structures	Nos	0		0		0		0		0		0		0		0		0	
	ST2	Head offices	Nos	0		0		0		0		0		0		0		0		0	
	ST3	Market/commercial centers	Nos	0		0		0		0		0		0		0		0		0	
	ST4	Warehouses	Nos	0		0		0		0		0		0		0		0		0	
	ST5	Other works	Nos	0		0		0		0		0		0		0		0		0	
Agro-forest	AG1	Damaged rice area	Ha	4,295	1,492,900,000	3,285	1,242,175,000	1,648	309,880,000	0	0	640	344,950,000	530	326,800,000	630	343,300,000	1,000	547,750,000	530	230,850,000
		+Lost completely	Ha	1,649	1,071,850,000	1,475	958,750,000	80	52,000,000	0		500	325,000,000	500	325,000,000	500	325,000,000	800	520,000,000	300	195,000,000
		+Seed lost (just sown)	Ha	148	8,880,000	145	8,700,000	8	480,000	0		30	1,800,000	30	1,800,000	30	1,800,000	50	3,000,000	20	1,200,000
		+Productivity decreased	Ha	2,498	412,170,000	1,665	274,725,000	1,560	257,400,000	0		110	18,150,000	0		100	16,500,000	150	24,750,000	210	34,650,000
	AG2	Damaged flowers/vegetables	Ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		+Lost completely	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
		+Productivity decreased	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG3	Damaged field crops	Ha	24	75,000,000	25	79,800,000	9	28,600,000	0	0	0	0	0	0	0	0	0	0	0	0
		+Lost completely	Ha	7	35,000,000	9	45,000,000	3	15,000,000	0		0		0		0		0		0	
		+Seed lost (just sown)	Ha	5	4,000,000	6	4,800,000	2	1,600,000	0		0		0		0		0		0	
		+Productivity decreased	Ha	12	36,000,000	10	30,000,000	4	12,000,000	0		0		0		0		0		0	
	AG4	Damaged perennial trees	Ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		+Dead	*Ha*	NA		NA		NA		NA		NA		NA		NA		NA		NA	
		+Productivity decreased	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG5	Damaged fruit trees	Ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		+Dead	*Ha*	NA		NA		NA		NA		NA		NA		NA		NA		NA	
		+Productivity decreased	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG6	Damaged seeds	Ton	350	164,500,000	20	9,400,000	25	11,750,000	0		0		0		0		0		0	
	AG7	Damaged food	Ton	NA		NA		NA		0		0		0		0		0		0	
	AG8	Number of dead big livestock	Nos	5	5,000,000	3	2,400,000	2	1,600,000	2	2,000,000	8	8,000,000	9	7,200,000	7	5,600,000	2	1,600,000	2	2,000,000
	AG9	Number of dead little livestock	Nos	7	2,100,000	9	2,300,000	4	2,000,000	5	1,500,000	10	3,000,000	12	3,000,000	20	6,000,000	1	300,000	3	900,000
	AG10	Dead poultry	Nos	1,500	6,000,000	1,000	4,000,000	200	800,000	500	2,000,000	250	1,000,000	550	2,300,000	250	1,000,000	50	200,000	130	520,000
	AG11	Damaged fertilizers	Ton	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG12	Damaged agro-chemicals	Ton	20	1,800,000	5	4,500,000	0		0		0		0		0		0		0	
	AG13	Farm land eroded w/o recovery	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG14	Housing land eroded/lost	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Irrigation	IR1	Dyke damaged	Meter	1,830	80,000,000	0		0		0		0		0		0		0		0	
	IR2	Embankment damaged	Meter	0		0		0		0		0		0		0		0		0	
	IR3	Canal & Ditch damaged	Meter	3,500	140,000,000	2,000	80,000,000	0		0		0		0		0		0		0	
	IR4	Water reservoir and dam	Nos	1	480,000,000	0		1	400,000,000	0		0		0		0		0		0	
	IR5	Pumping station damaged	Nos	0		0		0		0		0		0		0		0		0	
	IR6	Other irrigation facilities	Nos	1	200,000,000	0		0		0		0		0		0		0		0	
Fishery	FI1	Aquaculture pond damages	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI2	Fish/shrimp lost from ponds	Ton	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI3	Fish cage, raft, trap damaged	No.	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI4	Other fishing tools damaged	Set.	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI5	Boats and ships lost	Nos	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Transport	TR1	roads	Meter	7,000	224,000,000	0		0		0		0		0		0		0		0	
	TR2	Damaged rural roads	Meter	42,000	840,000,000	30,000	60,000,000	20,000	400,000,000	15,000	300,000,000	15,000	300,000,000	10,000	200,000,000	8,000	160,000,000	7,000	140,000,000	5,000	100,000,000
	TR3	Damaged railways	Meter	0		0		0		0		0		0		0		0		0	
	TR4	Damaged bridges/culverts	Nos	1	27,840,000	0		0		0		0		0		0		0		1	25,000,000
	TR5	Damaged ports	Nos	0		0		0		0		0		0		0		0		0	
	TR6	Damaged airports	Nos	0		0		0		0		0		0		0		0		0	
	TR7	Damaged boats/vehicles	Nos	0		0		0		0		0		0		0		0		0	
	TR8	Other damages	Riel	0		0		0		0		0		0		0		0		0	
on	CO1	Damaged houses/stations	Nos	0		0		0		0		0		0		0		0		0	
	CO2	Damaged equipment/assets	Riel	0		0		0		0		0		0		0		0		0	
	CO3	Communication poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	CO4	Communication wires cut	Meter	0		0		0		0		0		0		0		0		0	
	CO5	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Industry	IN1	High tension poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	IN2	Electric wires cut	Meter	0		0		0		0		0		0		0		0		0	
	IN3	Damaged transformer stations	Nos	0		0		0		0		0		0		0		0		0	
	IN4	Damaged power plants	Nos	0		0		0		0		0		0		0		0		0	
	IN5	Damaged factories & plants	Nos	0		0		0		0		0		0		0		0		0	
	IN6	Damaged mines	Nos	0		0		0		0		0		0		0		0		0	
	IN7	Damaged machines, equipment	Nos	0		0		0		0		0		0		0		0		0	
	IN8	Damaged industrial products	Ton	0		0		0		0		0		0		0		0		0	
	IN9	Other industrial damages	Riel	0		0		0		0		0		0		0		0		0	
Construction	CS1	damaged	Nos	0		0		0		0		0		0		0		0		0	
	CS2	Unfinished works swept away	M3	0		0		0		0		0		0		0		0		0	
	CS3	Construction material damaged	Riel	0		0		0		0		0		0		0		0		0	
	CS4	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Water & Envi-	WE1	Number of damaged wells	Nos	250	358,500,000	110	157,740,000	110	157,740,000	200	286,800,000	180	258,120,000	158	226,572,000	182	258,120,000	250	358,500,000	220	315,480,000
ronment	WE2	Water supply stations damaged	Nos	0		0		0		0		0		0		0		0		0	
	WE3	Drainage system damaged	Meter	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	WE4	Number of people without water	Person	7,000	21,000,000	3,500	10,500,000	3,300	9,900,000	6,500	19,500,000	4,750	14,250,000	4,000	12,000,000	4,500	13,500,000	7,000	21,000,000	6,500	19,500,000
	WE5	area	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Prevention &	PR1	Flood prevention costs	Riel		12,000,000		8,000,000		6,000,000		9,000,000		6,500,000		4,500,000		7,000,000		5,500,000		3,600,000
Rescue (Gov	PR2	Temporary relocation sites	Riel		72,000,000		46,000,000		18,000,000		57,000,000		32,000,000		15,000,000		48,000,000		28,000,000		12,000,000
+NGOs)	PR3	Foods & medicine etc. supplied	Riel		95,000,000		75,000,000		54,000,000		74,000,000		56,000,000		38,000,000		68,000,000		49,000,000		27,000,000
	PR4	Costs for rescue	Riel		1,200,000		900,000		600,000		1,100,000		720,000		450,000		1,000,000		670,000		390,000
	PR5	Others	Riel		NA		NA		NA		NA		NA		NA		NA		NA		NA
Other costs	OT1	?	???																		
	OT2	?	???																		
	OT3	?	???																		
			1000 US	4,000	1,107		470		368		210		294		267		252		315		206
		Grand Total	Mil Riel		4,426.09		1,878.54		1,471.42		838.38		1,177.74		1,066.12		1,007.62		1,258.45		823.52
	Direct damages Housing		Mil Riel		122.50		93.00		69.00		84.00		92.00		79.50		95.00		104.50		85.50
	Direct Damages Agriculture		Mil Riel		1,747.30		1,344.58		354.63		5.50		356.95		339.30		355.90		549.85		234.27
	Relief&emergency		Mil Riel		180.20		129.90		78.60		141.10		95.22		57.95		124.00		83.17		42.99
	Direct damages Infrastructure		Mil Riel		2,376.09		311.06		969.19		607.78		633.57		589.37		432.72		520.93		460.76

Attachment 1.4: Flood damage data (current price in Riel)

Inventory of Direct Flood Damages at District Level from 2000 to 2008

Country: Cambodia
Province: Takeo **CURRENCY:** Riel
District: Samroang

Types	No	Items	Unit	Year: 2000		Year: 2001		Year: 2002		Year: 2003		Year: 2004		Year: 2005		Year: 2006		Year: 2007		Year: 2008	
				Quant	Cost	Quant	Cost	Quant	Cost	Quant	Cost	Quant	Cost	Quant	Cost	Quant	Cost	Quant	Cost	Quant	Cost
Human	HU1	Number of causalities	Person	0		0		0		0		0		0		0		0		0	
	HU2	Number of missing people	Person	0		0		0		0		0		0		0		0		0	
	HU3	Number of injured people	Person	0		0		0		0		0		0		0		0		0	
	HU4	Number of affected households	Family	4,259		432		642		3,130		216		146		892		376		218	
	HU5	Number of affected people	Person	17,036		2,160		2,568		12,252		1,086		735		4,463		1,875		1,096	
Housing	HO1	Collapsed/swept away houses	Nos	0		0		0		0		0		0		0		0		0	
	HO2	houses	Nos	416	208,000,000	102	51,000,000	132	66,000,000	384	192,000,000	46	23,000,000	32	16,000,000	278	139,000,000	56	28,000,000	4	2,000,000
	HO3	Damaged properties	Riel	LS	33,241,000	LS	5,132,000	LS	4,845,000	LS	15,360,000	LS	2,346,800	LS	1,921,000	LS	16,668,000	LS	2,988,000	LS	1,243,000
Education	ED1	Number of affected schools	Nos	1	1,500,000	1	500,000	1	1,040,000	0		0		0		0		0		0	
	ED2	Damaged classrooms	Nos	3	2,000,000	2	500,000	0		0		0		0		0		0		0	
	ED3	Damaged houses	Nos	0		0		0		0		0		0		0		0		0	
	ED4	Damaged desks & chairs	Set	20	1,000,000	0		0		0		0		0		0		0		0	
	ED5	Damaged books	Nos	0		0		0		0		0		0		0		0		0	
	ED6	Damaged education equipment	Set	0		0		0		0		0		0		0		0		0	
Health care	HE1	Number of affected clinics	Nos	0		0		0		0		0		0		0		0		0	
	HE2	Damaged rooms	Nos	0		0		0		0		0		0		0		0		0	
	HE3	Medicine damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE4	Medical equipment damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE5	Other assets damaged	Riel	0		0		0		0		0		0		0		0		0	
Structures	ST1	Cultural/historical structures	Nos	0		0		0		0		0		0		0		0		0	
	ST2	Head offices	Nos	0		0		0		0		0		0		0		0		0	
	ST3	Market/commercial centers	Nos	0		0		0		0		0		0		0		0		0	
	ST4	Warehouses	Nos	0		0		0		0		0		0		0		0		0	
	ST5	Other works	Nos	0		0		0		0		0		0		0		0		0	
Agro-forest	AG1	Damaged rice area	Ha	1,589	1,085,200,000	1,235	890,750,000	138	95,180,000	478	161,502,000	440	198,000,000	0	0	0	0	0	0	0	0
		+Lost completely	*Ha*	659	527,200,000	445	369,350,000	30	26,400,000	131	86,460,000	0		0		0		0		0	
		+Seed lost (just sown)	*Ha*	0		0		5	800,000	138	6,072,000	0		0		0		0		0	
		+Productivity decreased	*Ha*	930	558,000,000	790	521,400,000	103	67,980,000	209	68,970,000	440	198,000,000	0		0		0		0	
	AG2	Damaged flowers/vegetables	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
		+Lost completely	*Ha*	NA		NA		NA		NA		NA		NA		NA		NA		NA	
		+Productivity decreased	*Ha*	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG3	Damaged field crops	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
		+Lost completely	*Ha*	NA		NA		NA		NA		NA		NA		NA		NA		NA	
		+Seed lost (just sown)	*Ha*	NA		NA		NA		NA		NA		NA		NA		NA		NA	
		+Productivity decreased	*Ha*	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG4	Damaged perennial trees	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
		+Dead	*Ha*	NA		NA		NA		NA		NA		NA		NA		NA		NA	
		+Productivity decreased	*Ha*	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG5	Damaged fruit trees	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
		+Dead	*Ha*	NA		NA		NA		NA		NA		NA		NA		NA		NA	
		+Productivity decreased	*Ha*	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG6	Damaged seeds	Ton	0		0		0		0		0		0		0		0		0	
	AG7	Damaged food	Ton	0		0		0		0		0		0		0		0		0	
	AG8	Number of dead big livestock	Nos	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG9	Number of dead little livestock	Nos	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG10	Dead poultry	Nos	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG11	Damaged fertilizers	Ton	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG12	Damaged agro-chemicals	Ton	0		0		0		0		0		0		0		0		0	
	AG13	Farm land eroded w/o recovery	Ha	0		0		0		0		0		0		0		0		0	
	AG14	Housing land eroded/lost	Ha	0		0		0		0		0		0		0		0		0	
Irrigation	IR1	Dyke damaged	Meter	1,800	72,000,000	1,000	40,000,000	0		0		0		0		0		0		0	
	IR2	Embankment damaged	Meter	0		0		0		0		0		0		0		0		0	
	IR3	Canal & Ditch damaged	Meter	5,000	200,000,000	2,000	80,000,000	0		200	8,000,000	150	6,000,000	230	9,200,000	258	7,584,000	140	5,475,000	170	6,800,000
	IR4	Water reservoir and dam	Nos	2	1,168,000,000	1	800,000,000	1	880,000,000	0		0		0		0		0		0	
	IR5	Pumping station damaged	Nos	0		0		0		0		0		2	32,000,000	1	9,500,000	1	8,000,000	0	
	IR6	Other irrigation facilities	Nos	0		0		0		0		0		0		0		0		0	
Fishery	FI1	Aquaculture pond damages	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI2	Fish/shrimp lost from ponds	Ton	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI3	Fish cage, raft, trap damaged	No.	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI4	Other fishing tools damaged	Set.	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI5	Boats and ships lost	Nos	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Transport	TR1	roads	Meter	28,000	224,000,000	0		0		0		0		0		0		0		0	
	TR2	Damaged rural roads	Meter	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	TR3	Damaged railways	Meter	0		0		0		0		0		0		0		0		0	
	TR4	Damaged bridges/culverts	Nos	0		0		0		0		0		0		0		0		0	
	TR5	Damaged ports	Nos	0		0		0		0		0		0		0		0		0	
	TR6	Damaged airports	Nos	0		0		0		0		0		0		0		0		0	
	TR7	Damaged boats/vehicles	Nos	0		0		0		0		0		0		0		0		0	
	TR8	Other damages	Riel	0		0		0		0		0		0		0		0		0	
on	CO1	Damaged houses/stations	Nos	0		0		0		0		0		0		0		0		0	
	CO2	Damaged equipment/assets	Riel	0		0		0		0		0		0		0		0		0	
	CO3	Communication poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	CO4	Communication wires cut	Meter	0		0		0		0		0		0		0		0		0	
	CO5	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Industry	IN1	High tension poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	IN2	Electric wires cut	Meter	0		0		0		0		0		0		0		0		0	
	IN3	Damaged transformer stations	Nos	0		0		0		0		0		0		0		0		0	
	IN4	Damaged power plants	Nos	0		0		0		0		0		0		0		0		0	
	IN5	Damaged factories & plants	Nos	0		0		0		0		0		0		0		0		0	
	IN6	Damaged mines	Nos	0		0		0		0		0		0		0		0		0	
	IN7	Damaged machines, equipment	Nos	1	200,000	0		0		0		0		0		0		0		0	
	IN8	Damaged industrial products	Ton	0		0		0		0		0		0		0		0		0	
	IN9	Other industrial damages	Riel	0		0		0		0		0		0		0		0		0	
Construction	CS1	damaged	Nos	0		0		0		0		0		0		0		0		0	
	CS2	Unfinished works swept away	M3	0		0		0		0		0		0		0		0		0	
	CS3	Construction material damaged	Riel	0		0		0		0		0		0		0		0		0	
	CS4	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Water & Envi-	WE1	Number of damaged wells	Nos	100	143,400,000	27	38,718,000	40	57,360,000	70	100,380,000	30	43,020,000	51	73,134,000	20	28,680,000	40	57,360,000	17	24,378,000
ronment	WE2	Water supply stations damaged	Nos	0		0		0		0		0		0		0		0		0	
	WE3	Drainage system damaged	Meter	0		0		0		0		0		0		0		0		0	
	WE4	Number of people without water	Person	2,500	7,500,000	675	2,025,000	1,000	3,000,000	1,750	5,250,000	750	2,250,000	1,275	3,825,000	500	1,500,000	1,000	3,000,000	425	1,275,000
	WE5	area	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Prevention &	PR1	Flood prevention costs	Riel	0		0		0		0		0		0		0		0		0	
Rescue (Gov	PR2	Temporary relocation sites	Riel	0		0		0		0		0		0		0		0		0	
+NGOs)	PR3	Foods & medicine etc. supplied	Riel	LS	49,960,000	LS	20,442,000	LS	26,400,000	LS	28,972,000	LS	19,872,000	LS	15,956,000	LS	27,876,000	LS	12,362,000	LS	1,312,000
	PR4	Costs for rescue	Riel	0		0		0		0		0		0		0		0		0	
	PR5	Others	Riel	0		0		0		0		0		0		0		0		0	
Other costs	OT1	Rice seed providing	ton	55	22,000,000	15	6,750,000	17	8,500,000	14	7,000,000	10	5,000,000	8	4,800,000	7	4,200,000	4	3,200,000	5	4,000,000
	OT2	?	???																		
	OT3	?	???																		
			1000 US	4,000	805		484		286		130		75		39		59		30		10
		Grand Total	Mil Riel		3,218.00		1,935.82		1,142.33		518.46		299.49		156.84		235.01		120.39		41.01
		Direct damages Housing	Mil Riel		241.24		56.13		70.85		207.36		25.35		17.92		155.67		30.99		3.24
		Direct Damages Agriculture	Mil Riel		1,107.20		897.50		103.68		168.50		203.00		4.80		4.20		3.20		4.00
		Relief&emergency	Mil Riel		49.96		20.44		26.40		28.97		19.87		15.96		27.88		12.36		1.31
		Direct damages Infrastructure	Mil Riel		1,819.60		961.74		941.40		113.63		51.27		118.16		47.26		73.84		32.45

Attachment 1.5: Flood damage data (current price in Riel)

Inventory of Direct Flood Damages at District Level from 2000 to 2007

Country: **Cambodia**
Province: **Takeo** **CURRENCY:** **Riel**
District: **Koh Andaet**

				Year: 2000		Year: 2001		Year: 2002		Year: 2003		Year: 2004		Year: 2005		Year: 2006		Year: 2007	
Types	**No**	**Items**	**Unit**	**Quantity**	**Cost**	**y**	**Cost**	**y**	**Cost**	**y**	**Cost**	**y**	**Cost**	**y**	**Cost**	**y**	**Cost**	**y**	**Cost**
Human	HU1	Number of causalities	Person	6		3		2		1		1		0		2		0	
	HU2	Number of missing people	Person	0		0		0		0		0		0		0		0	
	HU3	Number of injured people	Person	NA		NA		NA		NA		NA		NA		NA		NA	
	HU4	Number of affected households	Family	6,345		2,471		2,235		1,730		1,570		1,025		975		740	
	HU5	Number of affected people	Person	25,380		9,884		8,940		6,920		6,280		4,115		3,200		2,960	
Housing	HO1	Collapsed/swept away houses	Nos	16	25,200,000	8	12,608,000	5	7,880,000	0	0	0	0	0	0	0	0	0	0
	HO2	houses	Nos	47	37,600,000	35	28,000,000	17	13,600,000	12	9,600,000	11	8,800,000	13	10,400,000	8	6,400,000	9	7,200,000
	HO3	Damaged properties	Riel	NA		NA		NA		NA		NA		NA		NA		NA	
Education	ED1	Number of affected schools	Nos	13	13,000,000	11	11,000,000	11	11,000,000	11	11,000,000	8	8,000,000	8	8,000,000	6	6,000,000	6	6,000,000
	ED2	Damaged classrooms	Nos	3	24,000,000	0		0		0		0		0		0		0	
	ED3	Damaged houses	Nos	0		0		0		0		0		0		0		0	
	ED4	Damaged desks & chairs	Set	35	2,100,000	22	1,320,000	0		0		0		0		0		0	
	ED5	Damaged books	Nos	0		0		0		0		0		0		0		0	
	ED6	Damaged education equipment	Set	0		0		0		0		0		0		0		0	
Health care	HE1	Number of affected clinics	Nos	1	400,000	0		0		0		0		0		0		0	
	HE2	Damaged rooms	Nos	0		0		0		0		0		0		0		0	
	HE3	Medicine damaged	Riel	0		0		0		0		0		0		0		0	
	HE4	Medical equipment damaged	Riel	0		0		0		0		0		0		0		0	
	HE5	Other assets damaged	Riel	0		0		0		0		0		0		0		0	
Structures	ST1	Cultural/historical structures	Nos	0		0		0		0		0		0		0		0	
	ST2	Head offices	Nos	0		0		0		0		0		0		0		0	
	ST3	Market/commercial centers	Nos	1		1		1		0		0		0		0		0	
	ST4	Warehouses	Nos	0		0		0		0		0		0		0		0	
	ST5	Other works	Nos	0		0		0		0		0		0		0		0	
Agro-forest	AG1	Damaged rice area	Ha	14,369		13,161		3,795		4,914		1,855		1,050		0		0	
		+Lost completely	Ha	383	268,100,000	1,614	1,129,800,000	538	376,600,000	115	80,500,000	82	57,400,000	0		0		0	
		+Seed lost (just sown)	Ha	328	52,480,000	350	56,000,000	194	31,040,000	15	2,400,000	12	1,920,000	79	12,640,000	0		0	
		+Productivity decreased	Ha	13,658	4,370,560,000	11,197	3,583,040,000	3,063	980,160,000	4,784	1,530,880,000	1,761	563,520,000	971	310,720,000	0		0	
	AG2	Damaged flowers/vegetables	Ha	97		83		91		78		88		65		98		48	
		+Lost completely	Ha	0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	97		83		91		78		88		65		98		48	
	AG3	Damaged field crops	Ha	109		50		0		0		0		0		0		0	
		+Lost completely	Ha	19	13,680,000	5	3,600,000	0	0	0	0	0	0	0	0	0	0	0	0
		+Seed lost (just sown)	Ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		+Productivity decreased	Ha	90	32,400,000	45	16,200,000	0	0	0	0	0	0	0	0	0	0	0	0
	AG4	*Damaged perennial trees*	*Ha*	NA		NA		NA		NA		NA		NA		0		0	
		+Dead	*Ha*	NA		NA		NA		NA		NA		NA		0		0	
		+Productivity decreased	Ha	NA		NA		NA		NA		NA		NA		0		0	
	AG5	*Damaged fruit trees*	*Ha*	4		3		2		3		1		1		0		0	
		+Dead	*Ha*	3		2		1		2		0		0		0		0	
		+Productivity decreased	Ha	1		1		1		1		1		1		0		0	
	AG6	Damaged seeds	Ton	0		0		0		0		0		0		0		0	
	AG7	Damaged food	Ton	18		14		0		0		0		0		0		0	
	AG8	Number of dead big livestock	Nos	6	3,600,000	0	0	0	0	0		0		0		0		0	
	AG9	Number of dead little livestock	Nos	3	672,000	2	448,000	0	0	0		0		0		0		0	
	0	Dead poultry	Nos	650	2,600,000	230	920,000	180	720,000	0		0		0		0		0	
	1	Damaged fertilizers	Ton	0		0		0		0		0		0		0		0	
	2	Damaged agro-chemicals	Ton	0		0		0		0		0		0		0		0	
	3	Farm land eroded w/o recovery	Ha	0		0		0		0		0		0		0		0	
	4	Housing land eroded/lost	Ha	0		0		0		0		0		0		0		0	
Irrigation	IR1	Dyke damaged	Meter	4,460	175,055,000	3,280	128,740,000	2,650	104,012,500	1,800	70,650,000	1,250	49,062,500	820	32,185,000	540	21,195,000	365	14,326,250
	IR2	Embankment damaged	Meter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	IR3	Canal & Ditch damaged	Meter	6,080	109,440,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	IR4	Water reservoir and dam	Nos	0		0		0		0		0		0		0		0	
	IR5	Pumping station damaged	Nos	3		0		0		0		0		0		0		0	
	IR6	Other irrigation facilities	Nos	0		0		0		0		0		0		0		0	
Fishery	FI1	Aquaculture pond damages	Ha	0		0		0		0		0		0		0		0	
	FI2	Fish/shrimp lost from ponds	Ton	0		0		0		0		0		0		0		0	
	FI3	Fish cage, raft, trap damaged	No.	0		0		0		0		0		0		0		0	
	FI4	Other fishing tools damaged	Set.	0		0		0		0		0		0		0		0	
	FI5	Boats and ships lost	Nos	0		0		0		0		0		0		0		0	
Transport	TR1	roads	Meter	6,500	65,000,000	350	3,500,000	0	0	0		0		0		0		0	
	TR2	Damaged rural roads	Meter	42,000	139,700,000	37,000	123,000,000	25,000	83,000,000	15,000	49,892,857	12,000	39,840,000	7,500	24,900,000	6,300	20,916,000	5,200	17,264,000
	TR3	Damaged railways	Meter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TR4	Damaged bridges/culverts	Nos	17	1,017,000	5	188,370,000	0	0	0	0	0	0	0	0	0	0	0	0
	TR5	Damaged ports	Nos	0		0		0		0		0		0		0		0	
	TR6	Damaged airports	Nos	0		0		0		0		0		0		0		0	
	TR7	Damaged boats/vehicles	Nos	0		0		0		0		0		0		0		0	
	TR8	Other damages	Riel	0		0		0		0		0		0		0		0	
n	CO1	Damaged houses/stations	Nos	0		0		0		0		0		0		0		0	
	CO2	Damaged equipment/assets	Riel	0		0		0		0		0		0		0		0	
	CO3	Communication poles collapsed	Nos	0		0		0		0		0		0		0		0	
	CO4	Communication wires cut	Meter	0		0		0		0		0		0		0		0	
	CO5	Other damages	Riel	0		0		0		0		0		0		0		0	
Industry	IN1	High tension poles collapsed	Nos	0		0		0		0		0		0		0		0	
	IN2	Electric wires cut	Meter	0		0		0		0		0		0		0		0	
	IN3	Damaged transformer stations	Nos	0		0		0		0		0		0		0		0	
	IN4	Damaged power plants	Nos	0		0		0		0		0		0		0		0	
	IN5	Damaged factories & plants	Nos	0		0		0		0		0		0		0		0	
	IN6	Damaged mines	Nos	0		0		0		0		0		0		0		0	
	IN7	Damaged machines, equipment	Nos	0		0		0		0		0		0		0		0	
	IN8	Damaged industrial products	Ton	0		0		0		0		0		0		0		0	
	IN9	Other industrial damages	Riel	0		0		0		0		0		0		0		0	
Construction	CS1	Construction instrument damaged	Nos	0		0		0		0		0		0		0		0	
	CS2	Unfinished works swept away	M3	0		0		0		0		0		0		0		0	
	CS3	Construction material damaged	Riel	0		0		0		0		0		0		0		0	
	CS4	Other damages	Riel	0		0		0		0		0		0		0		0	
Water & Envi-	WE1	Number of damaged wells	Nos	215	58,700,000	NA		NA		0		0		0		0		0	
ronment	WE2	Water supply stations damaged	Nos	0		0		0		0		0		0		0		0	
	WE3	Drainage system damaged	Meter	0		0		0		0		0		0		0		0	
	WE4	Number of people without water	Person	0		0		0		0		0		0		0		0	
	WE5	area	Ha	145		145		145		110		100		95		87		70	
Prevention &	PR1	Flood prevention costs	Riel	NA		NA		NA		NA		NA		NA		NA		NA	
Rescue (Gov	PR2	Temporary relocation sites	Riel	NA		NA		NA		NA		NA		NA		NA		NA	
+NGOs)	PR3	Foods & medicine etc. supplied	Riel	LS	296,000,000	LS	176,000,000	LS	114,000,000	LS	80,000,000	LS	102,000,000	LS	105,000,000	LS	98,000,000	LS	110,000,000
	PR4	Costs for rescue	Riel	LS	689,000,000	LS	200,000,000	LS	120,000,000	LS	120,000,000	LS	100,000,000	LS	110,000,000	LS	110,000,000	LS	115,000,000
	PR5	Others	Riel																
Other costs	OT1	?	???																
	OT2	?	???																
	OT3	?	???																
Grand Total			Mil Riel		6,380.30		5,662.55		1,842.01		1,954.92		930.54		613.85		262.51		269.79
Direct damages Housing & Structures			Mil Riel		62.80		40.61		21.48		9.60		8.80		10.40		6.40		7.20
Direct Damages Agriculture			Mil Riel		4,744.09		4,790.01		1,388.52		1,613.78		622.84		323.36		0.00		0.00
Relief&emergency			Mil Riel		985.00		376.00		234.00		200.00		202.00		215.00		208.00		225.00

Attachment 1.6: Flood damage data (current price in Riel)

Inventory of Direct Flood Damages at District Level from 2000 to 2008

Country: Cambodia
Province: Takeo **CURRENCY:** Riel
District: Traing

Types	No	Items	Unit	Year: 2000 Quantity	Year: 2000 Cost	Year: 2001 Quantity	Year: 2001 Cost	Year: 2002 y	Year: 2002 Cost	Year: 2003 y	Year: 2003 Cost	Year: 2004 y	Year: 2004 Cost	Year: 2005 y	Year: 2005 Cost	Year: 2006 y	Year: 2006 Cost	Year: 2007 y	Year: 2007 Cost	Year: 2008 y	Year: 2008 Cost
Human	HU1	Number of causalities	Person	0		0		0		0		0		0		0		0		0	
	HU2	Number of missing people	Person	0		0		0		0		0		0		0		0		0	
	HU3	Number of injured people	Person	0		0		0		0		0		0		0		0		0	
	HU4	Number of affected households	Family	15		0		0		0		0		0		0		0		0	
	HU5	Number of affected people	Person	62		0		0		0		0		0		0		0		0	
Housing	HO1	Collapsed/swept away houses	Nos	0		0		0		0		0		0		0		0		0	
	HO2	houses	Nos	2	1,700,000	0		0		0		0		0		0		0		0	
	HO3	Damaged properties	Riel	LS	10,200,000	0		0		0		0		0		0		0		0	
Education	ED1	Number of affected schools	Nos	0		0		0		2	1,000,000	0		0		0		0		0	
	ED2	Damaged classrooms	Nos	0		0		0		11	75,555,000	0		0		0		0		0	
	ED3	Damaged houses	Nos	0		0		0		0		0		0		0		0		0	
	ED4	Damaged desks & chairs	Set	0		0		0		100	1,600,000	0		0		0		0		0	
	ED5	Damaged books	Nos	0		0		0		420	1,680,000	0		0		0		0		0	
	ED6	Damaged education equipment	Set	0		0		0		5	800,000	0		0		0		0		0	
Health care	HE1	Number of affected clinics	Nos	0		0		0		0		0		0		0		0		0	
	HE2	Damaged rooms	Nos	0		0		0		0		0		0		0		0		0	
	HE3	Medicine damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE4	Medical equipment damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE5	Other assets damaged	Riel	0		0		0		0		0		0		0		0		0	
Structures	ST1	Cultural/historical structures	Nos	0		0		0		0		0		0		0		0		0	
	ST2	Head offices	Nos	0		0		0		0		0		0		0		0		0	
	ST3	Market/commercial centers	Nos	0		0		0		0		0		0		0		0		0	
	ST4	Warehouses	Nos	0		0		0		0		0		0		0		0		0	
	ST5	Other works	Nos	0		0		0		0		0		0		0		0		0	
Agro-forest	AG1	Damaged rice area	Ha	18,606	6,834,580,000	9,029	1,841,520,000	1,213	345,820,000	360	57,600,000	150	24,000,000	57	9,120,000	0	0	0	0	0	0
		+Lost completely	*Ha*	8,773	5,263,800,000	902	541,200,000	346	207,600,000	0		0		0		0		0		0	
		+Seed lost (just sown)	*Ha*	25	1,500,000	0		5	300,000	0		0		0		0		0		0	
		+Productivity decreased	*Ha*	9,808	1,569,280,000	8,127	1,300,320,000	862	137,920,000	360	57,600,000	150	24,000,000	57	9,120,000	0		0		0	
	AG2	Damaged flowers/vegetables	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
		+Lost completely	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
		+Productivity decreased	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
	AG3	Damaged field crops	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
		+Lost completely	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
		+Seed lost (just sown)	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
		+Productivity decreased	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
	AG4	Damaged perennial trees	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
		+Dead	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
		+Productivity decreased	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
	AG5	Damaged fruit trees	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
		+Dead	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
		+Productivity decreased	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
	AG6	Damaged seeds	Ton	0		0		0		0		0		0		0		0		0	
	AG7	Damaged food	Ton	0		0		0		0		0		0		0		0		0	
	AG8	Number of dead big livestock	Nos	12	7,440,000	10	6,200,000	7	4,410,000	0		0		0		0		0		0	
	AG9	Number of dead little livestock	Nos	10	3,000,000	14	4,200,000	11	3,520,000	0		0		0		0		0		0	
	AG10	Dead poultry	Nos	260	1,040,000	304	1,368,000	200	900,000	0		0		0		0		0		0	
	AG11	Damaged fertilizers	Ton	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG12	Damaged agro-chemicals	Ton	0		0		0		0		0		0		0		0		0	
	AG13	Farm land eroded w/o recovery	Ha	0		0		0		0		0		0		0		0		0	
	AG14	Housing land eroded/lost	Ha	0		0		0		0		0		0		0		0		0	
Irrigation	IR1	Dyke damaged	Meter	500	20,000,000	0		300	15,000,000	0		0		0		0		0		0	
	IR2	Embankment damaged	Meter	0		0		0		0		0		0		0		0		0	
	IR3	Canal & Ditch damaged	Meter	6,000	120,000,000	0		0		0		0		0		0		0		0	
	IR4	Water reservoir and dam	Nos	0		0		0		0		0		0		0		0		0	
	IR5	Pumping station damaged	Nos	2	62,000,000	0		0		0		0		0		0		0		0	
	IR6	Other irrigation facilities	Nos	0		0		0		0		0		0		0		0		0	
Fishery	FI1	Aquaculture pond damages	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI2	Fish/shrimp lost from ponds	Ton	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI3	Fish cage, raft, trap damaged	No.	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI4	Other fishing tools damaged	Set.	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	FI5	Boats and ships lost	Nos	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Transport	TR1	roads	Meter	17,000	408,000,000	0		0		0		0		0		0		0		0	
	TR2	Damaged rural roads	Meter	1,600	12,800,000	1,500	12,000,000	0		500	4,000,000	0		0		0		0		0	
	TR3	Damaged railways	Meter	0		0		0		0		0		0		0		0		0	
	TR4	Damaged bridges/culverts	Nos	19	7,600,000	6	2,400,000	0		8	3,200,000	0		0		0		0		0	
	TR5	Damaged ports	Nos	0		0		0		0		0		0		0		0		0	
	TR6	Damaged airports	Nos	0		0		0		0		0		0		0		0		0	
	TR7	Damaged boats/vehicles	Nos	0		0		0		0		0		0		0		0		0	
	TR8	Other damages	Riel	0		0		0		0		0		0		0		0		0	
n	CO1	Damaged houses/stations	Nos	0		0		0		0		0		0		0		0		0	
	CO2	Damaged equipment/assets	Riel	0		0		0		0		0		0		0		0		0	
	CO3	Communication poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	CO4	Communication wires cut	Meter	0		0		0		0		0		0		0		0		0	
	CO5	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Industry	IN1	High tension poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	IN2	Electric wires cut	Meter	0		0		0		0		0		0		0		0		0	
	IN3	Damaged transformer stations	Nos	0		0		0		0		0		0		0		0		0	
	IN4	Damaged power plants	Nos	0		0		0		0		0		0		0		0		0	
	IN5	Damaged factories & plants	Nos	0		0		0		0		0		0		0		0		0	
	IN6	Damaged mines	Nos	0		0		0		0		0		0		0		0		0	
	IN7	Damaged machines, equipment	Nos	0		0		0		0		0		0		0		0		0	
	IN8	Damaged industrial products	Ton	0		0		0		0		0		0		0		0		0	
	IN9	Other industrial damages	Riel	0		0		0		0		0		0		0		0		0	
Construction	CS1	damaged	Nos	0		0		0		0		0		0		0		0		0	
	CS2	Unfinished works swept away	M3	0		0		0		0		0		0		0		0		0	
	CS3	Construction material damaged	Riel	0		0		0		0		0		0		0		0		0	
	CS4	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Water & Envi-ronment	WE1	Number of damaged wells	Nos	274	392,916,000	50	71,700,000	20	28,680,000	0		0		0		0		0		0	
	WE2	Water supply stations damaged	Nos	0		0		0		0		0		0		0		0		0	
	WE3	Drainage system damaged	Meter	0		0		0		0		0		0		0		0		0	
	WE4	Number of people without water	Person	8,220	24,660,000	1,500	4,500,000	600	1,800,000	0		0		0		0		0		0	
	WE5	area	Ha	NA		NA		NA		0		0		0		0		0		0	
Prevention & Rescue (Gov +NGOs)	PR1	Flood prevention costs	Riel	0		0		0		0		0		0		0		0		0	
	PR2	Temporary relocation sites	Riel	0		0		0		0		0		0		0		0		0	
	PR3	Foods & medicine etc. supplied	Riel	LS	127,000,000	LS	20,000,000	LS	17,000,000	0		0		0		0		0		0	
	PR4	Costs for rescue	Riel	0		0		0		0		0		0		0		0		0	
	PR5	Others	Riel	0		0		0		0		0		0		0		0		0	
Other costs	OT1	?	???																		
	OT2	?	???																		
	OT3	?	???																		
			1000 US	4,000	2,008		491		104		36		6		2		0		0		0
Grand Total			Mil Riel		**8,032.94**		**1,963.89**		**417.13**		**145.44**		**24.00**		**9.12**		**0.00**		**0.00**		**0.00**
Direct damages Housing			Mil Riel		11.90		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Direct Damages Agriculture			Mil Riel		6,846.06		1,853.29		354.65		57.60		24.00		9.12		0.00		0.00		0.00
Relief&emergency			Mil Riel		127.00		20.00		17.00		0.00		0.00		0.00		0.00		0.00		0.00
Direct Damages Infrastrucutre			Mil Riel		1,047.98		90.60		45.48		87.84		0.00		0.00		0.00		0.00		0.00

Attachment 1.7: Flood damage data (current price in Riel)

Inventory of Direct Flood Damages at District Level from 2000 to 2008

Country: Cambodia
Province: Takaev **CURRENCY:** Riel
District: Bourei Cholsar

Types	No	Items	Unit	Year: 2000		Year: 2001		Year: 2002		Year: 2003		Year: 2004		Year: 2005		Year: 2006		Year: 2007		Year: 2008	
				Quantity	Cost	Quantity	Cost	Quantity	Cost	y	Cost	y	Cost	Quantity	Cost	y	Cost	y	Cost	y	Cost
Human	HU1	Number of causalities	Person	12		9		0		0		1		0		9		3		2	
	HU2	Number of missing people	Person	0		0		0		0		0		0		0		0		0	
	HU3	Number of injured people	Person	0		0		1		0		2		0		0		0		0	
	HU4	Number of affected households	Family	2,070		3,643		3,647		3,582		3,600		3,568		2,511		2,831		2,967	
	HU5	Number of affected people	Person	17,714		27,052		27,062		18,764		19,000		18,708		13,804		14,162		14,416	
Housing	HO1	Collapsed/swept away houses	Nos	108	518,400,000	0		0		0		0		4	24,000,000	0		1	6,800,000	0	
	HO2	houses	Nos	NA		128	153,600,000	116	55,680,000	0		7	4,200,000	42	8,400,000	0		0		4	8,000,000
	HO3	Damaged properties	Riel	NA		NA		NA		0		0		0		0		0		0	
Education	ED1	Number of affected schools	Nos	19	9,500,000	16	4,540,000	15	8,775,000	5	130,000	17	3,160,000	22	9,120,000	16	1,185,000	20	7,870,000	16	17,196,500
	ED2	Damaged classrooms	Nos	43	33,817,000	10	2,350,000	11	6,190,000	2	500,000	16	8,170,000	15	1,910,000	10	1,290,000	10	1,855,000	20	36,995,000
	ED3	Damaged houses	Nos	0		0		0		0		0		0		0		0		0	
	ED4	Damaged desks & chairs	Set	355	13,540,000	31	1,490,000	25	950,000	0		0		0		20	1,000,000	63	2,050,000	42	5,400,000
	ED5	Damaged books	Nos	5,400	3,256,000	250	750,000	0		15	30,000	26	77,000	15	45,000	0		70	210,000	200	600,000
	ED6	Damaged education equipment	Set	8	320,000	0		0		0		0		0		0		0		5	50,000
Health care	HE1	Number of affected clinics	Nos	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
	HE2	Damaged rooms	Nos	3	1,440,000	6	2,316,000	0	0	8	1,160,000	2	636,000	4	1,560,000	3	6,000,000	2	1,192,000	9	1,200,000
	HE3	Medicine damaged	Riel	LS	1,520,000	LS	556,000	LS	960,000	LS	1,040,000	LS	716,000	LS	588,000	LS	792,000	LS	1,112,000	LS	596,000
	HE4	Medical equipment damaged	Riel	6	680,000	3	360,000	4	544,000	0	0	3	1,168,000	2	1,304,000	3	2,716,000	5	1,120,000	5	792,000
	HE5	Other assets damaged	Riel	LS	5,200,000	LS	800,000	LS	312,000	LS	1,192,000	0		LS	1,480,000	LS	1,584,000	LS	1,712,000	LS	588,000
Structures	ST1	Cultural/historical structures	Nos	0		0		0		0		0		0		0		0		0	
	ST2	Head offices	Nos	0		0		0		0		0		0		0		0		0	
	ST3	Market/commercial centers	Nos	0		0		0		0		0		0		0		0		0	
	ST4	Warehouses	Nos	0		0		0		0		0		0		0		0		0	
	ST5	Other works	Nos	0		0		0		0		0		0		0		0		0	
Agro-forest	AG1	Damaged rice area	Ha	6,699	4,766,800,000	5,732	4,181,400,000	1,761	1,339,880,000	609	691,600,000	81	87,400,000	54	64,320,000	0	0	0	0	0	0
		+Lost completely	Ha	3,844	3,075,200,000	2,770	2,437,600,000	584	654,080,000	530	636,000,000	43	60,200,000	31	47,120,000	0		0		0	
		+Seed lost (just sown)	Ha	107	42,800,000	167	66,800,000	102	40,800,000	19	7,600,000	8	3,200,000	3	1,200,000	0		0		0	
		+Productivity decreased	Ha	2,748	1,648,800,000	2,795	1,677,000,000	1,075	645,000,000	60	48,000,000	30	24,000,000	20	16,000,000	0		0		0	
	AG2	Damaged flowers/vegetables	Ha	18	10,400,000	15	11,200,000	14	10,000,000	13	8,400,000	0	0	0	0	0	0	0	0	0	0
		+Lost completely	Ha	8	6,400,000	13	10,400,000	11	8,800,000	8	6,400,000	0		NA		0		0		0	
		+Productivity decreased	Ha	10	4,000,000	2	800,000	3	1,200,000	5	2,000,000	0		NA		0		0		0	
	AG3	Damaged field crops	Ha	19	50,800,000	15	39,600,000	12	26,400,000	8	20,000,000	0	0	0	0	0	0	0	0	0	0
		+Lost completely	Ha	18	50,400,000	14	39,200,000	9	25,200,000	7	19,600,000	0		0		0		0		0	
		+Seed lost (just sown)	Ha	1	400,000	1	400,000	3	1,200,000	1	400,000	0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG4	Damaged perennial trees	Ha	1.5	6,000,000	0.5	2,000,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		+Dead	*Ha*	1.5	6,000,000	0.5	2,000,000	0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG5	Damaged fruit trees	Ha	5	18,000,000	4	14,000,000	2	6,000,000	0	0	0	0	0	0	0	0	0	0	0	0
		+Dead	*Ha*	4	16,000,000	3	12,000,000	1	4,000,000	0		0		0		0		0		0	
		+Productivity decreased	Ha	1	2,000,000	1	2,000,000	1	2,000,000	0		0		0		0		0		0	
	AG6	Damaged seeds	Ton	15	12,000,000	0		0		0		0		0		0		0		0	
	AG7	Damaged food	Ton	0		0		0		0		0		0		0		0		0	
	AG8	Number of dead big livestock	Nos	22	22,000,000	9	9,000,000	NA		8	8,000,000	5	5,000,000	1	1,000,000	0		0		0	
	AG9	Number of dead little livestock	Nos	5	2,000,000	25	10,000,000	NA		3	1,200,000	5	2,000,000	4	1,600,000	0		0		0	
	AG10	Dead poultry	Nos	350	3,500,000	230	2,300,000	NA		NA		200	2,000,000	180	1,800,000	0		0		0	
	AG11	Damaged fertilizers	Ton	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG12	Damaged agro-chemicals	Ton	0		0		0		0		0		0		0		0		0	
	AG13	Farm land eroded w/o recovery	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG14	Housing land eroded/lost	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Irrigation	IR1	Dyke damaged	Meter	0		0		0		0		0		0		0		0		0	
	IR2	Embankment damaged	Meter	500	4,000,000	450	1,200,000	450	2,800,000	1,200	2,000,000	500	3,400,000	1,000	3,000,000	NA		NA		1,000	3,000,000
	IR3	Canal & Ditch damaged	Meter	1,800	31,500,000	0		0		4,760	19,992,000	0		0		0		0		0	
	IR4	Water reservoir and dam	Nos	2	3,000,000	0		0		0		0		0		0		0		0	
	IR5	Pumping station damaged	Nos	3	6,000,000	3	3,400,000	3	4,200,000	0		0		0		0		0		0	
	IR6	Other irrigation facilities	Nos	0		0		0		0		0		0		0		0		0	
Fishery	FI1	Aquaculture pond damages	Ha	0		0		0		0		0		0		0		0		0	
	FI2	Fish/shrimp lost from ponds	Ton	0		0		0		0		0		0		0		0		0	
	FI3	Fish cage, raft, trap damaged	No.	800	6,400,000	550	4,400,000	450	3,600,000	600	4,800,000	400	4,300,000	650	5,200,000	500	4,000,000	550	4,400,000	650	5,200,000
	FI4	Other fishing tools damaged	Set.	300	1,500,000	250	1,250,000	200	1,000,000	200	1,000,000	250	1,250,000	150	750,000	300	1,500,000	200	1,000,000	250	1,250,000
	FI5	Boats and ships lost	Nos	10	6,000,000	7	4,200,000	5	3,000,000	4	2,400,000	8	4,800,000	6	3,600,000	6	3,600,000	8	4,800,000	10	6,000,000
Transport	TR1	roads	Meter	700	27,920,000	800	29,360,000	500	28,880,000	0		0		0		0		0		0	
	TR2	Damaged rural roads	Meter	3,400	20,760,000	2,300	13,560,000	1,900	11,160,000	0		0		0		0		0		0	
	TR3	Damaged railways	Meter	0		0		0		0		0		0		0		0		0	
	TR4	Damaged bridges/culverts	Nos	4	14,000,000	1	4,900,000	0		0		0		0		0		0		0	
	TR5	Damaged ports	Nos	0		0		0		0		0		0		0		0		0	
	TR6	Damaged airports	Nos	0		0		0		0		0		0		0		0		0	
	TR7	Damaged boats/vehicles	Nos	10	10,000,000	0		0		0		0		0		0		0		0	
	TR8	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Communication	CO1	Damaged houses/stations	Nos	0		0		0		0		0		0		0		0		0	
	CO2	Damaged equipment/assets	Riel	0		0		0		0		0		0		0		0		0	
	CO3	Communication poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	CO4	Communication wires cut	Meter	0		0		0		0		0		0		0		0		0	
	CO5	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Industry	IN1	High tension poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	IN2	Electric wires cut	Meter	0		0		0		0		0		0		0		0		0	
	IN3	Damaged transformer stations	Nos	0		0		0		0		0		0		0		0		0	
	IN4	Damaged power plants	Nos	0		0		0		0		0		0		0		0		0	
	IN5	Damaged factories & plants	Nos	0		0		0		0		0		0		0		0		0	
	IN6	Damaged mines	Nos	0		0		0		0		0		0		0		0		0	
	IN7	Damaged machines, equipment	Nos	0		0		0		0		0		0		0		0		0	
	IN8	Damaged industrial products	Ton	0		0		0		0		0		0		0		0		0	
	IN9	Other industrial damages	Riel	0		0		0		0		0		0		0		0		0	
Construction	CS1	damaged	Nos	0		0		0		0		0		0		0		0		0	
	CS2	Unfinished works swept away	M3	0		0		0		0		0		0		0		0		0	
	CS3	Construction material damaged	Riel	0		0		0		0		0		0		0		0		0	
	CS4	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Water & Envi-ronment	WE1	Number of damaged wells	Nos	38	4,560,000	25	3,000,000	15	1,800,000	0		0		0		0		0		0	
	WE2	Water supply stations damaged	Nos	0		0		0		0		0		0		0		0		0	
	WE3	Drainage system damaged	Meter	0		0		0		0		0		0		0		0		0	
	WE4	Number of people without water	Person	1,119	6,714,000	750	4,500,000	370	2,220,000	0		0		0		0		0		0	
	WE5	area	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Prevention & Rescue (Gov +NGOs)	PR1	Flood prevention costs	Riel	0		0		27 houses	162,000,000	0		69 houses	54,000,000	20 houses	96,000,000	0		0		0	
	PR2	Temporary relocation sites	Riel	0		0		0		0			140,000,000		60,000,000	0		2	54,640,000	0	
	PR3	Foods & medicine etc. supplied	Riel	87 tons	78,000,000	115 tons	116,130,000	53 tons	61,830,000	11 tons	13,410,000	11 tons	13,350,000			14 tons	19,600,000	3 tons	4,750,000	0	
	PR4	Costs for rescue	Riel	0		0		0		0			0			0		0		0	
	PR5	Others	Riel	0		0		0		LS	10,000,000	LS	10,000,000	LS	15,000,000	LS	11,000,000	LS	34,000,000	LS	28,560,000
Other costs	OT1	NGO	???	0		0		24 boats	22,950,000	0		101	92,920,000	140	128,800,000	0		0		0	
	OT2	NGO	???									69	10,350,000	24	3,600,000	0		0		0	
	OT3	?	???																		

	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008
Grand Total	Mil Riel	**5,700**	**4,622**	**1,761**	**787**	**449**	**433**	**54**	**128**	**115**
Direct damages Housing	Mil Riel	518	154	56	0	4	32	0	7	8
Direct Damages Agriculture	Mil Riel	4,905	4,279	1,390	737	107	78	9	10	12
Relief&emergency	Mil Riel	78	116	224	23	217	171	31	93	29
Direct damages infrastructures	Mil Riel	198	73	69	26	17	19	15	17	66

Attachment 1.8: Flood damage data (current price in Riel)

Inventory of Direct Flood Damages at District Level from 2000 to 2008

Country: Cambodia
Province: Takaev **CURRENCY:** Riel
District: Bati

Types	No	Items	Unit	Year: 2000 Quantity	Year: 2000 Cost	Year: 2001 Quantity	Year: 2001 Cost	Year: 2002 y	Year: 2002 Cost	Year: 2003 y	Year: 2003 Cost	Year: 2004 y	Year: 2004 Cost	Year: 2005 y	Year: 2005 Cost	Year: 2006 y	Year: 2006 Cost	Year: 2007 y	Year: 2007 Cost	Year: 2008 Quantity	Year: 2008 Cost
Human	HU1	Number of causalities	Person	0		0		0		0		0		0		0		0		0	
	HU2	Number of missing people	Person	0		0		0		0		0		0		0		0		0	
	HU3	Number of injured people	Person	0		0		0		0		0		0		0		0		0	
	HU4	Number of affected households	Family	2,822		0		115		2,345		0		0		0		0		0	
	HU5	Number of affected people	Person	14,110		0		575		11,725		0		0		0		0		0	
Housing	HO1	Collapsed/swept away houses	Nos	0		0		0		0		0		0		0		0		0	
	HO2	houses	Nos	0		0		0		0		0		0		0		0		0	
	HO3	Damaged properties	Riel	0		0		0		0		0		0		0		0		0	
Education	ED1	Number of affected schools	Nos	0		0		0		0		0		0		0		0		0	
	ED2	Damaged classrooms	Nos	0		0		0		0		0		0		0		0		0	
	ED3	Damaged houses	Nos	0		0		0		0		0		0		0		0		0	
	ED4	Damaged desks & chairs	Set	0		0		0		0		0		0		0		0		0	
	ED5	Damaged books	Nos	0		0		0		0		0		0		0		0		0	
	ED6	Damaged education equipment	Set	0		0		0		0		0		0		0		0		0	
Health care	HE1	Number of affected clinics	Nos	0		0		0		0		0		0		0		0		0	
	HE2	Damaged rooms	Nos	0		0		0		0		0		0		0		0		0	
	HE3	Medicine damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE4	Medical equipment damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE5	Other assets damaged	Riel	0		0		0		0		0		0		0		0		0	
Structures	ST1	Cultural/historical structures	Nos	0		0		0		0		0		0		0		0		0	
	ST2	Head offices	Nos	0		0		0		0		0		0		0		0		0	
	ST3	Market/commercial centers	Nos	0		0		0		0		0		0		0		0		0	
	ST4	Warehouses	Nos	0		0		0		0		0		0		0		0		0	
	ST5	Other works	Nos	0		0		0		0		0		0		0		0		0	
Agro-forest	AG1	Damaged rice area	Ha	1,557	851,200,000	1,961	1,124,800,000	188	82,720,000	791	217,492,000	0	0	0	0	0	0	0	0	0	0
		+Lost completely	Ha	571	456,800,000	851	680,800,000	0		82	72,160,000	0		0		0		0		0	
		+Seed lost (just sown)	Ha	0		0		0		541	71,412,000	0		0		0		0		0	
		+Productivity decreased	Ha	986	394,400,000	1,110	444,000,000	188	82,720,000	168	73,920,000	0		0		0		0		0	
	AG2	Damaged flowers/vegetables	Ha	0		0		0		0		0		0		0		0		0	
		+Lost completely	Ha	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG3	Damaged field crops	Ha	0		0		0		0		0		0		0		0		0	
		+Lost completely	Ha	0		0		0		0		0		0		0		0		0	
		+Seed lost (just sown)	Ha	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG4	*Damaged perennial trees*	*Ha*	0		0		0		0		0		0		0		0		0	
		+Dead	*Ha*	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG5	*Damaged fruit trees*	*Ha*	0		0		0		0		0		0		0		0		0	
		+Dead	*Ha*	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG6	Damaged seeds	Ton	0		0		0		0		0		0		0		0		0	
	AG7	Damaged food	Ton	0		0		0		0		0		0		0		0		0	
	AG8	Number of dead big livestock	Nos	0		0		0		0		0		0		0		0		0	
	AG9	Number of dead little livestock	Nos	0		0		0		0		0		0		0		0		0	
	AG10	Dead poultry	Nos	0		0		0		0		0		0		0		0		0	
	AG11	Damaged fertilizers	Ton	0		0		0		0		0		0		0		0		0	
	AG12	Damaged agro-chemicals	Ton	0		0		0		0		0		0		0		0		0	
	AG13	Farm land eroded w/o recovery	Ha	0		0		0		0		0		0		0		0		0	
	AG14	Housing land eroded/lost	Ha	0		0		0		0		0		0		0		0		0	
Irrigation	IR1	Dyke damaged	Meter	0		0		0		0		0		0		0		0		0	
	IR2	Embankment damaged	Meter	0		0		0		0		0		0		0		0		0	
	IR3	Canal & Ditch damaged	Meter	0		0		0		0		0		0		0		0		0	
	IR4	Water reservoir and dam	Nos	4	380,000,000	0		0		0		0		0		0		0		0	
	IR5	Pumping station damaged	Nos	0		0		0		0		0		0		0		0		0	
	IR6	Other irrigation facilities	Nos	0		0		0		0		0		0		0		0		0	
Fishery	FI1	Aquaculture pond damages	Ha	0.89	8,722,000	0		1.0	11,521,000	0		0		0		0		0		0	
	FI2	Fish/shrimp lost from ponds	Ton	11	30,976,000	0		4.5	13,190,000	0		0		0		0		0		0	
	FI3	Fish cage, raft, trap damaged	No.	0		0		0		0		0		0		0		0		0	
	FI4	Other fishing tools damaged	Set.	0		0		0		0		0		0		0		0		0	
	FI5	Boats and ships lost	Nos	0		0		0		0		0		0		0		0		0	
Transport	TR1	roads	Meter	0		0		0		0		0		0		60	5,671,000	0		0	
	TR2	Damaged rural roads	Meter	648	6,800,000	350	3,500,000	480	4,790,000	1,260	15,120,000	0		0		500	7,168,000	0		0	
	TR3	Damaged railways	Meter	0		0		0		0		0		0		0		0		0	
	TR4	Damaged bridges/culverts	Nos	0		0		0		0		0		0		0		0		0	
	TR5	Damaged ports	Nos	0		0		0		0		0		0		0		0		0	
	TR6	Damaged airports	Nos	0		0		0		0		0		0		0		0		0	
	TR7	Damaged boats/vehicles	Nos	0		0		0		0		0		0		0		0		0	
	TR8	Other damages	Riel	0		0		0		0		0		0		0		0		0	
n	CO1	Damaged houses/stations	Nos	0		0		0		0		0		0		0		0		0	
	CO2	Damaged equipment/assets	Riel	0		0		0		0		0		0		0		0		0	
	CO3	Communication poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	CO4	Communication wires cut	Meter	0		0		0		0		0		0		0		0		0	
	CO5	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Industry	IN1	High tension poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	IN2	Electric wires cut	Meter	0		0		0		0		0		0		0		0		0	
	IN3	Damaged transformer stations	Nos	0		0		0		0		0		0		0		0		0	
	IN4	Damaged power plants	Nos	0		0		0		0		0		0		0		0		0	
	IN5	Damaged factories & plants	Nos	0		0		0		0		0		0		0		0		0	
	IN6	Damaged mines	Nos	0		0		0		0		0		0		0		0		0	
	IN7	Damaged machines, equipment	Nos	0		0		0		0		0		0		0		0		0	
	IN8	Damaged industrial products	Ton	0		0		0		0		0		0		0		0		0	
	IN9	Other industrial damages	Riel	0		0		0		0		0		0		0		0		0	
Construction	CS1	damaged	Nos	0		0		0		0		0		0		0		0		0	
	CS2	Unfinished works swept away	M3	0		0		0		0		0		0		0		0		0	
	CS3	Construction material damaged	Riel	0		0		0		0		0		0		0		0		0	
	CS4	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Water & Envi-ronment	WE1	Number of damaged wells	Nos	6	480,000	7	560,000	12	1,378,000	8	712,000	0		0		9	801,000	0		0	
	WE2	Water supply stations damaged	Nos	0		0		0		0		0		0		0		0		0	
	WE3	Drainage system damaged	Meter	0		0		0		0		0		0		0		0		0	
	WE4	Number of people without water	Person	308	1,848,000	495	2,970,000	607	3,642,000	403	2,418,000	0		0		147	882,000	0		0	
	WE5	area	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Prevention & Rescue (Gov +NGOs)	PR1	Flood prevention costs	Riel	0		0		0		0		0		0		0		0		0	
	PR2	Temporary relocation sites	Riel	0		0		0		0		0		0		0		0		0	
	PR3	Foods & medicine etc. supplied	Riel	LS	201,500,000	0		0		0		0		0		0		0		0	
	PR4	Costs for rescue	Riel	0		0		0		0		0		0		0		0		0	
	PR5	Others	Riel	0		0		0		0		0		0		0		0		0	
Other costs	OT1	?	???																		
	OT2	?	???																		
	OT3	?	???																		
Grand Total			Mil Riel		1,481.53		1,131.83		117.24		235.74		0.00		0.00		14.52		0.00		0.00
Direct damages Housing			Mil Riel		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Direct Damages Agriculture			Mil Riel		890.90		1,124.80		107.43		217.49		0.00		0.00		0.00		0.00		0.00
Relief&emergency			Mil Riel		201.50		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Direct damages Infrastructure			Mil Riel		389.13		7.03		9.81		18.25		0.00		0.00		14.52		0.00		0.00

Attachment 1.9: Flood damage data (current price in Riel)

Inventory of Direct Flood Damages at District Level from 2000 to 2008

Country: Cambodia
Province: Takaev **CURRENCY:** Riel
District: Kiri Vong

Types	No	Items	Unit	Year: 2000		Year: 2001		Year: 2002		Year: 2003		Year: 2004		Year: 2005		Year: 2006		Year: 2007		Year: 2008	
				y	Cost	y	Cost	y	Cost	y	Cost	y	Cost	y	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Human	HU1	Number of causalities	Person	6		4		0		6		2		3		1		0		0	
	HU2	Number of missing people	Person	0		0		0		0		0		0		0		0		0	
	HU3	Number of injured people	Person	0		0		0		0		0		0		0		0		0	
	HU4	Number of affected households	Family	850		685		685		600		600		600		685		685		685	
	HU5	Number of affected people	Person	4,250		3,525		3,525		3,025		3,025		3,025		3,768		3,768		3,768	
Housing	HO1	Collapsed/swept away houses	Nos	42	92,400,000	0		0		0		0		0		0		11	27,500,000	0	
	HO2	houses	Nos	0		0		0		0		0		0		0		41	32,800,000	0	
	HO3	Damaged properties	Riel	0		0		0		0		0		0		0		0		0	
Education	ED1	Number of affected schools	Nos	0		0		0		0		0		0		0		0		0	
	ED2	Damaged classrooms	Nos	0		0		0		0		0		0		0		0		0	
	ED3	Damaged houses	Nos	0		0		0		0		0		0		0		0		0	
	ED4	Damaged desks & chairs	Set	0		0		0		0		0		0		0		0		0	
	ED5	Damaged books	Nos	0		0		0		0		0		0		0		0		0	
	ED6	Damaged education equipment	Set	0		0		0		0		0		0		0		0		0	
Health care	HE1	Number of affected clinics	Nos	0		0		2	0	0		0		0		0		0		0	
	HE2	Damaged rooms	Nos	0		0		0		0		0		0		0		0		0	
	HE3	Medicine damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE4	Medical equipment damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE5	Other assets damaged	Riel	0		0		LS	27,280,000	0		0		LS	38,767,000	0		0		LS	1,556,000
Structures	ST1	Cultural/historical structures	Nos	0		0		0		0		0		0		0		0		0	
	ST2	Head offices	Nos	0		0		0		0		0		0		0		0		0	
	ST3	Market/commercial centers	Nos	0		0		0		0		0		0		0		0		0	
	ST4	Warehouses	Nos	0		0		0		0		0		0		0		0		0	
	ST5	Other works	Nos	0		0		0		0		0		0		0		0		0	
Agro-forest	AG1	Damaged rice area	Ha	11,240		12,405		978		345		455		169		0		0		0	
		+Lost completely	Ha	140	171,000,000	205	256,250,000	10	13,500,000	0		55	82,500,000	0		0		0		0	
		+Seed lost (just sown)	Ha	1,100	88,500,000	1,000	85,000,000	168	15,880,000	0		0		0		0		0		0	
		+Productivity decreased	Ha	10,000	5,000,000,000	11,200	5,600,000,000	800	400,000,000	345	227,700,000	400	288,000,000	169	138,411,000	0		0		0	
	AG2	Damaged flowers/vegetables	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
		+Lost completely	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
		+Productivity decreased	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
	AG3	Damaged field crops	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
		+Lost completely	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
		+Seed lost (just sown)	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
		+Productivity decreased	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
	AG4	*Damaged perennial trees*	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
		+Dead	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
		+Productivity decreased	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
	AG5	*Damaged fruit trees*	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
		+Dead	*Ha*	NA		NA		NA		NA		NA		NA		0		0		0	
		+Productivity decreased	Ha	NA		NA		NA		NA		NA		NA		0		0		0	
	AG6	Damaged seeds	Ton	342	136,800,000	115	47,725,000	84	36,960,000	0		0		0		0		0		0	
	AG7	Damaged food	Ton	1,250	500,000,000	992	411,680,000	322	141,680,000	151	66,440,000	116	69,600,000	0		0		0		0	
	AG8	Number of dead big livestock	Nos	3	1,800,000	2	1,300,000	3	2,100,000	7	5,600,000	11	8,800,000	8	6,400,000	0		0		0	
	AG9	Number of dead little livestock	Nos	15	2,250,000	32	5,120,000	23	3,795,000	19	3,135,000	26	4,420,000	12	2,040,000	7	1,224,000	5	952,000	6	1,105,000
	AG10	Dead poultry	Nos	720	1,440,000	704	1,760,000	480	1,197,000	175	525,000	224	784,000	112	448,000	130	580,000	190	850,000	160	795,000
	AG11	Damaged fertilizers	Ton	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG12	Damaged agro-chemicals	Ton	0		0		0		0		0		0		0		0		0	
	AG13	Farm land eroded w/o recovery	Ha	0		0		0		0		0		0		0		0		0	
	AG14	Housing land eroded/lost	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Irrigation	IR1	Dyke damaged	Meter	0		0		241	31,724,000	0		60	2,550,000	85	10,124,000	0		95	14,624,000	0	
	IR2	Embankment damaged	Meter	0		0		0		0		0		0		0		0		0	
	IR3	Canal & Ditch damaged	Meter	0		0		268	13,936,000	0		0		145	7,150,000	0		269	16,476,000	0	
	IR4	Water reservoir and dam	Nos	0		0		0		0		0		0		0		0		0	
	IR5	Pumping station damaged	Nos	0		0		0		0		0		0		0		0		0	
	IR6	Other irrigation facilities	Nos	0		0		0		0		0		0		0		4	106,800,000	0	
Fishery	FI1	Aquaculture pond damages	Ha	0		0		0		0		0		0		2	0	0		0	
	FI2	Fish/shrimp lost from ponds	Ton	0		0		0		0		0		0		14	8,400,000	0		0	
	FI3	Fish cage, raft, trap damaged	No.	150	1,200,000	70	560,000	100	800,000	50	400,000	45	360,000	80	640,000	70	560,000	90	720,000	50	400,000
	FI4	Other fishing tools damaged	Set.	50	250,000	30	150,000	20	100,000	70	350,000	60	300,000	40	200,000	110	6,500,000	80	400,000	70	350,000
	FI5	Boats and ships lost	Nos	5	3,000,000	2	1,200,000	0		1	600,000	0		0		3	1,800,000	0		4	2,400,000
Transport	TR1	roads	Meter	1,726	207,120,000	0		0		0		0		0		0		0		0	
	TR2	Damaged rural roads	Meter	51,000	816,000,000	12,000	192,000,000	NA		NA		NA		NA		NA		NA		NA	
	TR3	Damaged railways	Meter	0		0		0		0		0		0		0		0		0	
	TR4	Damaged bridges/culverts	Nos	6	36,000,000	0		0		0		0		0		0		0		0	
	TR5	Damaged ports	Nos	0		0		0		0		0		0		0		0		0	
	TR6	Damaged airports	Nos	0		0		0		0		0		0		0		0		0	
	TR7	Damaged boats/vehicles	Nos	0		0		0		0		0		0		0		0		0	
	TR8	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Communication	CO1	Damaged houses/stations	Nos	0		0		0		0		0		0		0		0		0	
	CO2	Damaged equipment/assets	Riel	0		0		0		0		0		0		0		0		0	
	CO3	Communication poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	CO4	Communication wires cut	Meter	0		0		0		0		0		0		0		0		0	
	CO5	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Industry	IN1	High tension poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	IN2	Electric wires cut	Meter	0		0		0		0		0		0		0		0		0	
	IN3	Damaged transformer stations	Nos	0		0		0		0		0		0		0		0		0	
	IN4	Damaged power plants	Nos	0		0		0		0		0		0		0		0		0	
	IN5	Damaged factories & plants	Nos	0		0		0		0		0		0		0		0		0	
	IN6	Damaged mines	Nos	0		0		0		0		0		0		0		0		0	
	IN7	Damaged machines, equipment	Nos	0		0		0		0		0		0		0		0		0	
	IN8	Damaged industrial products	Ton	0		0		0		0		0		0		0		0		0	
	IN9	Other industrial damages	Riel	0		0		0		0		0		0		0		0		0	
Construction	CS1	damaged	Nos	0		0		0		0		0		0		0		0		0	
	CS2	Unfinished works swept away	M3	0		0		0		0		0		0		0		0		0	
	CS3	Construction material damaged	Riel	0		0		0		0		0		0		0		0		0	
	CS4	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Water & Envi-ronment	WE1	Number of damaged wells	Nos	166	66,400,000	21	8,400,000	22	8,800,000	0		0		0		0		26		36	
	WE2	Water supply stations damaged	Nos	0		0		0		0		0		0		0		0		0	
	WE3	Drainage system damaged	Meter	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	WE4	Number of people without water	Person	15,400	92,400,000	1,560	9,360,000	1,600	9,600,000	0		0		0		0		2,000		3,200	
	WE5	area	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Prevention & Rescue (Gov +NGOs)	PR1	Flood prevention costs	Riel	LS	41,250,000	0		0		0		0		0		0		0		0	
	PR2	Temporary relocation sites	Riel	0		0		0		0		0		0		0		0		0	
	PR3	Foods & medicine etc. supplied	Riel	LS	247,000,000	0		LS	194,450,000	0		0		0		0		LS		0	
	PR4	Costs for rescue	Riel	0		0		0		0		0		0		0		0		0	
	PR5	Others	Riel	0		0		0		0		0		0		0		0		0	
Other costs	OT1	Rice seed providing	ton																		
	OT2	?	???																		
	OT3	?	???																		
Grand Total			**Mil Riel**		**7,504.8**		**6,620.5**		**901.8**		**304.8**		**457.3**		**204.2**		**19.1**		**201.1**		**6.6**
Direct damages Housing			Mil Riel		92.4		0.0		0.0		0.0		0.0		0.0		0.0		60.3		0.0
Direct Damages Agriculture			Mil Riel		5,906.2		6,410.7		616.0		304.8		454.8		148.1		19.1		2.9		5.1
Relief&emergency			Mil Riel		288.3		0.0		194.5		0.0		0.0		0.0		0.0		0.0		0.0
Direct Damages Infrastructure			Mil Riel		1,217.9		209.8		91.3		0.0		2.6		56.0		0.0		137.9		1.6

Attachment 1.10: Flood damage data (current price in Riel)

Inventory of Direct Flood Damages at District Level from 2000 to 2008

Country: Cambodia
Province: Takaev **CURRENCY:** Riel
District: Kandal Stueng

Types	No	Items	Unit	Year: 2000 Quantity	Year: 2000 Cost	Year: 2001 Quantity	Year: 2001 Cost	Year: 2002 Quantity	Year: 2002 Cost	Year: 2003 Quantity	Year: 2003 Cost	Year: 2004 y	Year: 2004 Cost	Year: 2005 Quantity	Year: 2005 Cost	Year: 2006 y	Year: 2006 Cost	Year: 2007 y	Year: 2007 Cost	Year: 2008 Quantity	Year: 2008 Cost
Human	HU1	Number of causalities	Person	0		0		0		0		0		0		0		0		0	
	HU2	Number of missing people	Person	0		0		0		0		0		0		0		0		0	
	HU3	Number of injured people	Person	0		0		0		0		0		0		0		0		0	
	HU4	Number of affected households	Family	3,205		620		0		1,434		0		0		3,625		0		0	
	HU5	Number of affected people	Person	14,696		3,100		0		7,170		0		0		16,172		0		0	
Housing	HO1	Collapsed/swept away houses	Nos	97	194,000,000	0		0		0		0		0		1	2,000,000	0		0	
	HO2	houses	Nos	59	11,800,000	0		0		0		0		0		2	400,000	0		0	
	HO3	Damaged properties	Riel	LS	24,250,000	0		0		0		0		0		LS	2,500,000	0		0	
Education	ED1	Number of affected schools	Nos	5	4,000,000	0		0		0		0		0		0		0		0	
	ED2	Damaged classrooms	Nos	25	194,000,000	0		0		0		0		0		0		0		0	
	ED3	Damaged houses	Nos	0		0		0		0		0		0		0		0		0	
	ED4	Damaged desks & chairs	Set	92	6,000,000	0		0		0		0		0		0		0		0	
	ED5	Damaged books	Nos	2,800	4,140,000	0		0		0		0		0		0		0		0	
	ED6	Damaged education equipment	Set	176	1,224,000	0		0		0		0		0		0		0		0	
Health care	HE1	Number of affected clinics	Nos	0		0		0		0		0		0		0		0		0	
	HE2	Damaged rooms	Nos	0		0		0		0		0		0		0		0		0	
	HE3	Medicine damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE4	Medical equipment damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE5	Other assets damaged	Riel	0		0		0		0		0		0		0		0		0	
Structures	ST1	Cultural/historical structures	Nos	0		0		0		0		0		0		0		0		0	
	ST2	Head offices	Nos	0		0		0		0		0		0		0		0		0	
	ST3	Market/commercial centers	Nos	0		0		0		0		0		0		0		0		0	
	ST4	Warehouses	Nos	0		0		0		0		0		0		0		0		0	
	ST5	Other works	Nos	0		0		0		0		0		0		0		0		0	
Agro-forest	AG1	Damaged rice area	Ha	9,464	5,623,665,000	7,505	3,314,119,000	1,800	732,439,000	1,496	1,279,885,000	0	0	0	0	1,162	0	0	0	0	0
		+Lost completely	Ha	3,688	3,209,297,000	695	556,069,000	103	83,337,000	710	816,145,000	0		0		525		0		0	
		+Seed lost (just sown)	Ha	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	5,776	2,414,368,000	6,810	2,758,050,000	1,697	649,102,000	786	463,740,000	0		0		637		0		0	
	AG2	Damaged flowers/vegetables	Ha	0		0		0		0		0		0		0		0		0	
		+Lost completely	Ha	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG3	Damaged field crops	Ha	0		0		0		0		0		0		0		0		0	
		+Lost completely	*Ha*	0		0		0		0		0		0		0		0		0	
		+Seed lost (just sown)	*Ha*	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	*Ha*	0		0		0		0		0		0		0		0		0	
	AG4	Damaged perennial trees	Ha	0.0		0.0		0.0		0.0		0		0		0.0		0		0	
		+Dead	*Ha*	0.0		0.0		0.0		0.0		0		0		0.0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG5	*Damaged fruit trees*	*Ha*	0		0		0		0		0		0		0		0		0	
		+Dead	*Ha*	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG6	Damaged seeds	Ton	0		0		0		0		0		0		0		0		0	
	AG7	Damaged food	Ton	0		0		0		0		0		0		0		0		0	
	AG8	Number of dead big livestock	Nos	0		0		0		0		0		0		0		0		0	
	AG9	Number of dead little livestock	Nos	0		0		0		0		0		0		0		0		0	
	0	Dead poultry	Nos	0		0		0		0		0		0		0		0		0	
	1	Damaged fertilizers	Ton	905	72,400,000	600	54,000,000	300	27,000,000	225	22,500,000	0		0		205		0		0	
	2	Damaged agro-chemicals	Ton	0		0		0		0		0		0		0		0		0	
	3	Farm land eroded w/o recovery	Ha	0		0		0		0		0		0		0		0		0	
	4	Housing land eroded/lost	Ha	NA		NA		NA		NA		0		0		NA		0		0	
Irrigation	IR1	Dyke damaged	Meter	750	60,000,000	0		0		0		1,580	126,400,000	0		0		0		0	
	IR2	Embankment damaged	Meter	0		0		0		0		0		0		0		0		0	
	IR3	Canal & Ditch damaged	Meter	7,450	178,800,000	0		2,900	69,600,000	0		36,925	886,200,000	0		0		0		0	
	IR4	Water reservoir and dam	Nos	0		0		0		0		0		0		0		0		0	
	IR5	Pumping station damaged	Nos	0		0		0		0		0		0		0		0		0	
	IR6	Other irrigation facilities	Nos	0		0		0		0		0		0		0		0		0	
Fishery	FI1	Aquaculture pond damages	Ha	0		0		0		0		0		0		0		0		0	
	FI2	Fish/shrimp lost from ponds	Ton	0		0		0		0		0		0		0		0		0	
	FI3	Fish cage, raft, trap damaged	No.	0		0		0		0		0		0		0		0		0	
	FI4	Other fishing tools damaged	Set.	0		0		0		0		0		0		0		0		0	
	FI5	Boats and ships lost	Nos	0		0		0		0		0		0		0		0		0	
Transport	TR1	roads	Meter	29,671	1,130,000,000	13,850	253,000,000	0		0		0		0		0		0		0	
	TR2	Damaged rural roads	Meter	300	960,000	7,000	42,000,000	0		0		0		0		0		0		0	
	TR3	Damaged railways	Meter	0		0		0		0		0		0		0		0		0	
	TR4	Damaged bridges/culverts	Nos	2	110,700,000	0		0		0		0		0		0		0		0	
	TR5	Damaged ports	Nos	0		0		0		0		0		0		0		0		0	
	TR6	Damaged airports	Nos	0		0		0		0		0		0		0		0		0	
	TR7	Damaged boats/vehicles	Nos	0		0		0		0		0		0		0		0		0	
	TR8	Other damages	Riel	0		0		0		0		0		0		0		0		0	
n	CO1	Damaged houses/stations	Nos	0		0		0		0		0		0		0		0		0	
	CO2	Damaged equipment/assets	Riel	0		0		0		0		0		0		0		0		0	
	CO3	Communication poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	CO4	Communication wires cut	Meter	0		0		0		0		0		0		0		0		0	
	CO5	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Industry	IN1	High tension poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	IN2	Electric wires cut	Meter	0		0		0		0		0		0		0		0		0	
	IN3	Damaged transformer stations	Nos	0		0		0		0		0		0		0		0		0	
	IN4	Damaged power plants	Nos	0		0		0		0		0		0		0		0		0	
	IN5	Damaged factories & plants	Nos	0		0		0		0		0		0		0		0		0	
	IN6	Damaged mines	Nos	0		0		0		0		0		0		0		0		0	
	IN7	Damaged machines, equipment	Nos	0		0		0		0		0		0		0		0		0	
	IN8	Damaged industrial products	Ton	0		0		0		0		0		0		0		0		0	
	IN9	Other industrial damages	Riel	0		0		0		0		0		0		0		0		0	
Construction	CS1	damaged	Nos	0		0		0		0		0		0		0		0		0	
	CS2	Unfinished works swept away	M3	0		0		0		0		0		0		0		0		0	
	CS3	Construction material damaged	Riel	0		0		0		0		0		0		0		0		0	
	CS4	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Water & Envi-ronment	WE1	Number of damaged wells	Nos	270	32,400,000	0		0		0		0		0		0		0		0	
	WE2	Water supply stations damaged	Nos	0		0		0		0		0		0		0		0		0	
	WE3	Drainage system damaged	Meter	0		0		0		0		0		0		0		0		0	
	WE4	Number of people without water	Person	1,830	915,000	0		0		0		0		0		0		0		0	
	WE5	area	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Prevention & Rescue (Gov +NGOs)	PR1	Flood prevention costs	Riel	0		0		0		0		0		0		0		0		0	
	PR2	Temporary relocation sites	Riel	0		0		0		0		0		0		0		0		0	
	PR3	Foods & medicine etc. supplied	Riel	LS	96,150,000	LS	18,600,000	0		LS	37,910,000	0		0		LS	135,937,500	0		0	
	PR4	Costs for rescue	Riel	0		0		0		0		0		0		0		0		0	
	PR5	Others	Riel	0		0		0		0		0		0		0		0		0	
Other costs	OT1	???	???																		
	OT2	???	???																		
	OT3	???	???																		
Grand Total			Mil Riel		**7,745.40**		**3,681.72**		**829.04**		**1,340.30**		**1,012.60**		**0.00**		**140.84**		**0.00**		**0.00**
Direct damages Housing			Mil Riel		230.05		0.00		0.00		0.00		0.00		0.00		4.90		0.00		0.00
Direct Damages Agriculture			Mil Riel		5,696.07		3,368.12		759.44		1,302.39		0.00		0.00		0.00		0.00		0.00
Relief&emergency			Mil Riel		96.15		18.60		0.00		37.91		0.00		0.00		135.94		0.00		0.00
Direct Damages Infrastructure			Mil Riel		1,723		295		70		0		1,013		0		0		0		0

Attachment 1.11: Flood damage data (current price in Riel)

Inventory of Direct Flood Damages at District Level from 2000 to 2008

Country: Cambodia
Province: Kandal — **CURRENCY:** Riel
District: S'ang

Types	No	Items	Unit	Year: 2000 Quantity	Year: 2000 Cost	Year: 2001 Quantity	Year: 2001 Cost	Year: 2002 Quantity	Year: 2002 Cost	Year: 2003 y	Year: 2003 Cost	Year: 2004 y	Year: 2004 Cost	Year: 2005 Quantity	Year: 2005 Cost	Year: 2006 y	Year: 2006 Cost	Year: 2007 y	Year: 2007 Cost	Year: 2008 Quantity	Year: 2008 Cost
Human	HU1	Number of causalities	Person	8		3		0		0		2		0		0		0		0	
	HU2	Number of missing people	Person	0		0		0		0		0		0		0		0		0	
	HU3	Number of injured people	Person	0		0		0		0		0		0		0		0		0	
	HU4	Number of affected households	Family	9,955		9,709		7,330		NA		1,706		63		0		0		0	
	HU5	Number of affected people	Person	49,775		48,545		36,650		NA		8,530		315		0		0		0	
Housing	HO1	Collapsed/swept away houses	Nos	92	368,000,000	NA		0		0		0		6	7,200,000	0		0		0	
	HO2	houses	Nos	104	20,800,000	173	34,672,000	70	280,000,000	5	1,000,000	63	252,000,000	0		0		0		0	
	HO3	Damaged properties	Riel	NA		NA		NA		NA		NA		NA		0		0		0	
Education	ED1	Number of affected schools	Nos	15	0	3	1,500,000	1	68,000,000	0		0		0		0		0		0	
	ED2	Damaged classrooms	Nos	31	44,000,000	0		0		0		0		0		0		0		0	
	ED3	Damaged houses	Nos	0		0		0		0		0		0		0		0		0	
	ED4	Damaged desks & chairs	Set	75	15,600,000	0		0		0		0		0		0		0		0	
	ED5	Damaged books	Nos	800	2,800,000	0		0		0		0		0		0		0		0	
	ED6	Damaged education equipment	Set	12	1,800,000	0		0		0		0		0		0		0		0	
Health care	HE1	Number of affected clinics	Nos	0		0		0		0		0		0		0		0		0	
	HE2	Damaged rooms	Nos	0		0		0		0		0		0		0		0		0	
	HE3	Medicine damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE4	Medical equipment damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE5	Other assets damaged	Riel	0		0		0		0		0		0		0		0		0	
Structures	ST1	Cultural/historical structures	Nos	0		0		0		0		0		0		0		0		0	
	ST2	Head offices	Nos	0		0		0		0		0		0		0		0		0	
	ST3	Market/commercial centers	Nos	0		0		0		0		0		0		0		0		0	
	ST4	Warehouses	Nos	0		0		0		0		0		0		0		0		0	
	ST5	Other works	Nos	0		0		0		0		0		0		0		0		0	
Agro-forest	AG1	Damaged rice area	Ha	3,014	2,484,080,000	2,907	3,488,400,000	540	446,600,000	0	0	0	0	0	0	0	0	0	0	0	0
		+Lost completely	Ha	1,784	1,998,080,000	2,907	3,488,400,000	298	357,600,000	0		0		0		0		0		0	
		+Seed lost (just sown)	Ha	30	6,000,000	0		39	7,800,000	0		0		0		0		0		0	
		+Productivity decreased	Ha	1,200	480,000,000	0		203	81,200,000	0		0		0		0		0		0	
	AG2	Damaged flowers/vegetables	Ha	247	1,111,500,000	NA		NA		0	0	0	0	0	0	0	0	0	0	0	0
		+Lost completely	Ha	247	1,111,500,000	NA		NA		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		NA		NA		0		0		0		0		0		0	
	AG3	Damaged field crops	Ha	762	762,000,000	634	950,318,000	531	1,593,000,000	0	0	0	0	0	0	0	0	0	0	0	0
		+Lost completely	Ha	0		634	950,318,000	531	1,593,000,000	0		0		0		0		0		0	
		+Seed lost (just sown)	Ha	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	762	762,000,000	0		0		0		0		0		0		0		0	
	AG4	Damaged perennial trees	*Ha*	570	1,710,000,000	NA		NA		0	0	0	0	0	0	0	0	0	0	0	0
		+Dead	*Ha*	570.0	1,710,000,000	NA		NA		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		NA		NA		0		0		0		0		0		0	
	AG5	Damaged fruit trees	*Ha*	655	1,637,500,000	NA		NA		0	0	0	0	0	0	0	0	0	0	0	0
		+Dead	*Ha*	655	1,637,500,000	NA		NA		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		NA		NA		0		0		0		0		0		0	
	AG6	Damaged seeds	Ton	0		0		0		0		0		0		0		0		0	
	AG7	Damaged food	Ton	0		0		0		0		0		0		0		0		0	
	AG8	Number of dead big livestock	Nos	8	8,000,000	5	5,000,000	4	4,000,000	0		0		0		0		0		0	
	AG9	Number of dead little livestock	Nos	23	4,600,000	54	10,800,000	15	3,000,000	0		0		0		0		0		0	
	0	Dead poultry	Nos	NA		NA		NA		0		0		0		0		0		0	
	1	Damaged fertilizers	Ton	NA		NA		NA		0		0		0		0		0		0	
	2	Damaged agro-chemicals	Ton	0		0		0		0		0		0		0		0		0	
	3	Farm land eroded w/o recovery	Ha	NA		NA		NA		0		0		0		0		0		0	
	4	Housing land eroded/lost	Ha	NA		NA		NA		0		NA		NA		0		0		0	
Irrigation	IR1	Dyke damaged	Meter	6,370	509,600,000	620	49,600,000	300	24,000,000	850	68,000,000	0		0		300	240,000,000	0		0	
	IR2	Embankment damaged	Meter	0		0		0		0		0		0		0		0		0	
	IR3	Canal & Ditch damaged	Meter	23,890	573,360,000	6,400	153,600,000	11,693	280,632,000	6,740	161,760,000	26,568	637,632,000	3,660	87,840,000	4,630	111,120,000	5,113	122,712,000	1,810	43,440,000
	IR4	Water reservoir and dam	Nos	0		0		0		0		0		0		0		0		0	
	IR5	Pumping station damaged	Nos	0		0		0		0		0		0		0		0		0	
	IR6	Other irrigation facilities	Nos	0		0		0		0		5 culverts	60,000,000	0		0		0		0	
Fishery	FI1	Aquaculture pond damages	Ha	2	3,006,000	0		0		0		0		0		0		0		0	
	FI2	Fish/shrimp lost from ponds	Ton	1.2	3,800,000	0		0		0		0		0		0		0		0	
	FI3	Fish cage, raft, trap damaged	No.	12	600,000	0		0		0		0		0		0		0		0	
	FI4	Other fishing tools damaged	Set.	LS	2,700,000	0		0		0		0		0		0		0		0	
	FI5	Boats and ships lost	Nos	0		0		0		0		0		0		0		0		0	
Transport	TR1	roads	Meter	10,000	5,040,000,000	0		0		0		0		0		0		0		0	
	TR2	Damaged rural roads	Meter	28,400	545,200,000	19,400	620,800,000	11,500	368,000,000	0		0		7,000	224,000,000	0		3,000	9,600,000	0	
	TR3	Damaged railways	Meter	0		0		0		0		0		0		0		0		0	
	TR4	Damaged bridges/culverts	Nos	4	174,702,000	0		0		0		0		0		0		0		0	
	TR5	Damaged ports	Nos	0		0		0		0		0		0		0		0		0	
	TR6	Damaged airports	Nos	0		0		0		0		0		0		0		0		0	
	TR7	Damaged boats/vehicles	Nos	15	18,000,000	0		0		0		0		0		0		0		0	
	TR8	Other damages	Riel	0		0		0		0		0		0		0		0		0	
n	CO1	Damaged houses/stations	Nos	0		0		0		0		0		0		0		0		0	
	CO2	Damaged equipment/assets	Riel	0		0		0		0		0		0		0		0		0	
	CO3	Communication poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	CO4	Communication wires cut	Meter	0		0		0		0		0		0		0		0		0	
	CO5	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Industry	IN1	High tension poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	IN2	Electric wires cut	Meter	0		0		0		0		0		0		0		0		0	
	IN3	Damaged transformer stations	Nos	0		0		0		0		0		0		0		0		0	
	IN4	Damaged power plants	Nos	0		0		0		0		0		0		0		0		0	
	IN5	Damaged factories & plants	Nos	0		0		0		0		0		0		0		0		0	
	IN6	Damaged mines	Nos	0		0		0		0		0		0		0		0		0	
	IN7	Damaged machines, equipment	Nos	0		0		0		0		0		0		0		0		0	
	IN8	Damaged industrial products	Ton	0		0		0		0		0		0		0		0		0	
	IN9	Other industrial damages	Riel	0		0		0		0		0		0		0		0		0	
Construction	CS1	Construction instrument damaged	Nos	0		0		0		0		0		0		0		0		0	
	CS2	Unfinished works swept away	M3	0		0		0		0		0		0		0		0		0	
	CS3	Construction material damaged	Riel	0		0		0		0		0		0		0		0		0	
	CS4	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Water & Envi-ronment	WE1	Number of damaged wells	Nos	253	303,600,000	0		33	39,600,000	0		0		0		0		0		0	
	WE2	Water supply stations damaged	Nos	0		0		0		0		0		0		0		0		0	
	WE3	Drainage system damaged	Meter	0		0		0		0		0		0		0		0		0	
	WE4	Without water	Person	NA		0		NA		0		0		0		0		0		0	
	WE5	Polluted residential area	Ha	0		0		0		0		0		0		0		0		0	
Prevention & Rescue (Gov +NGOs)	PR1	Flood prevention costs	Riel		89,280,000		104,160,000		119,040,000		126,480,000		133,920,000		141,360,000		0		0		0
	PR2	Temporary relocation sites	Riel		0		0		0		0		0		0		0		0		0
	PR3	Foods & medicine etc. supplied	Riel		223,987,000		130,770,000		109,950,000		NA		38,960,000		NA		0		0		0
	PR4	Costs for rescue	Riel		0		0		8,000,000		0		0		0		0		0		0
	PR5	Others	Riel																		
Other costs	OT1	???	???																		
	OT2	???	???																		
	OT3	???	???																		
Grand Total			Mil Riel		**15,658.52**		**5,549.62**		**3,343.82**		**357.24**		**1,122.51**		**460.40**		**351.12**		**132.31**		**43.44**
Direct damages Housing			Mil Riel		388.80		34.67		280.00		1.00		252.00		7.20		0.00		0.00		0.00
Direct Damages Agriculture			Mil Riel		7,727.79		4,454.52		2,046.60		0.00		0.00		0.00		0.00		0.00		0.00
Relief&emergency			Mil Riel		313.27		234.93		236.99		126.48		172.88		141.36		0.00		0.00		0.00
Direct Damages Infrastructure			Mil Riel		7,229		826		780		230		698		312		351		132		43

Attachment 1.12: Flood damage data (current price in Riel)

Inventory of Direct Flood Damages at District Level from 2000 to 2008

Country: Cambodia
Province: Kandal **CURRENCY:** Riel
District: Ta Khmau

Types	No	Items	Unit	Year: 2000 Quantity	Year: 2000 Cost	Year: 2001 Quantity	Year: 2001 Cost	Year: 2002 Quantity	Year: 2002 Cost	Year: 2003 y	Year: 2003 Cost	Year: 2004 y	Year: 2004 Cost	Year: 2005 Quantity	Year: 2005 Cost	Year: 2006 y	Year: 2006 Cost	Year: 2007 y	Year: 2007 Cost	Year: 2008 Quantity	Year: 2008 Cost
Human	HU1	Number of causalities	Person	0		0		0		0		0		0		0		0		0	
	HU2	Number of missing people	Person	0		0		0		0		0		0		0		0		0	
	HU3	Number of injured people	Person	0		0		0		0		0		0		0		0		0	
	HU4	Number of affected households	Family	4,947		1,213		3,204		15		20		38		10		15		0	
	HU5	Number of affected people	Person	22,824		6,037		16,020		60		80		152		50		62		0	
Housing	HO1	Collapsed/swept away houses	Nos	0		0		0		0		0		0		0		0		0	
	HO2	Partly damaged or submersed houses	Nos	101	17,230,000	64	24,700,000	80	22,400,000	0		0		0		10	6,000,000	15	#######	0	
	HO3	Damaged properties	Riel	0		0		0		0		0		0		0		0		0	
Education	ED1	Number of affected schools	Nos	1	500,000	0		0		0		0		0		0		0		0	
	ED2	Damaged classrooms	Nos	0		0		0		0		0		0		0		0		0	
	ED3	Damaged houses	Nos	0		0		0		0		0		0		0		0		0	
	ED4	Damaged desks & chairs	Set	0		0		0		0		0		0		0		0		0	
	ED5	Damaged books	Nos	0		0		0		0		0		0		0		0		0	
	ED6	Damaged education equipment	Set	0		0		0		0		0		0		0		0		0	
Health care	HE1	Number of affected clinics	Nos	0		0		0		0		0		0		0		0		0	
	HE2	Damaged rooms	Nos	0		0		0		0		0		0		0		0		0	
	HE3	Medicine damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE4	Medical equipment damaged	Riel	0		0		0		0		0		0		0		0		0	
	HE5	Other assets damaged	Riel	0		0		0		0		0		0		0		0		0	
Structures	ST1	Cultural/historical structures	Nos	0		0		0		0		0		0		0		0		0	
	ST2	Head offices	Nos	0		0		0		0		0		0		0		0		0	
	ST3	Market/commercial centers	Nos	0		0		0		0		0		0		0		0		0	
	ST4	Warehouses	Nos	0		0		0		0		0		0		0		0		0	
	ST5	Other works	Nos	0		0		0		0		0		0		0		0		0	
Agro-forest	AG1	Damaged rice area	Ha	127	230,419,000	93	186,720,000	0	0	0	0	0	0	0	0	42	#########	0	0	0	0
		+Lost completely	Ha	54	129,600,000	63	141,120,000	0		0		0		0		42	#########	0		0	
		+Seed lost (just sown)	Ha	11	5,786,000	0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	62	95,033,000	30	45,600,000	0		0		0		0		0		0		0	
	AG2	Damaged flowers/vegetables	Ha	106	60,420,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		+Lost completely	Ha	106	60,420,000	0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG3	Damaged field crops	Ha	0	0	287	177,305,000	0	0	0	0	0	0	0	0	37	21,275,000	0	0	0	0
		+Lost completely	Ha	0		213	103,305,000	0		0		0		0		37	21,275,000	0		0	
		+Seed lost (just sown)	Ha	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		74	74,000,000	0		0		0		0		0		0		0	
	AG4	Damaged perennial trees	*Ha*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		+Dead	*Ha*	0.0		0.0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG5	Damaged fruit trees	*Ha*	0		0		0		0		0		0		0		0		0	
		+Dead	*Ha*	0		0		0		0		0		0		0		0		0	
		+Productivity decreased	Ha	0		0		0		0		0		0		0		0		0	
	AG6	Damaged seeds	Ton	0		0		0		0		0		0		0		0		0	
	AG7	Damaged food	Ton	0		0		0		0		0		0		0		0		0	
	AG8	Number of dead big livestock	Nos	3	4,500,000	0		0		0		0		0		0		0		0	
	AG9	Number of dead little livestock	Nos	4	2,000,000	0		0		0		0		0		0		0		0	
	AG10	Dead poultry	Nos	48	480,000	0		0		0		0		0		0		0		0	
	AG11	Damaged fertilizers	Ton	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG12	Damaged agro-chemicals	Ton	0		0		0		0		0		0		0		0		0	
	AG13	Farm land eroded w/o recovery	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
	AG14	Housing land eroded/lost	Ha	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Irrigation	IR1	Dyke damaged	Meter	450	36,000,000	0		0		0		0		0		0		0		0	
	IR2	Embankment damaged	Meter	0		0		0		0		0		0		0		0		0	
	IR3	Canal & Ditch damaged	Meter	2,300	55,200,000	0		1,400	33,600,000	0		0		0		0		0		0	
	IR4	Water reservoir and dam	Nos	0		0		0		0		0		0		0		0		0	
	IR5	Pumping station damaged	Nos	0		0		0		0		0		0		0		0		0	
	IR6	Other irrigation facilities	Nos	0		0		0		0		0		0		0		0		0	
Fishery	FI1	Aquaculture pond damages	Ha	0.6	2,400,000	0		0		0		0		0		0		0		0	
	FI2	Fish/shrimp lost from ponds	Ton	36	204,000,000	0		0		0		0		0		0		0		0	
	FI3	Fish cage, raft, trap damaged	No.	10	500,000	0		0		0		0		0		0		0		0	
	FI4	Other fishing tools damaged	Set.	LS	2,850,000	0		0		0		0		0		0		0		0	
	FI5	Boats and ships lost	Nos	0		0		0		0		0		0		0		0		0	
Transport	TR1	Damaged national/provincial roads	Meter	1,200	141,000,000	0		0		0		0		0		0		0		0	
	TR2	Damaged rural roads	Meter	6,200	284,000,000	0		0		0		0		0		0		0		0	
	TR3	Damaged railways	Meter	0		0		0		0		0		0		0		0		0	
	TR4	Damaged bridges/culverts	Nos	2	284,130,000	1	122,692,000	0		0		0		0		0		0		0	
	TR5	Damaged ports	Nos	0		0		0		0		0		0		0		0		0	
	TR6	Damaged airports	Nos	0		0		0		0		0		0		0		0		0	
	TR7	Damaged boats/vehicles	Nos	0		0		0		0		0		0		0		0		0	
	TR8	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Communication	CO1	Damaged houses/stations	Nos	0		0		0		0		0		0		0		0		0	
	CO2	Damaged equipment/assets	Riel	0		0		0		0		0		0		0		0		0	
	CO3	Communication poles collapsed	Nos	0		0		0		0		0		0		2	400,000	0		0	
	CO4	Communication wires cut	Meter	0		0		0		0		0		0		250	2,000,000	0		0	
	CO5	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Industry	IN1	High tension poles collapsed	Nos	0		0		0		0		0		0		0		0		0	
	IN2	Electric wires cut	Meter	0		0		0		0		0		0		0		0		0	
	IN3	Damaged transformer stations	Nos	0		0		0		0		0		0		0		0		0	
	IN4	Damaged power plants	Nos	0		0		0		0		0		0		0		0		0	
	IN5	Damaged factories & plants	Nos	0		0		0		0		0		0		0		0		0	
	IN6	Damaged mines	Nos	0		0		0		0		0		0		0		0		0	
	IN7	Damaged machines, equipment	Nos	0		0		0		0		0		0		0		0		0	
	IN8	Damaged industrial products	Ton	0		0		0		0		0		0		0		0		0	
	IN9	Other industrial damages	Riel	0		0		0		0		0		0		0		0		0	
Construction	CS1	Construction instrument damaged	Nos	0		0		0		0		0		0		0		0		0	
	CS2	Unfinished works swept away	M3	0		0		0		0		0		0		0		0		0	
	CS3	Construction material damaged	Riel	0		0		0		0		0		0		0		0		0	
	CS4	Other damages	Riel	0		0		0		0		0		0		0		0		0	
Water & Envi-ronment	WE1	Number of damaged wells	Nos	154	7,700,000	0		0		0		0		0		0		0		0	
	WE2	Water supply stations damaged	Nos	0		0		0		0		0		0		0		0		0	
	WE3	Drainage system damaged	Meter	0		0		0		0		0		0		0		0		0	
	WE4	Without water	Person	9,234	9,234,000	0		0		0		0		0		0		0		0	
	WE5	Polluted residential area	Ha	NA		0		0		0		0		0		0		0		0	
Prevention & Rescue (Gov +NGOs)	PR1	Flood prevention costs	Riel		999,717,000		0		0		0		0		0		0		0		0
	PR2	Temporary relocation sites	Riel		0		0		0		0		0		0		0		0		0
	PR3	Foods & medicine etc. supplied	Riel		334,836,000		240,000,000		320,000,000		37,000,000		0		0		NA		NA		0
	PR4	Costs for rescue	Riel		7,260,000		750,000		250,000		0		0		0		0		0		0
	PR5	Others	Riel		0		0		0		0		0		0		0		0		0
Other costs	OT1	???	???																		
	OT2	???	???																		
	OT3	???	???																		
Grand Total			Mil Riel		**2,684.38**		**752.17**		**376.25**		**37.00**		**0.00**		**0.00**		**130.48**		**3.15**		**0.00**
Direct damages Housing			Mil Riel		17.23		24.70		22.40		0.00		0.00		0.00		6.00		3.15		0.00
Direct Damages Agriculture			Mil Riel		507.57		364.03		0.00		0.00		0.00		0.00		122.08		0.00		0.00
Relief&emergency			Mil Riel		1,341.81		240.75		320.25		37.00		0.00		0.00		0.00		0.00		0.00
Direct Damages Infrastructure			Mil Riel		817.76		122.69		33.60		0.00		0.00		0.00		2.40		0.00		0.00

Attachment 1.13: Flood damage data (current price in Riel)

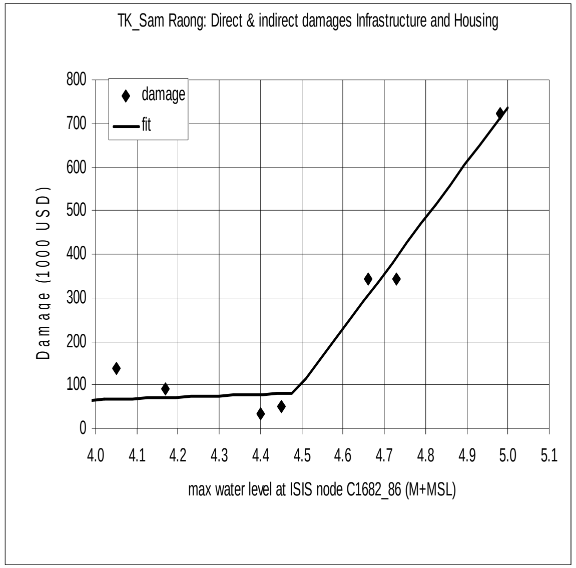
Inventory of Direct Flood Damages at District Level from 2000 to 2007

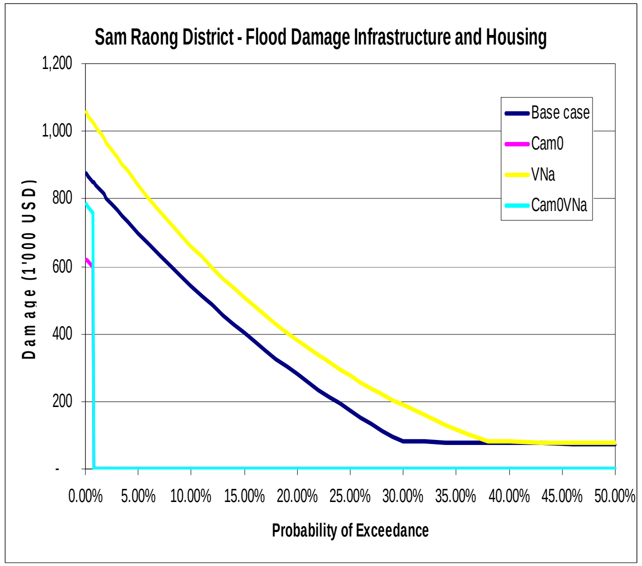
Country: Cambodia
Province: Kandal **CURRENCY:** Riel
District: Koh Thum

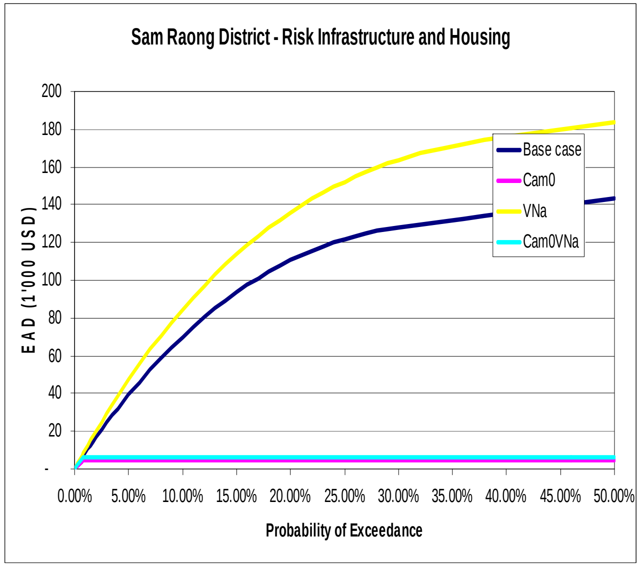
Types	No	Items	Unit	Year: 2000		Year: 2001		Year: 2002		Year: 2003		Year: 2004		Year: 2005		Year: 2006		Year: 2007	
				Quantity	Cost	y	Cost	y	Cost	y	Cost	y	Cost	y	Cost	y	Cost	y	Cost
Human	HU1	Number of causalities	Person	16		3		1		0		0		0		0		0	
	HU2	Number of missing people	Person	0		0		0		0		0		0		0		0	
	HU3	Number of injured people	Person	87		0		0		0		0		0		0		0	
	HU4	Number of affected households	Family	25,067		NA		NA		NA		NA		NA		NA		NA	
	HU5	Number of affected people	Person	136,542		NA		NA		NA		NA		NA		NA		NA	
Housing	HO1	Collapsed/swept away houses	Nos	127	50,000,000	NA		NA		NA		NA		NA		NA		NA	
	HO2	houses	Nos	315	63,000,000	NA		NA		NA		NA		NA		NA		NA	
	HO3	Damaged properties	Riels	NA		NA		NA		NA		NA		NA		NA		NA	
Education	ED1	Number of affected schools	Nos	9	9,000,000	9	9,000,000	9	9,000,000	9	9,000,000	9	9,000,000	9	9,000,000	9	9,000,000	9	9,000,000
	ED2	Damaged classrooms	Nos	5	80,000,000	0		0		0		0		0		0		0	
	ED3	Damaged houses	Nos	1	1,600,000	0		0		0		0		0		0		0	
	ED4	Damaged desks & chairs	Set	50	2,000,000	0		0		0		0		0		0		0	
	ED5	Damaged books	Nos	10,000	30,000,000	0		0		0		0		0		0		0	
	ED6	Damaged education equipment	Set	NA		0		0		0		0		0		0		0	
Health care	HE1	Number of affected clinics	Nos	0		0		0		0		0		0		0		0	
	HE2	Damaged rooms	Nos	0		0		0		0		0		0		0		0	
	HE3	Medicine damaged	Riels	0		0		0		0		0		0		0		0	
	HE4	Medical equipment damaged	Riels	0		0		0		0		0		0		0		0	
	HE5	Other assets damaged	Riels	0		0		0		0		0		0		0		0	
Structures	ST1	Cultural/historical structures	Nos	0		0		0		0		0		0		0		0	
	ST2	Head offices	Nos	0		0		0		0		0		0		0		0	
	ST3	Market/commercial centers	Nos	0		0		0		0		0		0		0		0	
	ST4	Warehouses	Nos	0		0		0		0		0		0		0		0	
	ST5	Other works	Nos	0		0		0		0		0		0		0		0	
Agro-forest	AG1	Damaged rice area	Ha	2,289		1,889		633		NA		NA		201		0		0	
		+Lost completely	Ha	370	259,000,000	210	147,000,000	300	210,000,000	NA		NA		75	52,500,000	0		0	
		+Seed lost (just sown)	Ha	75	12,000,000	48	7,680,000	30	4,800,000	NA		NA		10	1,600,000	0		0	
		+Productivity decreased	Ha	1,844	590,080,000	1,631	521,920,000	303	96,960,000	NA		NA		116	37,120,000	0		0	
	AG2	Damaged flowers/vegetables	Ha	370		NA		NA		NA		NA		NA		0		0	
		+Lost completely	Ha	4		NA		NA		NA		NA		NA		0		0	
		+Productivity decreased	Ha	27		NA		NA		NA		NA		NA		0		0	
	AG3	Damaged field crops	Ha	2,200		520		329		NA		NA		2,082		55		33	
		+Lost completely	Ha	57	41,040,000	45	32,400,000	47	33,840,000	NA		NA		700	504,000,000	55	39,600,000	33	23,760,000
		+Seed lost (just sown)	Ha	NA		0		0		NA		NA		82	13,120,000	0	0	0	0
		+Productivity decreased	Ha	2,143	771,480,000	475	171,000,000	282	101,520,000	NA		NA		1,300	468,000,000	0	0	0	0
	AG4	*Damaged perennial trees*	*Ha*	27		30		30		NA		NA		NA		NA		NA	
		+Dead	*Ha*	2		1		0		NA		NA		NA		NA		NA	
		+Productivity decreased	Ha	4		3		3		NA		NA		NA		NA		NA	
	AG5	*Damaged fruit trees*	*Ha*	8		NA		NA		NA		NA		NA		NA		NA	
		+Dead	*Ha*	1		NA		NA		NA		NA		NA		NA		NA	
		+Productivity decreased	Ha	4		NA		NA		NA		NA		NA		NA		NA	
	AG6	Damaged seeds	Ton	0		0		0		NA		NA		0		0		0	
	AG7	Damaged food	Ton	0		0		0		NA		NA		0		0		0	
	AG8	Number of dead big livestock	Nos	21		NA		NA		NA		NA		NA		5		31	
	AG9	Number of dead little livestock	Nos	9		NA		NA		NA		NA		NA		0		54	
	AG10	Dead poultry	Nos	NA		NA		NA		NA		NA		NA		NA		NA	
	AG11	Damaged fertilizers	Ton	0		0		0		NA		0		0		0		0	
	AG12	Damaged agro-chemicals	Ton	0		0		0		NA		0		0		0		0	
	AG13	Farm land eroded w/o recovery	Ha	3		0		0		0		0		0		0		0	
	AG14	Housing land eroded/lost	Ha	2.7		0		0		0		0		0		0		0	
Irrigation	IR1	Dyke damaged	Meter	44,850	879,060,000	NA		NA		NA		NA		NA		0		0	
	IR2	Embankment damaged	Meter	NA		NA		NA		NA		NA		NA		NA		NA	
	IR3	Canal & Ditch damaged	Meter	64,200	577,800,000	NA		NA		NA		NA		NA		NA		NA	
	IR4	Water reservoir and dam	Nos	2		2		2		2		2		2		NA		NA	
	IR5	Pumping station damaged	Nos	0		0		0		0		0		0		2		2	
	IR6	Other irrigation facilities	Nos	0		NA		NA		NA		NA		NA		0		0	
Fishery	FI1	Aquaculture pond damages	Ha	NA		NA		NA		NA		NA		NA		NA		NA	
	FI2	Fish/shrimp lost from ponds	Ton	NA		NA		NA		NA		NA		NA		NA		NA	
	FI3	Fish cage, raft, trap damaged	No.	NA		NA		NA		NA		NA		NA		NA		NA	
	FI4	Other fishing tools damaged	Set.	0		0		0		NA		NA		NA		NA		NA	
	FI5	Boats and ships lost	Nos	0		0		0		0		0		0		NA		NA	
Transport	TR1	National/provincial roads	Meter	4,645		2,557		0		0		0		0		0		0	
	TR2	Damaged rural roads	Meter	56,771		63,226	87,000,000	0		0		0		0		0		0	
	TR3	Damaged railways	Meter	0		0		0		0		0		0		0		0	
	TR4	Damaged bridges/culverts	Nos	23		2		0		0		0		1	13,000,000	0		0	
	TR5	Damaged ports	Nos	0		0		0		0		0		0		0		0	
	TR6	Damaged airports	Nos	0		0		0		0		0		0		0		0	
	TR7	Damaged boats/vehicles	Nos	0		0		0		0		0		0		0		0	
	TR8	Other damages	Riels	0		0		0		0		0		0		0		0	
n	CO1	Damaged houses/stations	Nos	0		0		0		0		0		0		0		0	
	CO2	Damaged equipment/assets	Riels	0		0		0		0		0		0		0		0	
	CO3	Communication poles collapsed	Nos	0		0		0		0		0		0		0		0	
	CO4	Communication wires cut	Meter	0		0		0		0		0		0		0		0	
	CO5	Other damages	Riels	0		0		0		0		0		0		0		0	
Industry	IN1	High tension poles collapsed	Nos	0		0		0		0		0		0		0		0	
	IN2	Electric wires cut	Meter	0		0		0		0		0		0		0		0	
	IN3	Damaged transformer stations	Nos	0		0		0		0		0		0		0		0	
	IN4	Damaged power plants	Nos	0		0		0		0		0		0		0		0	
	IN5	Damaged factories & plants	Nos	0		0		0		0		0		0		0		0	
	IN6	Damaged mines	Nos	0		0		0		0		0		0		0		0	
	IN7	Damaged machines, equipment	Nos	0		0		0		0		0		0		0		0	
	IN8	Damaged industrial products	Ton	0		0		0		0		0		0		0		0	
	IN9	Other industrial damages	Riels	0		0		0		0		0		0		0		0	
Construction	CS1	Construction instrument damaged	Nos	0		0		0		0		0		0		0		0	
	CS2	Unfinished works swept away	M3	0		0		0		0		0		0		0		0	
	CS3	Construction material damaged	Riels	0		0		0		0		0		0		0		0	
	CS4	Other damages	Riels	0		0		0		0		0		0		0		0	
Water & Envi-ronment	WE1	Number of damaged wells	Nos	320	87,040,000	NA		NA		NA		NA		NA		NA		NA	
	WE2	Water supply stations damaged	Nos	0		0		0		0		0		0		0		0	
	WE3	Drainage system damaged	Meter	0		0		0		0		0		0		0		0	
	WE4	Number of people without water	Person	0		0		0		0		0		0		0		0	
	WE5	Polluted residential area	Ha	NA		NA		NA		NA		NA		NA		NA		NA	
Prevention & Rescue (Gov +NGOs)	PR1	Flood prevention costs	Riels	NA		NA		NA		NA		NA		NA		NA		NA	
	PR2	Temporary relocation sites	Riels	NA		NA		NA		NA		NA		NA		NA		NA	
	PR3	Foods & medicine etc. supplied	Riels	LS	747,000,000	LS	560,000,000	LS	400,000,000	LS	250,000,000	LS	230,000,000	LS	240,000,000	LS	250,000,000	LS	203,000,000
	PR4	Costs for rescue	Riels	LS	326,000,000	LS	300,000,000	LS	250,000,000	LS	200,000,000	LS	180,000,000	LS	215,000,000	LS	180,000,000	LS	225,000,000
	PR5	Others	Riels																
Other costs	OT1	?	???																
	OT2	?	???																
	OT3	?	???																
Grand Total			**Mil Riel**		**4,526.10**		**1,836.00**		**1,106.12**		**459.00**		**419.00**		**1,553.34**		**478.60**		**460.76**
Direct damages Housing & Structures			Mil Riel		113.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00
Direct Damages Agriculture			Mil Riel		1,673.60		880.00		447.12		0.00		0.00		1,076.34		39.60		23.76
Relief&emergency			Mil Riel		1,073.00		860.00		650.00		450.00		410.00		455.00		430.00		428.00

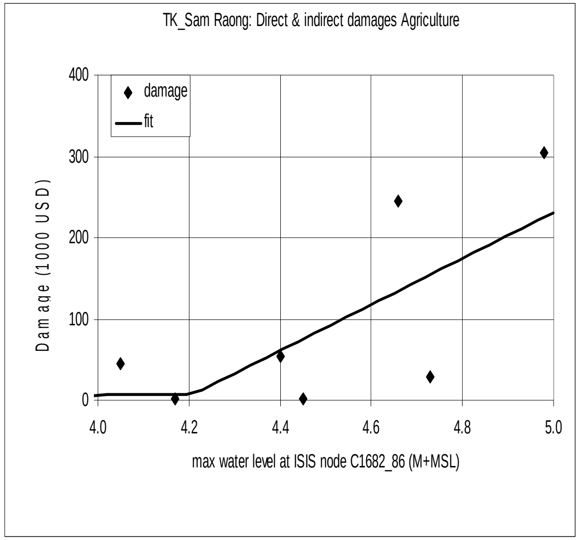
Attachment 2 Flood damage , flood damage probability and flood risk graphs for 13 Districts

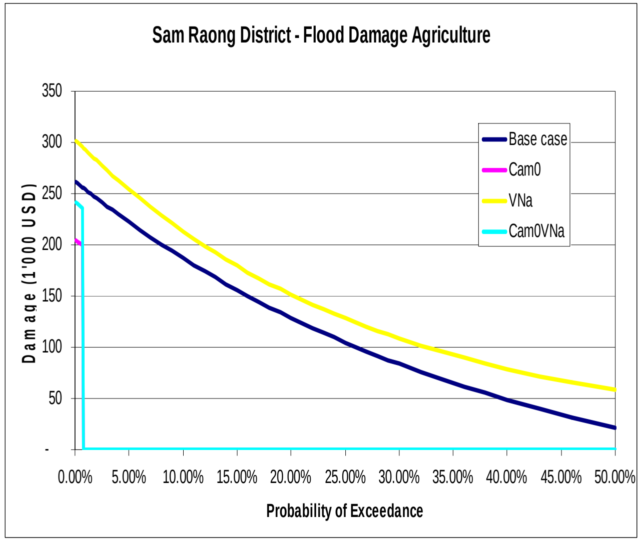
Attachment 2.1 Flood damage , flood damage probability and flood risk in Sam Raong District

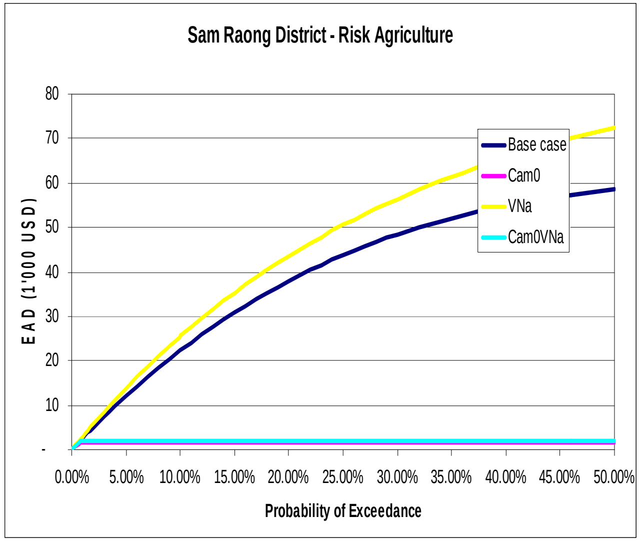




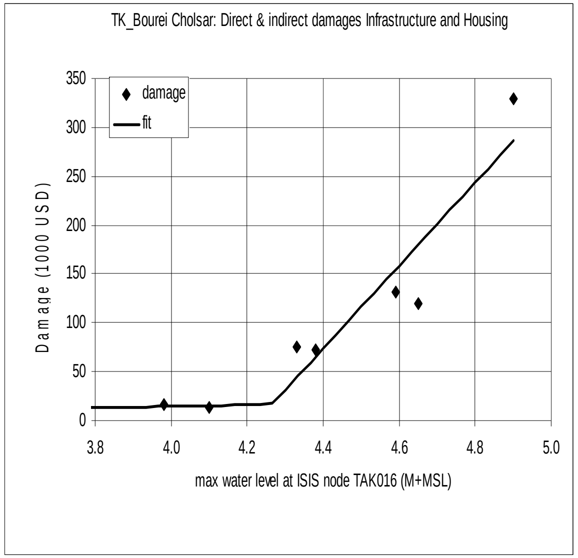


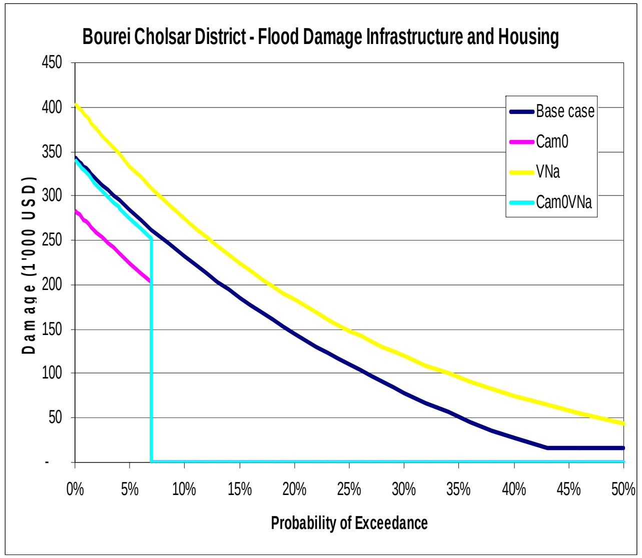


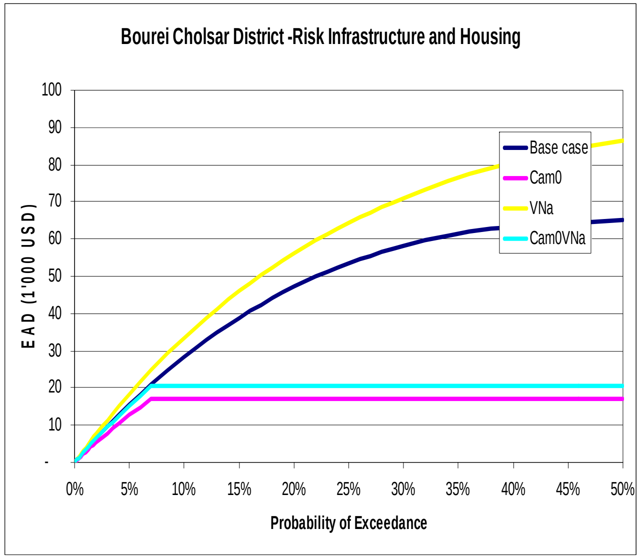


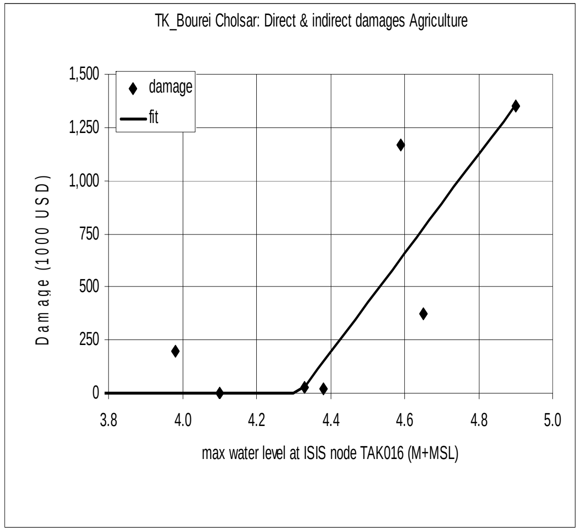


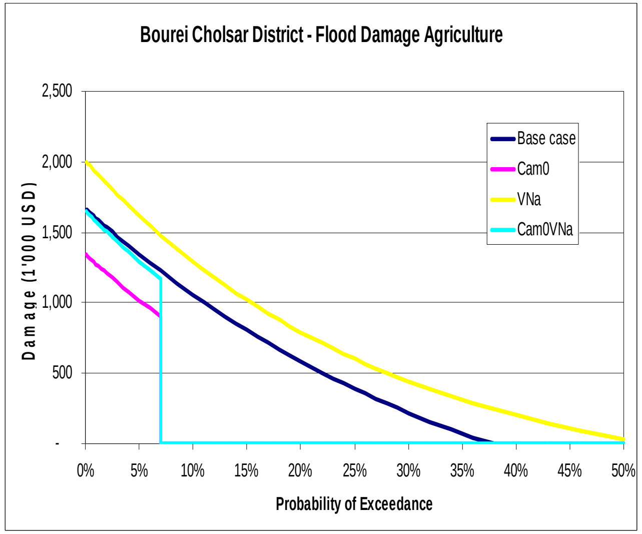
Attachment 2.2 **Flood damage , flood damage probability and flood risk in Bourai Cholsar District**

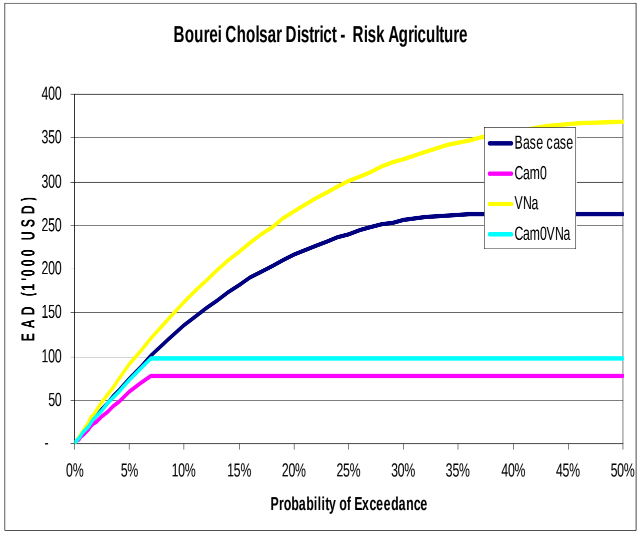




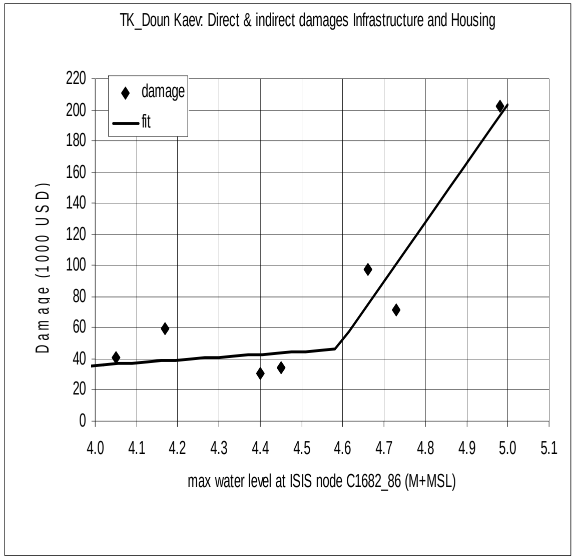


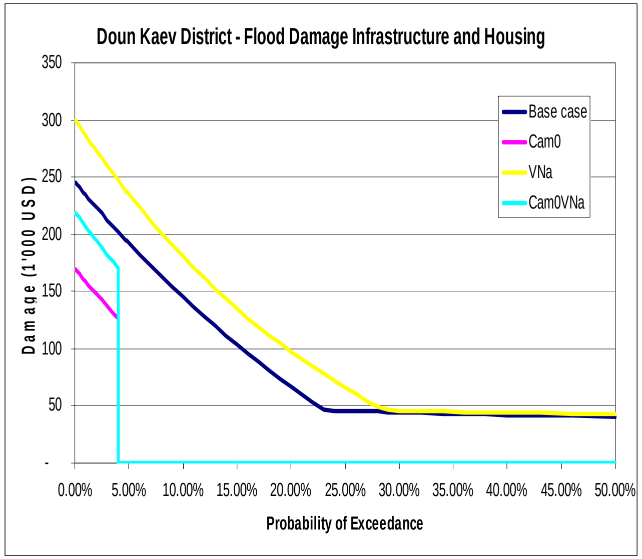


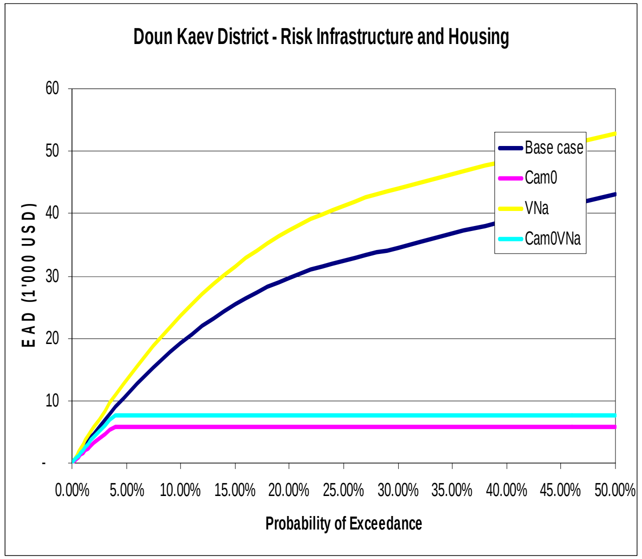


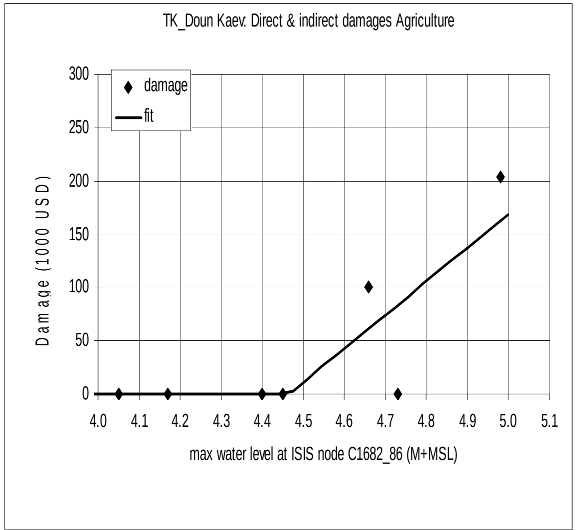


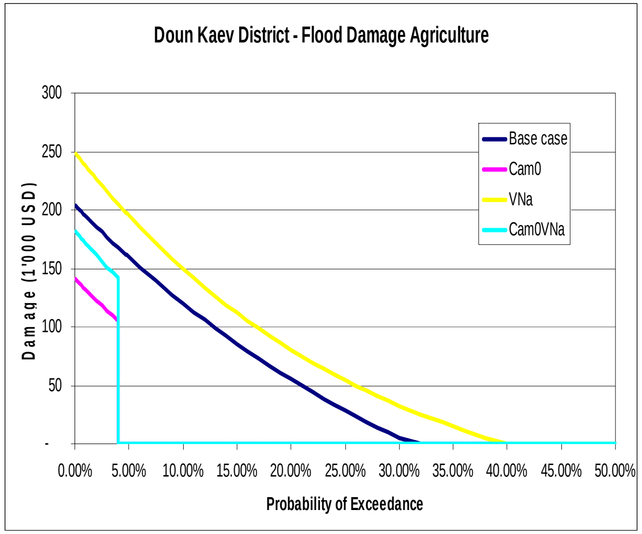
Attachment 2.3 Flood damage , flood damage probability and flood risk in Doun Kaev District

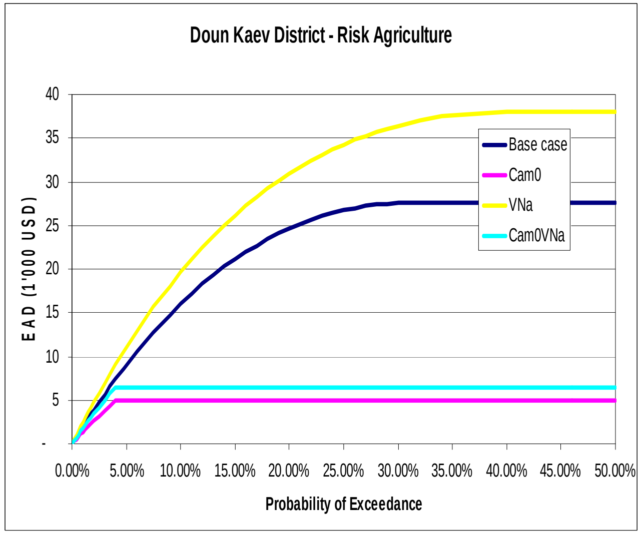




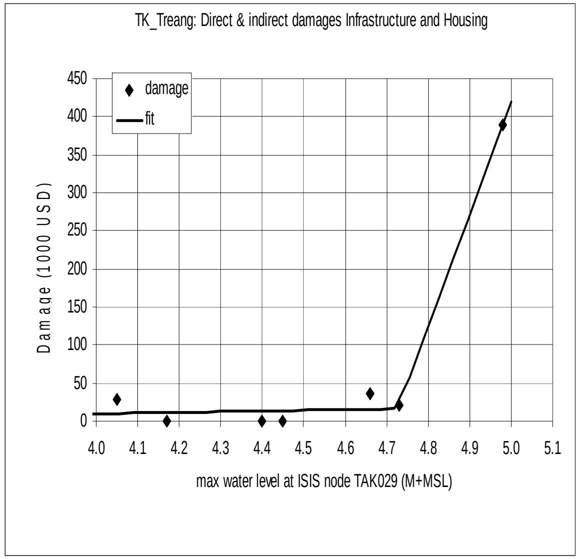


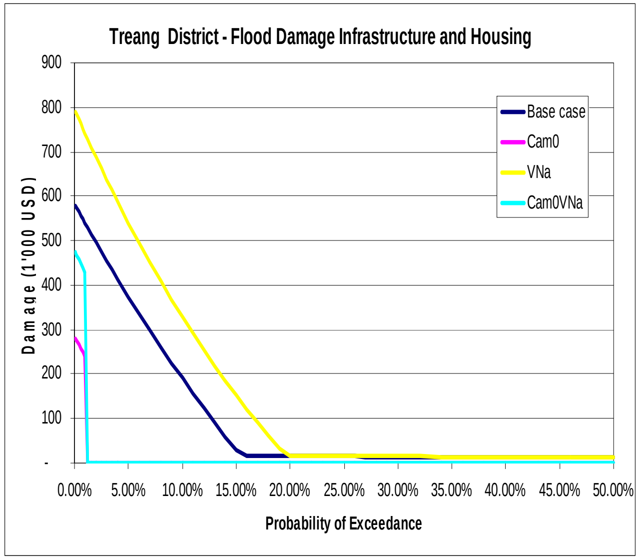


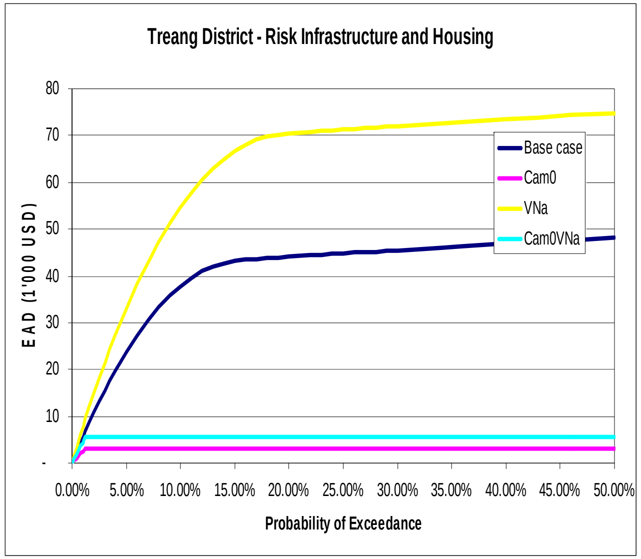


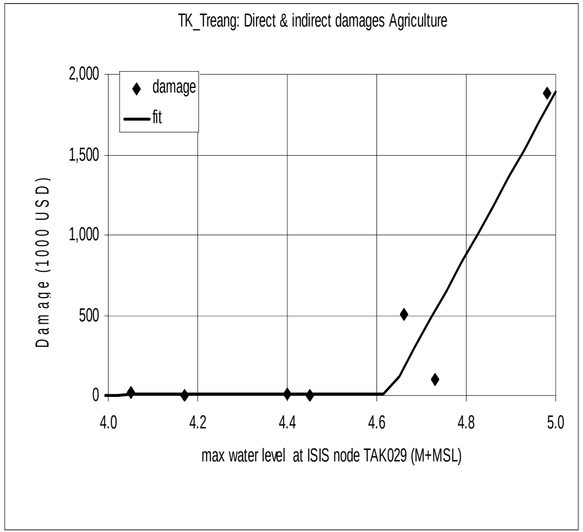


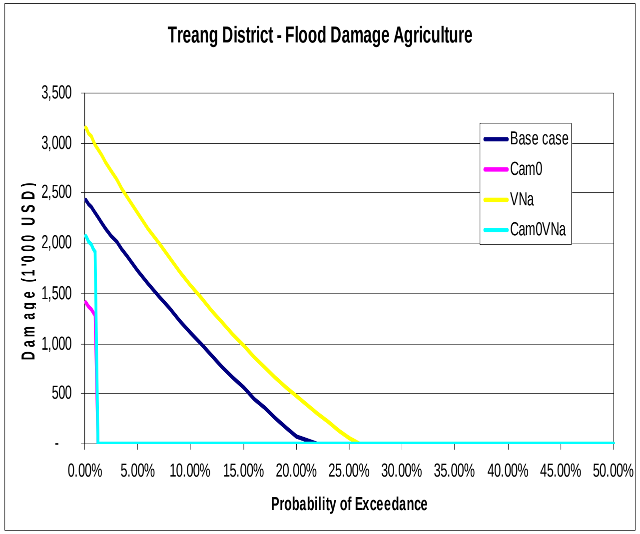
Attachment 2.4 Flood damage, flood damage probability and flood risk in Treang District

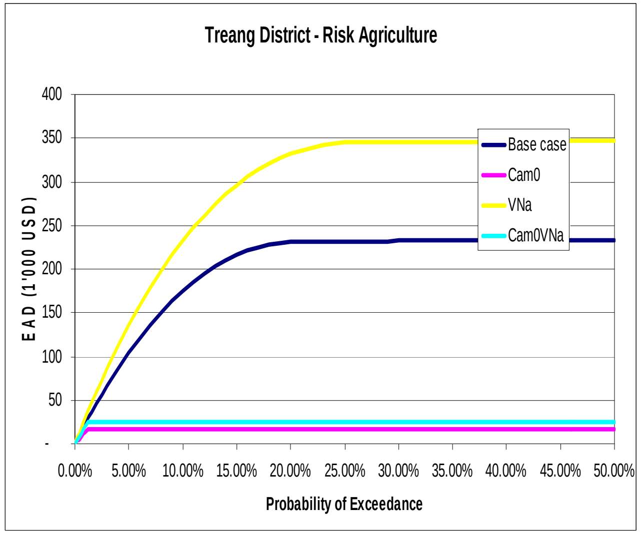




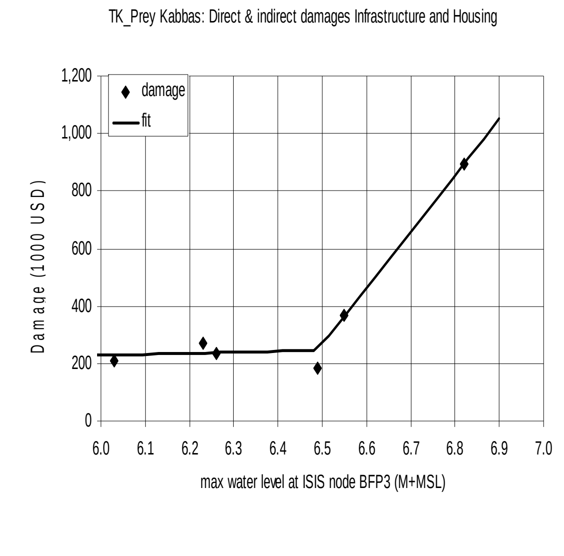


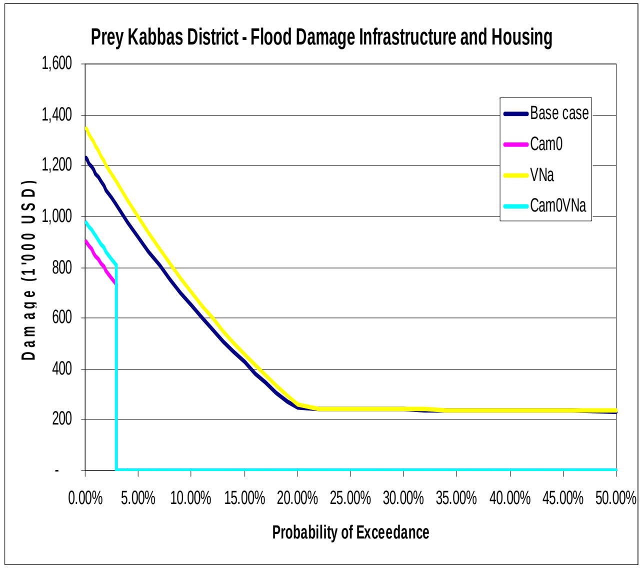


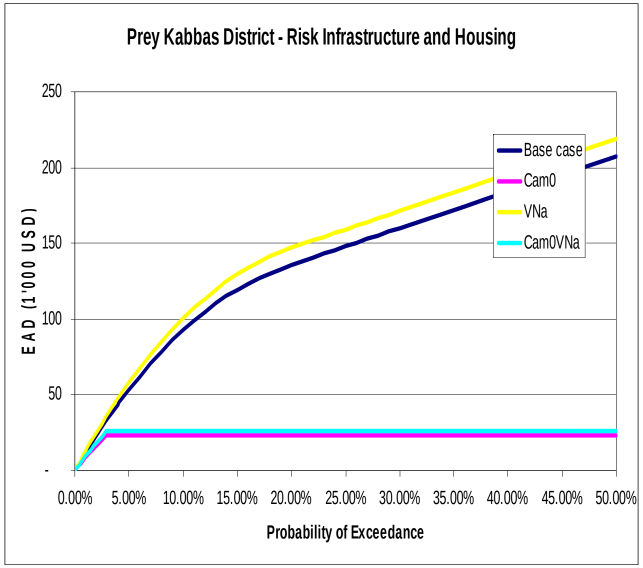


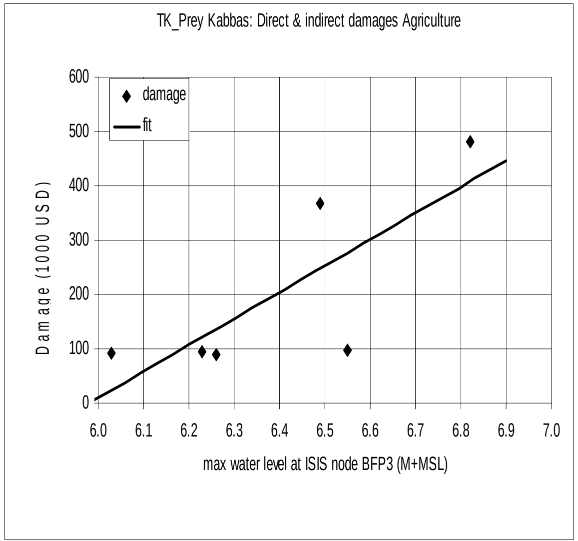


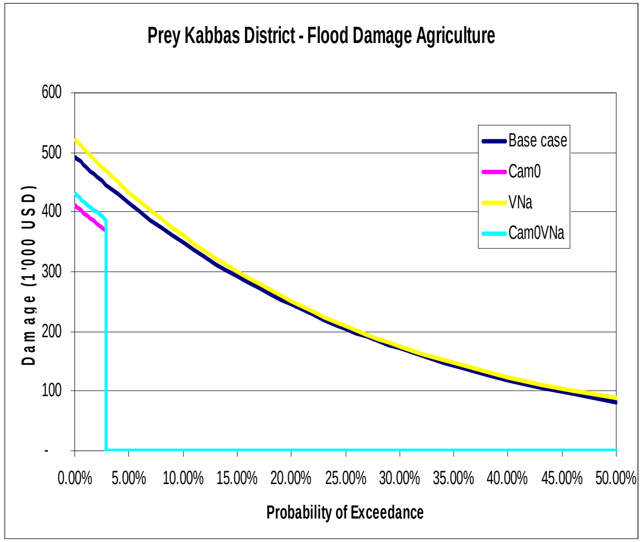
Attachment 2.5 Flood damage , flood damage probability and flood risk in Prey Kabbas District

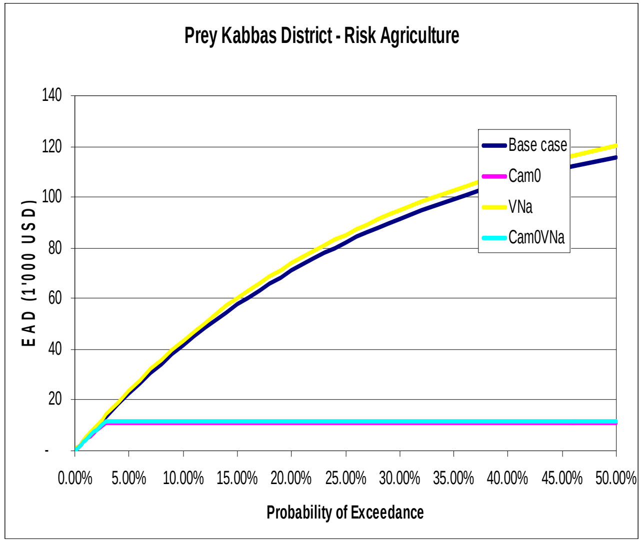




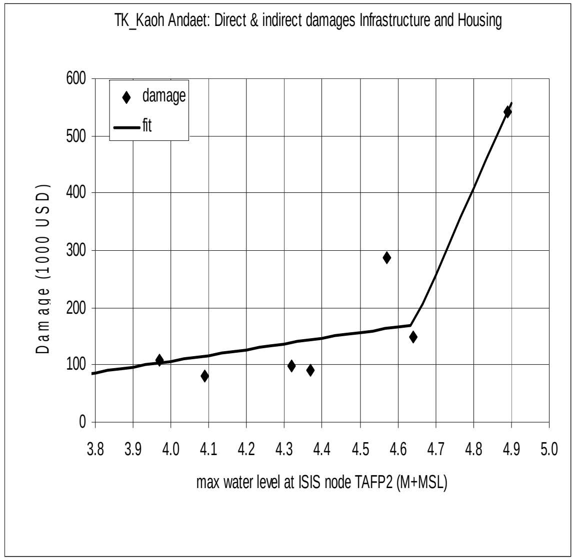


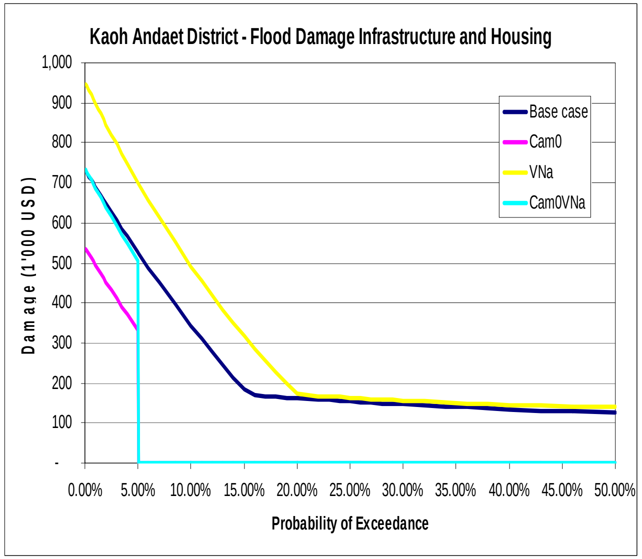


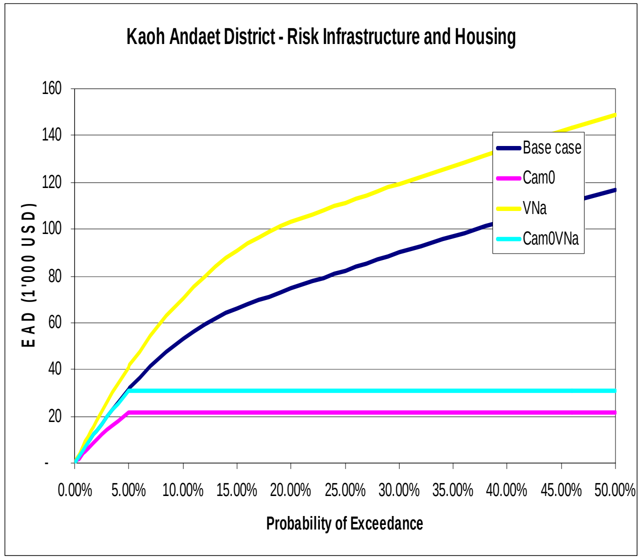


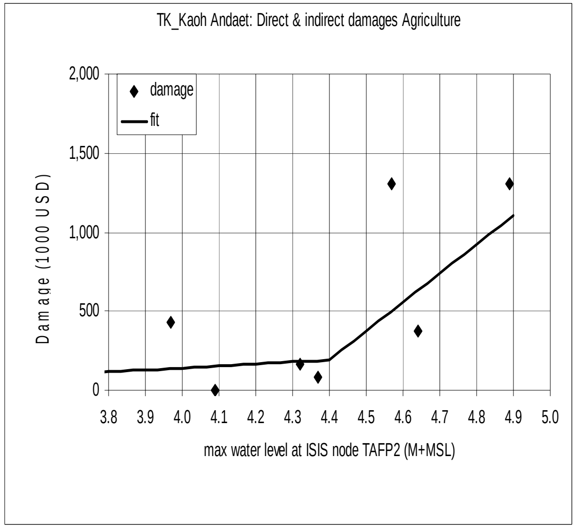


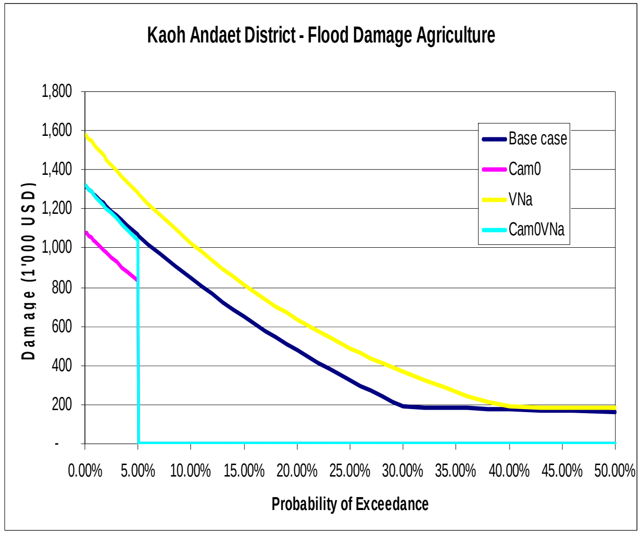
Attachment 2.6 Flood damage, flood damage probability and flood risk in Kaoh Andaet District

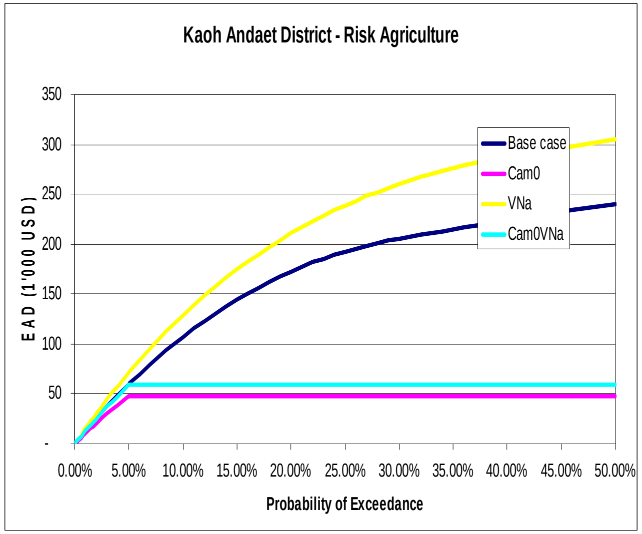




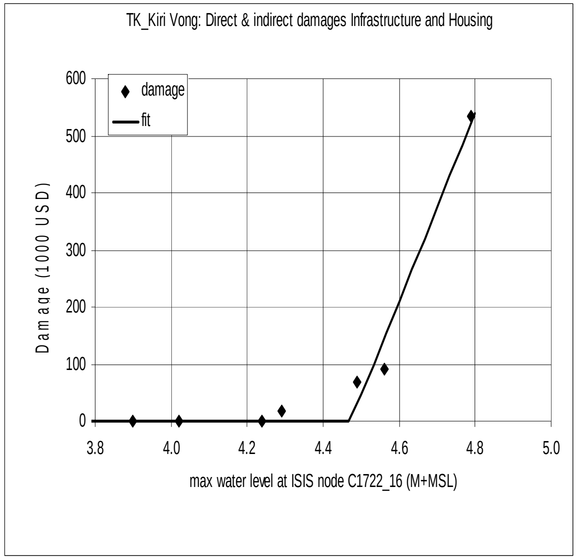


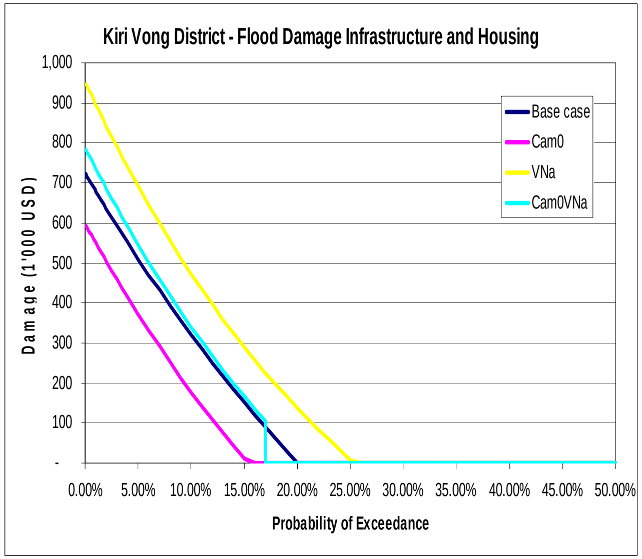


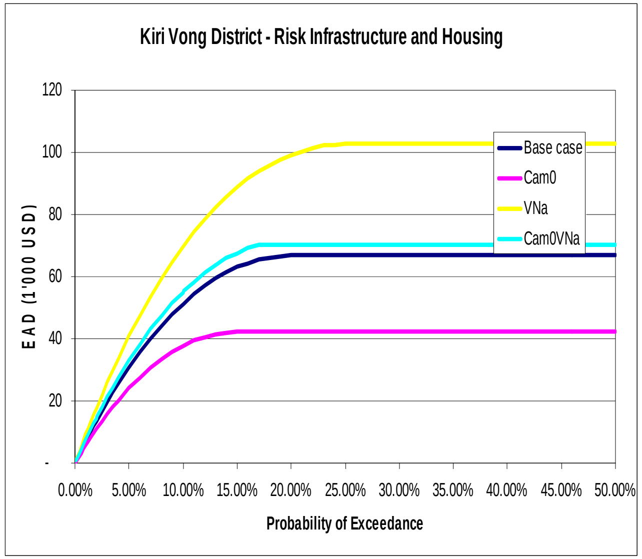


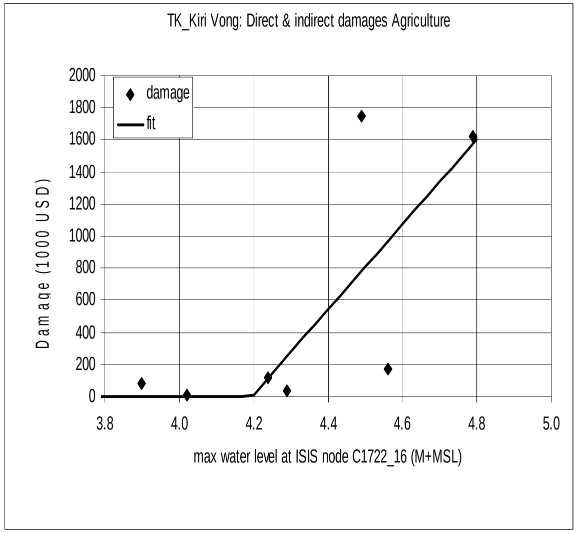


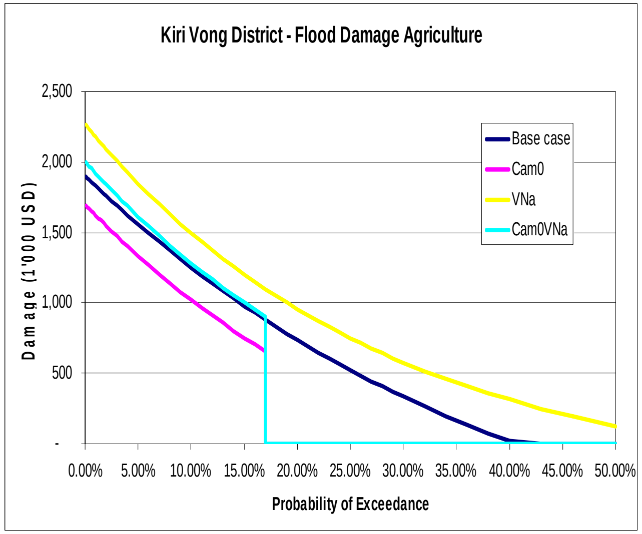
Attachment 2.7 Flood damage, flood damage probability and flood risk in Kiri Vong District

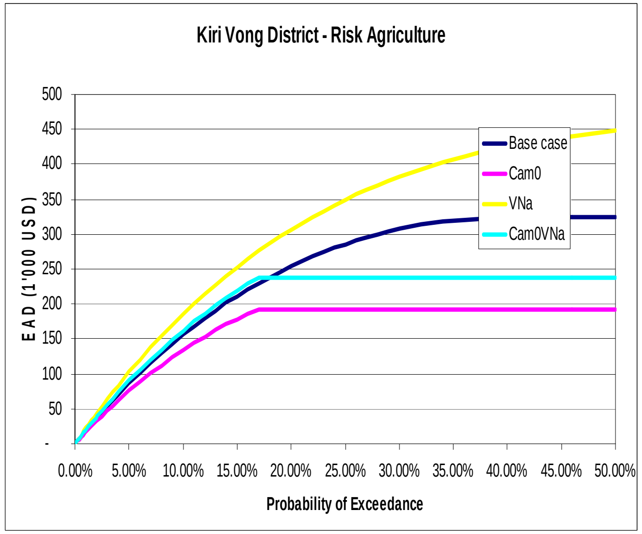




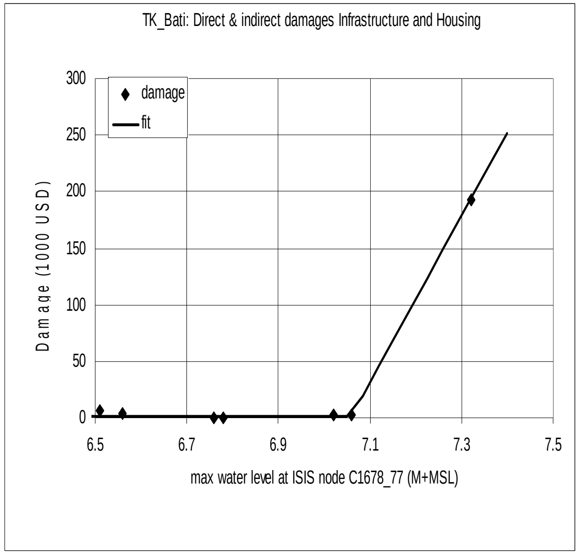


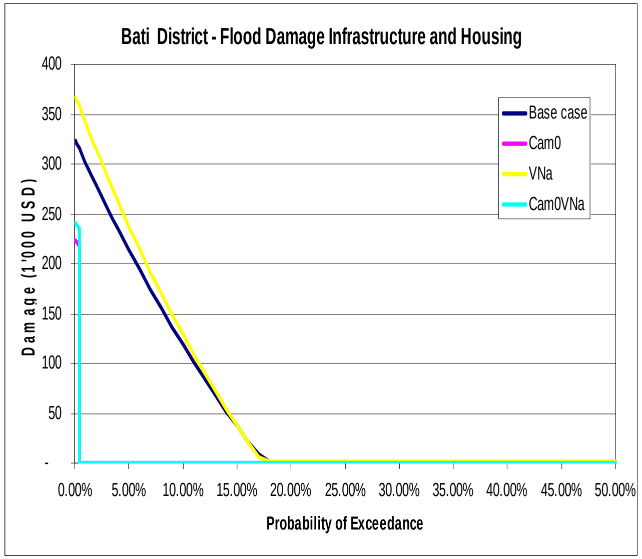


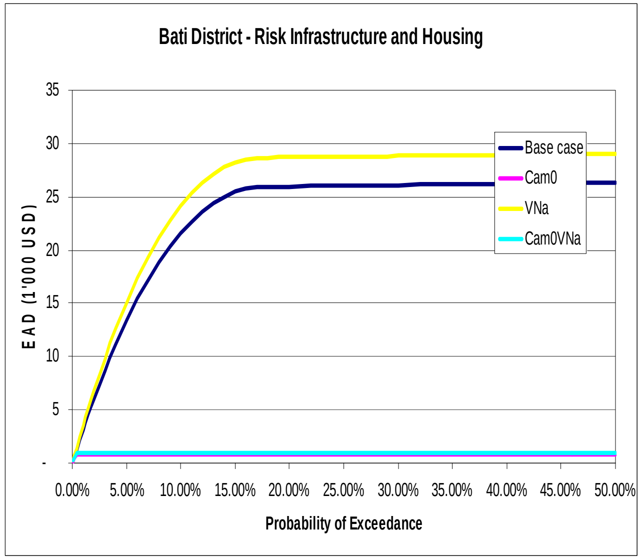


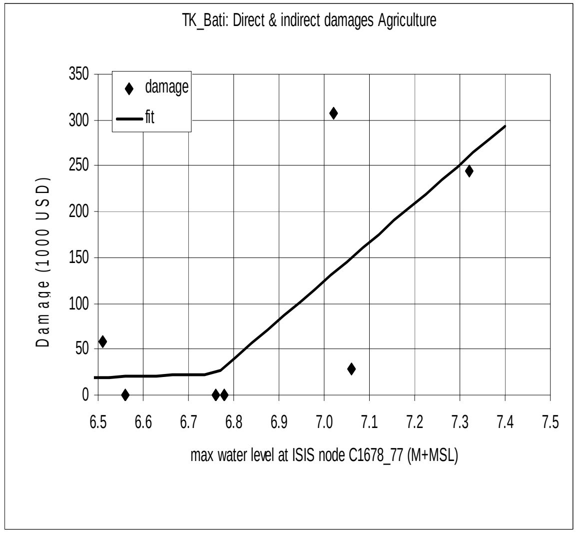


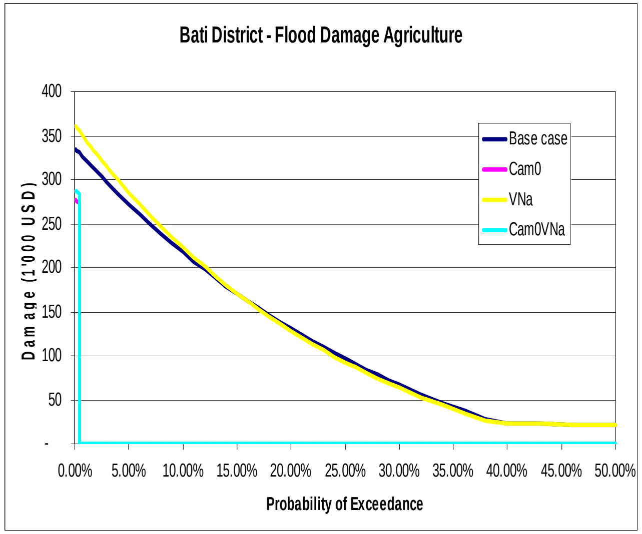
Attachment 2.8 Flood damage, flood damage probability and flood risk in Bati District

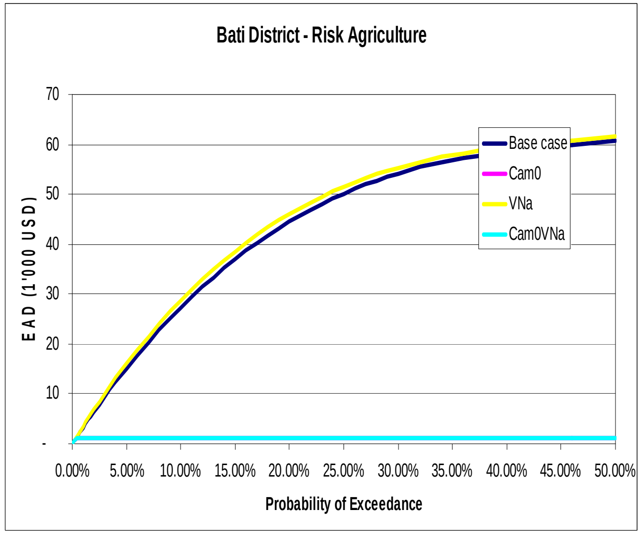




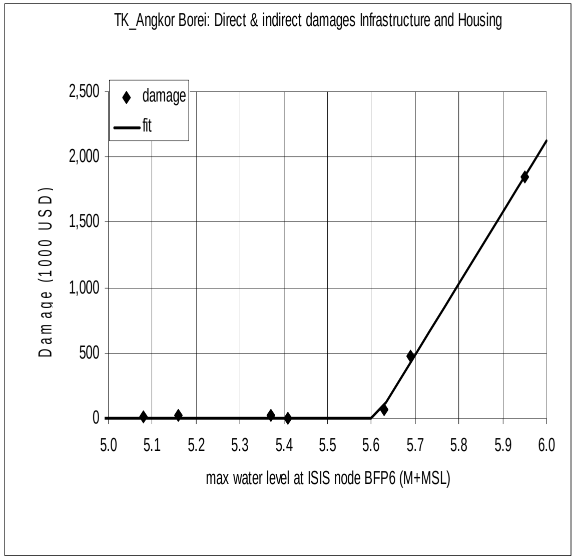


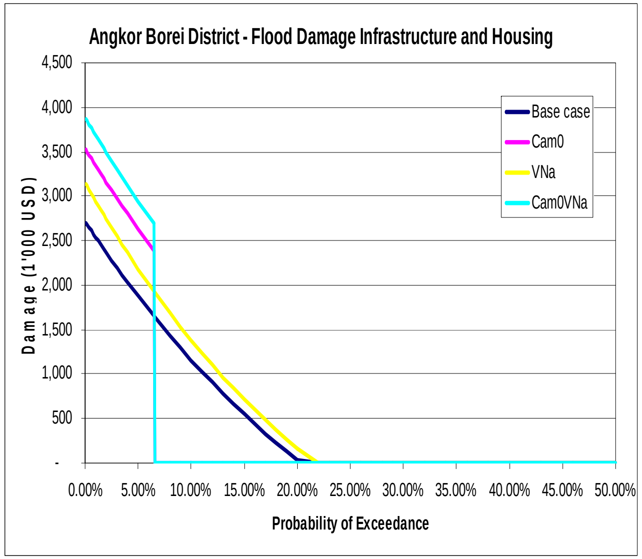


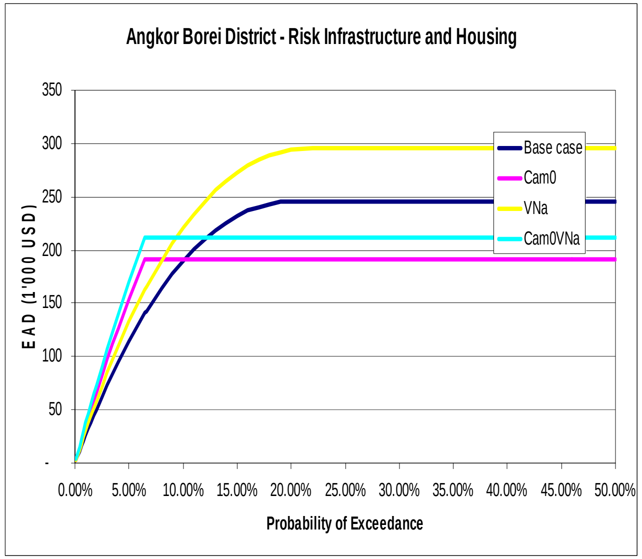


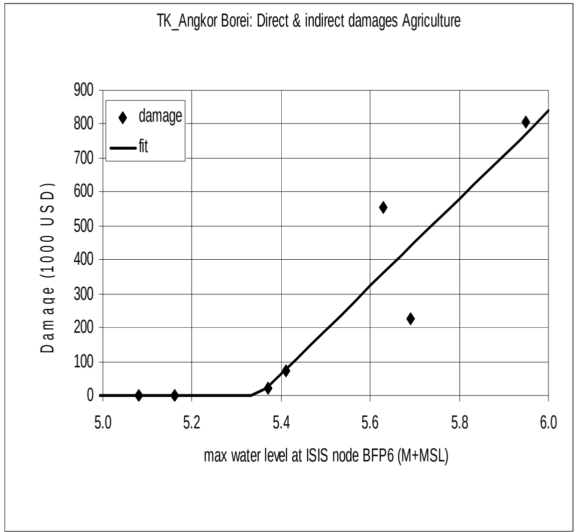


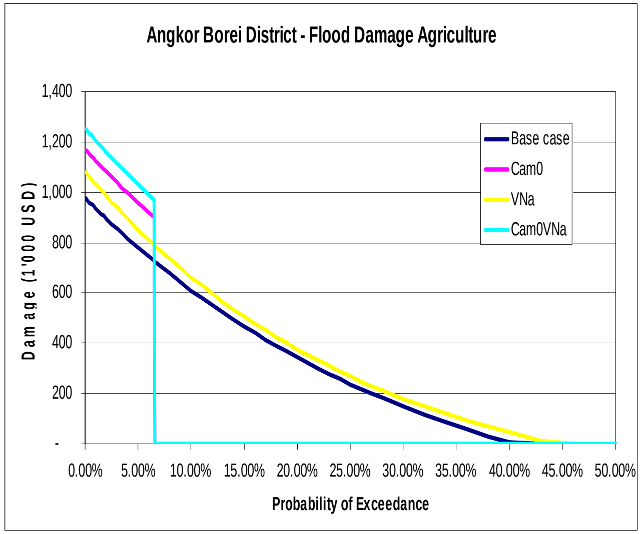
Attachment 2.9 Flood damage, flood damage probability and flood risk in Angkor Borei District

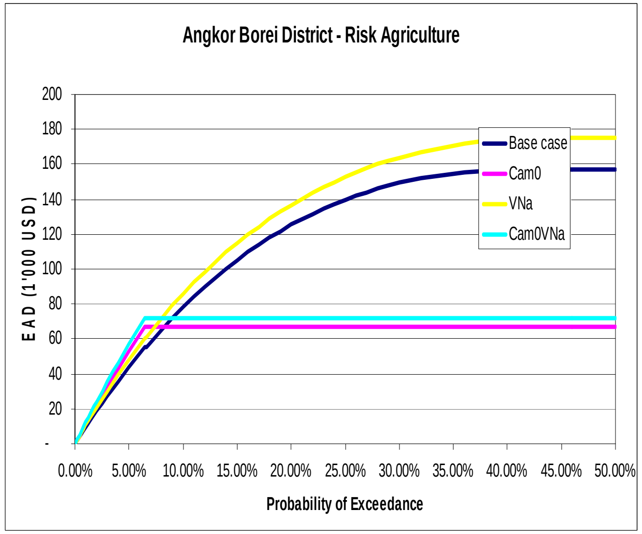




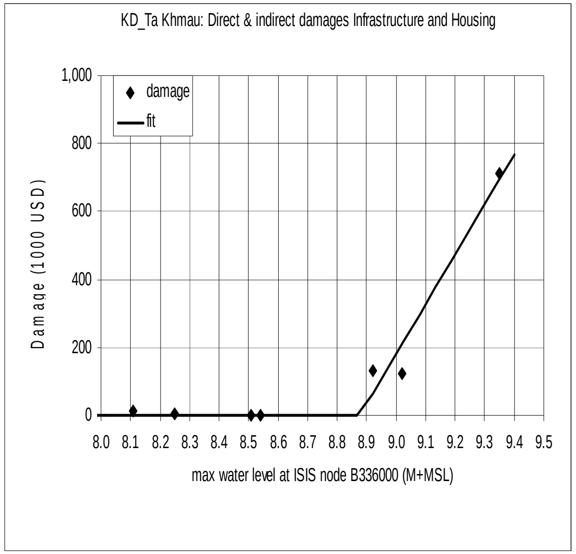


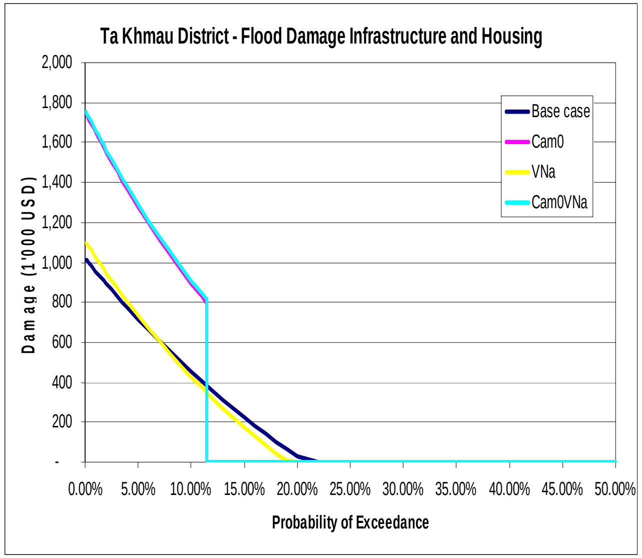


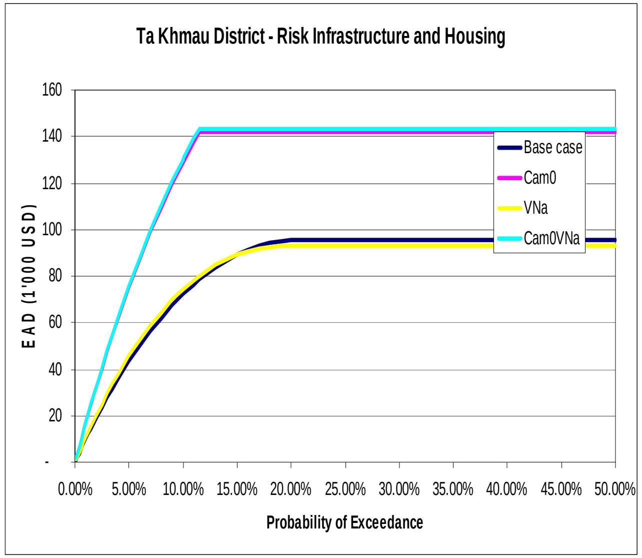


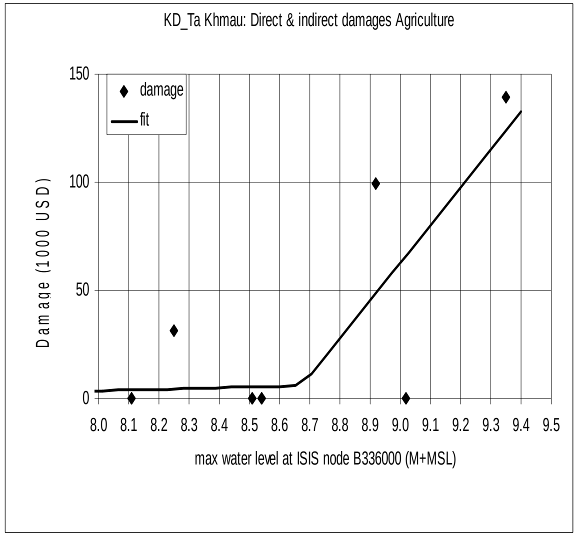


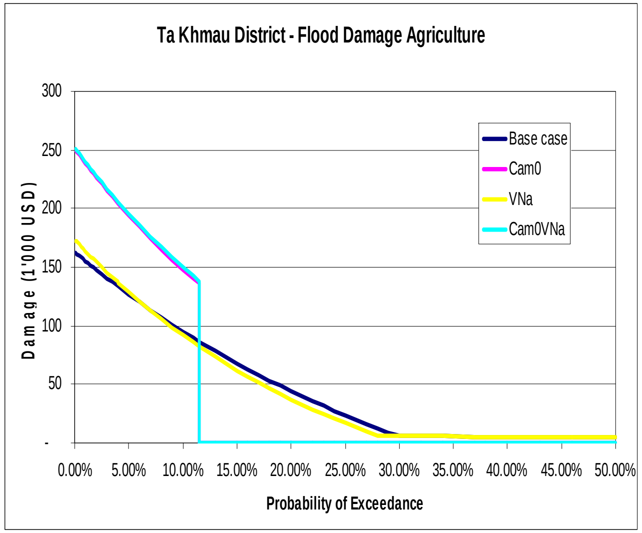
Attachment 2.10 Flood damage, flood damage probability and flood risk in Ta Khmau District

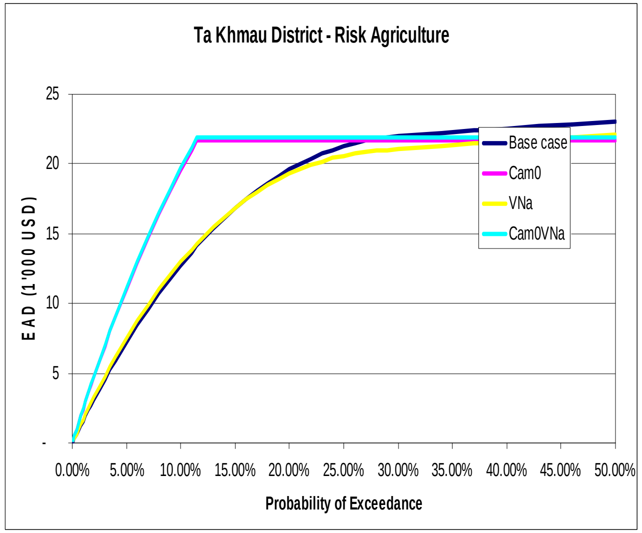




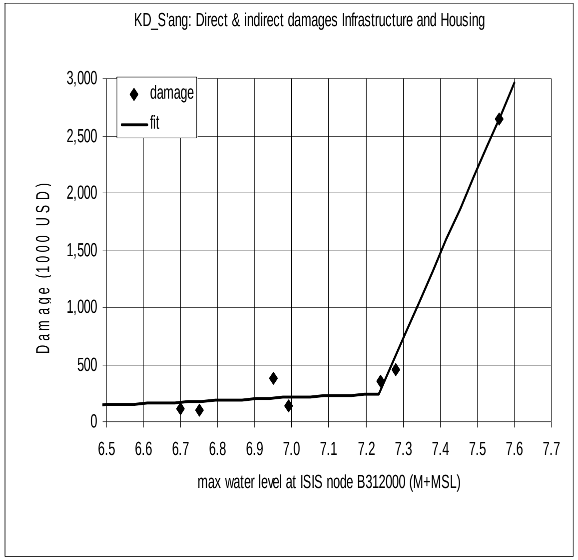


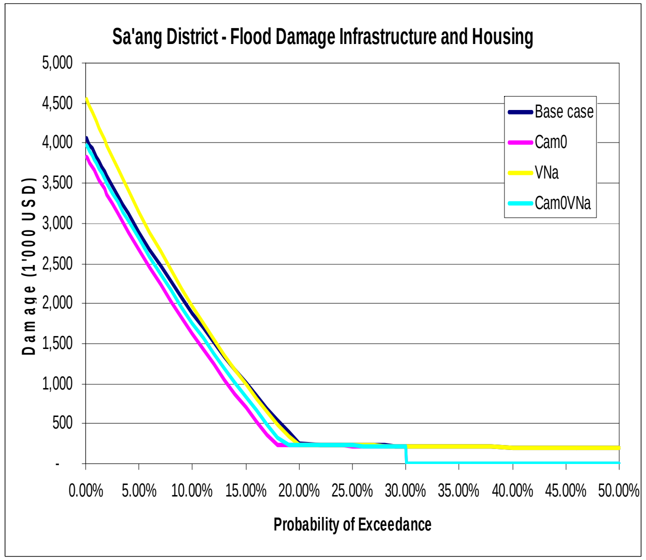


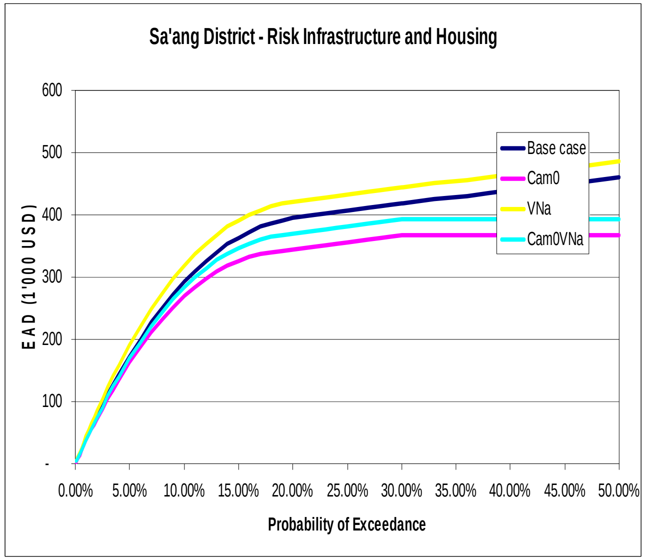


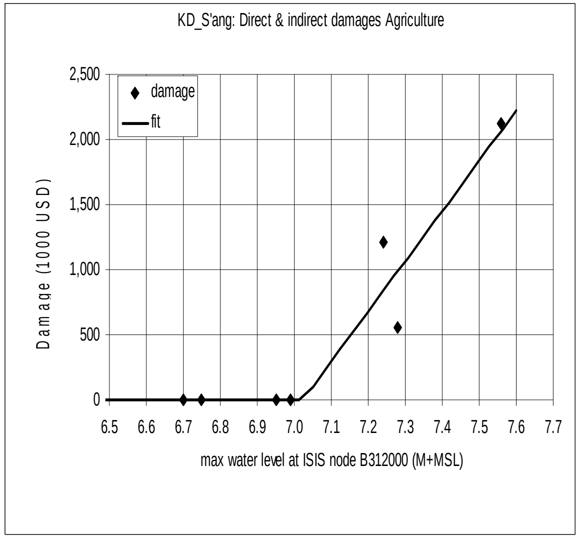


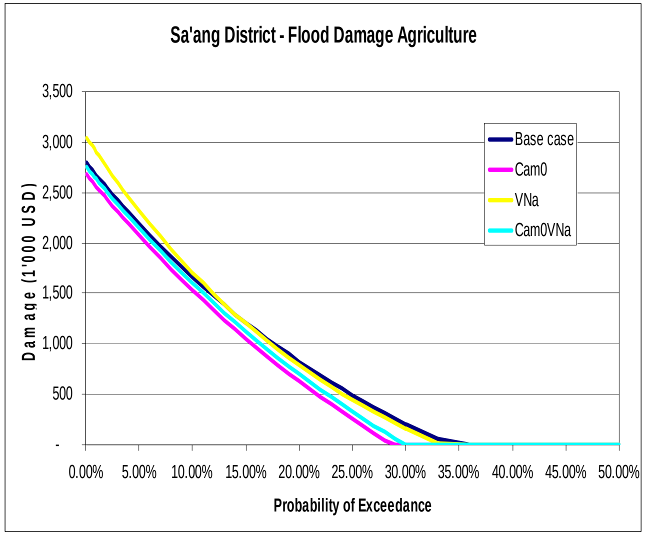
Attachment 2.11 Flood damage, flood damage probability and flood risk in Sa'ang District

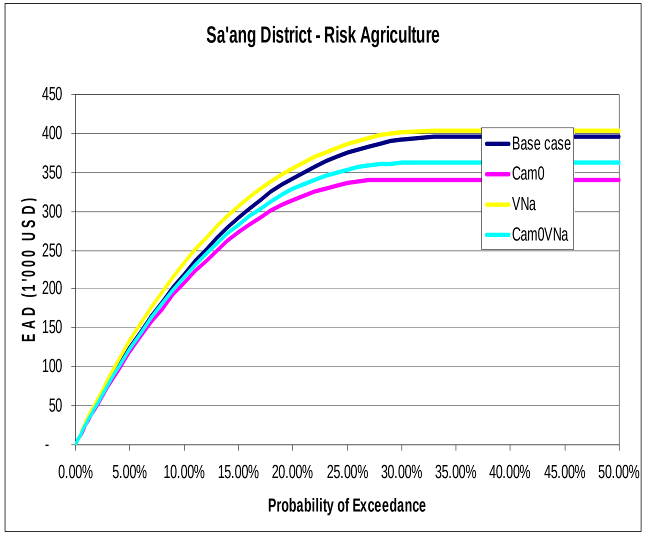




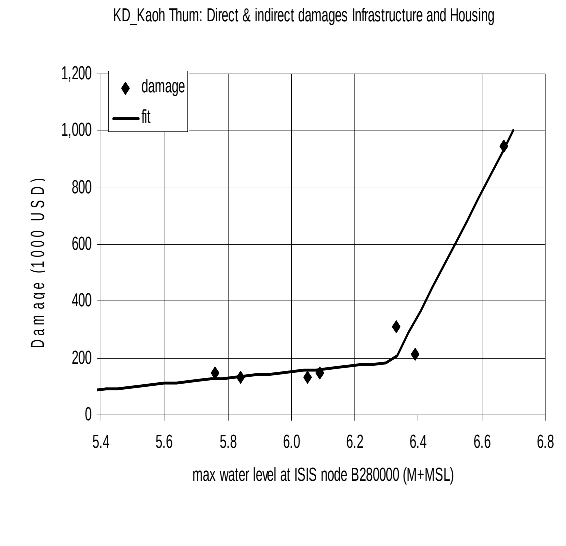


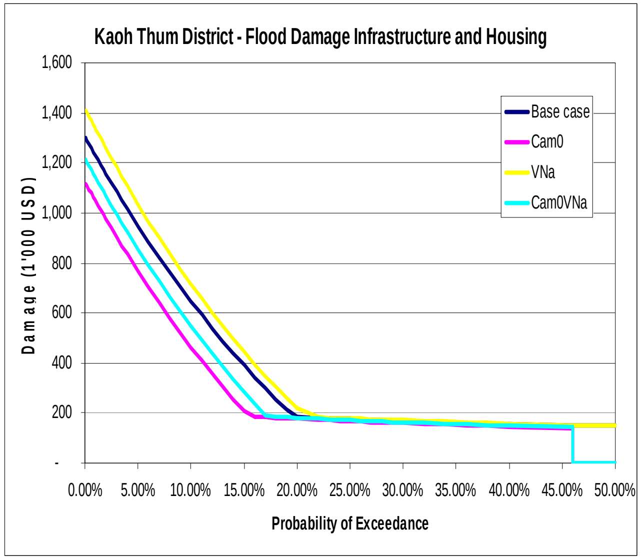


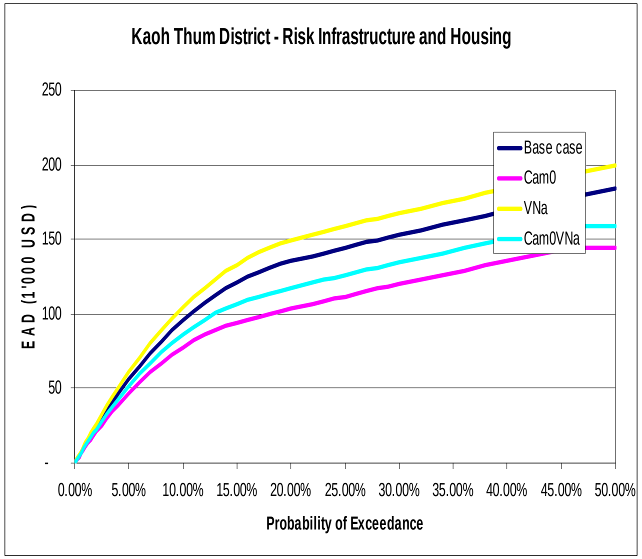


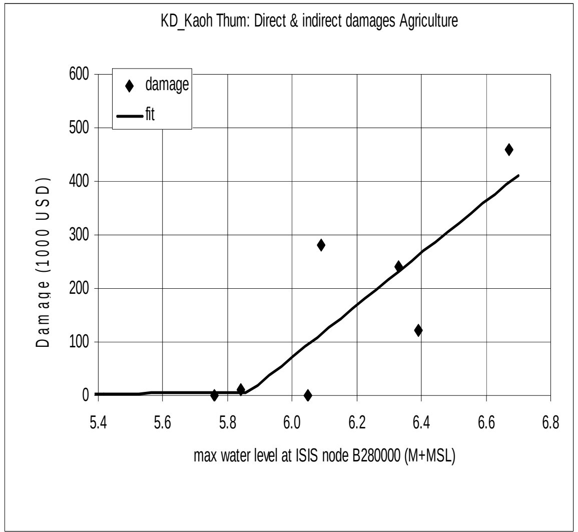


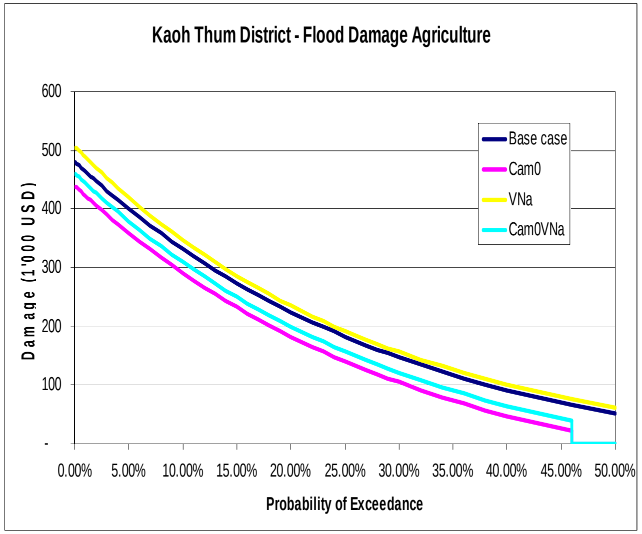
Attachment 2.12 Flood damage , flood damage probability and flood risk in Kaoh Thum District

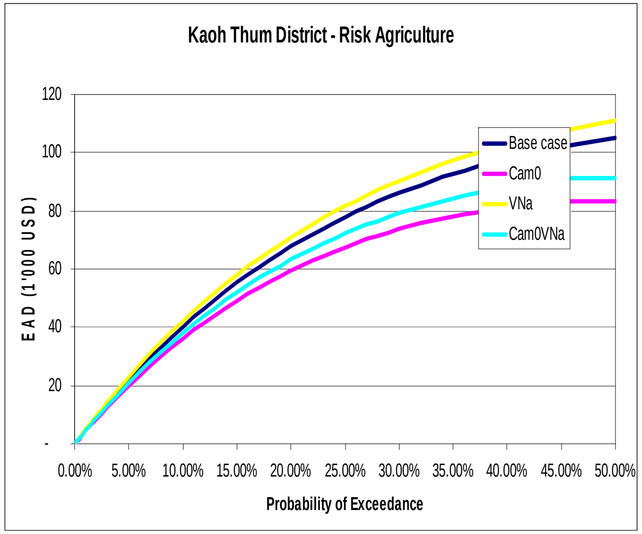




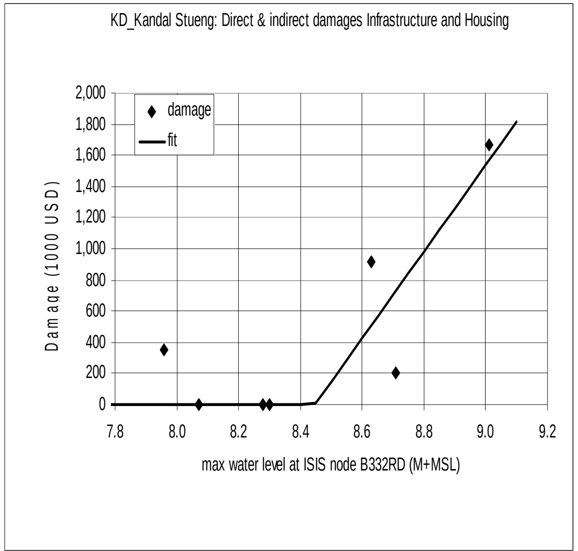


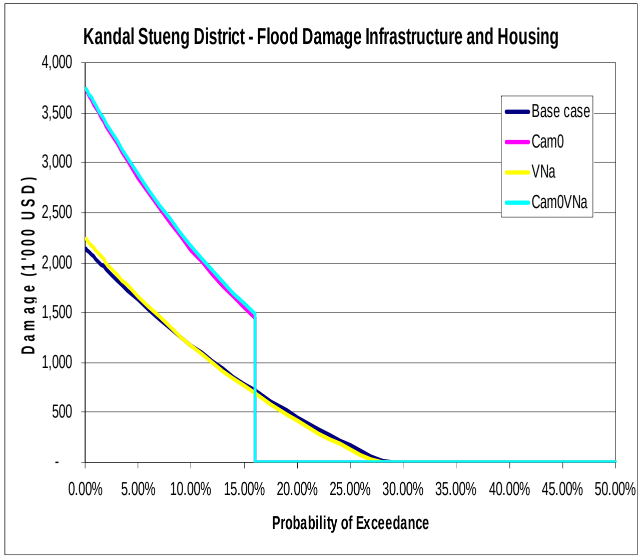


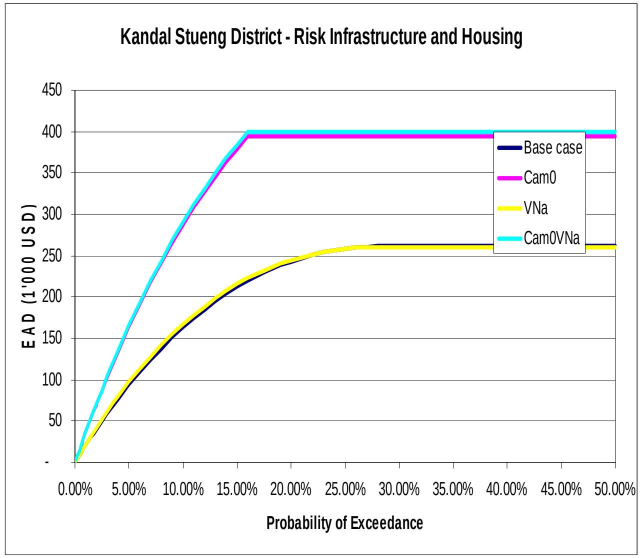


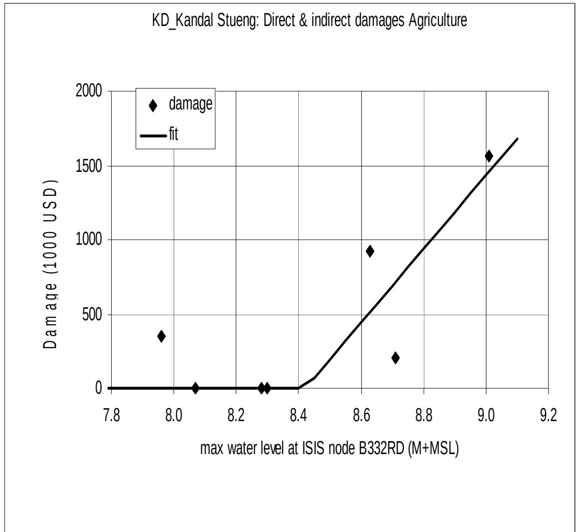


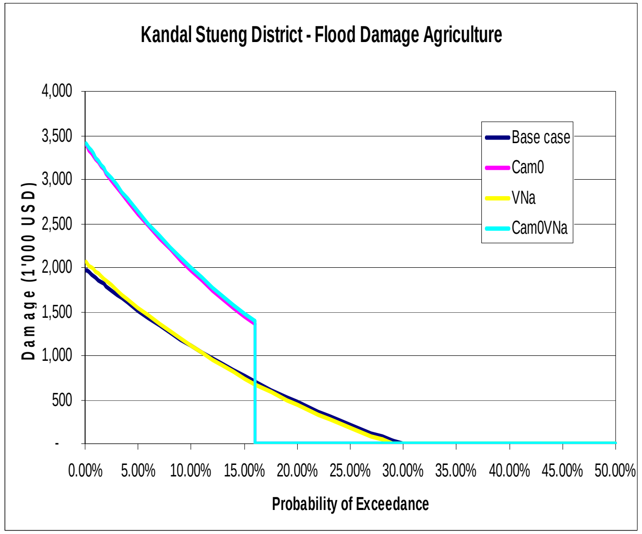
Attachment 2.13 Flood damage , flood damage probability and flood risk in Ba Phnum District

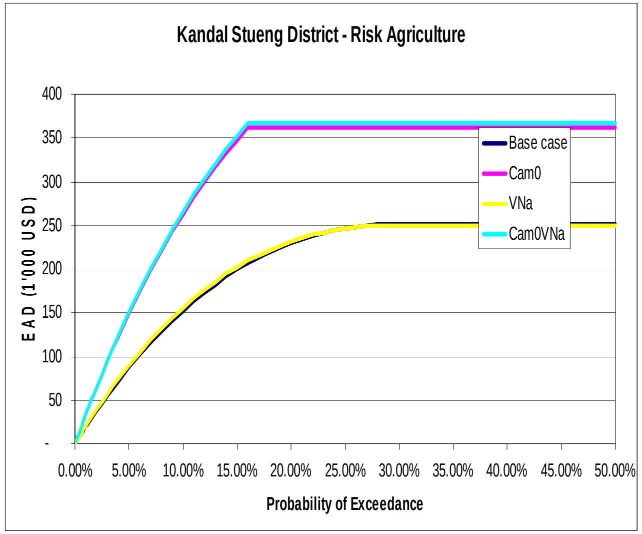








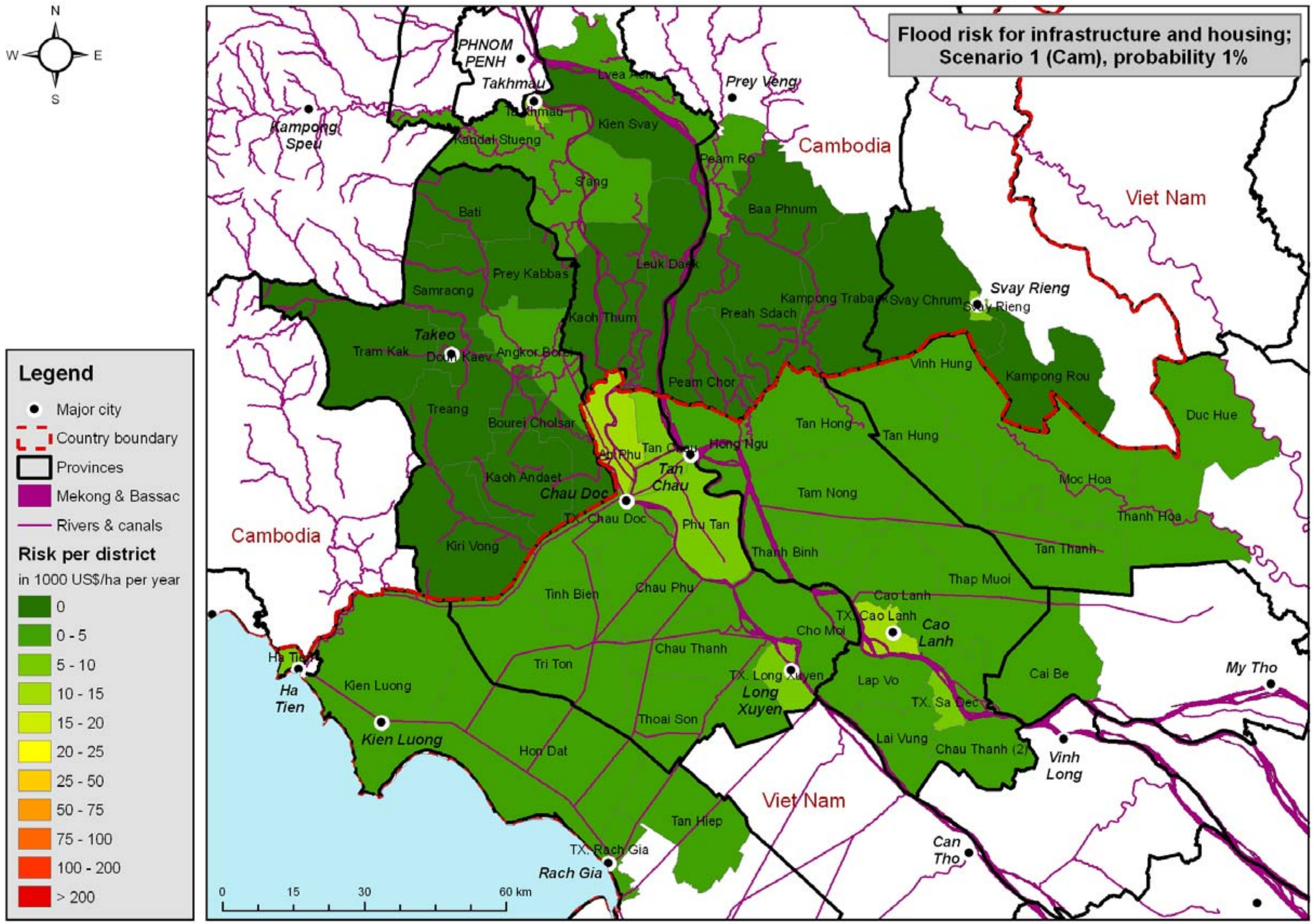




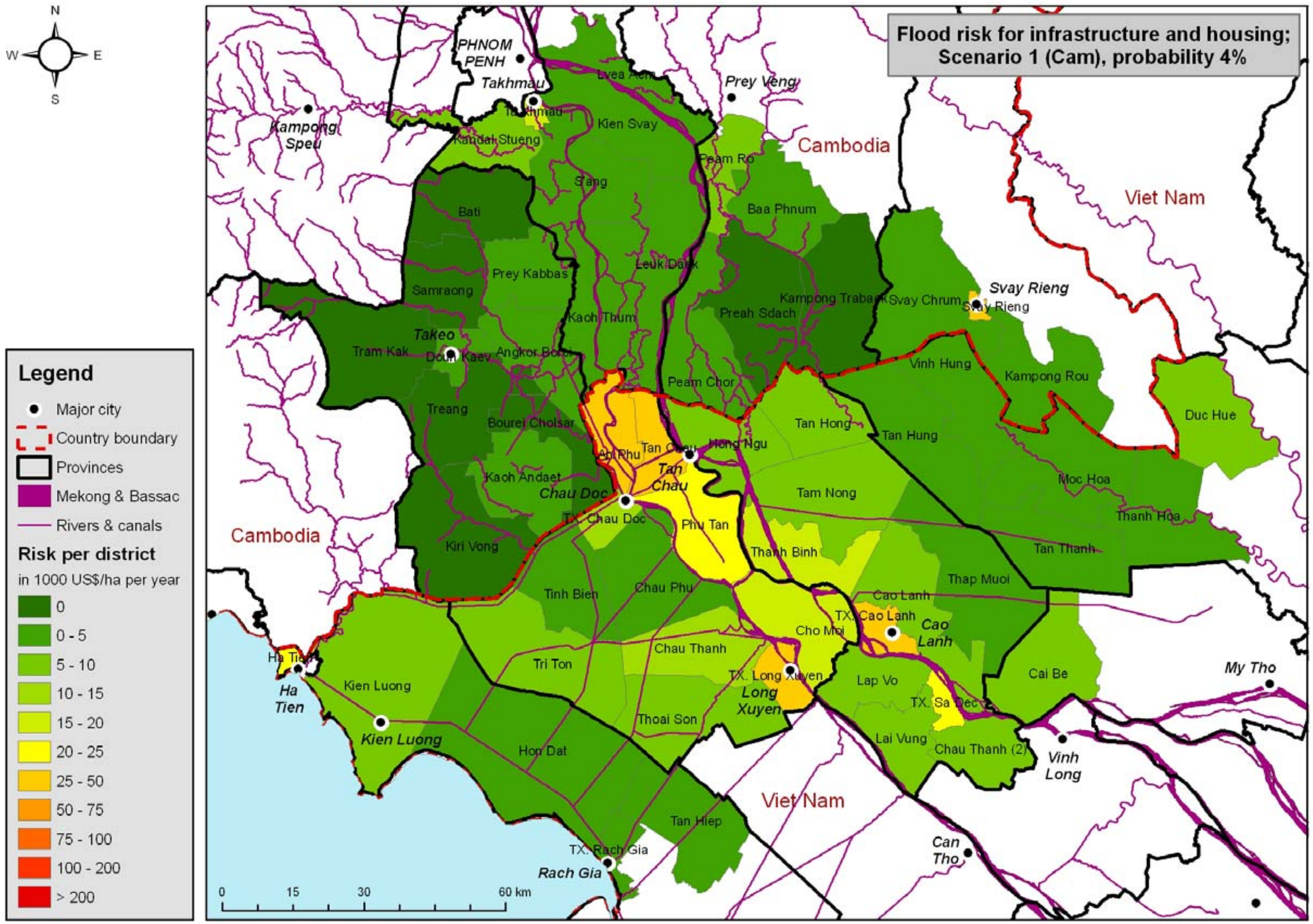
Attachment 3:

Flood Risk maps of the Mekong Delta

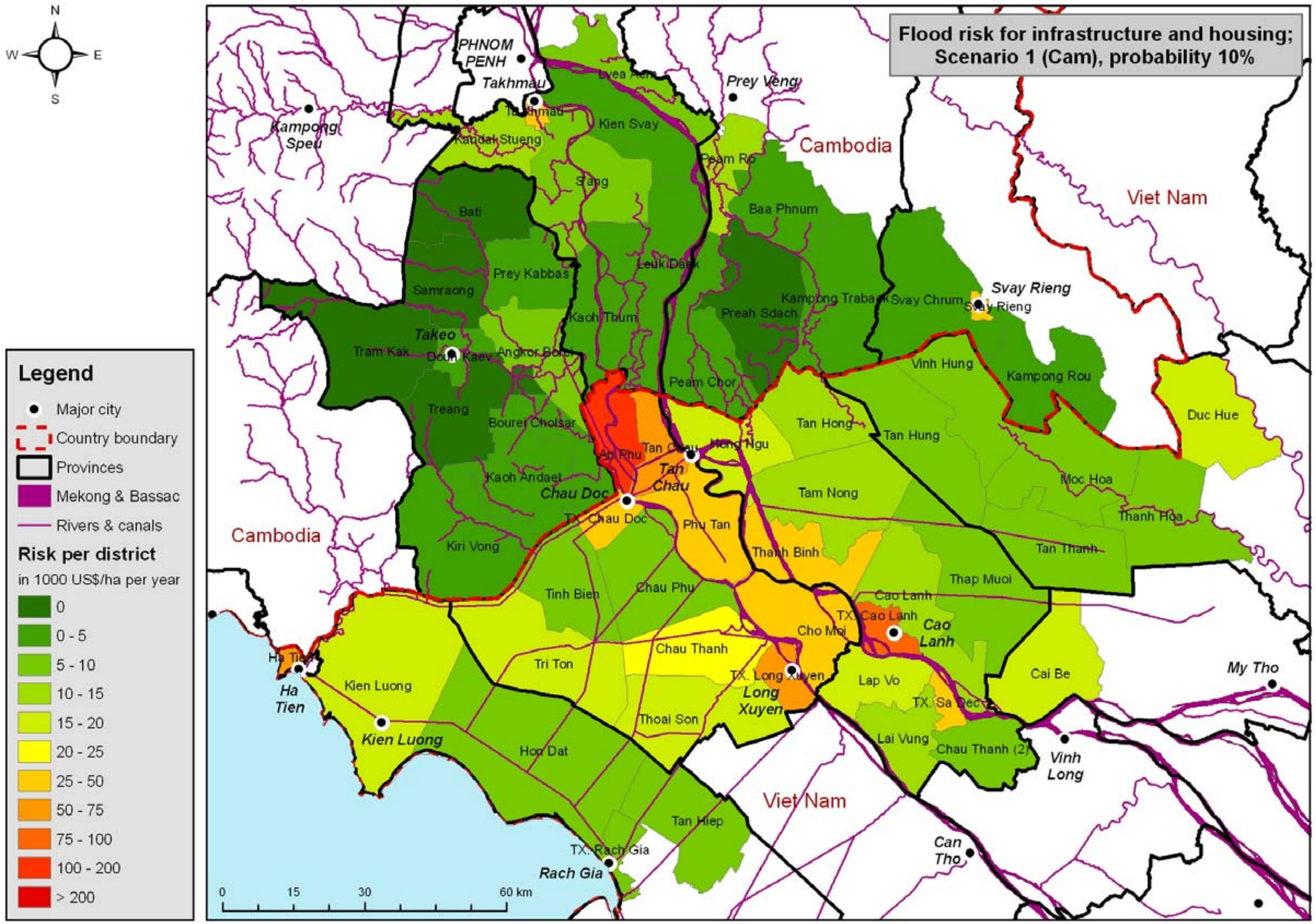
Attachment 3.1: Flood risk map at p=1%, Infrastructure and Housing, Scenario Cam0



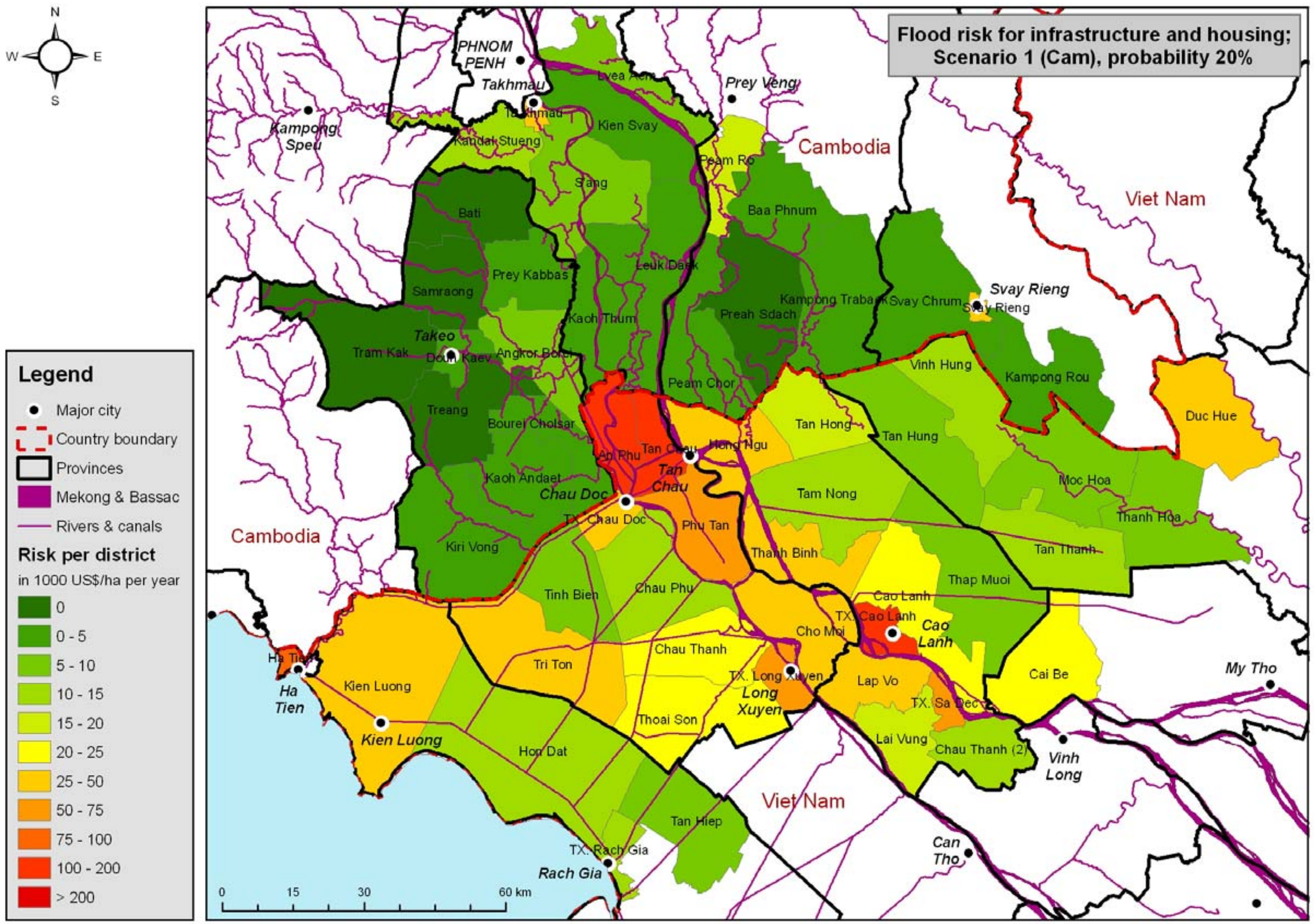
Attachment 3.2: Flood risk map at p=4%, Infrastructure and Housing, Scenario Cam0



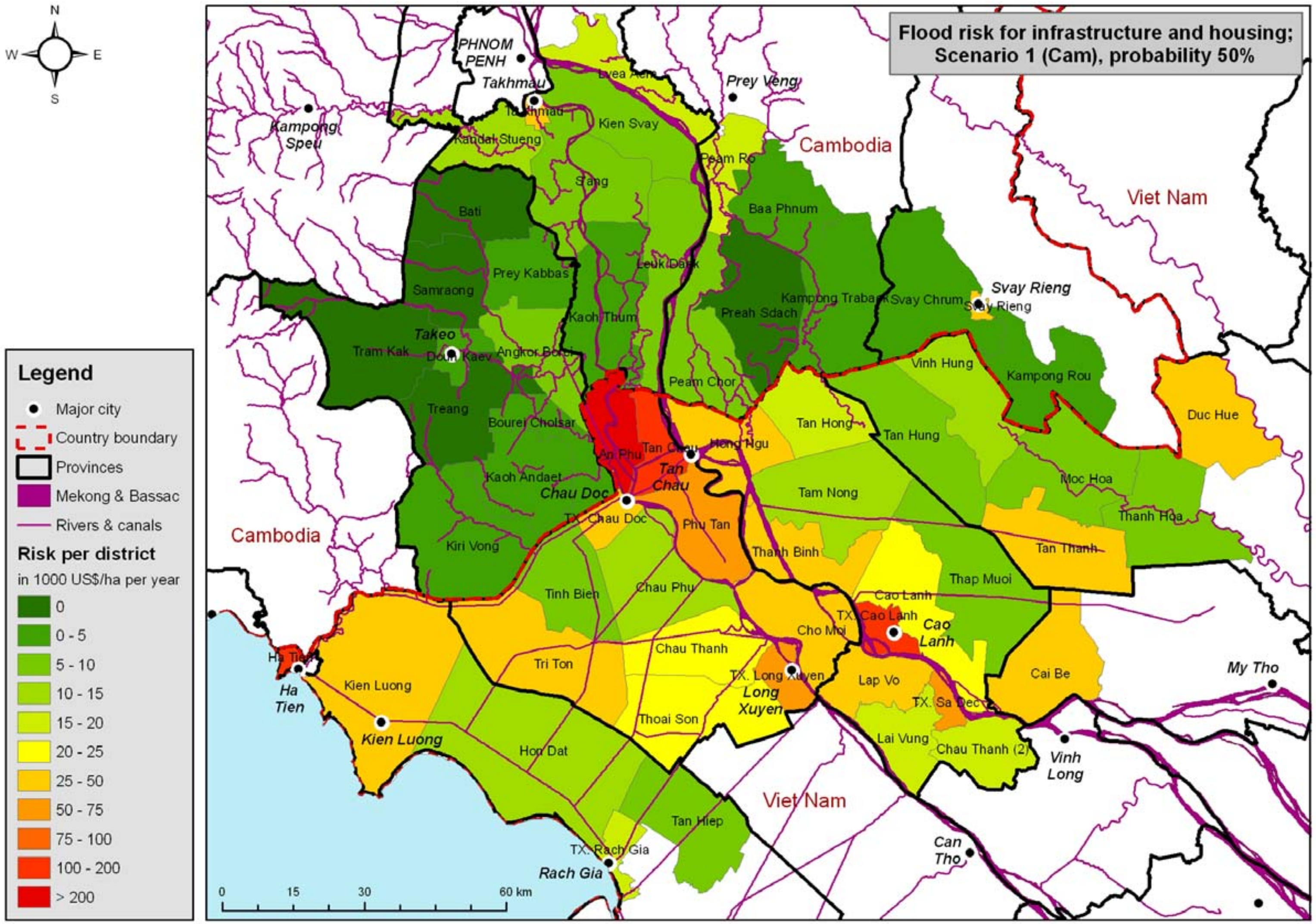
Attachment 3.3: Flood risk map at p=10%, Infrastructure and Housing, Scenario Cam0



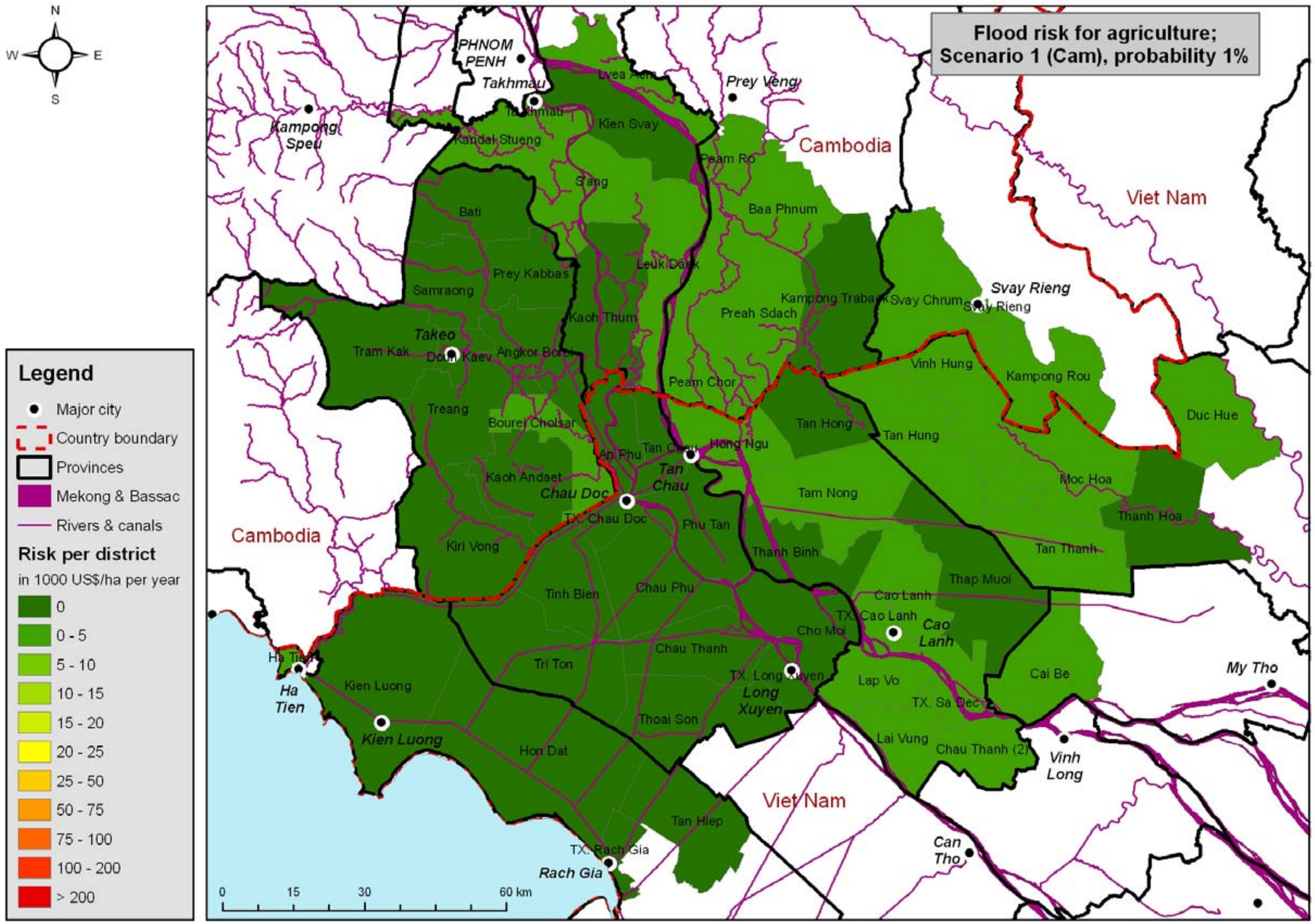
Attachment 3.4: Flood risk map at p=20%, Infrastructure and Housing, Scenario Cam0



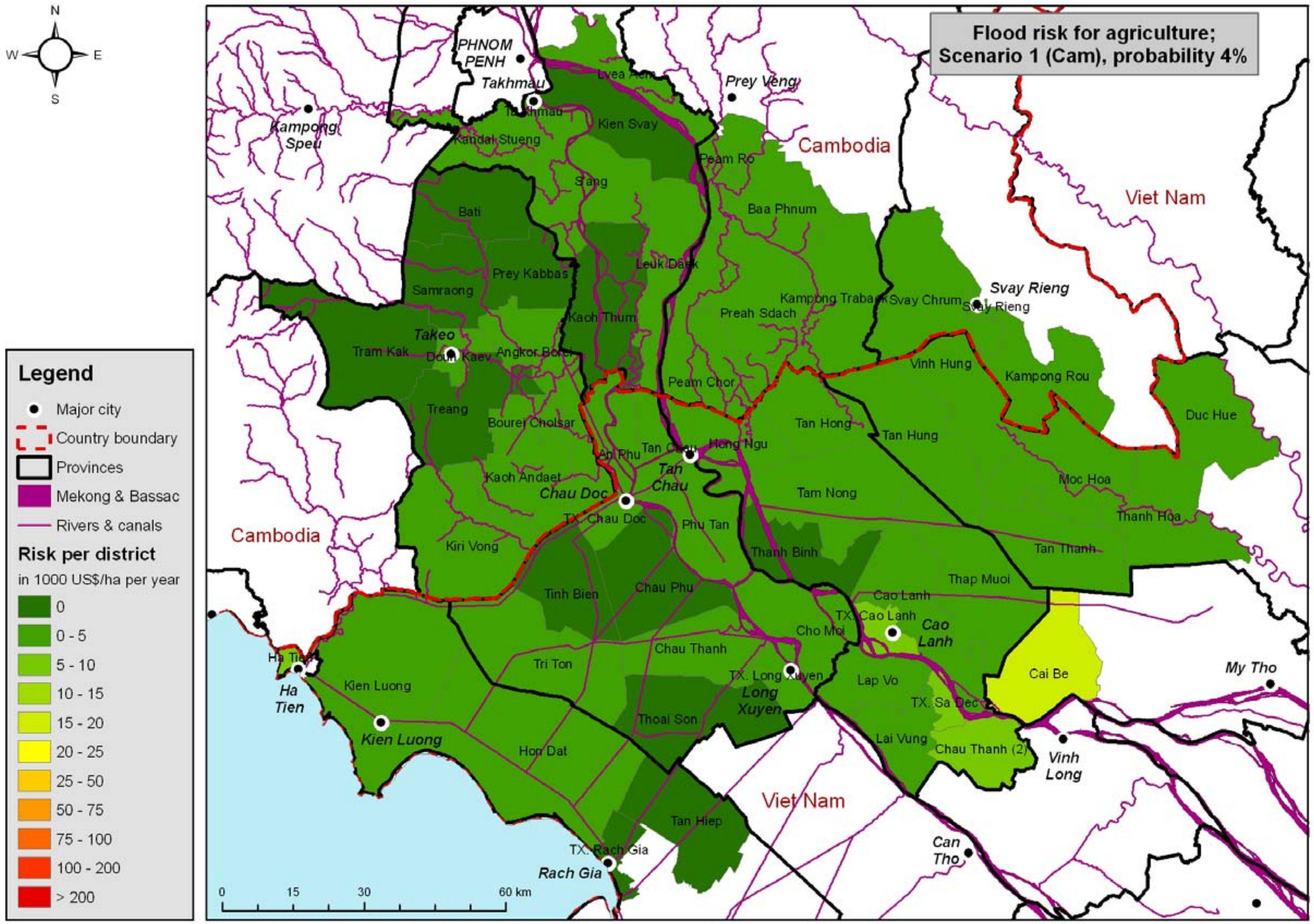
Attachment 3.5: Flood risk map at p=50%, Infrastructure and Housing, Scenario Cam0



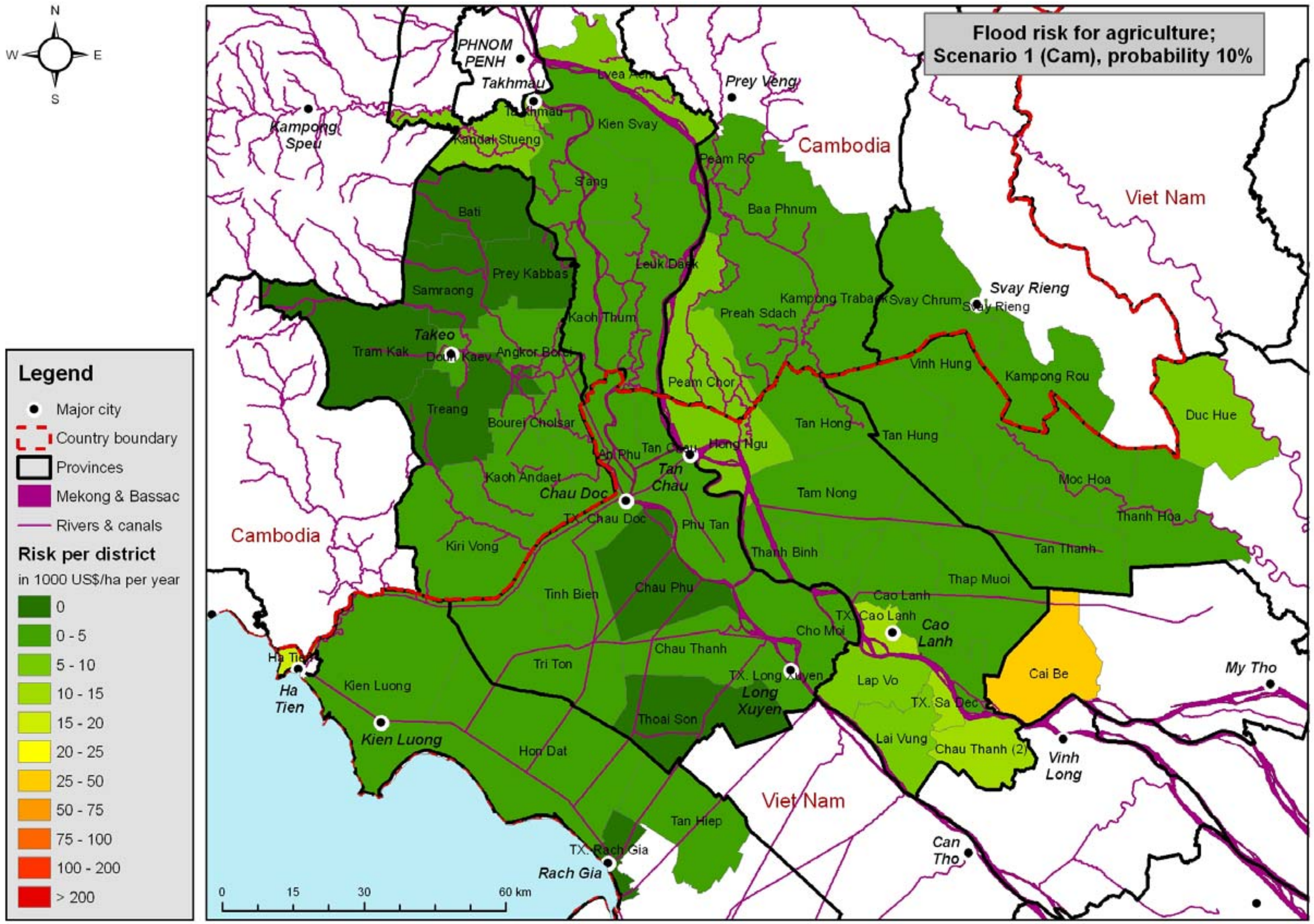
Attachment 3.6: Flood risk map damage at p=1%, Agriculture



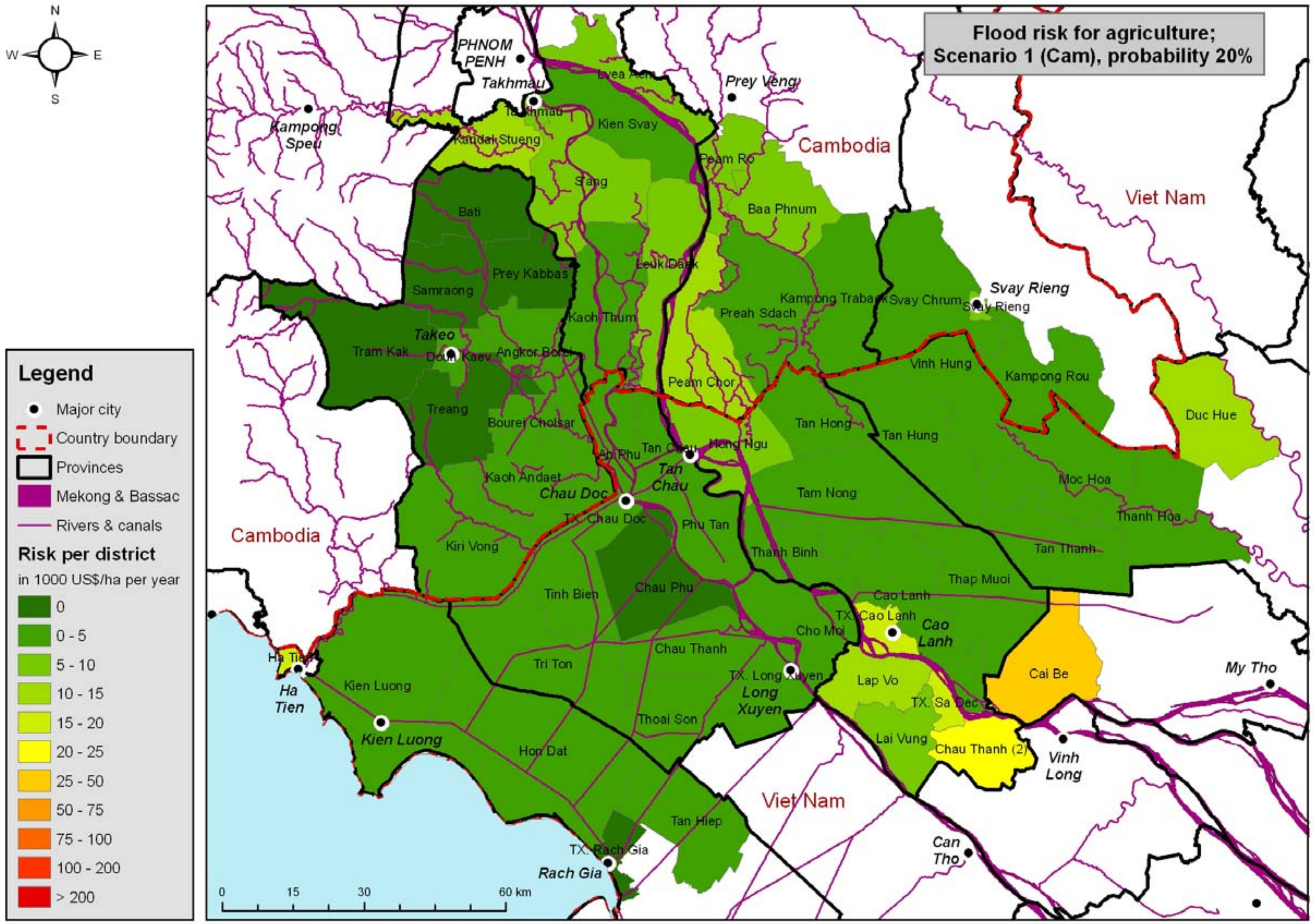
Attachment 3.7: Flood risk map damage at p=4%, Agriculture



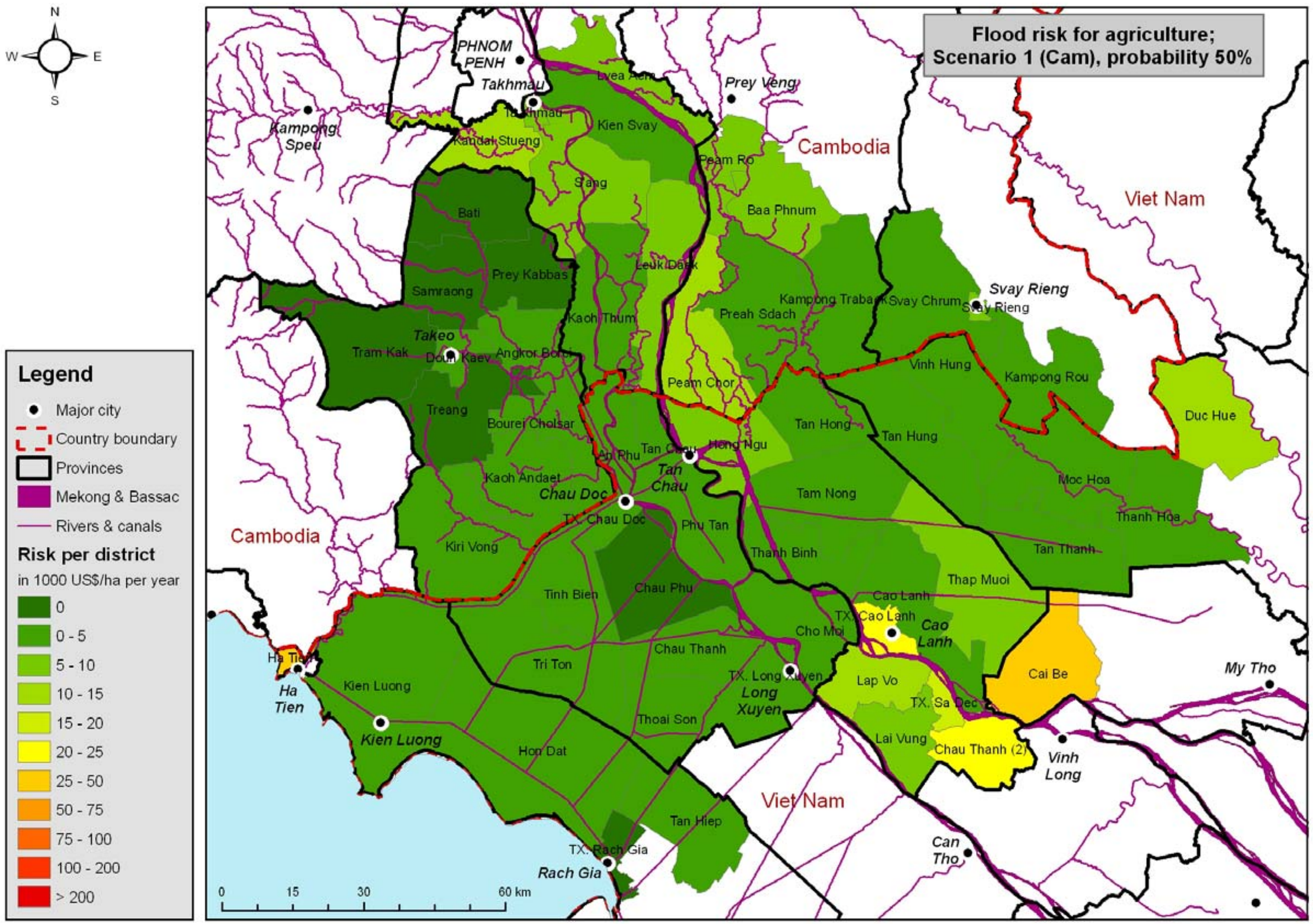
Attachment 3.8: Flood risk map damage at p=10%, Agriculture



Attachment 3.9: Flood risk map damage at p=20%, Agriculture



Attachment 3.10: Flood risk map damage at p=50%, Agriculture



Appendix 3 Socio-economics and agriculture

CONTENTS

1 PROJECT AREA

1.1 Location and area

The Project area is 227,119ha and it is delimited to the north and the west by RN2, to the east by the RN21 and to the south by the Vietnam-Cambodian border. The project covers 85 communes in Takeo and Kandal provinces. Of which, there are 63 communes in 9 districts of Takeo and 22 communes in 4 districts of Kandal. Forty four communes are totally located in the project area of which 40 communes in Takeo and 4 communes in Kandal. See Figure 1.1 map of the project and Attachment 1: List of communes in the project area.

Based on annual flooding conditions (deep and shallow flooded area), existing infrastructures and actual land and water use conditions (road as flood protection dike embankment, existing natural and man made drainage network), the West Bassac area could be subdivided into three zones for effective flood risk management:

Zone#1 is located along Bassac river with an area of 27,419ha of which 3,397ha in Takeo province and 24,022ha in Kandal province. It covers 23 communes of which 15 communes in Kaoh Thom, Ta Khmau and S'ang districts and 8 communes in Angkor Borei and Prey Kabbas districts. The area is shallow flooded and planted mainly by cash crops. Potential agricultural land is 22,157ha. This zone is conceived to be a full flood protection area consisting of four large polder systems. The Prek Ambel will be improved and managed as a bypass canal to mitigate water level increase in the eastern area of the Bassac River that might be impacted by the proposed infrastructure.

Zone#3 is located along the NR#2 with an area of 104,288ha. It covers 54 communes in Takeo province along the NR2 and 10 communes in Kandal province. It is classified as shallow flooded area. The area would be protected against peak flood from the Mekong by a dike system and from the western catchment by a drainage/irrigation canal along the RN2. Potential agricultural land is estimated at 77,848ha.

Zone#2 is located between zone#1 and zone#3 along depression areas of the project with an area of 104,288ha. It covers 39 communes in Takeo province and 19 communes in Kandal province in deep flooded area. This zone is proposed to be protected against the early flood up to 31 of July. The area will be flooded after this date.

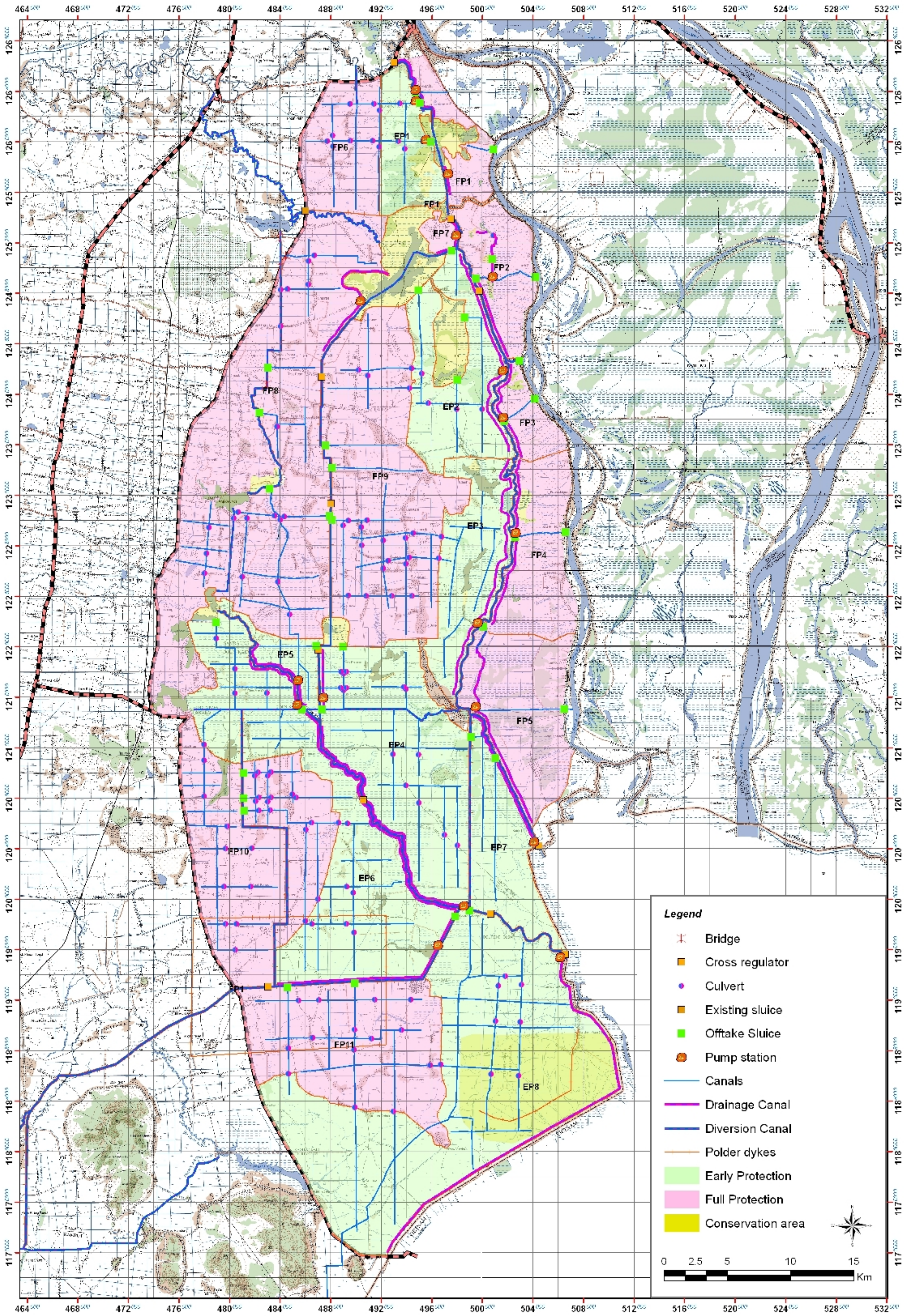


Figure 1.1 **Map of West Bassac Demonstration Project**

1.2 Population and main occupation

Total population in the project area according to 2007 commune database was 682,200 of which female population occupied 51%. There were nearly 128,600 families in the project area with average size of family of 5.31 persons, of which about 24,200 families in Zone#1; 43,000 families in Zone#2; and 61,400 families in zone#3. There was about 1,700 Islam households occupying 1.3% and about 500 Vietnamese households occupying 0.4%. Most Vietnamese families are living in Zone 1 meanwhile most Islamic families are living in zone 1 and 2. Details are in Table 1.1.

Average family size still remains high in Cambodia event though family planning program has been carried out to reduce fertility rate. This decline has taken place at approximately the same pace in urban and rural areas throughout almost all provinces. It varies by residence (urban or rural) and level of education. There was no information on poverty rate in the 2007 commune database, however the figure[1] in 2002 show that poverty rates varied from 14% to 47% between the districts. Average poverty rate of all districts in the project areas was 36%. See Table 1.2.

There exists sex imbalance in age-groups. In young age-groups before 17, male is more than female, especially from 7-17 the different rate was 5%. All age groups after 18,, female population is more than male and the different rates were increased with age groups (1% for a group of 18-24, 4.6% for a group of 25-35, 6.4% for a group of 36-45, 10.7% for a group of 46-60, and 14.6% for groups more than 61). See Figure 1.2.

Main occupation of families in the project area is crop cultivation with about 111,000 occupying 86% (lower rate was found in zone 1 of 69% and higher rate was in zone 3 of 92%). There is a lower rate of rice cultivation families In zone #1 (48%) compared to zone#2 (86%) and zone#3 (91%). However high rate of families whose primary occupation of non-rice crop cultivation (fruits, vegetables and upland crops) was found in zone#1 (21%), zone#2 (3%) and very small percentage (0.7%) in zone#3.

There was relative high concentration of fishing families in zone#1 with 884 families, occupying 3.7% compared to zone#2 (0.9%) and zone#3 (0.2%). Rate of families who occupation mainly trading and services was high in zone#1 (34%) compared to zone#2 (18%) and zone#3 (20%) Details are presented in Table 1.3 and Table 1.4.

[1] Poverty Rate 2002, Ministry of Planning/World Food Program. Poverty line (Riel/person/day): Phnom Penh-2,351, Other urban-1,952 and Rural-1,753

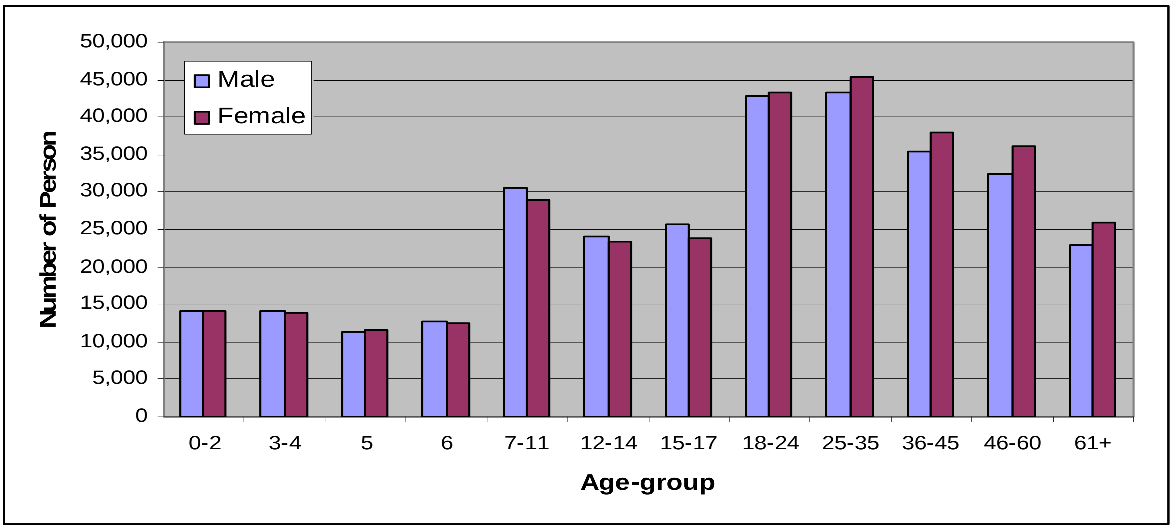


Figure 1.2 Population distribution by age-groups in the project area

Table 1.1 Population and Household in related districts and in project area

No		Population (person)	Female (person)	# of Family	HH Size	Poverty rate	Islam HH	%	Vietnam HH	%
I	**Kandal**	**1,279,876**	**646,316**	**245,379**	**5.22**		**2,333**	**1.0%**	**4,282**	**1.7%**
1	Kandal Stueng	102,098	52,793	21,468	4.76	24%	2	0.0%	2	0.0%
2	Kaoh Thum	152,274	78,082	28,036	5.43	47%	975	3.5%	2,113	7.5%
3	S'ang	200,521	100,954	37,831	5.30	28%	9	0.0%	179	0.5%
II	**Takeo**	**950,623**	**484,569**	**182,096**	**5.22**		**1,014**	**0.6%**	**149**	**0.1%**
1	Angkor Borei	56,792	28,488	9,373	6.06	35%	10	0.1%	8	0.1%
2	Bati	152,508	77,183	27,823	5.48	44%	18	0.1%	9	0.0%
3	Bourei Cholsar	26,145	13,443	5,128	5.10	42%	507	9.9%	76	1.5%
4	Kiri Vong	108,299	55,033	22,361	4.84	28%	5	0.0%	1	0.0%
5	Kaoh Andaet	51,462	26,435	10,242	5.02	39%	163	1.6%	2	0.0%
6	Prey Kabbas	104,608	52,005	20,229	5.17	43%	16	0.1%	0	0.0%
7	Samraong	130,967	67,038	24,247	5.40	44%	9	0.0%	3	0.0%
8	Doun Kaev	42,338	20,963	7,393	5.73	14%	65	0.9%	11	0.1%
9	Treang	111,342	57,086	21,550	5.17	39%	209	1.0%	38	0.2%
1	ZONE #1	133,191	67,015	24,155	5.51		833	3.4%	367	1.5%
2	ZONE #2	226,012	115,001	43,011	5.25		687	1.6%	117	0.3%
3	ZONE #3	322,997	162,968	61,392	5.26		198	0.3%	17	0.0%
III	**TOTAL**	**682,200**	**344,983**	**128,558**	**5.31**		**1,718**	**1.3%**	**501**	**0.4%**

Source: 2007 commune database and consultant estimates for project area. Poverty rate was at 2002.

Table 1.2 Household distribution by main occupation (HH)

Main occupation HH	Kandal	Takeo	Project	Zone #1	Zone #2	Zone #3
Rice farmer	**134,552**	**167,907**	**104,210**	11,606	36,805	55,799
Long-term crops	**10,108**	**99**	**1,107**	850	214	43
Short-term crops	**25,088**	**712**	**4,559**	3,619	732	208
Vegetables	**9,053**	**353**	**1,045**	608	243	193
Fish man	**8,381**	**394**	**1,366**	884	384	99
Livestock farmer	**2,393**	**476**	**425**	102	178	146
NT forest products	**140**	**40**	**99**	82	15	3
Furniture craft	**145**	**69**	**28**	2	6	20
Metal craft	**110**	**28**	**35**	19	3	14
Food craft	**145**	**42**	**34**	12	8	14
Plastic craft	**12**	**4**	**8**	4	3	1
Cloth craft	**3,747**	**1,024**	**961**	21	257	683
Other craft	**491**	**107**	**79**	13	24	41
Trades	**10,615**	**1,750**	**3,541**	2,202	659	680
Repair services	**1,970**	**592**	**673**	235	191	247
Transport services	**4,074**	**480**	**836**	385	180	271
Other services	**5,136**	**557**	**1,333**	783	464	87
Government staffs	**14,430**	**10,502**	**7,699**	1,689	2,048	3,961
Private sector staffs	**38,689**	**19,975**	**13,832**	2,901	4,160	6,771
Total Households	**245,379**	**182,096**	**128,558**	24,155	43,011	61,392

Source: 2007 commune database

Table 1.3 Household distribution by main occupation (%)

Main occupation HH	Kandal	Takeo	Project	Zone #1	Zone #2	Zone #3
Rice farmer	**54.8%**	**92.2%**	**81.1%**	48.0%	85.6%	90.9%
Long-term crops	**4.1%**	**0.1%**	**0.9%**	3.5%	0.5%	0.1%
Short-term crops	**10.2%**	**0.4%**	**3.5%**	15.0%	1.7%	0.3%
Vegetables	**3.7%**	**0.2%**	**0.8%**	2.5%	0.6%	0.3%
Fish man	**3.4%**	**0.2%**	**1.1%**	3.7%	0.9%	0.2%
Livestock farmer	**1.0%**	**0.3%**	**0.3%**	0.4%	0.4%	0.2%
NT forest products	**0.1%**	**0.0%**	**0.1%**	0.3%	0.0%	0.0%
Furniture craft	**0.1%**	**0.0%**	**0.0%**	0.0%	0.0%	0.0%
Metal craft	**0.0%**	**0.0%**	**0.0%**	0.1%	0.0%	0.0%
Food craft	**0.1%**	**0.0%**	**0.0%**	0.1%	0.0%	0.0%
Plastic craft	**0.0%**	**0.0%**	**0.0%**	0.0%	0.0%	0.0%
Cloth craft	**1.5%**	**0.6%**	**0.7%**	0.1%	0.6%	1.1%
Other craft	**0.2%**	**0.1%**	**0.1%**	0.1%	0.1%	0.1%
Trades	**4.3%**	**1.0%**	**2.8%**	9.1%	1.5%	1.1%
Repair services	**0.8%**	**0.3%**	**0.5%**	1.0%	0.4%	0.4%
Transport services	**1.7%**	**0.3%**	**0.7%**	1.6%	0.4%	0.4%
Other services	**2.1%**	**0.3%**	**1.0%**	3.2%	1.1%	0.1%
Government staffs	**5.9%**	**5.8%**	**6.0%**	7.0%	4.8%	6.5%
Private sector staffs	**15.8%**	**11.0%**	**10.8%**	12.0%	9.7%	11.0%

Source: 2007 commune database

1.3 Living conditions

Housing in the project area is mainly tiled roof and zinc/fibro roof occupying 86%. There is 12% of house with thatched roof, the remains are concrete and villa house at very small percentage.

Electricity connection to house in the project area is quite low at 19%, which is between Takeo province (8%) and Kandal province (30%). Relative high electricity connection to household is found in zone 1 (55%). It is followed by zone 2 (13%) and zone 3 (10%).. 70% of households in the project area use battery for lighting and the remains of 11% uses gasoline for lighting. Details are in Table 1.4.

Table 1.4 Housing status (# of house and percentage)

No	Items	Kandal	Takeo	Project	Kandal	Takeo	Project
1	# Houses with thatched roof	26,732	27,634	14,023	12%	16%	12%
2	# House with zinc/fibro roof	110,847	64,665	51,539	51%	38%	43%
3	# Houses with tiled roof	74,009	76,233	51,020	34%	45%	43%
4	# Flats/apartments	1,076	499	363	0%	0%	0%
5	# Concrete house or flats	4,346	1,781	1,658	2%	1%	1%
6	# Villa house	530	70	95	0%	0%	0%
7	# Houses with electricity	65,279	13,656	22,838	30%	8%	19%
8	# Houses with battery	147,327	124,666	83,638	68%	73%	70%
9	# Houses with TV	189,409	102,227	85,149	87%	60%	72%
	Total houses	217,540	170,882	118,698	100%	100%	100%

Source: 2007 commune database

In the project area, there is a small number of family (8%) using purified system equipment for drinking water. However, Forty six percent of family boil water before drinking. Water use for domestic is from several sources as pumping from mixed wells (39%) river, pond, lake (47%) etc. There were 53% of families taking water from unsafe sources. According to 2007 commune data, 38% of families get water at their house; 9% get water from public taps or wells within 150m. Latrine rate was very low at 26% or at a rate of one proper latrine for each 4 families. Details are presented in Table 1.5.

Table 1.5 Water and sanitation (percentage of families)

Items	Kandal	Takeo	Project	Zone#1	Zone#2	Zone#3
Purified system equipment	10%	5%	**8%**	15%	7%	5%
Pump, mixed wells	28%	37%	**39%**	25%	38%	44%
Ring wells, opened dug wells	6%	15%	**6%**	1%	5%	9%
Pond	6%	35%	**27%**	2%	28%	36%
Rain water storage	2%	1%	**1%**	2%	1%	1%
Rivers, lakes, natural ponds	48%	7%	**20%**	54%	22%	5%
Clean/safe sources	45%	47%	**47%**	38%	44%	53%
Unsafe sources	55%	53%	**53%**	62%	56%	47%
Filter for drinking	7%	6%	**7%**	4%	9%	7%
Boil water for drinking	65%	40%	**46%**	68%	41%	42%
At their house	49%	28%	**38%**	43%	36%	37%
Within 150m of their house.	13%	16%	**9%**	5%	7%	12%
Latrines	37%	17%	**26%**	45%	20%	23%
Total families (number)	**245,379**	**182,096**	**128,558**	**24,155**	**43,011**	**61,392**

Source: 2007 commune database

1.4 Existing agriculture

Total land of the West Bassac project is 227,119ha of which 27,419ha in Zone#1, 104,288ha in Zone#2, and 95,413ha in Zone#3. Potential agricultural land in the project area is estimated at 176,830ha occupying 77.8% of the total area. It was broken down as 22,157ha in Zone#1, 76,824ha in Zone#2, and 77,848ha in Zone#3. Protected area for crane at Boeung Lpeouv is 8,460ha.

There are a few irrigation facilities in the project area excepting small scale schemes taking water for irrigation from pond/lake and river. Embankment for protecting crops from early flood is limited, therefore, single cropping system is prevailing in the project area before flooding and/or during flood recession.

There are two crop seasons in the project area depending on elevation of rice field, characteristics of flooding, and water availability in dry season (i) Wet season total cultivated rice area was about 74,632 ha of which 2,196ha in zone#1; 22,677ha in zone#2 and 49,756ha in zone#3; (ii) Dry season total cultivated rice area was 79,378 ha of which 10,670ha in zone#1; 49,367ha in zone#2 and 19,340ha in zone#3.

There was a significant difference between cultivated rice area in dry and wet season by zones depending on cultivation constraints in flood and drought. The cultivated rice areas in dry season in zone#1 and zone#2 were much more that those in wet season (nearly five times in zone#1 and 2 times in zone#3). Meanwhile, in zone#3 cultivated rice area in wet season was 2.5 time of that in dry season.

Cropping intensity in the area was very low at 89% in an average varying from 73% in zone#1 to 94% in zone#2. See Table 1.6 and more details are presented in Table 1.7.

- Wet season crop: (i) Early Rice is planted in April and harvested in July (before main flood); (ii) Medium Rice with long stem varieties is planted in May-June and harvested in November-December; and (iii) Late Rice with long stem and long duration varieties is planted in May-June and harvested in January-February. The crops planting in wet season are mainly rain-fed. Only 12% of wet season cropped area was supported by supplementary irrigation during dry spells. Average rice yield was 2.25 ton/ha for the whole project and 2.77 ton/ha for Zone#1, 2.32 ton/ha for zone #2, and 2.19 ton/ha for zone#3.
- Dry season crop: It is planted after flooding especially for a low land area. Depending on the progress of flood recession, crop is planted in November-December and harvested in March-April. According to 2007 commune database, full irrigation in the dry season crop was 87% of total cultivated rice in the project area. Average rice yield in the project area was 3.71 ton/ha, higher yield was found in zone#2 which was at 3.86 ton/ha. It was followed by zone#1 (3.77 ton/ha) and zone#3 (3.31 ton/ha).

General speaking, crop cultivation technique in the project area is extensive farming with little use of fertilizers and pesticides, except crop in dry season with full irrigation. There were 95 % of families who cultivate crops/plants use fertilizers, and only 72% of them use pesticides.

The amount of fertilizers applied were 100-150kg/ha for wet season rice (early and medium planting date) and 200-250kg/ha for wet season late rice and dry season irrigated rice. Common fertilizers used are Urea and DAP with high proportion of Urea. Amount of fertilizers applied for fruit trees are much higher than rice. It would be 160-300kg/ha/year in the first 3 years after planting and it would be increased to 400-560kg/ha/year during fruitful period.

There are many type of pesticides available in the market and the information got from crop-budget survey can not be in quantity but in the cost of pesticides farmers spent for crops. Very little pesticides (1-2 US$/ha) used for wet season rice but significantly high (37 US$/ha) for dry irrigated rice.

Upland crops such as corn, beans, peanut and sweet potatoes are mainly plated in zone#1 on a levee along the Bassac river.

Table 1.6 Summary of existing land use for agriculture in 2009

ITEMS	PROJECT	Zone#1	Zone#2	Zone#3
Gross area	**227,119**	**27,419**	**104,288**	**95,413**
Potential agricultural land	**176,830**	**22,157**	**76,824**	**77,848**
Total dry-season rice land	88,125	11,823	56,010	20,292
Cultivated dry-season rice land	79,378	10,670	49,367	19,340
Total area of wet-season rice land	80,378	2,519	26,736	51,123
Total area of cultivated wet-season rice	74,632	2,196	22,677	49,759
Total non-rice cultivated crops (ha)	3,770	3,231	420	118
Total planted crop area (ha)	157,779	16,097	72,464	69,217
Cropping intensity (%)	89%	73%	94%	89%

Source: 2007 commune database

Table 1.7 Existing land use for agriculture (ha) in 2009

ITEMS	KANDAL	TAKEO	PROJECT	Zone#1	Zone#2	Zone#3
Gross area	**356,372**	**349,050**	**227,119**	**27,419**	**104,288**	**95,413**
Potential agricultural land	**297,966**	**285,420**	**176,830**	**22,157**	**76,824**	**77,848**
Total dry-season rice land	**89,127**	**80,586**	**88,125**	**11,823**	**56,010**	**20,292**
Cultivated dry-season rice land	66,933	73,799	79,378	10,670	49,367	19,340
Recession dry season rice land	16,479	8,461	9,924	720	4,690	4,514
Full-irrigated dry season rice land	50,455	65,337	69,454	9,950	44,678	14,826
Average dry-season rice yield (t/ha)	3.05	3.17	3.71	3.77	3.86	3.31
Rice production in dry season (ton)	227,491	273,165	294,547	40,211	190,318	64,017
Total area of wet-season rice land	**44,084**	**162,790**	**80,378**	**2,519**	**26,736**	**51,123**
Total area of cultivated wet-season rice	40,528	157,459	74,632	2,196	22,677	49,759
Area rain fed rice land	27,999	145,911	65,639	1,595	19,544	44,500
Area supplemental irrigated rice land	12,528	11,548	8,993	601	3,133	5,259
+Irrigated from canal/dam	9,851	7,482	6,898	538	1,893	4,467
+Irrigated from river, natural pond	2,505	2,993	2,041	61	1,211	769
+Irrigated from drilled well	112	18	48	2	23	23
+Irrigated from dug pond	60	1,056	6	0	6	0
Average wet-season rice yield (t/ha)	2.45	2.07	2.25	2.77	2.32	2.19
Rice production in wet season (ton)	89,293	309,869	167,754	6,088	52,629	109,036
Intensive rice cultivation at first time	5,504	24,301	15,717	1,316	6,640	7,762
Average intensive rice yield (t/ha)	2.88	2.17				
Intensive rice cultivation at second time	2,125	15,812	9,594	663	4,561	4,371
Average intensive rice yield (ton/ha)	2.38	2.05				
Total of actual upland rice crop	912	2,391	788	8	198	581
Average upland rice yield		2.50				
Total non-rice cultivated crops (ha)	**18,158**	**1,676**	**3,770**	**3,231**	**420**	**118**
+ Corn cultivation area	12,073	344	1,788	1,673	115	0
Corn average yield	2.91	1.41				
+ Soya bean cultivation area	491	0	170	143	26	0
Soya bean average yield	2.55					
+ Green bean cultivation area	3,824	302	1,322	1,128	141	53
Green bean average yield	1.54	1.45				
+ Peanut cultivation area	728	138	136	76	59	0
Peanut average yield	2.31	0.73				
+ Cassava cultivation area	80	607	96	5	34	57
Cassava average yield	2.39	2.66				
+ Sweet potatoes cultivation area	437	282	238	187	43	7
Sweet potatoes average yield	3.29	2.68				
+ Sesame cultivation area	526	4	21	19	2	0
Sesame average yield	1.04	0.15				
Planted crop area (ha)	**126,531**	**235,325**	**158,567**	**16,106**	**72,663**	**69,799**
Cropping intensity (%)	42%	82%	90%	73%	95%	90%

Source: 2007 commune database

1.5 Crop benefits

Representative crop-budgets for zone 1, zone 2 and zone 3 of the project area were collected in April 2009 under framework of the FMMP_C2 activities. The standard crop-budget forms were developed and national socio-economic consultant team was trained before carrying out the data collection at the field.

Economic benefit of crops were derived from financial benefit by applying conversion factors (CF) to remove transfer-payments (taxes, tariffs, and loan interest). The CF was 70% for unskilled labour, 80% for fertilizers, and 90% for other cost items as seed, mechanical equipments, etc.

1.5.1 Zone 1

Financial benefit of rice cultivation in zone#1 varies from 90-290 US$/ha in wet season depending early or late planting. Higher benefit was found in medium and late rice in the wet season. The financial benefit of rice cultivation in dry season with irrigation was at about 350-360 US$/ha which is significantly higher than wet season crop. The economic benefit of rice cultivation would be higher than financial benefit by 50% in average.

Upland-crops were found more profitable than rice, especially vegetables. Sugar-cane in the area was also high net benefit at an order of 1,000 US$/ha, however this sugar-cane is for juice not for processing sugar. It is therefore market would be the main constrains for expansion sugar plantation. Details are presented in Table 1.8 and Attachment 2.

Table 1.8 Net benefit of selected annual crops in zone#1

No	Crops	Production	Revenue	Total Inputs	Physical input	Financial NB	Economic NB
		(kg)	US$	US$	US$	US$	US$
1	Medium Rice (Wet)	3,000	750	573	368	177	285
2	Late Rice (Wet)	2,900	727	439	309	288	368
3	Floating Rice (Wet)	2,000	440	347	233	93	156
4	Early Rice (Dry)	5,000	1,260	904	696	357	507
5	Early Rice (Wet)	2,700	594	473	320	121	210
6	Sugarcane	26,000	3,120	2,077	1,453	1,044	1,396
7	Broccoli	9,000	3,600	2,786	870	814	1,500
8	Chinese Cabbage	9,500	2,375	1,666	830	709	1,063
9	Red Corn	5,500	1,375	895	567	480	648
10	White Corn (seed)	2,200	1,100	661	380	439	569
11	White Corn	6,000	900	710	497	190	318
12	Green Bean	1,050	735	519	262	216	325
13	Leek	28,000	3,360	2,009	1,283	1,351	1,740
14	Kinky Cabbage	9,500	1,900	1,186	644	714	961
15	Small Cucumber	16,000	3,200	2,167	1,081	1,034	1,503
16	Sweet Banana	4,200	5,250	3,877	2,270	1,373	2,149
17	Papaya	19,250	2,310	1,426	706	884	1,190

Source: FMMP_C2: Survey data, April 2009

Prevailing fruit trees in zone #1 are mango, coconut, jackfruit and sapodilla. Investment for fruit garden is 900-1,500 US$/ha depending on types. Low investment would be coconut, and high investment would be jackfruit and mango.

Since the fruit trees are perennial crops with economic cycle (fruitful period) of 7-15 years, net present value and annual net benefit (annuity) were calculated to make it possible to compare with annual crops. Financial net benefit quite high for mango and coconut as an order of 1,000-1,400 US$/ha/year. Economic annual net benefit from fruits would be higher than financial net benefit by 25% in average. Details are presented in Table 1.9.

Table 1.9 Net benefit of selected fruits in zone#1

	Fruit Trees		**Mango**	**Coconut**	**Jackfruit**	**Sapodilla**
1	**Investment (1st year)**	**US$**	**1,464**	**906**	**1,547**	**1,172**
2	Economic cycle	year	13	15	13	7
3	Year starting harvest	year	Year-4	Year-4	Year-4	Year-4
4	Year having high yield	year	Year-10	Year-10	Year-10	Year-7
5	High yield	kg	17,850	15,400	670	6,000
6	Inputs before yielding	US$/year	695	418	445	751
7	Inputs at high yielding	US$/year	664	399	307	390
8	Benefit (high yielding)	US$/year	2,906	2,681	1,703	1,110
9	Annual Labor	US$	386	399	242	210
	Financial NPV, 12%	**US$**	**6,485**	**9,313**	**5,792**	**1,072**
	Financial NB, 12%	**US$/year**	**868**	**1,247**	**775**	**144**
	Economic NPV, 12%	**US$**	**7,484**	**10,082**	**6,573**	**1,749**
	Economic NB, 12%	**US$/year**	**1,002**	**1,350**	**880**	**234**

Source: FMMP_C2: Survey data, April 2009

1.5.2 Zone 2

Financial net benefit for rice cultivation in zone #2 varies from 100-200 US$/ha for wet season crops. Rice crop cultivated in dry season with irrigation has almost double yield and net benefit compared to the rain-fed ones. However, there is a limitation in expansion of dry season crops since water availability for irrigation in the area is limited. This zone has high potential for irrigation development to increase dry season crop in future. The economic net benefit of rice crops are higher than the financial NB by about 60% in average.

Non-rice crops, especially vegetables show higher net benefit than rice. However market for vegetables is Phnom Penh and local consumption, the expansion vegetables area should be carefully planned in a connection with markets. Economic benefit of non-rice crops are higher than financial NB by about 40% in average. The area in West Bassac in general is suitable for high-brid corn which is used for animal feed processing. It would be an alternative diversification crop for future development of the area. The same as zone #1, sugar-cane shows high return but it can not be expanded to large scale. Details are presented in Table 1.10 and Attachment 3.

Prevailing fruit tree in zone #2 is mango, planting in garden surrounding houses. Future development in Zone #2 is early flood control, the cultivation of trees would be as existing condition in the high land around the houses.

Table 1.10 Net benefit of selected annual crops in zone#2

No	Crops	Production	Revenue	Total Inputs	Physical input	Financial NB	Economic NB
		(kg)	US$	US$	US$	US$	US$
1	Early Rice (Dry)	5,200	1,300	899	722	401	553
2	Early Rice (Wet)	2,900	580	372	214	208	281
3	Medium Rice(Wet)	2,800	560	453	282	107	194
4	Late Rice(Wet)	3,100	620	508	220	112	227
5	Chinese Cabbage	9,000	2,700	1,849	687	852	1,288
6	White Corn	5,500	825	620	430	205	319
7	Soybean	712	570	301	149	269	330
8	String Beans	10,000	3,000	2,402	1,430	598	1,075
9	Kinky Cabbage	8,200	2,460	1,434	750	1,026	1,326
10	Sweet Banana	3,600	4,500	2,965	2,060	1,535	2,096
11	Water Melon	2,700	675	359	272	316	379
12	Sugarcane	20,000	2,000	1,060	685	941	1,131

Source: FMMP_C2: Survey data, April 2009

Table 1.11 Net benefit of selected fruits in zone#2

	Fruit Trees		**Mango**
1	**Investment (1st year)**	**US$**	**676**
2	Economic cycle	year	15
3	Year starting harvest	year	Year-4
4	Year having high yield	year	Year-10
5	High yield	kg	12,000
6	Inputs before yielding	US$/year	395
7	Inputs at high yielding	US$/year	625
8	Benefit (high yield)	US$	2,375
9	Annual Labor	US$	200
	Financial NPV, 12%	**US$**	**6,110**
	Financial NB, 12%	**US$/year**	**818**
	Economic NPV, 12%	**US$**	**6,885**
	Economic NB, 12%	**US$/year**	**922**

Source: FMMP_C2: Survey data, April 2009

1.5.3 Zone 3

Net benefit of rice cultivation in zone #3 in general is lower than other zones. Financial NB varies 100-150 US$/ha in wet season and about 190 US$/ha in dry season with irrigation. The economic NB is higher the financial one by about 70% in average.

The same as other zones, high net return is observed in non-rice crops, especially vegetables with financial net benefit pf about 1,500 US$/ha. The economic net benefit is higher than financial one by about 40%. Details are presented in
and Attachment 4.

Table 1.12 Net benefit of selected annual crops in zone#3

No	Crops	Production	Revenue	Total Inputs	Physical input	Financial NB	Economic NB
		(kg)	US$	US$	US$	US$	US$
1	Early Rice (Wet)	3,100	775	628	498	147	252
2	Medium Rice (Wet)	2,950	739	623	418	115	228
3	Late Rice (Wet)	2,500	635	484	366	151	233
4	Early Rice (Dry)	3,500	885	696	516	190	312
5	Broccoli	8,500	3,400	2,410	1,030	990	1,535
6	Kinky Cabbage	11,000	2,750	1,455	859	1,295	1,587
7	Water Melon	3,000	750	408	262	342	418
8	Cassava	9,000	1,350	655	394	695	821

Source: FMMP_C2: Survey data, April 2009

2 FUTURE AGRICULTURAL DEVELOPMENT

2.1 Future without project

According to the commune database 2007, agriculture in the project area had a low cropping intensity of 90% of total potential land (176,830ha) for agriculture. The cultivated crops were 158,576ha of which 79,378ha of cultivated dry season rice, 74,632ha of cultivated wet season rice, 788ha cultivated upland rice, and 3,770ha cultivated non-rice crops. There were 87% cultivated dry season rice being irrigated by different water sources: pond/lake, well, river/stream, and canal/reservoir. Supplementary irrigation for rice in wet season covered 12% of the cultivated area.

The land in project area is flat and very suitable for agriculture, however main constrain for agricultural development in the area is availability of water in dry season and flooding. Crop field elevation is varied from 6 to 8m above MSL and water level in Bassac river in dry season in an order of 2 m, pumping irrigation would be required for the area from canal distribution net-work to the field. Possibility for gravity irrigation is limited except from some existing natural lake/pond.

There would certainly be a small-scale irrigation scheme development in future without the project. However, It is expected that an irrigated area from new irrigation schemes would be balanced the deteriorated rate of existing irrigation schemes. With this assumption, it is expected that future without project would be more or less the same as existing agriculture.

2.2 Future with project

The project provides irrigation facilities (canal, regulators, pumping stations), and flood control measures (ring dykes, compartment dykes, sluice-gates) for early flood protection in July to ensure the double cropping system in the deep flooded area and year around full flood protection for zone#1 and Zone#3 (shallow flooded area).

The first crop in the project area would be planting in November-December and harvesting in March-April which is fully irrigated in dry season.

The second crop would be planting in March-April and harvesting in June-July when early flood arrives in the area. The early flood protection (embankments and gates) would ensure the second crop safely harvested. Irrigation is also needed during April-June when no rain or insufficient rain compared to crop requirement.

The third crop in full flood protection areas would be planted in August and harvested in November. This crop season would be rain-fed with provision of flood protection and local rain drainage.

For the purpose of FMMP_C2 to investigate preliminary assessment on economic feasible for flood control measures and irrigation development, it is assumed that:

1. Agricultural land in future with the project would be reduced by 5% compared to future without project for infrastructure development (canal systems, embankments, rural roads and on-farm development, etc)
2. Cultivated crops would cover at a maximum rate of 90% land availability;
3. Zone #1: In dry season crops planted mainly non-rice crops. In wet season 50% of area planted by rice and the remains for non-rice crops. There would be 10,000ha (48% of the area) that the third non-rice crop could be planted;
4. Zone #2: Crops are mainly rice for dry and wet seasons. There would be two crops per year. Triple crop land in the area would not be possible.

5. Zone #3: “Lowland” would be planted wet and dry rice crops (two crops/year). “Highland” would be planted wet and dry non-rice crops (two crops/year). There would be about 20,000ha (27% of the area) in the low land that third crop of non-rice could be planted.

With the above assumption, it is expected that:

- Cultivated dry season rice would be about 110,000ha with full irrigation of which more than 65,000ha in zone#2 and 45,000ha in zone#3. There would be no dry season rice in zone#1, since zone#1 in the dry season would be covered totally by non-rice crops;
- Cultivated wet season rice would be nearly 120,000ha with supplementary irrigation, of which about 9,000ha in zone#1, 65,000ha in zone#2, and 45,000ha in zone#3;
- There would be no upland rice in future with project, this land would be convert into non-rice crop area;

Cultivated non-rice crops would be mainly covered by red corn in wet and dry seasons for animal feeds, there would be some other potential non-rice crops such as green bean, soy bean and peanut for domestic consumption. Total cultivated area of non-rice crops would be about 102,000ha of which 38,000ha in zone#1, 900ha in zone#2, and 63,000ha in zone#3. Details are presented in Table 2.1.

Overall cropping intensity in 2007 and future without project conditions was 90%, of which 95% in Zone#2, and 90% in Zone#3 and 73% in Zone#1. Future with project with provision of flood protection measures and irrigation facilities. It is expected that cropping intensity would be 228%, 180%, and 207% in zone#1, zone#2, and zone#3 respectively.

Even full flood protection in zone#1 and zone#3 but due to limitation of irrigation water in dry season, therefore, the expansion of third crop in the area would be limited.

It is noted that there would be significant needs for agricultural extension services in the project area for supporting farmers in cultivation techniques, new crop varieties, proper application of fertilizers & pesticides, and marketing. Short-term credit would also be provided to farmer to cover their physical inputs required during crop cultivation.

Table 2.1 Future land use

		Future without Project				Future with Project			
	ITEMS	**Project**	Zone#1	Zone#2	Zone#3	**Project**	Zone#1	Zone#2	Zone#3
I	**Gross Area**	**227,119**	**27,419**	**104,288**	**95,413**	**227,119**	**27,419**	**104,288**	**95,413**
II	**Non agricultural land**	**50,290**	**5,261**	**27,463**	**17,565**	**59,131**	**6,369**	**31,304**	**21,458**
III	**Agricultural Land**	**176,830**	**22,157**	**76,824**	**77,848**	**167,988**	**21,049**	**72,983**	**73,955**
IV	**Total Cropped Area**	**158,567**	**16,106**	**72,663**	**69,799**	**332,378**	**47,889**	**131,370**	**153,120**
1	**Cultivated dry-season rice**	**79,378**	**10,670**	**49,367**	**19,340**	**110,235**	**0**	**65,235**	**45,000**
	Recession dry season	9,924	720	4,690	4,514	-	-	-	-
	Full-irrigated dry season	69,454	9,950	44,678	14,826	110,235	-	65,235	45,000
2	**Cultivated wet-season rice**	**74,632**	**2,196**	**22,677**	**49,759**	**119,707**	**9,472**	**65,235**	**45,000**
	Rain fed rice	65,639	1,595	19,544	44,500	-	-	-	-
	Supplemental irrigated	8,993	601	3,133	5,259	119,707	9,472	65,235	45,000
3	**Cultivated upland rice**	**788**	**8**	**198**	**581**	**-**	**-**	**-**	**-**
4	**Cultivated non-rice crops**	**3,770**	**3,231**	**420**	**118**	**102,437**	**38,417**	**900**	**63,120**
	Corn#1 (Dry)	-	-	-	-	40,954	18,945	450	21,560
	Corn#2 (Wet)	1,788	1,673	115	-	31,032	9,472	-	21,560
	Soy bean	170	143	26	-	13,000	3,000	-	10,000
	Green bean	1,322	1,128	141	53	15,450	5,000	450	10,000
	Peanut	136	76	59	-	2,000	2,000	-	-
	Cassava	96	5	34	57	-	-	-	-
	Sweet potatoes	238	187	43	7	-	-	-	-
	Sesame	21	19	2	-	-	-	-	-
V	**Cropping intensity (%)**	**90%**	**73%**	**95%**	**90%**	**198%**	**228%**	**180%**	**207%**

Source: 2007 commune database and consultant estimates

3 AGRICULTURAL BENEFITS

3.1 Assumption

1. Construction of the project for main elements (flood control dykes, primary canal system and regulators, primary pumping stations) would be in 5 years. During construction of main structures, secondary and tertiary canals/structures which proposed to be funded by local governments would be started and it is assumed to be fully completed after 10 years. The potential maximum net benefits from cultivation can be reached since the year 10 of the project;
2. There would be higher crop yield in the future due to new high-yielding and good quality varieties developed by agricultural department and/or researches. This factor of future higher yield would not be claimed as result of the project;
3. The benefit from agriculture would be realized in year 5 and being reached at potential maximum in year 10 of the project time frame;
4. Agricultural net benefit of the project is an incremental NB due to higher crop intensity. It is estimated by crop NBs with project deducted by those without project. Thus beside the crop NBs, the project has to claim for benefit of flood reduction by protection measures.

3.2 Economic net benefit of selected crops

Crop-budget analysis was done for financial and economic perspective for different zones in the project area. It was presented in section 2 of this report. Red corn is now cultivated in zone#1 and it is proposed to be expanded to other zones in future with project, and it is expected the economic NB of corn would be the same as in zone#1. Economic NB of peanut, sesame, soy bean are assumed to be the same in the 3 zones. The summary of result was in Table 3.1.

The individual crop-budgets would be investigated in more detail during preparation of feasibility study of the West Bassac in a coming phase.

Table 3.1 Economic net benefit of selected crops (US$/ha)

No	Crops	Zone#1	Zone#2	Zone#3
1	Rice (Wet-rainfed)	210	109	228
2	Rive (Wet-irrigated)	368	281	252
a	Early Rice (Wet)	210	281	252
b	Medium Rice (Wet)	285	194	228
c	Late Rice (Wet)	368	227	233
3	Early Rice (Dry irrigated)	507	553	312
4	Early Rice (Dry recession)	406	442	250
5	Red Corn (Dry)	648	(648)	(648)
6	White Corn (Wet)	318	319	(318)
7	Green Bean	325	(325)	(325)
8	Soy bean	(330)	330	(330)
9	Peanuts	(330)	(330)	(330)
10	Cassava	(821)	(821)	821
11	Sesame	(330)	(330)	(330)

Source: From section 2. The value in bracket is assumed to be the same as other zone

3.3 Economic benefits from cultivation

Given the agricultural land-use and economic net benefit of crops in the project area, the economic net benefits would be 129.65 million US$/year and 54.76 million US$/year for future with project and future without project respectively. It would result in an ***incremental NB of the project at a level of 74,886,000 US$/year***. It would be contributed from cultivation from zone #1 by 15,111,000 US$/year, from zone#2 by 24,877,000 US$/year, and from zone#3 by 34,898,000 US$/year. Details are presented in Table 3.2.

Table 3.2 Potential economic net benefit of agriculture by zone (1000 US$/year)

		Future without Project				Future with Project			
	ITEMS	**Project**	Zone#1	Zone#2	Zone#3	**Project**	Zone#1	Zone#2	Zone#3
1	**Cultivated dry-season rice**	**37,871**	**5,337**	**26,781**	**5,752**	**50,115**	**0**	**36,075**	**14,040**
	Recession dry season	3,494	292	2,075	1,127	-	-	-	-
	Full-irrigated dry season	34,377	5,045	24,707	4,626	50,115	-	36,075	14,040
2	**Cultivated wet-season rice**	**15,468**	**556**	**3,011**	**11,901**	**33,157**	**3,486**	**18,331**	**11,340**
	Rain fed rice	13,041	335	2,130	10,576	-	-	-	-
	Supplemental irrigated	2,427	221	880	1,325	33,157	3,486	18,331	11,340
3	**Cultivated upland rice**	162	2	22	138	**-**	-	-	-
4	**Cultivated non-rice crops**	**1,263**	**1,043**	**153**	**67**	**46,378**	**18,563**	**438**	**27,377**
	Corn#1 (Dry)	-	-	-	-	26,538	12,276	292	13,971
	Corn#2 (Wet)	569	532	37	-	9,868	3,012	-	6,856
	Soy bean	56	47	9	-	4,290	990	-	3,300
	Green bean	430	367	46	17	5,021	1,625	146	3,250
	Peanut	45	25	20	-	660	660	-	-
	Cassava	79	4	28	47	-	-	-	-
	Sweet potatoes	78	62	14	2	-	-	-	-
	Sesame	7	6	-	-	-	-	-	-
5	**Total net benefits**	**54,764**	**6,938**	**29,967**	**17,859**	**129,650**	**22,049**	**54,844**	**52,757**
6	**Incremental NB**					**74,886**	**15,111**	**24,877**	**34,898**

Source: Consultant estimates

ATTACHMENTS

Attachment 1: List of communes in the project area

FMMP_C2: WEST BASSAC DEMONSTRATION PROJECT
COUNTRY: CAMBODIA
UPDATED: 23 JULY 2009

Province/ District	Commune	% in project	Remarks	Gross area (ha)	Project area (ha)	Agriculture (ha)	Z#1 (%)	Z#2 (%)	Z#3 (%)	Project area (ha) Zone #1	Zone #2	Zone #3
TAKEO				**349,050**		**285,420**						
TAKEO in project					**181,160**	**142,714**				**3,397**	**89,651**	**88,112**
1. Angkor Borei		**100%**		**30,079**	**30,003**	**24,850**				**3,322**	**21,012**	**5,668**
	1. Angkor Borei	100%	Deep flood	4,780	4,780	4,022	6	94	-	295	4,485	-
	2. Ba Srae	100%	Deep and shallow	4,326	4,326	3,620	12	50	38	537	2,147	1,641
	3. Kouk Thlok	99%	Deep and shallow	6,565	6,490	5,517	26	73	-	1,693	4,797	-
	4. Ponley	100%	Deep and shallow	5,400	5,399	4,195	-	46	54	-	2,471	2,928
	5. Preaek Phtoul	100%	Deep flood	4,253	4,253	3,615	19	81	-	797	3,456	-
	6. Prey Phkoam	100%	Deep and shallow	4,755	4,755	3,882	-	77	23	-	3,656	1,099
2. Bati (P)		**44%**		**37,357**	**16,278**	**12,593**				**-**	**-**	**16,278**
	1. Chambak	63%	Shallow flood	1,960	1,238	1,052	-	-	63	-	-	1,238
	2. Champei	100%	Shallow flood	1,997	1,997	1,591	-	-	100	-	-	1,997
	3. Doung	100%	Shallow flood	2,440	2,440	2,025	-	-	100	-	-	2,440
	4. Kandoeng	26%	Shallow flood	4,062	1,073	912	-	-	26	-	-	1,073
	7. Krang Thnong	25%	Shallow flood	3,815	936	795	-	-	25	-	-	936
	9. Pea Ream	100%	Shallow flood	2,426	2,426	2,062	-	-	100	-	-	2,426
	10. Pot Sar	98%	Shallow flood	3,752	3,670	2,032	-	-	98	-	-	3,670
	13. Tnaot	100%	Shallow flood	1,865	1,865	1,585	-	-	100	-	-	1,865
	15. Trapeang Sab	26%	Shallow flood	2,411	633	538	-	-	26	-	-	633
3. Borei Cholsa		**97%**		**24,436**	**23,786**	**16,081**				**-**	**22,268**	**1,518**
	1. Bourei Cholsar	99%	Deep flood	6,737	6,695	5,623	-	99	-	-	6,695	-
	2. Chey Chouk	93%	Deep flood	3,403	3,155	1,402	-	93	-	-	3,155	-
	4. Doung Khpos	100%	Deep and shallow	2,818	2,816	2,350	-	52	48	-	1,458	1,358
	5. Kampong Krasang	95%	Deep flood	6,897	6,540	2,836	-	95	-	-	6,540	-
	7. Kouk Pou	100%	Deep and shallow	4,582	4,581	3,870	-	96	3	-	4,421	160
4. Kirivong (P)		**9%**		**59,275**	**5,488**	**4,665**				**-**	**5,488**	**-**
	2. Preah Bat Choan Chum	35%	Deep flood	5,122	1,785	1,517	-	35	-	-	1,785	-
	3. Kamnab	96%	Deep flood	2,687	2,589	2,200	-	96	-	-	2,589	-
	5. Kiri Chong Kaoh	19%	Deep flood	2,797	545	463	-	19	-	-	545	-
	7. Phnum Den	29%	Deep flood	1,971	570	484	-	29	-	-	570	-
5. Doun Keav (P)		**84%**		**9,458**	**7,989**	**6,368**				**-**	**4,214**	**3,774**
	1. Baray	100%	Deep and shallow	4,267	4,263	3,550	-	80	20	-	3,394	868
	2. Roka Knong	78%	Deep and shallow	1,834	1,437	985	-	7	72	-	121	1,315
	3. Roka Krau	68%	Deep and shallow	3,357	2,289	1,833	-	21	47	-	699	1,591
6. Koah Andeth		**98%**		**35,017**	**34,461**	**26,012**	-	57	41	**-**	**20,130**	**14,331**
	1. Krapum Chhuk	100%	Deep and shallow	7,161	7,161	5,338	-	45	55	-	3,210	3,951
	2. Pech Sar	93%	Deep and shallow	5,631	5,214	4,432	-	42	50	-	2,381	2,833
	3. Prey Khla	100%	Deep and shallow	7,195	7,195	4,634	-	32	68	-	2,323	4,872
	4. Prey Yuthka	97%	Deep and shallow	4,681	4,542	3,257	-	91	6	-	4,273	269
	5. Romenh	100%	Deep and shallow	7,003	7,003	5,507	-	77	23	-	5,422	1,581
	6. Thlea Prachum	100%	Deep and shallow	3,347	3,346	2,844	-	75	25	-	2,522	825
7. Prey Kabbas		**100%**		**26,585**	**26,585**	**22,147**				**75**	**7,992**	**18,519**
	1. Angkanh	100%	Deep and shallow	1,267	1,267	1,063	-	19	81	-	238	1,030
	2. Ban Kam	100%	Deep and shallow	1,836	1,836	1,561	0	42	58	2	771	1,063
	3. Champa	100%	Shallow flood	1,554	1,554	1,321	-	-	100	-	-	1,554
	4. Char	100%	Deep and shallow	3,064	3,064	2,566	-	39	61	-	1,209	1,855
	5. Kampeaeng	100%	Shallow flood	2,632	2,632	2,237	-	-	100	-	-	2,632
	6. Kampong Reab	100%	Deep and shallow	1,938	1,938	1,500	3	94	3	62	1,815	61
	7. Kdanh	100%	Shallow flood	1,212	1,212	1,030	-	-	100	-	-	1,212
	8. Pou Rumchak	100%	Deep and shallow	2,643	2,643	2,215	0	36	63	9	958	1,675
	9. Prey Kabbas	100%	Deep and shallow	2,216	2,216	1,779	0	44	56	1	970	1,245
	10. Prey Lvea	100%	Deep and shallow	2,085	2,085	1,670	-	27	73	-	569	1,516
	11. Prey Phdau	100%	Shallow flood	2,110	2,110	1,791	-	-	100	-	-	2,110
	12. Snao	100%	Deep and shallow	2,426	2,426	2,053	-	60	40	-	1,461	965
	13. Tang Yab	100%	Shallow flood	1,602	1,602	1,361	-	-	100	-	-	1,602

Attachment 1: List of communes in the project area (continued)

FMMP_C2: WEST BASSAC DEMONSTRATION PROJECT
COUNTRY: CAMBODIA
UPDATED: 23 JULY 2009

Province/ District	Commune	% in project	Remarks	Gross area (ha)	Project area (ha)	Agriculture (ha)	Z#1 (%)	Z#2 (%)	Z#3 (%)	Project area (ha)		
										Zone #1	Zone #2	Zone #3
8. Samraong (P)		**50%**		**29,737**	**14,923**	**11,753**				**-**	**1,311**	**13,612**
	3. Cheung Kuon	100%	Shallow flood	2,126	2,126	1,685	-	-	100	-	-	2,126
	6. Lumchang	68%	Deep and shallow	2,698	1,826	1,207	-	25	42	-	683	1,142
	7. Rovieng	63%	Shallow flood	4,083	2,565	2,180	-	-	63	-	-	2,565
	8. Samraong	66%	Shallow flood	1,782	1,183	942	-	-	66	-	-	1,183
	9. Soeng	88%	Shallow flood	3,012	2,651	2,136	-	-	88	-	-	2,651
	10. Sla	100%	Shallow flood	2,016	2,016	1,479	-	-	100	-	-	2,016
	11. Trea	100%	Deep and shallow	2,556	2,555	2,125	-	25	75	-	627	1,928
9. Treang (p)		**53%**		**41,075**	**21,648**	**18,246**				**-**	**7,236**	**14,412**
	0. Angkanh	100%	Shallow flood	1,538	1,538	1,307	-	-	100	-	-	1,538
	1. Angk Khnaor	100%	Shallow flood	3,397	3,397	2,888	-	-	100	-	-	3,397
	2. Chi Khmar	19%	Shallow flood	1,697	316	269	-	-	19	-	-	316
	4. Prambei Mom	24%	Shallow flood	2,210	523	444	-	-	24	-	-	523
	6. Prey Sloek	32%	Shallow flood	3,642	1,148	972	-	-	32	-	-	1,148
	8. Sambuor	100%	Deep and shallow	5,598	5,598	4,758	-	72	28	-	4,011	1,586
	10. Smaong	85%	Shallow flood	1,530	1,303	1,108	-	-	85	-	-	1,303
	11. Srangae	100%	Deep and shallow	2,734	2,734	2,173	-	55	45	-	1,500	1,234
	12. Thlok	100%	Deep and shallow	4,845	4,845	4,118	-	26	74	-	1,241	3,604
	13. Tralach	100%	Deep and shallow	1,784	1,784	1,516	-	27	73	-	483	1,301
KANDAL				**356,373**		**297,966**						
KANDAL in project					**45,959**	**34,115**				**24,022**	**14,637**	**7,301**
1 Kandal Stung		**34%**		**26,337**	**9,080**	**7,298**				**-**	**2,424**	**6,656**
	1 Ampov Prey	96%	Deep and shallow	1,381	1,330	1,117	-	27	69	-	377	953
	4 Boeng Khyang	97%	Deep and shallow	1,877	1,819	1,348	-	10	87	-	195	1,624
	5 Cheung Kaeub	100%	Deep and shallow	1,611	1,605	1,349	-	25	74	-	409	1,196
	7 Kandaok	100%	Deep and shallow	2,370	2,370	1,821	-	51	49	-	1,206	1,164
	12 Preaek Kampis	47%	Deep and shallow	1,117	526	447	-	0	47	-	2	524
	14 Preaek Slaeng	94%	Deep and shallow	1,079	1,018	865	-	22	73	-	235	783
	18 Siem Reab	87%	Shallow flood	471	412	350	-	-	87	-	-	412
2. Kaoh Thom		**28%**		**48,255**	**13,645**	**11,368**				**13,629**	**16**	**-**
	5 Kaoh Thum Kha	86%	Deep flood	1,524	1,317	1,119	86	1	-	1,305	11	-
	9 Preaek Sdei	92%	Deep flood	5,293	4,856	4,108	92	0	-	4,854	1	-
	10 Preaek Thmei	86%	Deep flood	3,129	2,676	2,063	85	0	-	2,672	4	-
	11 Sampov Lun	75%	Deep flood	6,416	4,797	4,077	75	-	-	4,797	-	-
3. Ta Khmau (P)		**52%**		**3,151**	**1,654**	**1,405**				**787**	**861**	**5**
	1 Ta Kdol	7%	Deep flood	247	16	14	6	1	-	15	1	-
	4 Ta Khmau	55%	Deep flood	1,018	558	474	54	0	-	553	5	-
	5 Preaek Hour	85%	Deep and shallow	1,008	855	727	0	84	1	2	848	5
	6 Kampong Samnanh	64%	Deep flood	350	224	191	62	2	-	217	7	-
4. S'Ang		**42%**		**51,856**	**21,581**	**14,044**				**9,606**	**11,335**	**640**
	3 Kaoh Khael	88%	Deep flood	2,052	1,814	1,531	63	25	-	1,301	513	-
	5 Krang Yov	100%	Deep and shallow	5,077	5,077	2,747	2	85	13	109	4,329	639
	7 Preaek Ambel	94%	Deep flood	5,053	4,754	3,716	34	60	-	1,719	3,035	-
	8 Preaek Koy	87%	Deep flood	1,524	1,323	1,078	87	-	-	1,323	-	-
	9 Roka Khpos	72%	Deep flood	3,452	2,488	1,232	62	10	-	2,142	346	-
	10 S'ang Phnum	100%	Deep flood	4,157	4,157	2,127	25	75	0	1,044	3,112	1
	16 Tuek Vil	92%	Deep flood	2,136	1,969	1,612	92	0	-	1,968	1	-
TOTAL					**227,119**	**176,830**	**23**	**58**	**64**	**27,419**	**104,288**	**95,413**
										227,119		

Attachment 2-1: Annual crop-budgets in Zone #1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Sa Ang
Commune:	Prek Ambil (Zone 1)
Crop:	Medium Rice (Wet)
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	June
Harvesting at month:	November

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**750**
	Main Product	Kg	0.23	3,000	690
	By products	Ox-cart	15.00	4	60
II	**INPUTS**				**573**
1	**Physical inputs**				**368**
i	**Seed/Planting materials**	Kg/seedling	0.25	40	**10**
ii	**Fertilizers**			150	**95**
	Urea	Kg	0.6	50	30
	DAP	Kg	0.8	50	40
	NPK(16:16:8)	Kg			
	NPK(14:14:14)	Kg			
	Single SP	Kg			
	Triple SP	Kg			
	KCL	Kg	0.5	50	25
	Leaves fertilizers	$			
	Lime	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**53**
	Fungicides	Bottle			
	Pesticides	Bottle	2.5	1	3
	Herbicides	Bottle			
	FYM	kg	0.02	2,500	50
iv	**Mechanization**				**73**
	Ploughing	Round	30	1	30
	Rotavating	Round	30		
	Discing	Round	30		
	Threshing	Tone	10	2.95	30
	Transport to farm gate	Bag	0.25	55	14
v	**Cow/Buffalo**				**15**
	Ploughing	Round			
	Rotavating	Round			
	Levelling	Ha	15.00	1	15
vi	**Other inputs**				**122**
	Bags &packaging	Kg	0.0025	2,950	7
	Tools & equipment	lumpsum			15
	Pumping irrigation cost	hour	10.00	10	100
	Drainage pumping cost	hour			
2	**Labour**			**75**	**205**
	Land preparation	wd	2.50	5	13
	Seedling preparation	wd	2.50	1	3
	Transplanting/ planting	wd	2.50	30	75
	Fertilizer application	wd	2.50	5	13
	FYM application	wd	2.50		
	Agrochemical application	wd	2.50	1	3
	Weeding	wd	2.50	5	13
	Harvesting	wd	2.50	20	50
	Threshing	wd	2.50		
	Transport to farm gate	wd	2.50		
	Drying	wd	2.50		
	Broadcat rice	wd	2.50		
	Irrigation applications	wd	10.00	2	20
	Irrigation canal maintenance	wd	5.00	1	5
	Protection from birds/rats	wd	2.50	5	13
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**177**

Attachment 2-2: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Sa Ang
Commune:	Prek Ambil (Zone 1)
Crop:	Late Rice (Wet)
Irrigation:	
Rainfed:	✓
Irrigation+Rainfed:	
Planting from month:	June
Harvesting at month:	December- January

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**727**
	Main Product	Kg	0.23	2,900	667
	By products	Ox-cart	15.00	4	60
II	**INPUTS**				**439**
1	**Physical inputs**				**309**
i	**Seed/Planting materials**	Kg/seedling	0.25	120	**30**
ii	**Fertilizers**			150	**95**
	Urea	Kg	0.6	50	30
	DAP	Kg	0.8	50	40
	NPK(16:16:8)	Kg			
	NPK(14:14:14)	Kg			
	Single SP	Kg			
	Triple SP	Kg			
	KCL	Kg	0.5	50	25
	Leaves fertilizers	$			
	Lime	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**55**
	Fungicides	Bottle			
	Pesticides	Bottle	2.5	2	5
	Herbicides	Bottle			
	FYM	kg	0.02	2,500	50
iv	**Mechanization**				**68**
	Ploughing	Round	30	1	30
	Rotavating	Round	30		
	Discing	Round	30		
	Threshing	Tone	10	2.50	25
	Transport to farm gate	Bag	0.25	50	13
v	**Cow/Buffalo**				**45**
	Ploughing	Ha	30.00		
	Rotavating	Ha	30.00	1	30
	Levelling	Ha	15.00	1	15
vi	**Other inputs**				**16**
	Bags &packaging	Kg	0.0025	2,500	6
	Tools & equipment	lumpsum			10
	Pumping irrigation cost	hour			
	Drainage pumping cost	hour			
2	**Labour**			**51**	**130**
	Land preparation	wd	2.50	5	13
	Seedling preparation	wd	2.50		
	Showing	wd	2.50	8	20
	Fertilizer application	wd	2.50	5	13
	FYM application	wd	2.50		
	Agrochemical application	wd	2.50	1	3
	Weeding	wd	2.50	5	13
	Harvesting	wd	2.50	20	50
	Threshing	wd	2.50		
	Transport to farm gate	wd	2.50		
	Drying	wd	2.50	2	5
	Broadcat rice	wd	2.50		
	Irrigation applications	wd	2.50		
	Irrigation canal maintenance	wd	5.00	1	5
	Protection from birds/rats	wd	2.50	4	10
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**288**

Attachment 2-3: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Sa Ang
Commune:	Prek Ambel (Zone 1)
Crop:	Flooting Rice (Wet)
Irrigation:	
Rainfed:	✓
Irrigation+Rainfed:	
Planting from month:	June
Harvesting at month:	January

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**440**
	Main Product	Kg	0.20	2,000	400
	By products	track	10.00	4	40
II	**INPUTS**				**347**
1	**Physical inputs**				**233**
i	**Seed/Planting materials**	Kg/seedling	0.37	180	**67**
ii	**Fertilizers**			90	**54**
	Urea	Kg	0.5	60	30
	DAP	Kg	0.8	30	24
	NPK(16:16:8)	Kg			
	NPK(14:14:14)	Kg			
	Single SP	Kg			
	Triple SP	Kg			
	KCL	Kg			
	Leaves fertilizers	Time			
	Lime	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**15**
	Fungicides	Bottle			
	Pesticides	Bottle	5.00	3	15
	Herbicides	Lite			
	FYM	kg			
iv	**Mechanization**				**82**
	Ploughing	Round	35.00	1	35
	Rotavating	Round	35.00	1	35
	Discing	Round	35.00		
	Threshing	Tone			
	Transport to farm gate	Bag	0.3	40	12
v	**Cow/Buffalo**				
	Ploughing	Round			
	Rotavating	Ha			
	Levelling	Ha			
vi	**Other inputs**				**15**
	Bags &packaging	Bag			
	Tools & equipment	lumpsum			15
	Pumping irrigation cost	Lite			
	Drainage pumping cost	hour			
2	**Labour**			**43**	**115**
	Land preparation	wd	2.50		
	Seedling preparation	wd	2.50		
	Transplanting	wd	2.50	15	38
	Fertilizer application	wd	5.00	2	10
	FYM application	wd	5.00		
	Agrochemical application	wd	5.00		
	Weeding	wd	3.00	4	12
	Harvesting	wd	2.50	22	55
	Threshing	wd	2.50		
	Transport to farm gate	wd	2.50		
	Drying	wd	2.50		
	Broadcat rice	wd	2.50		
	Irrigation applications	wd			
	Irrigation canal maintenance	wd			
	Protection from birds/rats	wd			
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**93**

Attachment 2-4: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Koh Thom
Commune:	Koh Thom Khor (Zone 1)
Crop:	Early Rice (Dry)
Irrigation:	✓
Rainfed:	
Irrigation+Rainfed:	
Planting from month:	January
Harvesting at month:	March

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**1,260**
	Main Product	Kg	0.25	5,000	1,250
	By products	track	10.00	1	10
II	**INPUTS**				**904**
1	**Physical inputs**				**696**
i	**Seed/Planting materials**	Kg/seedling	0.6	30	**18**
ii	**Fertilizers**			250	**185**
	Urea	Kg	0.7	150	105
	DAP	Kg	0.80	100	80
	NPK(16:16:8)	Kg			
	NPK(14:14:14)	Kg			
	Lime	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**95**
	Fungicides	Bottle			
	Pesticides	Bottle	8.00	5	40
	Herbicides	Lite	5.00	6	30
	FYM	kg	0.025	1,000	25
iv	**Mechanization**				**138**
	Ploughing	Round	37.00	1	37
	Rotavating	Round	30.00	1	30
	Discing	Round	30.00		
	Threshing	Tone	10.00	5	50
	Transport to farm gate	Bag	0.35	60	21
v	**Cow/Buffalo**				**30**
	Ploughing	Plow			
	Rotavating	Plow			
	Levelling	Ha	30.00	1	30
vi	**Other inputs**				**230**
	Bags &packaging	Bag	0.25	60	15
	Tools & equipment	lumpsum			35
	Pumping irrigation cost	Lite	1.50	120	180
	Drainage pumping cost	hour			
2	**Labour**			**77**	**208**
	Land preparation	wd	2.50	3	8
	Seedling preparation	wd	2.50	2	5
	Transplanting	wd	2.50	15	38
	Fertilizer application	wd	2.50	3	8
	FYM application	wd	2.50	2	5
	Agrochemical application	wd	5.00	6	30
	Weeding	wd	2.50	6	15
	Harvesting	wd	2.50	30	75
	Threshing	wd	2.50		
	Transport to farm gate	wd	2.50		
	Drying	wd	2.50	3	8
	Broadcat rice	wd	2.50	3	8
	Irrigation applications	wd	2.50		
	Irrigation canal maintenance	wd	2.50		
	Protection from birds/rats	wd	2.50	4	10
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**357**

Attachment 2-5: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Sa Ang
Commune:	Prek Ambil (Zone 1)
Crop:	Early Rice (Wet)
Irrigation:	
Rainfed:	✓
Irrigation+Rainfed:	
Planting from month:	June
Harvesting at month:	September

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**594**
	Main Product	Kg	0.22	2,700	594
	By products	track			
II	**INPUTS**				**473**
1	**Physical inputs**				**320**
i	**Seed/Planting materials**	Kg/seedling	0.4	40	**16**
ii	**Fertilizers**			150	**110**
	Urea	Kg	0.70	100	70
	DAP	Kg	0.80	50	40
	NPK(16:16:8)	Kg			
	NPK(14:14:14)	Kg			
	Lime	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**66**
	Fungicides	Bottle			
	Pesticides	Bottle	3.00	2	6
	Herbicides	Lite			
	FYM	kg	0.02	3,000	60
iv	**Mechanization**				**36**
	Ploughing	Round			
	Rotavating	Round			
	Discing	Round			
	Threshing	Tone	7.00	3.0	21
	Transport to farm gate	Bag	0.25	60	15
v	**Cow/Buffalo**				**55**
	Ploughing	Ha	20.00	1	20
	Rotavating	Ha	20.00	1	20
	Levelling	Ha	15.00	1	15
vi	**Other inputs**				**37**
	Bags &packaging	Bag	0.20	60	12
	Tools & equipment	lumpsum			25
	Pumping irrigation cost	Lite			
	Drainage pumping cost	hour			
2	**Labour**			**59**	**153**
	Land preparation	wd	2.50	3	8
	Seedling preparation	wd	2.50	3	8
	Transplanting	wd	2.50	15	38
	Fertilizer application	wd	2.50	3	8
	FYM application	wd	2.50	3	8
	Agrochemical application	wd	3.00	1	3
	Weeding	wd	2.50	3	8
	Harvesting	wd	2.50	20	50
	Threshing	wd	2.50		
	Transport to farm gate	wd	2.50		
	Drying	wd	2.50	3	8
	Broadcat rice	wd	2.50	3	8
	Irrigation applications	wd	2.50		
	Irrigation canal maintenance	wd	2.50		
	Protection from birds/rats	wd	2.50	2	10
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**121**

Attachment 2-6: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Koh Thom
Commune:	Prek Thmei (Zone 1)
Crop:	Sugarcane
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	May
Harvesting at month:	October

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**3,120**
	Main Product	Kg	0.12	26,000	3,120
	By products	Ox-cart			
II	**INPUTS**				**2,077**
1	**Physical inputs**				**1,453**
i	**Seed/Planting materials**	Bunch	0.075	7,000	**525**
ii	**Fertilizers**			300	**200**
	Urea	Kg	0.7	200	140
	DAP	Kg	0.8		
	NPK(20:20:15)	Kg	0.85	100	60
	NPK(14:14:14)	Kg			
iii	**Agrochemical**				**228**
	Fungicides	Bottle			
	Pesticides	Bottle	3.00	6	18
	Herbicides	Bottle			
	FYM	kg	0.03	7,000	210
iv	**Mechanization**				**120**
	Ploughing	Round	40.00	1	40
	Rotavating	Round	40.00	1	40
	Discing	Round	40.00	1	40
	Threshing	Tone			
	Transport to farm gate	Bag			
v	**Cow/Buffalo**				**30**
	Ploughing	Round			
	Rotavating	Ha			
	Levelling+ build drain	Ha	30.00	1	30
vi	**Other inputs**				**350**
	Bags &packaging	Bag			
	Tools & equipment	lumpsum			200
	Pumping irrigation cost	Time	1.50	100	150
	Drainage pumping cost	hour			
2	**Labour**			**154**	**624**
	Land preparation	wd	4.00	14	56
	Seedling preparation	wd	4.00		
	Planting	wd	4.00	40	160
	Fertilizer application	wd	4.00	12	48
	FYM application	wd	4.00	4	16
	Agrochemical application	wd	4.00	2	8
	Weeding	wd	4.00	6	24
	Harvesting	wd	4.00	60	240
	Threshing	wd	4.00		
	Transport to farm gate	wd	4.00		
	Drying	wd	4.00		
	Broadcat rice	wd	4.00		
	Irrigation applications	wd	4.00		
	Irrigation canal maintenance	wd	5.00	8	40
	Protection from birds/rats	wd	4.00	8	32
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**1,044**

Attachment 2-7: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Sa Ang
Commune:	Koh Khel (Zone 1)
Crop:	Broccoli
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	January
Harvesting at month:	February

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**3,600**
	Main Product	Kg	0.40	9,000	3,600
	By products	Ox-cart			
II	**INPUTS**				**2,786**
1	**Physical inputs**				**870**
i	**Seed/Planting materials**	Cans	4.00	35	**140**
ii	**Fertilizers**			300	**240**
	Urea	Kg	0.70	200	140
	DAP	Kg	1.00	100	100
	NPK(20:20:15)	Kg			
	NPK(14:14:14)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**160**
	Fungicides	Bottle	2.00	10	20
	Pesticides	Bottle	3.00	20	60
	Herbicides	Bottle			
	FYM	kg	0.02	4,000	80
iv	**Mechanization**				**100**
	Ploughing	Round	50.00	1	50
	Rotavating	Round	50.00	1	50
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Bag			
v	**Cow/Buffalo**				**40**
	Ploughing	Round			
	Rotavating	Ha			
	Levelling+ build drain	Ha	40.00	1	40
vi	**Other inputs**				**190**
	Bags &packaging	Bag			
	Tools & equipment	lumpsum			70
	Pumping irrigation cost	Time	1.50	80	120
	Drainage pumping cost	hour			
2	**Labour**			**470**	**1,916**
	Land preparation	wd	4.00	12	48
	Seedling preparation	wd	4.00	16	64
	Planting	wd	4.00	150	600
	Fertilizer application	wd	4.00	12	48
	FYM application	wd	4.00	12	48
	Agrochemical application	wd	5.00	12	60
	Weeding	wd	4.00	40	160
	Harvesting	wd	4.00	200	800
	Threshing	wd	4.00		
	Transport to farm gate	wd	4.00		
	Drying	wd	4.00		
	Broadcat rice	wd	4.00		
	Irrigation applications	wd	4.00		
	Irrigation canal maintenance	wd	10.00	4	40
	Protection from birds/rats	wd	4.00	12	48
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**814**

Attachment 2-8: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Sa Ang
Commune:	Prek Ambil (Zone 1)
Crop:	Chiness Cabbage
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	January
Harvesting at month:	February

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**2,375**
	Main Product	Kg	0.25	9,500	2,375
	By products	Ox-cart			
II	**INPUTS**				**1,666**
1	**Physical inputs**				**830**
i	**Seed/Planting materials**	Cans	5.00	25	**125**
ii	**Fertilizers**			250	**205**
	Urea	Kg	0.70	150	105
	DAP	Kg	1.00	100	100
	NPK(20:20:15)	Kg			
	NPK(14:14:14)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**145**
	Fungicides	Bottle			
	Pesticides	Bottle	3.00	10	30
	Herbicides	Bottle	3.00	5	15
	FYM	kg	0.025	4,000	100
iv	**Mechanization**				**80**
	Ploughing	Round	40.00	1	40
	Rotavating	Round	40.00	1	40
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Bag			
v	**Cow/Buffalo**				**30**
	Ploughing	Round			
	Rotavating	Ha			
	Levelling+ build drain	Ha	30.00	1	30
vi	**Other inputs**				**245**
	Bags &packaging	Bag	0.20	100	20
	Tools & equipment	lumpsum			50
	Pumping irrigation cost	Time	2.50	70	175
	Drainage pumping cost	hour			
2	**Labour**			**206**	**836**
	Land preparation	wd	4.00	8	32
	Seedling preparation	wd	4.00	10	40
	Planting	wd	4.00	45	180
	Fertilizer application	wd	4.00	9	36
	FYM application	wd	4.00	6	24
	Agrochemical application	wd	5.00	8	40
	Weeding	wd	4.00	40	160
	Harvesting	wd	4.00	70	280
	Threshing	wd	4.00		
	Transport to farm gate	wd	4.00		
	Drying	wd	4.00		
	Broadcat rice	wd	4.00		
	Irrigation applications	wd	4.00		
	Irrigation canal maintenance	wd	5.00	4	20
	Protection from birds/rats	wd	4.00	6	24
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**709**

Attachment 2-9: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Sa Ang
Commune:	Koh Khel (Zone 1)
Crop:	Red Corn
Irrigation:	✓
Rainfed:	
Irrigation+Rainfed:	
Planting from month:	January
Harvesting at month:	March

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**1,375**
	Main Product	Kg	0.25	5,500	1,375
	By products	Ox-cart			
II	**INPUTS**				**895**
1	**Physical inputs**				**567**
i	**Seed/Planting materials**	Cans	4.00	10	**40**
ii	**Fertilizers**			150	**125**
	Urea	Kg	0.8	100	80
	DAP	Kg	0.90	50	45
	NPK(20:20:15)	Kg			
	NPK(14:14:14)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**76**
	Fungicides	Bottle			
	Pesticides	Bottle	3.00	7	21
	Herbicides	Bottle	3.00	5	15
	FYM	kg	0.02	2,000	40
iv	**Mechanization**				**116**
	Ploughing	Round	38.00	1	38
	Rotavating	Round	38.00	1	38
	Discing	Round	20.00	1	20
	Harvesting	Tone			
	Transport to farm gate	Bag	0.25	80	20
v	**Cow/Buffalo**				**25**
	Ploughing	Round			
	Rotavating	Ha			
	Levelling+ build drain	Ha	25.00	1	25
vi	**Other inputs**				**185**
	Bags &packaging	Bag	0.25	80	20
	Tools & equipment	lumpsum			40
	Pumping irrigation cost	Time	2.50	50	125
	Drainage pumping cost	hour			
2	**Labour**			**87**	**328**
	Land preparation	wd	4.00	8	32
	Seedling preparation	wd			
	Planting	wd	3.00	20	60
	Fertilizer application	wd	4.00	3	12
	FYM application	wd	4.00	2	8
	Agrochemical application	wd	4.00	2	8
	Weeding	wd	4.00	6	24
	Harvesting	wd	4.00	40	160
	Threshing	wd	4.00		
	Transport to farm gate	wd	4.00		
	Drying	wd	4.00		
	Broadcat rice	wd	4.00		
	Irrigation applications	wd	4.00		
	Irrigation canal maintenance	wd	4.00		
	Protection from birds/rats	wd	4.00	6	24
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**480**

Attachment 2-10: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Sa Ang
Commune:	Koh Khel (Zone 1)
Crop:	White Corn (0nly corn seed)
Irrigation:	✓
Rainfed:	
Irrigation+Rainfed:	
Planting from month:	January
Harvesting at month:	April

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**1,100**
	Main Product	Kg	0.50	2,200	1,100
	By products	Ox-cart			
II	**INPUTS**				**661**
1	**Physical inputs**				**380**
i	**Seed/Planting materials**	Kg	1.25	30	**38**
ii	**Fertilizers**			100	**80**
	Urea	Kg	0.8	100	80
	DAP	Kg			
	NPK(20:20:15)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**60**
	Fungicides	Bottle			
	Pesticides	Bottle	5.00	4	20
	Herbicides	Bottle	5.00	2	10
	FYM	kg	0.02	1,500	30
iv	**Mechanization**				**15**
	Ploughing	Round			
	Rotavating	Round			
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Bag	0.30	50	15
v	**Cow/Buffalo**				**80**
	Ploughing	Ha	30.00	1	30
	Rotavating	Ha	30.00	1	30
	Levelling+ build drain	Ha	20.00	1	20
vi	**Other inputs**				**108**
	Bags &packaging	Bag	0.15	50	8
	Tools & equipment	lumpsum			25
	Pumping irrigation cost	Time	2.50	30	75
	Drainage pumping cost	hour			
2	**Labour**			**74**	**281**
	Land preparation	wd	4.00	8	32
	Seedling preparation	wd	4.00		
	Planting	wd	4.00	15	60
	Fertilizer application	wd	4.00	2	8
	FYM application	wd	4.00	2	8
	Agrochemical application	wd	4.00	2	8
	Weeding	wd	4.00	5	20
	Harvesting	wd	4.00	20	80
	Threshing(pick grain carefully)	wd	3.00	15	45
	Transport to farm gate	wd	4.00		
	Drying	wd	4.00	2	8
	Broadcat rice	wd	4.00		
	Irrigation applications	wd	4.00		
	Irrigation canal maintenance	wd	4.00		
	Protection from birds/rats	wd	4.00	3	12
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**439**

Attachment 2-11: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Sa Ang
Commune:	Koh Prek Ambil(Zone 1)
Crop:	White Corn(Corn Seed and Corncob)
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	April
Harvesting at month:	July

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**900**
	Main Product	Kg	0.15	6,000	900
	By products	Ox-cart			
II	**INPUTS**				**710**
1	**Physical inputs**				**497**
i	**Seed/Planting materials**	Kg	1.30	33	**43**
ii	**Fertilizers**			150	**140**
	Urea	Kg	0.8	100	80
	DAP	Kg	1.20	50	60
	NPK(20:20:15)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**72**
	Fungicides	Bottle	2.00	6	12
	Pesticides	Bottle	2.00	10	20
	Herbicides	Bottle	2.00	10	20
	FYM	kg	0.02	1,000	20
iv	**Mechanization**				**120**
	Ploughing	Round	30.00	1	30
	Rotavating	Round	30.00	1	30
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Tone	10.00	6	60
v	**Cow/Buffalo**				**20**
	Ploughing	Ha			
	Rotavating	Ha			
	Levelling+ build drain	Ha	20.00	1	20
vi	**Other inputs**				**102**
	Bags &packaging	Bag	0.15	80	12
	Tools & equipment	lumpsum			30
	Pumping irrigation cost	Time	4.00	15	60
	Drainage pumping cost	hour			
2	**Labour**			**58**	**213**
	Land preparation	wd	3.00	9	27
	Seedling preparation	wd	3.00		
	Planting	wd	3.00	14	42
	Fertilizer application	wd	4.00	3	12
	FYM application	wd	4.00	1	4
	Agrochemical application	wd	5.00	2	10
	Weeding	wd	4.00	4	16
	Harvesting	wd	4.00	18	72
	Threshing	wd			
	Transport to farm gate	wd			
	Drying	wd	4.00	2	8
	Broadcat rice	wd			
	Irrigation applications	wd	5.00	2	10
	Irrigation canal maintenance	wd			
	Protection from birds/rats	wd	4.00	3	12
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**190**

Attachment 2-12: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Levea Aem
Commune:	Thmor Kaul (Zone ….)
Crop:	Green Bean
Irrigation:	
Rainfed:	✓
Irrigation+Rainfed:	
Planting from month:	December-January
Harvesting at month:	March-April

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**735**
	Main Product	Kg	0.70	1,050	735
	By products	Ox-cart			
II	**INPUTS**				**519**
1	**Physical inputs**				**262**
i	**Seed/Planting materials**	Kg	0.80	60	**48**
ii	**Fertilizers**			70	**53**
	Urea	Kg	0.7	50	35
	DAP	Kg	0.90	20	18
	NPK(20:20:15)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**58**
	Fungicides	Bottle	4.00	2	8
	Pesticides	Bottle	5.00	6	30
	Herbicides	Bottle			
	FYM	kg	0.02	1,000	20
iv	**Mechanization**				**9**
	Ploughing	Round			
	Rotavating	Round			
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Bag	0.30	30	9
v	**Cow/Buffalo**				**65**
	Ploughing	Ha	25.00	1	25
	Rotavating	Ha	25.00	1	25
	Levelling+ build drain	Ha	15.00	1	15
vi	**Other inputs**				**29**
	Bags &packaging	Bag	0.12	30	4
	Tools & equipment	lumpsum			25
	Pumping irrigation cost	Time			
	Drainage pumping cost	hour			
2	**Labour**			**64**	**257**
	Land preparation	wd	4.00	4	16
	Seedling preparation	wd	4.00		
	Planting	wd	4.00	14	56
	Fertilizer application	wd	4.00	3	12
	FYM application	wd	4.00	2	8
	Agrochemical application	wd	5.00	1	5
	Weeding	wd	4.00	4	16
	Harvesting	wd	4.00	20	80
	Threshing(To pick carefully)	wd	4.00	8	32
	Transport to farm gate	wd	4.00		
	Drying	wd	4.00	4	16
	Broadcat rice	wd			
	Irrigation applications	wd			
	Irrigation canal maintenance	wd			
	Protection from birds/rats	wd	4.00	4	16
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**216**

Attachment 2-13: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	S' ang
Commune:	Preak Ambil (Zone 1)
Crop:	Leek
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	May
Harvesting at month:	August

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**3,360**
	Main Product	Kg	0.12	28,000	3,360
	By products	Ox-cart			
II	**INPUTS**				**2,009**
1	**Physical inputs**				**1,283**
i	**Seed/Planting materials**	Kg	20.00	3.0	**60**
ii	**Fertilizers**			350	**425**
	Urea	Kg	0.70	200	140
	DAP	Kg	0.90	150	135
	NPK(20:20:15)	Kg			
	Leaves fertilizers	Time	30.0	5	150
	Lime	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**158**
	Fungicides	Bottle	4.00	2	8
	Pesticides	Bottle	5.00	10	50
	Herbicides	Bottle			
	FYM	kg	0.02	5,000	100
iv	**Mechanization**				**115**
	Ploughing	Round	50.00	1	50
	Rotavating	Round	50.00	1	50
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Bag	0.30	50	15
v	**Cow/Buffalo**				**30**
	Ploughing	Ha			
	Rotavating	Ha			
	Levelling+ build drain	Ha	30.00	1	30
vi	**Other inputs**				**495**
	Bags &packaging	Bag	0.15	300	45
	Tools & equipment	lumpsum			50
	Pumping irrigation cost	Time	5.00	80	400
	Drainage pumping cost	hour			
2	**Labour**			**180**	**726**
	Land preparation	wd	4.00	10	40
	Seedling preparation	wd	4.00	10	40
	Planting	wd	4.00	40	160
	Fertilizer application	wd	4.00	8	32
	FYM application	wd	4.00	8	32
	Agrochemical application	wd	4.00	4	16
	Weeding	wd	4.00	20	80
	Harvesting	wd	4.00	60	240
	Threshing	wd	4.00		
	Transport to farm gate	wd	4.00		
	Drying(cleaning)	wd	4.00	6	24
	Broadcat rice	wd	4.00		
	Irrigation applications	wd	4.00		
	Irrigation canal maintenance	wd	5.00	6	30
	Protection from birds/rats	wd	4.00	8	32
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**1,351**

Attachment 2-14: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Koh Thom
Commune:	Prek Thmei (Zone 1)
Crop:	Kinky Cabbage
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	Mid September
Harvesting at month:	November

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**1,900**
	Main Product	Kg	0.20	9,500	1,900
	By products	Ox-cart			
II	**INPUTS**				**1,186**
1	**Physical inputs**				**644**
i	**Seed/Planting materials**	Kg	30.00	0.50	**15**
ii	**Fertilizers**			250	**195**
	Urea	Kg	0.7	150	105
	DAP	Kg	0.90	100	90
	NPK(16:16:8)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**134**
	Fungicides	Bottle	4.00	4	16
	Pesticides	Bottle	3.00	6	18
	Herbicides	Bottle			
	FYM	kg	0.02	5,000	100
iv	**Mechanization**				**80**
	Ploughing	Round	40.00	1	40
	Rotavating	Round	40.00	1	40
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Tone			
v	**Cow/Buffalo**				**20**
	Ploughing	Ha			
	Rotavating	Ha			
	Levelling+ build drain	Ha	20.00	1	20
vi	**Other inputs**				**200**
	Bags &packaging	Bag			
	Tools & equipment	lumpsum			40
	Pumping irrigation cost	Time	2.00	80	160
	Drainage pumping cost	hour			
2	**Labour**			**124**	**542**
	Land preparation	wd	4.00	8	32
	Seedling preparation	wd	4.00	3	12
	Planting	wd	4.00	30	120
	Fertilizer application	wd	4.00	8	32
	FYM application	wd	4.00	4	16
	Agrochemical application	wd	5.00	8	40
	Weeding	wd	4.00	15	60
	Harvesting	wd	4.00	30	120
	Threshing	wd			
	Transport to farm gate	wd			
	Drying(Cleaning)	wd	5.00	8	40
	Broadcat rice	wd			
	Irrigation applications	wd			
	Irrigation canal maintenance	wd	10.00	4	40
	Protection from birds/rats	wd	5.00	6	30
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**714**

Attachment 2-15: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Koh Thom
Commune:	Prek Ambil(Zone 1)
Crop:	Small Cucumber
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	October
Harvesting at month:	December

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**3,200**
	Main Product	Kg	0.20	16,000	3,200
	By products	Ox-cart			
II	**INPUTS**				**2,167**
1	**Physical inputs**				**1,081**
i	**Seed/Planting materials**	Package	3.00	13.0	**39**
ii	**Fertilizers**			465	**357**
	Urea	Kg	0.60	170	102
	DAP	Kg	0.90	75	68
	NPK(15:1515)	Kg	0.90	70	63
	NPK(16:20:0)	Kg	0.40	70	60
	KCL	Kg	0.65	80	52
	Leaves fertilizers	Time			
	Lime	Kg	0.15	80	12
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**195**
	Fungicides	Bottle	5.00	5	25
	Pesticides	Bottle	5.00	10	50
	Herbicides	Bottle			
	FYM	kg	0.02	6,000	120
iv	**Mechanization**				**190**
	Ploughing	Round	40.00	1	40
	Rotavating	Round	40.00	1	40
	Discing	Round	30.00	1	30
	Harvesting	Tone			
	Transport to farm gate	Tone	5.00	16.0	80
v	**Cow/Buffalo**				**30**
	Ploughing	Ha			
	Rotavating	Ha			
	Levelling+ build drain	Ha	30.00	1	30
vi	**Other inputs**				**270**
	Bags &packaging	Bag	0.50	100	50
	Tools & equipment	lumpsum			70
	Pumping irrigation cost	Time	1.50	100	150
	Drainage pumping cost	hour			
2	**Labour**			**269**	**1,086**
	Land preparation	wd	4.00	15	60
	Seedling preparation	wd	4.00	20	80
	Planting	wd	4.00	60	240
	Fertilizer application	wd	4.00	16	64
	FYM application	wd	4.00	12	48
	Agrochemical application	wd	5.00	2	10
	Weeding	wd	4.00	36	144
	Harvesting	wd	4.00	70	280
	Threshing(keeping)	wd	4.00	6	24
	Transport to farm gate	wd	4.00		
	Drying(cleaning)	wd	4.00	12	48
	Broadcat rice	wd			
	Irrigation applications	wd			
	Irrigation canal maintenance	wd	4.00	12	48
	Protection from birds/rats	wd	5.00	8	40
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**1,034**

Attachment 2-16: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	S'ang
Commune:	Prek Ambil (Zone 1)
Crop:	Sweet Banana
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	November
Harvesting at month:	May-June

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**5,250**
	Main Product	Bunch	1.25	4,200	5,250
	By products	Kg			
II	**INPUTS**				**3,877**
1	**Physical inputs**				**2,270**
i	**Seed/Planting materials**	Trees	0.30	2600	**780**
ii	**Fertilizers**			900	**670**
	Urea	Kg	0.70	600	420
	DAP	Kg	0.80	200	160
	NPK(15:1515)	Kg	0.90	100	90
	Carbonized rice hull	Tone			
iii	**Agrochemical**				
	Fungicides	Bottle			
	Pesticides	Bottle			
	Herbicides	Bottle			
	FYM	kg			
iv	**Mechanization**				**180**
	Ploughing	Round	50.00	1	50
	Rotavating	Round	50.00	1	50
	Discing	Round	50.00	1	50
	Harvesting	Tone			
	Transport to farm gate	Tone	5.00	6.0	30
v	**Cow/Buffalo**				**30**
	Ploughing	Ha			
	Rotavating	Ha			
	Levelling	Ha	30.00	1	30
vi	**Other inputs**				**610**
	Bags &packaging	Bag	0.50	100	50
	Tools & equipment	lumpsum			200
	Pumping irrigation cost	Time	2.00	180	360
	Drainage pumping cost	hour			
2	**Labour**			**369**	**1,607**
	Land preparation	4 wd	5.00	20	100
	Seedling preparation(dig a whole)	4 wd	4.00	40	160
	Planting	4 wd	4.00	80	320
	Fertilizer application	2 wd	4.00	8	32
	FYM application	wd	4.00		
	Agrochemical application	wd	4.00		
	Weeding	5 wd	4.00	50	200
	Harvesting	5 wd	4.00	100	400
	Threshing(keeping)	4 wd	4.00	40	160
	Transport to farm gate	wd			
	Drying	wd			
	Broadcat rice	wd			
	Irrigation applications	wd			
	Irrigation canal maintenance	4 wd	10.00	16	160
	Protection from birds/rats	3 wd	5.00	15	75
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**1,373**

Attachment 2-17: Annual crop-budgets in Zone 1

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Sa Ang
Commune:	Prek Ambil (Zone 1)
Crop:	Papaya
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	November
Harvesting at month:	May

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**2,310**
	Main Product	Kg	0.12	19,250	2,310
	By products	Kg			
II	**INPUTS**				**1,426**
1	**Physical inputs**				**706**
i	**Seed/Planting materials**	Trees	0.12	550	**66**
ii	**Fertilizers**			250	**195**
	Urea	Kg	0.70	150	105
	DAP	Kg	0.90	100	90
	NPK(15:1515)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**90**
	Fungicides	Bottle	5.00	4	20
	Pesticides	Bottle	5.00	4	20
	Herbicides	Bottle			
	FYM	kg	0.025	2,000	50
iv	**Mechanization**				**150**
	Ploughing	Round	50.00	1	50
	Rotavating	Round	50.00	1	50
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Tone	10.00	5	50
v	**Cow/Buffalo**				**30**
	Ploughing	Ha			
	Rotavating	Ha			
	Levelling	Ha	30.00	1	30
vi	**Other inputs**				**175**
	Bags &packaging	Bag	0.50	50	25
	Tools & equipment	lumpsum			100
	Pumping irrigation cost	Time	5.00	10	50
	Drainage pumping cost	hour			
2	**Labour**			**175**	**720**
	Land preparation	wd	4.00	8	32
	Seedling preparation(dig a whole)	wd	4.00	20	80
	Planting	wd	4.00	30	120
	Fertilizer application	wd	4.00	4	16
	FYM application	wd	4.00	2	8
	Agrochemical application	wd	4.00	2	8
	Weeding	wd	4.00	9	36
	Harvesting	wd	4.00	40	160
	Threshing(keeping)	wd	4.00	40	160
	Transport to farm gate	wd			
	Drying	wd			
	Broadcat rice	wd			
	Irrigation applications	wd			
	Irrigation canal maintenance	wd	5.00	8	40
	Protection from birds/rats	wd	5.00	12	60
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**884**

Attachment 3-1: Annual crop-budget in Zone 2

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Borei Chulsar
Commune:	Borei Chulsar (Zone 2)
Crop:	Early Rice (Dry)
Irrigation	✓
Rainfed	
Irrigation+Rainfed:	
Planting from month:	Nov-Dec
Harvesting at month:	Feb-Mar

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**1,300**
	Main Product	Kg	0.25	5,200	1,300
	By products	Ox-cart			
II	**INPUTS**				**899**
1	**Physical inputs**				**722**
i	**Seed/Planting materials**	Kg/seedling	0.3	170	**51**
ii	**Fertilizers**			350	**269**
	Urea	Kg	0.5	150	75
	DAP	Kg	0.85	100	85
	NPK(16:16:8)	Kg	0.75	100	85
	Leaves fertilizers	Time	8.00	3	24
	Lime	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**90**
	Fungicides	Bottle	10.00	3	30
	Pesticides	Bottle	5.00	7	35
	Herbicides	Bottle	5.00	3	15
	FYM	kg	0.01	1,000	10
iv	**Mechanization**				**102**
	Ploughing	Round	20.00	1	20
	Rotavating	Round	20.00	1	20
	Discing	Round			
	Threshing	Tone	8.00	5.2	42
	Transport to farm gate	Bag	0.2	100	20
v	**Cow/Buffalo**				**15**
	Ploughing	Round			
	Rotavating	Ha			
	Levelling	Ha	15.00	1	15
vi	**Other inputs**				**195**
	Bags &packaging	Bag	0.25	110	28
	Tools & equipment	lumpsum			30
	Pumping irrigation cost	Lite	1.25	100	125
	Drainage pumping cost	hour	1.25	10	13
2	**Labour**			**58**	**178**
	Land preparation	wd			
	Seedling preparation	wd			
	Transplanting	wd	2.50	15	38
	Fertilizer application	wd	5.00	3	15
	FYM application	wd			
	Agrochemical application	wd	4.00	2	8
	Weeding	wd	4.00	6	24
	Harvesting	wd	2.50	20	50
	Threshing	wd			
	Transport to farm gate	wd			
	Drying	wd	2.50	2	5
	Broadcat rice	wd			
	Irrigation applications	wd			
	Irrigation canal maintenance	wd	5.00	4	20
	Protection from birds/rats	wd	3.00	6	18
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**401**

Attachment 3-2: Annual crop-budget in Zone 2

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Daun Keo
Commune:	Barai (Zone 2)
Crop:	Early Rice (Wet)
Irrigation	
Rainfed	
Irrigation+Rainfed:	✓
Planting from month:	April
Harvesting at month:	August

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**580**
	Main Product	Kg	0.20	2,900	580
	By products	track			
II	**INPUTS**				**372**
1	**Physical inputs**				**214**
i	**Seed/Planting materials**	Kg/seedling	0.25	70	**18**
ii	**Fertilizers**			110	**44**
	Urea	Kg	0.37	70	26
	DAP	Kg	0.45	40	18
	NPK(16:16:8)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**41**
	Fungicides	Bottle			
	Pesticides	Bottle	1.25	1	1
	Herbicides	Lite			
	FYM	kg	0.02	2,000	40
iv	**Mechanization**				**15**
	Ploughing	Round			
	Rotavating	Round			
	Discing	Round			
	Threshing	Tone			
	Transport to farm gate	Bag	0.25	60	15
v	**Cow/Buffalo**				**60**
	Ploughing	Ha	20.00	1	20
	Rotavating	Ha	20.00	1	20
	Levelling	Ha	20.00	1	20
vi	**Other inputs**				**37**
	Bags &packaging	Bag	0.15	30	5
	Tools & equipment	lumpsum			20
	Pumping irrigation cost	Time	6.00	2	12
	Drainage pumping cost	hour			
2	**Labour**			**65**	**158**
	Land preparation	wd	2.50	3	8
	Seedling preparation	wd	2.50	2	5
	Transplanting	wd	2.50	10	25
	Fertilizer application	wd	2.50	2	5
	FYM application	wd	2.50	2	5
	Agrochemical application	wd	2.50	2	5
	Weeding	wd	2.50	2	5
	Harvesting	wd	2.50	20	50
	Threshing	wd	2.50	10	25
	Transport to farm gate	wd	2.50		
	Drying	wd	2.00	5	10
	Broadcat rice	wd	2.00	5	10
	Irrigation applications	wd	2.50		
	Irrigation canal maintenance	wd	2.50		
	Protection from birds/rats	wd	2.50	2	5
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**208**

Attachment 3-3: Annual crop-budget in Zone 2

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Angkor Borei
Commune:	Angkor Borei (Zone 2)
Crop:	Medium Rice(Wet)
Irrigation	
Rainfed	✓
Irrigation+Rainfed	
Planting from month:	May-June
Harvesting at month:	Nov-Dec

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**560**
	Main Product	Kg	0.20	2,800	560
	By products	track			
II	**INPUTS**				**453**
1	**Physical inputs**				**282**
i	**Seed/Planting materials**	Kg/seedling	0.20	80	**16**
ii	**Fertilizers**			150	**74**
	Urea	Kg	0.37	50	19
	DAP	Kg	0.60	50	30
	NPK(16:16:8)	Kg	0.5	50	25
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**33**
	Fungicides	Bottle			
	Pesticides	Bottle	1.00	2	2
	Herbicides	Lite	0.60	1	1
	FYM	kg	0.02	1,500	30
iv	**Mechanization**				**100**
	Ploughing	Round	30.00	1	30
	Rotavating	Round	30.00	1	30
	Discing	Round	30.00		
	Threshing	Tone	10.00	2.5	25
	Transport to farm gate	Bag	0.25	60	15
v	**Cow/Buffalo**				
	Ploughing	Ha			
	Rotavating	Ha			
	Levelling	Ha			
vi	**Other inputs**				**60**
	Bags &packaging	Bag	0.15	30	5
	Tools & equipment	lumpsum			15
	Pumping irrigation cost	Time	4.00	10	40
	Drainage pumping cost	hour			
2	**Labour**			**61**	**171**
	Land preparation	wd	5.00	2	10
	Seedling preparation	wd	5.00	2	10
	Transplanting	wd	3.00	15	45
	Fertilizer application	wd	3.00	2	6
	FYM application	wd	3.00	2	6
	Agrochemical application	wd	2.50	2	5
	Weeding	wd	2.50	4	10
	Harvesting	wd	2.50	20	50
	Threshing	wd	2.50		
	Transport to farm gate	wd	2.50		
	Drying	wd	2.00	5	10
	Broadcat rice	wd	3.00	5	15
	Irrigation applications	wd	2.00		
	Irrigation canal maintenance	wd	2.00		
	Protection from birds/rats	wd	2.00	2	4
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**107**

Attachment 3-4: Annual crop-budget in Zone 2

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Daun Keo
Commune:	Barai (Zone 2)
Crop:	Late Rice(Wet)
Irrigation:	
Rainfed:	
Irrigation+Rainfed	✓
Planting from month:	May-June
Harvesting at month:	Jan-Feb

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**620**
	Main Product	Kg	0.20	3,100	620
	By products	track			
II	**INPUTS**				**508**
1	**Physical inputs**				**220**
i	**Seed/Planting materials**	Kg/seedling	0.20	130	**26**
ii	**Fertilizers**			150	**67**
	Urea	Kg	0.37	100	37
	DAP	Kg	0.60	50	30
	NPK(16:16:8)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**41**
	Fungicides	Bottle			
	Pesticides	Bottle	1.25	1	1
	Herbicides	Lite			
	FYM	kg	0.02	2,000	40
iv	**Mechanization**				**15**
	Ploughing	Round			
	Rotavating	Round			
	Discing	Round			
	Threshing	Tone			
	Transport to farm gate	Bag	0.25	60	15
v	**Cow/Buffalo**				**50**
	Ploughing	Ha	15.00	1	15
	Rotavating	Ha	15.00	1	20
	Levelling	Ha	15.00	1	15
vi	**Other inputs**				**21**
	Bags &packaging	Bag	0.15	40	6
	Tools & equipment	lumpsum			15
	Pumping irrigation cost	Time			
	Drainage pumping cost	hour			
2	**Labour**			**109**	**288**
	Land preparation	wd	5.00	2	10
	Seedling preparation	wd	5.00	2	10
	Transplanting	wd	3.00	25	75
	Fertilizer application	wd	3.00	2	6
	FYM application	wd	3.00	2	6
	Agrochemical application	wd	3.00	1	3
	Weeding	wd	2.50	8	20
	Harvesting	wd	2.50	25	63
	Threshing	wd	2.00	15	30
	Transport to farm gate	wd	2.50	15	38
	Drying	wd	2.50	5	13
	Broadcat rice	wd	2.00	5	10
	Irrigation applications	wd	2.50		
	Irrigation canal maintenance	wd	2.50		
	Protection from birds/rats	wd	2.50	2	5
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**112**

Attachment 3-5: Annual crop-budget in Zone 2

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Sa Ang
Commune:	Kraing Yoav (Zone 2)
Crop:	Chiness Cabbage
Irrigation:	
Rainfed:	
Irrigation+Rainfed	✓
Planting from month:	January
Harvesting at month:	February

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**2,700**
	Main Product	Kg	0.30	9,000	2,700
	By products	Ox-cart			
II	**INPUTS**				**1,849**
1	**Physical inputs**				**687**
i	**Seed/Planting materials**	Cans	4.00	22	**88**
ii	**Fertilizers**			250	**195**
	Urea	Kg	0.7	150	105
	DAP	Kg	0.90	100	90
	NPK(20:20:15)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**143**
	Fungicides	Bottle			
	Pesticides	Bottle	3.00	5	15
	Herbicides	Bottle	3.00	5	15
	FYM	kg	0.025	4,500	113
iv	**Mechanization**				**80**
	Ploughing	Round	40.00	1	40
	Rotavating	Round	40.00	1	40
	Discing	Round	40.00		
	Harvesting	Tone			
	Transport to farm gate	Bag			
v	**Cow/Buffalo**				**30**
	Ploughing	Round			
	Rotavating	Ha			
	Levelling+ build drain	Ha	30.00	1	30
vi	**Other inputs**				**151**
	Bags &packaging	Bag	0.20	130	26
	Tools & equipment	lumpsum			50
	Pumping irrigation cost	Time	1.50	50	75
	Drainage pumping cost	hour			
2	**Labour**			**278**	**1,162**
	Land preparation	wd	4.00	8	32
	Seedling preparation	wd	4.00	24	96
	Planting	wd	4.00	105	420
	Fertilizer application	wd	4.00	9	36
	FYM application	wd	4.00	6	24
	Agrochemical application	wd	5.00	8	40
	Weeding	wd	4.00	40	160
	Harvesting	wd	4.00	70	280
	Threshing	wd	4.00		
	Transport to farm gate	wd	4.00		
	Drying	wd	4.00		
	Broadcat rice	wd	4.00		
	Irrigation applications	wd	4.00		
	Irrigation canal maintenance	wd	25.00	2	50
	Protection from birds/rats	wd	4.00	6	24
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**852**

Attachment 3-6: Annual crop-budget in Zone 2

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	Sa Ang
Commune:	Kraing Yoav (Zone 2)
Crop:	White Corn(Seed&Cob)
Irrigation:	
Rainfed:	
Irrigation+Rainfed	✓
Planting from month:	April
Harvesting at month:	July

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**825**
	Main Product	Kg	0.15	5,500	825
	By products	Ox-cart			
II	**INPUTS**				**620**
1	**Physical inputs**				**430**
i	**Seed/Planting materials**	Kg	1.30	25	**33**
ii	**Fertilizers**			150	**140**
	Urea	Kg	0.8	100	80
	DAP	Kg	1.20	50	60
	NPK(20:20:15)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**53**
	Fungicides	Bottle	2.00	4	8
	Pesticides	Bottle	3.00	5	15
	Herbicides	Bottle	2.00	5	10
	FYM	kg	0.02	1,000	20
iv	**Mechanization**				**120**
	Ploughing	Round	30.00	1	30
	Rotavating	Round	30.00	1	30
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Tone	10.00	6.0	60
v	**Cow/Buffalo**				**20**
	Ploughing	Ha			
	Rotavating	Ha			
	Levelling+ build drain	Ha	20.00	1	20
vi	**Other inputs**				**65**
	Bags &packaging	Bag	0.15	80	12
	Tools & equipment	lumpsum			30
	Pumping irrigation cost	Time	1.50	15	23
	Drainage pumping cost	hour			
2	**Labour**			**51**	**190**
	Land preparation	wd	3.00	4	12
	Seedling preparation	wd	3.00		
	Planting	wd	3.00	14	42
	Fertilizer application	wd	4.00	3	12
	FYM application	wd	4.00	2	8
	Agrochemical application	wd	5.00	2	10
	Weeding	wd	4.00	4	16
	Harvesting	wd	4.00	15	60
	Threshing	wd	4.00		
	Transport to farm gate	wd	4.00		
	Drying	wd	4.00	2	8
	Broadcat rice	wd	4.00		
	Irrigation applications	wd	5.00	2	10
	Irrigation canal maintenance	wd	5.00		
	Protection from birds/rats	wd	4.00	3	12
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**205**

Attachment 3-7: Annual crop-budget in Zone 2

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Angor Borei
Commune:	Angor Borei (Zone 2)
Crop:	Soybean
Irrigation:	
Rainfed	✓
Irrigation+Rainfed:	
Planting from month:	Apr-May
Harvesting at month:	Jun-Jul

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**570**
	Main Product	Kg	0.80	712	570
	By products	Ox-cart			
II	**INPUTS**				**301**
1	**Physical inputs**				**149**
i	**Seed/Planting materials**	Kg	0.80	30	**24**
ii	**Fertilizers**			25	**13**
	Urea	Kg	0.5	25	13
	DAP	Kg			
	NPK(20:20:15)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**50**
	Fungicides	Bottle			
	Pesticides	Bottle	5.00	2	10
	Herbicides	Bottle			
	FYM	kg	0.02	2,000	40
iv	**Mechanization**				**8**
	Ploughing	Round			
	Rotavating	Round			
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Bag	0.20	40	8
v	**Cow/Buffalo**				**36**
	Ploughing	Ha	12.00	1	12
	Rotavating	Ha	12.00	1	12
	Levelling+ build drain	Ha	12.00	1	12
vi	**Other inputs**				**19**
	Bags &packaging	Bag	0.12	30	4
	Tools & equipment	lumpsum			15
	Pumping irrigation cost	Time			
	Drainage pumping cost	hour			
2	**Labour**			**46**	**152**
	Land preparation	wd	3.00	2	6
	Seedling preparation	wd	3.00	2	6
	Planting	wd	3.00	8	24
	Fertilizer application	wd	3.00	2	6
	FYM application	wd	5.00	2	10
	Agrochemical application	wd	5.00	1	5
	Weeding	wd	3.00	6	18
	Harvesting	wd	3.00	15	45
	Threshing(To pick carefully)	wd	4.00	4	16
	Transport to farm gate	wd	4.00		
	Drying	wd	3.00		
	Broadcat rice	wd	3.00		
	Irrigation applications	wd	4.00		
	Irrigation canal maintenance	wd	4.00		
	Protection from birds/rats	wd	4.00	4	16
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**269**

Attachment 3-8: Annual crop-budget in Zone 2

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Prey Kabas
Commune:	Prey Lovea (Zone 2)
Crop:	String Beans
Irrigation:	
Rainfed:	
Irrigation+Rainfed	✓
Planting from month:	Mid Oct
Harvesting at month:	December

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**3,000**
	Main Product	Kg	0.30	10,000	3,000
	By products	Ox-cart			
II	**INPUTS**				**2,402**
1	**Physical inputs**				**1,430**
i	**Seed/Planting materials**	Kg	15.00	8	**120**
ii	**Fertilizers**			400	**420**
	Urea	Kg	0.6	200	120
	DAP	Kg	0.90	200	180
	NPK(20:20:15)	Kg			
	Leaves fertilizers	Time	20	6	120
	Lime	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**260**
	Fungicides	Bottle	4.00	5	20
	Pesticides	Bottle	4.00	10	40
	Herbicides	Bottle			
	FYM	kg	0.02	10,000	200
iv	**Mechanization**				
	Ploughing	Round			
	Rotavating	Round			
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Bag			
v	**Cow/Buffalo**				**130**
	Ploughing	Ha	45.00	1	45
	Rotavating	Ha	45.00	1	45
	Levelling+ build drain	Ha	40.00	1	40
vi	**Other inputs**				**500**
	Bags &packaging	Bag			
	Tools & equipment	lumpsum			100
	Pumping irrigation cost	Time	8.00	50	400
	Drainage pumping cost	hour			
2	**Labour**			**228**	**972**
	Land preparation	wd	4.00	12	48
	Seedling preparation	wd	4.00	4	16
	Planting	wd	4.00	36	144
	Fertilizer application	wd	5.00	10	50
	FYM application	wd	5.00	10	50
	Agrochemical application	wd	5.00	8	40
	Weeding	wd	4.00	16	64
	Harvesting	wd	4.00	120	480
	Threshing	wd	4.00		
	Transport to farm gate	wd	4.00		
	Drying	wd	4.00		
	Broadcat rice	wd	4.00		
	Irrigation applications	wd	4.00		
	Irrigation canal maintenance	wd	10.00	4	40
	Protection from birds/rats	wd	5.00	8	40
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**598**

Attachment 3-9: Annual crop-budget in Zone 2

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Daun Keo
Commune:	Barai (Zone 2)
Crop:	Kinky Cabbage
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	Mid October
Harvesting at month:	Early December

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**2,460**
	Main Product	Kg	0.30	8,200	2,460
	By products	Ox-cart			
II	**INPUTS**				**1,434**
1	**Physical inputs**				**750**
i	**Seed/Planting materials**	Kg	30.00	0.50	**15**
ii	**Fertilizers**			250	**195**
	Urea	Kg	0.7	150	105
	DAP	Kg	0.90	100	90
	NPK(16:16:8)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**190**
	Fungicides	Bottle	5.00	4	20
	Pesticides	Bottle	5.00	10	50
	Herbicides	Bottle			
	FYM	kg	0.02	6,000	120
iv	**Mechanization**				**80**
	Ploughing	Round	40.00	1	40
	Rotavating	Round	40.00	1	40
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Tone			
v	**Cow/Buffalo**				**20**
	Ploughing	Ha			
	Rotavating	Ha			
	Levelling+ build drain	Ha	20.00	1	20
vi	**Other inputs**				**250**
	Bags &packaging	Bag			
	Tools & equipment	lumpsum			50
	Pumping irrigation cost	Time	2.00	100	200
	Drainage pumping cost	hour			
2	**Labour**			**163**	**684**
	Land preparation	wd	4.00	16	64
	Seedling preparation	wd	4.00	3	12
	Planting	wd	4.00	45	180
	Fertilizer application	wd	4.00	8	32
	FYM application	wd	4.00	4	16
	Agrochemical application	wd	5.00	8	40
	Weeding	wd	4.00	15	60
	Harvesting	wd	4.00	50	200
	Threshing	wd	4.00		
	Transport to farm gate	wd	4.00		
	Drying(Cleaning)	wd	5.00	8	40
	Broadcat rice	wd	4.00		
	Irrigation applications	wd	4.00		
	Irrigation canal maintenance	wd	10.00	2	20
	Protection from birds/rats	wd	5.00	4	20
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**1,026**

Attachment 3-10: Annual crop-budget in Zone 2

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Kandal
District:	S'ang
Commune:	Sa Ang Phnom (Zone 2)
Crop:	Sweet Banana
Irrigation:	
Rainfed:	
Irrigation+Rainfed	✓
Planting from month:	November
Harvesting at month:	May

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**4,500**
	Main Product	Bunch	1.25	3,600	4,500
	By products	Kg			
II	**INPUTS**				**2,965**
1	**Physical inputs**				**2,060**
i	**Seed/Planting materials**	Trees	0.25	2300	**575**
ii	**Fertilizers**			1,100	**830**
	Urea	Kg	0.70	700	490
	DAP	Kg	0.80	200	160
	NPK(15:1515)	Kg	0.90	200	180
	Carbonized rice hull	Tone			
iii	**Agrochemical**				
	Fungicides	Bottle			
	Pesticides	Bottle			
	Herbicides	Bottle			
	FYM	kg			
iv	**Mechanization**				**150**
	Ploughing	Round	50.00	1	50
	Rotavating	Round	50.00	1	50
	Discing	Round	25.00	1	25
	Harvesting	Tone			
	Transport to farm gate	Tone	5.00	5.0	25
v	**Cow/Buffalo**				**30**
	Ploughing	Ha			
	Rotavating	Ha			
	Levelling	Ha	30.00	1	30
vi	**Other inputs**				**475**
	Bags &packaging	Bag	0.50	100	50
	Tools & equipment	lumpsum			200
	Pumping irrigation cost	Time	1.50	150	225
	Drainage pumping cost	hour			
2	**Labour**			**196**	**905**
	Land preparation	wd	5.00	10	50
	Seedling preparation(dig a whole)	wd	4.00	20	80
	Planting	wd	4.00	30	120
	Fertilizer application	wd	4.00	15	60
	FYM application	wd	4.00		
	Agrochemical application	wd	4.00		
	Weeding	wd	4.00	20	80
	Harvesting	wd	4.00	50	200
	Threshing(keeping)	wd	4.00	20	80
	Transport to farm gate	wd	4.00		
	Drying	wd	4.00		
	Broadcat rice	wd	4.00		
	Irrigation applications	wd	4.00		
	Irrigation canal maintenance	wd	10.00	16	160
	Protection from birds/rats	wd	5.00	15	75
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**1,535**

Attachment 3-11: Annual crop-budget in Zone 2

CROP BUDGET per ha (Currency: US$)

Country: Cambodia
Province: Takeo
District: Angkor Borei
Commune: Angkor Borei (Zone 2)
Crop: Water Melon
Irrigation:
Rainfed ✓
Irrigation+Rainfed:
Planting from month: April
Harvesting at month: July

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**675**
	Main Product	Kg	0.25	2,700	675
	By products	Kg			
II	**INPUTS**				**359**
1	**Physical inputs**				**272**
i	**Seed/Planting materials**	Package	2.50	10	**25**
ii	**Fertilizers**			200	**94**
	Urea	Kg	0.37	50	19
	DAP	Kg			
	NPK(15:1515)	Kg			
	NPK(14:14:14)	Kg	0.50	150	75
iii	**Agrochemical**				**70**
	Fungicides	Bottle	5.50	1	6
	Pesticides	Bottle	7.00	2	14
	Herbicides	Bottle			
	FYM	kg	0.025	2,000	50
iv	**Mechanization**				**25**
	Ploughing	Round			
	Rotavating	Round			
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Tone	10.00	3	25
v	**Cow/Buffalo**				**44**
	Ploughing	Ha	12.00	1	12
	Rotavating	Ha	12.00	1	12
	Levelling	Ha	20.00	1	20
vi	**Other inputs**				**15**
	Bags &packaging	Bag			
	Tools & equipment	lumpsum			15
	Pumping irrigation cost	Time			
	Drainage pumping cost	hour			
2	**Labour**			**30**	**87**
	Land preparation	wd	3.00	2	6
	Seedling preparation(dig a whole)	wd	4.00		
	Planting	wd	3.00	5	15
	Fertilizer application	wd	3.00	2	6
	FYM application	wd	3.00	2	6
	Agrochemical application	wd	4.00	2	8
	Weeding	wd	3.00	2	6
	Harvesting	wd	2.50	10	25
	Threshing(keeping)	wd	3.00	3	9
	Transport to farm gate	wd	4.00		
	Drying	wd			
	Broadcat rice	wd			
	Irrigation applications	wd			
	Irrigation canal maintenance	wd			
	Protection from birds/rats	wd	3.00	2	6
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**316**

Attachment 3-12: Annual crop-budget in Zone 2

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Daun Keo
Commune:	Barai (Zone 2)
Crop:	Sugarcane
Irrigation	✓
Rainfed:	
Irrigation+Rainfed:	
Planting from month:	May
Harvesting at month:	Sept-Oct

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**2,000**
	Main Product	Kg	0.10	20,000	2,000
	By products	Kg			
II	**INPUTS**				**1,060**
1	**Physical inputs**				**685**
i	**Seed/Planting materials**	Bunch	0.025	5000	**125**
ii	**Fertilizers**			250	**93**
	Urea	Kg	0.37	250	93
	DAP	Kg			
	NPK(15:1515)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**152**
	Fungicides	Bottle			
	Pesticides	Bottle	2.00	1	2
	Herbicides	Bottle			
	FYM	kg	0.015	10,000	150
iv	**Mechanization**				**50**
	Ploughing	Round	25.00	1	25
	Rotavating	Round	25.00	1	25
	Discing	Round	25.00		
	Harvesting	Tone			
	Transport to farm gate	Tone			
v	**Cow/Buffalo**				**15**
	Ploughing	Ha	15.00		
	Rotavating	Ha	15.00		
	Levelling	Ha	15.00	1	15
vi	**Other inputs**				**250**
	Bags &packaging	Bag			
	Tools & equipment	lumpsum			50
	Pumping irrigation cost	Time	5.00	40	200
	Drainage pumping cost	hour			
2	**Labour**			**136**	**375**
	Land preparation	wd	4.00	6	24
	Seedling preparation(dig a whole)	wd	2.50	8	20
	Planting	wd	2.50	40	100
	Fertilizer application	wd	2.50	6	15
	FYM application	wd	2.50	10	25
	Agrochemical application	wd	2.50	1	3
	Weeding	wd	2.50	3	8
	Harvesting	wd	2.50	50	125
	Threshing(keeping)	wd	4.00	4	16
	Transport to farm gate	wd	4.00		
	Drying	wd			
	Broadcat rice	wd			
	Irrigation applications	wd			
	Irrigation canal maintenance	wd	5.00	4	20
	Protection from birds/rats	wd	5.00	4	20
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**941**

Attachment 4-1: Annual crop-budget in Zone 3

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Bati
Commune:	Cham Pei (Zone 3)
Crop:	Early Rice (Wet)
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	August
Harvesting at month:	November

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**775**
	Main Product	Kg	0.25	3,100	775
	By products	Kg			
II	**INPUTS**				**628**
1	**Physical inputs**				**498**
i	**Seed/Planting materials**	Kg/seedling	0.55	180	**99**
ii	**Fertilizers**			150	**160**
	Urea	Kg	0.7	100	70
	DAP	Kg	0.9	50	45
	NPK(16:16:8)	Kg			45
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**34**
	Fungicides	Bottle			
	Pesticides	Bottle	2.00	2	4
	Herbicides	Lite			
	FYM	kg	0.02	1,500	30
iv	**Mechanization**				**125**
	Ploughing	Round	40.00	1	40
	Rotavating	Round	40.00	1	40
	Discing	Round			
	Threshing	Tone	10.00	3	32
	Transport to farm gate	Bag	0.25	50	13
v	**Cow/Buffalo**				**25**
	Ploughing	Round			
	Rotavating	Ha			
	Levelling	Ha	25.00	1	25
vi	**Other inputs**				**55**
	Bags &packaging	Bag	0.12	65	8
	Tools & equipment	lumpsum			25
	Pumping irrigation cost	Time	1.50	15	23
	Drainage pumping cost	hour			
2	**Labour**			**57**	**130**
	Land preparation	wd	2.50	3	8
	Seedling preparation	wd	2.50	2	5
	Transplanting	wd	2.50	10	25
	Fertilizer application	wd	2.50	4	10
	FYM application	wd	2.50	2	5
	Agrochemical application	wd	2.50	1	3
	Weeding	wd	2.50	4	10
	Harvesting	wd	2.00	25	50
	Threshing	wd			
	Transport to farm gate	wd			
	Drying	wd			
	Broadcat rice	wd	2.50	4	10
	Irrigation applications	wd			
	Irrigation canal maintenance	wd			
	Protection from birds/rats	wd	2.50	2	5
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**147**

Attachment 4-2: Annual crop-budget in Zone 3

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Traing
Commune:	Angkanh (Zone 3)
Crop:	Medium Rice (Wet)
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	June
Harvesting at month:	November

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**739**
	Main Product	Kg	0.23	2,950	679
	By products	Ox-cart	15.00	4	60
II	**INPUTS**				**623**
1	**Physical inputs**				**418**
i	**Seed/Planting materials**	Kg/seedling	0.25	40	**10**
ii	**Fertilizers**			150	**95**
	Urea	Kg	0.6	50	30
	DAP	Kg	0.8	50	40
	NPK(16:16:8)	Kg			
	KCL	Kg	0.5	50	25
	Leaves fertilizers	$			
	Lime	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**103**
	Fungicides	Bottle			
	Pesticides	Bottle	2.5	1	3
	Herbicides	Bottle			
	FYM	kg	0.04	2,500	100
iv	**Mechanization**				**73**
	Ploughing	Round	30	1	30
	Rotavating	Round			
	Discing	Round			
	Threshing	Tone	10	3	30
	Transport to farm gate	Bag	0.25	55	14
v	**Cow/Buffalo**				**15**
	Ploughing	Round			
	Rotavating	Round			
	Levelling	Ha	15.00	1	15
vi	**Other inputs**				**122**
	Bags &packaging	Kg	0.0025	2,950	7
	Tools & equipment	lumpsum			15
	Pumping irrigation cost	hour	10.00	10	100
	Drainage pumping cost	hour			
2	**Labour**			**75**	**205**
	Land preparation	wd	2.50	5	13
	Seedling preparation	wd	2.50	1	3
	Transplanting/ planting	wd	2.50	30	75
	Fertilizer application	wd	2.50	5	13
	FYM application	wd			
	Agrochemical application	wd	2.50	1	3
	Weeding	wd	2.50	5	13
	Harvesting	wd	2.50	20	50
	Threshing	wd			
	Transport to farm gate	wd			
	Drying	wd			
	Broadcat rice	wd			
	Irrigation applications	wd	10.00	2	20
	Irrigation canal maintenance	wd	5.00	1	5
	Protection from birds/rats	wd	2.50	5	13
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**115**

Attachment 4-3: Annual crop-budget in Zone 3

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Traing
Commune:	Sra ngae (Zone 3)
Crop:	Late Rice (Wet)
Irrigation:	
Rainfed:	✓
Irrigation+Rainfed:	
Planting from month:	June
Harvesting at month:	Dec-Jan

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**635**
	Main Product	Kg	0.23	2,500	575
	By products	Ox-cart	15.00	4	60
II	**INPUTS**				**484**
1	**Physical inputs**				**366**
i	**Seed/Planting materials**	Kg/seedling	0.25	120	**30**
ii	**Fertilizers**			150	**95**
	Urea	Kg	0.6	50	30
	DAP	Kg	0.8	50	40
	NPK(16:16:8)	Kg			
	KCL	Kg	0.5	50	25
	Leaves fertilizers	$			
	Lime	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**103**
	Fungicides	Bottle			
	Pesticides	Bottle	2.5	1	3
	Herbicides	Bottle			
	FYM	kg	0.04	2,500	100
iv	**Mechanization**				**68**
	Ploughing	Round	30	1	30
	Rotavating	Round			
	Discing	Round			
	Threshing	Tone	10	3	25
	Transport to farm gate	Bag	0.25	50	13
v	**Cow/Buffalo**				**55**
	Ploughing	Round			
	Rotavating	Ha	40.00	1	40
	Levelling	Ha	15.00	1	15
vi	**Other inputs**				**16**
	Bags &packaging	Kg	0.0025	2,500	6
	Tools & equipment	lumpsum			10
	Pumping irrigation cost	hour			
	Drainage pumping cost	hour			
2	**Labour**			**46**	**118**
	Land preparation	wd	2.50	5	13
	Seedling preparation	wd			
	Showing	wd	2.50	5	13
	Fertilizer application	wd	2.50	5	13
	FYM application	wd			
	Agrochemical application	wd	2.50	1	3
	Weeding	wd	2.50	5	13
	Harvesting	wd	2.50	20	50
	Threshing	wd			
	Transport to farm gate	wd			
	Drying	wd	2.50	2	5
	Broadcast rice	wd			
	Irrigation applications	wd			
	Irrigation canal maintenance	wd	5.00	1	5
	Protection from birds/rats	wd	2.50	2	5
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**151**

Attachment 4-4: Annual crop-budget in Zone 3

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Prey Kabas
Commune:	Prey Kabas (Zone 3)
Crop:	Early Rice (Dry)
Irrigation:	✓
Rainfed:	
Irrigation+Rainfed:	
Planting from month:	January
Harvesting at month:	March

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**885**
	Main Product	Kg	0.25	3,500	875
	By products	track	10.00	1	10
II	**INPUTS**				**696**
1	**Physical inputs**				**516**
i	**Seed/Planting materials**	Kg/seedling	0.6	40	**24**
ii	**Fertilizers**			230	**169**
	Urea	Kg	0.70	150	105
	DAP	Kg	0.80	80	64
	NPK(16:16:8)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**82**
	Fungicides	Bottle			
	Pesticides	Bottle	3.00	4	12
	Herbicides	Lite	5.00	4	20
	FYM	kg	0.025	2,000	50
iv	**Mechanization**				**118**
	Ploughing	Round	37.00	1	37
	Rotavating	Round	30.00	1	30
	Discing	Round			
	Threshing	Tone	10.00	3	30
	Transport to farm gate	Bag	0.35	60	21
v	**Cow/Buffalo**				**25**
	Ploughing	Plow			
	Rotavating	Plow			
	Levelling	Ha	25.00	1	25
vi	**Other inputs**				**98**
	Bags &packaging	Bag	0.25	60	15
	Tools & equipment	lumpsum			20
	Pumping irrigation cost	Time	1.25	50	63
	Drainage pumping cost	hour			
2	**Labour**			**66**	**180**
	Land preparation	wd	2.50	3	8
	Seedling preparation	wd	2.50	2	5
	Transplanting	wd	2.50	15	38
	Fertilizer application	wd	2.50	2	5
	FYM application	wd	2.50	3	8
	Agrochemical application	wd	5.00	6	30
	Weeding	wd	2.50	6	15
	Harvesting	wd	2.50	20	50
	Threshing	wd			
	Transport to farm gate	wd			
	Drying	wd	2.50	3	8
	Broadcat rice	wd	2.50	3	8
	Irrigation applications	wd			
	Irrigation canal maintenance	wd			
	Protection from birds/rats	wd	2.50	3	8
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**190**

Attachment 4-5: Annual crop-budget in Zone 3

CROP BUDGET per ha (Currency: US$)

Country: Cambodia
Province: Takeo
District: Bati
Commune: Peam Ream (Zone 3)
Crop: Broccoli
Irrigation:
Rainfed:
Irrigation+Rainfed: ✓
Planting from month: January
Harvesting at month: Early March

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**3,400**
	Main Product	Kg	0.40	8,500	3,400
	By products	Ox-cart			
II	**INPUTS**				**2,410**
1	**Physical inputs**				**1,030**
i	**Seed/Planting materials**	Cans	5.00	30	**150**
ii	**Fertilizers**			350	**275**
	Urea	Kg	0.70	200	140
	DAP	Kg	0.90	150	135
	NPK(20:20:15)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**215**
	Fungicides	Bottle	2.00	10	20
	Pesticides	Bottle	3.00	15	45
	Herbicides	Bottle			
	FYM	kg	0.025	6,000	150
iv	**Mechanization**				**100**
	Ploughing	Round	50.00	1	50
	Rotavating	Round	50.00	1	50
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Bag			
v	**Cow/Buffalo**				**40**
	Ploughing	Round			
	Rotavating	Ha			
	Levelling+ build drain	Ha	40.00	1	40
vi	**Other inputs**				**250**
	Bags &packaging	Bag			
	Tools & equipment	lumpsum			100
	Pumping irrigation cost	Time	1.50	100	150
	Drainage pumping cost	hour			
2	**Labour**			**342**	**1,380**
	Land preparation	2 wd	4.00	12	48
	Seedling preparation	2 wd	4.00	16	64
	Planting	10 wd	4.00	150	600
	Fertilizer application	3 wd	4.00	12	48
	FYM application	2 wd	4.00	12	48
	Agrochemical application	2 wd	5.00	12	60
	Weeding	4 wd	4.00	20	80
	Harvesting	5 wd	4.00	100	400
	Threshing	wd			
	Transport to farm gate	wd			
	Drying	wd			
	Broadcat rice	wd			
	Irrigation applications	wd			
	Irrigation canal maintenance	wd			
	Protection from birds/rats	2 wd	4.00	8	32
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**990**

Attachment 4-6: Annual crop-budget in Zone 3

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Bati
Commune:	Cham Pei (Zone 3)
Crop:	Kinky Cabbage
Irrigation:	
Rainfed:	
Irrigation+Rainfed:	✓
Planting from month:	October
Harvesting at month:	Early December

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**2,750**
	Main Product	Kg	0.25	11,000	2,750
	By products	Ox-cart			
II	**INPUTS**				**1,455**
1	**Physical inputs**				**859**
i	**Seed/Planting materials**	Kg	28.00	1	**14**
ii	**Fertilizers**			350	**275**
	Urea	Kg	0.70	200	140
	DAP	Kg	0.90	150	135
	NPK(16:16:8)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**165**
	Fungicides	Bottle	5.00	5	25
	Pesticides	Bottle	4.00	5	20
	Herbicides	Bottle			
	FYM	kg	0.02	6,000	120
iv	**Mechanization**				**100**
	Ploughing	Round	50.00	1	50
	Rotavating	Round	50.00	1	50
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Tone			
v	**Cow/Buffalo**				**25**
	Ploughing	Ha			
	Rotavating	Ha			
	Levelling+ build drain	Ha	25.00	1	25
vi	**Other inputs**				**280**
	Bags &packaging	Bag			
	Tools & equipment	lumpsum			100
	Pumping irrigation cost	Time	1.50	120	180
	Drainage pumping cost	hour			
2	**Labour**			**138**	**596**
	Land preparation	wd	4.00	8	32
	Seedling preparation	wd	4.00	2	8
	Planting	wd	4.00	30	120
	Fertilizer application	wd	4.00	8	32
	FYM application	wd	4.00	4	16
	Agrochemical application	wd	5.00	8	40
	Weeding	wd	4.00	18	72
	Harvesting	wd	4.00	40	160
	Threshing	wd			
	Transport to farm gate	wd			
	Drying(Cleaning)	wd	5.00	12	60
	Broadcat rice	wd			
	Irrigation applications	wd			
	Irrigation canal maintenance	wd	10.00	4	40
	Protection from birds/rats	wd	4.00	4	16
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**1,295**

Attachment 4-7: Annual crop-budget in Zone 3

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Traing
Commune:	Angkanh (Zone 3)
Crop:	Water Melon
Irrigation:	
Rainfed:	✓
Irrigation+Rainfed:	
Planting from month:	April
Harvesting at month:	July

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**750**
	Main Product	Kg	0.25	3,000	750
	By products	Kg			
II	**INPUTS**				**408**
1	**Physical inputs**				**262**
i	**Seed/Planting materials**	Package	2.50	10	**25**
ii	**Fertilizers**			150	**62**
	Urea	Kg	0.37	100	37
	DAP	Kg			
	NPK(15:1515)	Kg			
	NPK(14:14:14)	Kg	0.50	50	25
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**80**
	Fungicides	Bottle	5.50	1	6
	Pesticides	Bottle	7.00	2	14
	Herbicides	Bottle			
	FYM	kg	0.02	3,000	60
iv	**Mechanization**				**25**
	Ploughing	Round			
	Rotavating	Round			
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Tone	10.00	3	25
v	**Cow/Buffalo**				**50**
	Ploughing	Ha	15.00	1	15
	Rotavating	Ha	15.00	1	15
	Levelling	Ha	20.00	1	20
vi	**Other inputs**				**20**
	Bags &packaging	Bag			
	Tools & equipment	lumpsum			20
	Pumping irrigation cost	Time			
	Drainage pumping cost	hour			
2	**Labour**			**50**	**147**
	Land preparation	wd	3.00	6	18
	Seedling preparation	wd	4.00	2	8
	Planting	wd	3.00	10	30
	Fertilizer application	wd	3.00	2	6
	FYM application	wd	3.00	2	6
	Agrochemical application	wd	4.00	2	8
	Weeding	wd	3.00	4	12
	Harvesting	wd	2.50	15	38
	Threshing(keeping)	wd	3.00	3	9
	Transport to farm gate	wd			
	Drying	wd			
	Broadcat rice	wd			
	Irrigation applications	wd			
	Irrigation canal maintenance	wd			
	Protection from birds/rats	wd	3.00	4	12
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**342**

Attachment 4-8: Annual crop-budget in Zone 3

CROP BUDGET per ha (Currency: US$)

Country:	Cambodia
Province:	Takeo
District:	Traing
Commune:	Prey Sloeuk (Zone 3)
Crop:	Cassava
Irrigation:	
Rainfed:	✓
Irrigation+Rainfed:	
Planting from month:	May
Harvesting at month:	September

	Items	Unit	Unit Price ($/Unit)	Quantity	Value($)
I	**OUTPUTS**				**1,350**
	Main Product	Kg	0.15	9,000	1,350
	By products	Kg			
II	**INPUTS**				**655**
1	**Physical inputs**				**394**
i	**Seed/Planting materials**	Tree	0.05	2,000	**100**
ii	**Fertilizers**			200	**80**
	Urea	Kg	0.400	200	80
	DAP	Kg			
	NPK(15:1515)	Kg			
	Carbonized rice hull	Tone			
iii	**Agrochemical**				**60**
	Fungicides	Bottle			
	Pesticides	Bottle			
	Herbicides	Bottle			
	FYM	kg	0.012	5,000	60
iv	**Mechanization**				**45**
	Ploughing	Round			
	Rotavating	Round			
	Discing	Round			
	Harvesting	Tone			
	Transport to farm gate	Tone	5.00	9	45
v	**Cow/Buffalo**				**60**
	Ploughing	Ha	20.00	1	20
	Rotavating	Ha	20.00	1	20
	Levelling	Ha	20.00	1	20
vi	**Other inputs**				**49**
	Bags &packaging	Bag	0.125	150	19
	Tools & equipment	lumpsum			30
	Pumping irrigation cost	Time			
	Drainage pumping cost	hour			
2	**Labour**			**92**	**261**
	Land preparation	wd	4.00	4	16
	Seedling preparation(dig a whole)	wd	4.00	6	24
	Planting	wd	2.50	20	50
	Fertilizer application	wd	2.50	4	10
	FYM application	wd	2.50	4	10
	Agrochemical application	wd			
	Weeding	wd	2.50	6	15
	Harvesting	wd	2.50	40	100
	Threshing(keeping)	wd	4.00	4	16
	Transport to farm gate	wd			
	Drying	wd			
	Broadcat rice	wd			
	Irrigation applications	wd			
	Irrigation canal maintenance	wd			
	Protection from birds/rats	wd	5.00	4	20
3	**Other expenditures**				
	Agricultural taxes	$			
	Water charges	$			
	NET BENEFIT				**695**

Appendix 4 Preliminary engineering design and cost estimate

List of Appendices

List of Figures

1 INTRODUCTION

For Integrated Food Risk Management Plan of the West Bassac area, three flood management zones have been proposed based on a mix management concept option of full and early protection of different deep and shallow flooded areas. The implementation of flood risk in the area would lead to land use intensification therefore irrigation/drainage facilities have also been integrated into the plan. In the West Bassac three flood management zones are proposed:

(i) Zone 1: deep flooded area along the Bassac river;
(ii) Zone 2: deep flooded area along the West Bassac flood plain and;
(iii) Zone 3: the shallow and non flooded zone along the national road no 2.

For the preliminary engineering and the cost estimate a further division into *subzones* and *main structures* has been made:

Subzones
Each zone has been divided further into large management zones called *Subzones*. There are in total 19 subzones (see Figure 2.1).

Main structures
There are also main structures which are above subzone level. Those will be discussed separately.

2 DESIGN OF ZONE 1

The zone 1 is a deep flooded area extending between the RN 21 along the Bassac River from Ta Khmao town to the Cambodian-Vietnam border to the east and the Preik Ho-Preik Ambel-Preik Moat Chhrouk rivers to the west (Main Diversion canal). Zone 1 is to be fully protected against 1% flood (one hundred year flood). Combined flood mitigation measures have been proposed consisting of flow diversion and dike embankments. The flood diversion shall be made through a main diversion canal to be built by improving existing major natural drainage system, the Preik Ho, Preik Ambel and Preik Moat Chhrouk by connecting them and improving the conveyance capacity of the segment Preik Ho-Preik Ambel. The main diversion canal will be used also as main water supply source of water for irrigation and navigation (see Figure 2.1).

One main road dike embankment shall be built using existing structure along the main diversion canal at the western side of the polders and an additional dike segment to be built (Preik Hol to Preik Ambel). The RN 21 shall be used as the eastern dike by extending by a new dike segment between Chrey Thom to Kouk Thlok .

The zone 1 is subdivided into five large management zone built as independent polders, each one connected to the Bassac and the main diversion canal by a link canal. The five-link canals will assume the flood diversion function and irrigation water supply of some existing 90 colmatage canals which shall be closed at their respective entrance from the Bassac but will be improved to serve as irrigation/drainage canal connecting with each polder main drainage/irrigation canal running along the lowest part of each polder parallel to the main western dike.

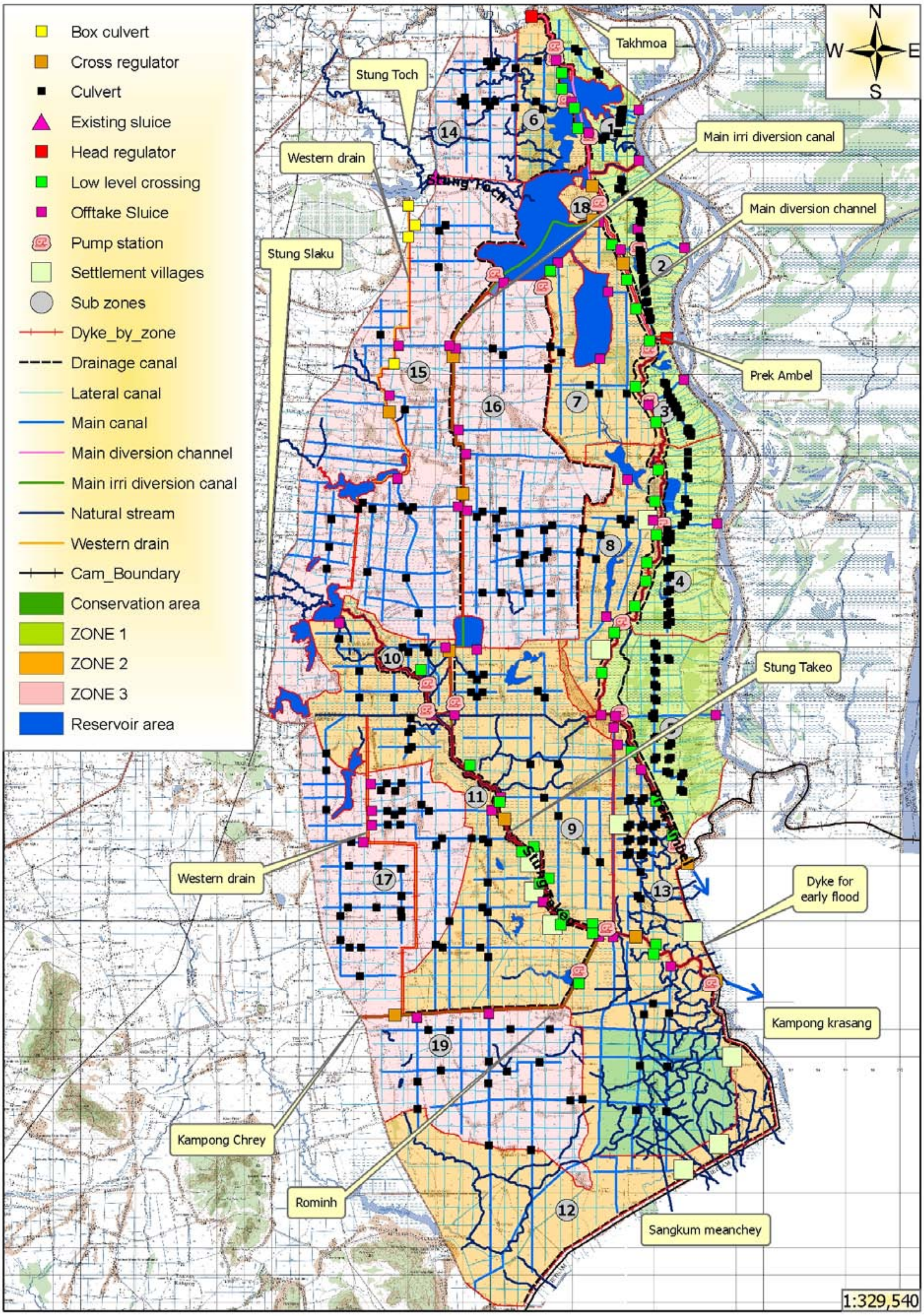


Figure 2.1 **West Bassac project area**

Flood mitigation measures open opportunities for land use intensification in the area mainly for cash crop in the shallow flooded area of each polder and rice for the remaining deepest part, therefore irrigation and drainage facilities are also proposed. The drainage and water supply for irrigation in each polder will be made through a principal irrigation/drainage canal behind the western dike taking water from the main diversion canal. Each polder will be equipped with a pumping station serving a double function as irrigation and drainage facilities. The internal drain of each polder will use the lowest part nearest to the main diversion canal as a retention reservoir.

Two categories of structures might be distinguished:
(i) Main structures belonging to the whole zone 1
(ii) Water management structures belonging to all individual polders (subzones)

2.1 Main structures Zone 1

The main structures of the Zone 1 are:
(i) The road embankment of the RN 21 which is currently assumed to be flood free but might still require standard checking (not included in the design and cost estimate) check level dike, compared to 1%
(ii) The Western dike running along the left bank of the main drain: Preik Ho-Preik Ambel-Angkor Borei-Kouk Thlok (at the border area).
(iii) The main Diversion Channel running along the West Bassac flood plain along the alignment of Preik Ho-Preik Ambel-Angkor Borei-Kouk Thlok

The western dike (main polder dike)
The western dike will be used to protect the settlement along the western side of the polders and along the RN 21 as well as cropping areas in each polder and serving as access road between polders and the national road. The dike is designed to protect the area against 1% (100 years return period) flood level based on the development scenario no 2 of the flood impact assessment during the Stage 1 of the project (Cambodian Focal Areas provided with a mix early flood control for deep flooded zones and complete protection for shallow zones and Vietnamese Focal Areas unchanged.)
The profile of the estimated water level is provided by ISIS model along the dike embankment.

The main polder dike is subdivided into two segments:
(i) Preik Ho - Preik Ambel: almost completely new construction linking Preik Ho to Preik Ambel
(ii) Preik Ambel - Angkor Borei-Kouk Thlok: improvement of existing dike
The dike embankment should be able to resist flood with recurrence period of 100 years and standard crest width for two lanes traffic.

Prek Ho - Prek Ambel segment
The design crest elevation of first segment of the dike is ranging from about 10m MSL at the entrance into Preik Ho and about 8m MSL at the end of the dike at Preik Ambel.

The maximum water level profile of probability 1% flood is ranging from 8.2m MSL at the entrance into Preik Ho and to about 6.5m MSL at the end of the dike, i.e. at the entrance of the Preik Ambel.

Prek Ambel - Angkor Borey-Kouk Thlok

The design crest elevation of second segment of the dike is ranging from about 9.56m MSL at the entrance into Preik Ambel and about 7.3m MSL at the end of the dike at Kouk Thlok

The maximum water level profile of probability 1% flood is ranging from 7.754m MSL at the entrance into Preik Ambel and to about 5.5m MSL at the end of the dike, i.e. at the downstream of zone 5.

The total length of the main polder dike is 98.50 km. The dike lengths per subzone are also mentioned in section 2.2.

Main Diversion Channel

The proposed main diversion channel comprises two segments:

Preik Ho - Preik Ambel segment

This diversion channel will convey part of the Bassac and Preik Thnot flood water, the remaining part will be conveyed through the northern part of the zone 2 deep flooded area. This channel runs through the natural lake, the Boeung Tuk Cho. This lake will be surrounded by a ring dike to be served as storage excess water retention reservoir for early crop flood protection and as reservoir for recession and dry season crop as well as fish sanctuary.

The design capacity of this channel is based on the maximum historical water level up to 31st July (based of typical 12 years time series of the total 97 years).

Preik Ambel - Angkor Borei - Kouk Thlok segment

In addition to its natural connection between the Bassac at Preik Ambel and again after crossing the Cambodian-Vietnam border, this channel plays the function as flood and flow regulator between the Bassac and the flood plain. During flood season the channel conveys large amount of flood water to the deep flooded area in the Zone 2 for temporary storage and release to downstream through Stung Takeo and Preik Moat Chrouk.

The maximum flood conveyance capacity of this channel is estimated by ISIS as 3000 m3/s at Preik Ambel and 1400 m3/s maximum before 31st July1. There is no plan to improve conveyance capacity of this part of the channel during the maximum flood period. Early flood will be contained by a low dike embankment designed to content the maximum flood up to 31st July (1,400m3/s). Excess flood flow after 31st July will be allowed to spill over into the zone 2 during high flood period.

The estimation of the conveyance capacity of the main diversion channel (natural stream of Preik Ambel) of 31st July maximum flood is based on ISIS simulation estimated at about 1400 m3/s. And based on the above discharge the dimension of the Preik Ambel channel is computed using Manning formula. Approximate dimension of the channel are:

Bottom width: 100m
Side slope: 2
Water depth: 6.71m
Bed slope: 0.0002
Manning roughness: 0.025

[1] It should be noted that the simulation is based on preliminary results from ISIS simulation only

It should be noted that during peak flood period of the year, flood water is allowed to spill over the right bank of the main diversion (Preik Ambel) channel through a number of (low level crossing built at 10% return period of maximum flood up to 31st July) between proposed two new settlement areas. The design crest level of right bank for early flood protection dike is ranging from about 5.8m MSL at the entrance into Preik Ambel to about 3.7m MSL at the end of the protection dike i.e. at the end of sub zone 5. And the design of early flood water surface is also ranging from about 5.8m MSL at the entrance into Preik Ambel to about 3.7m MSL at the end of the protection dike.

2.2 Water management structures in the subzones of Zone 1

Zone 1 is subdivided into 5 management subzones (5 polders).

Subzone 1 (area 2755 ha)
The first polder is delimited to the north by the Ta Khmao town, to the east by the RN 21, to the west by main polder dike including ring dike of the of the Boeung Preik Khmer, the south by the dike embankment of Preik Touch. The northern part of this polder will be part of the Ta Khmao town which should be protected against maximum flood and flood from local rainfall. This polder is linked to the Bassac by a link canal at about Km 313 (hydrographic atlas). The natural lake in this polder will be used as excess rainfall retention reservoir and drainage and a reservoir for irrigation water.

Proposed structures SZ 1	**Unit**
Internal drainage	
Main drain:	9 km
Retention reservoir:	10 km2
Pumping station:	2
Irrigation/drainage canal network primary:	18 km
Irrigation/drainage canal network secondary:	20.8 km
Culvert	13
Offtake sluice	4
Dike	30 km

Subzone 2 (area: 4824 ha)
The polder 2 is delimited to the north by the Preik Khmer road embankment, to the south by left bank of the Preik Ambel, the main polder dike to the west, the RN 21 to the east. The main features of this polder are: the S'ang, granitic hill, the S'ang Phnom village, the unique dirt road connecting RN21 to the western side of the Bassac flood plain. This polder is at its preliminary stage of development.

Proposed structures SZ 2	**Unit**
The main link canal	Maximum design capacity: 180m3/s Length: 5.49km
Internal drainage (main drain):	12.67km
Retention reservoir:	1.32km2
Pumping station	1
Irrigation/drainage canal network primary:	18.5km
Irrigation/drainage canal network secondary	67km
Culvert	38
Offtake sluice	3
Dike	30 km

Subzone 3 (area 2187.34 ha)
The polder 3 is delimited to the north by the left embankment of the Preik Ambel, to the south by the Preik Bak/Preik Samang, to the west by the main polder dike, to the east by the RN 21. This polder is at its early stage of development with a pilot project:

Proposed structures SZ 3	**Unit**
The main link canal	Maximum design capacity: 171.1 m3/s Length: 3.42km
Internal drainage (main drain):	8.47 km
Retention reservoir:	0.93km2
Pumping station	1
Irrigation/drainage canal network primary:	8.66km
Irrigation/drainage canal network secondary	38.75km
Culvert	20
Offtake sluice	2
Dike	17 km

Subzone 4 (area 6657.2ha)
This polder is delimited to the north by Preik Bak/Preik Samang, to the south by Preik Thom, to the west by the main polder dike, to the east by the RN 21.

Proposed structures SZ 4	**Unit**
The main link canal	Maximum design capacity: 305.72m3/s Length: 4.23km
Internal drainage (main drain):	13.85 km
Retention reservoir:	2.71 km2
Pumping station	1
Irrigation/drainage canal network primary:	19.44km
Irrigation/drainage canal network secondary	79.5km
Culvert	28
Offtake sluice	2
Dike	34 km

Subzone 5 (area 9040ha)
This polder is delimited to the north by the Preik Thom, to the south by the proposed closing dike Chrey Thom to Kouk Thlok, to the west by the main polder dike and to the east by the RN 21. The main feature of this polder is its connection point with Takeo town by the Takeo canal, the Moat Chrouk canal to Vietnam, to Stung Takeo-Rominh and RN 2.

Proposed structures SZ 5	**Unit**
The main link canal	Maximum design capacity: 90.4m3/s Length: 8.2 km
Internal drainage (main drain):	18.18 km
Retention reservoir:	-
Pumping station	1
Irrigation/drainage canal network primary:	21.67km
Irrigation/drainage canal network secondary	95.5km
Culvert	29
Offtake sluice	2
Dike	38 km

3 DESIGN OF ZONE 2

The deep flooded area zone 2 will be protected against early flood (May to 31st July) of agricultural crop. After last harvesting date the area will be flooded and will be used again for rice recession and dry season crop (November-April). The design concept for the zone 2 is to protect crop from early flooding and droughts. The zone 2 is extending between the western bank of the main diversion canal of zone 1 (Preik Ho, Preik Ambel, Preik Moat Chhrouk) and is delimited to the west by the shallow flooded area (Zone 3) flood protection dike, to the north by the RN 2 and to the south by the low dike embankment Kampong Krasaing - Sangkum Mean Chey - Phnom Den. IFRM measures in this zone consist of a combination of structural measures and their operation to protect rice crop against early flood (May- 31St July) as well to provide supplement irrigation water. During this period, water level in this zone will be maintained below design flood level controlled by a dike system along the right bank of the main drain of the zone 1 and the Stung Takeo assuring that excess water could be conveyed through the main drain, the Stung Takeo, store in reservoirs and furthermore regulated by sluice gates at Preik Ambel, Preik Ho and Stung Takeo, the five link canal entrance. The main irrigation diversion canal linking Boeung Choeung Luong and Stung Takeo flood plain will play also important role in reducing flood risk as well as supplement irrigation water supply.

For Integrated Flood Risk Management (IFRM) of this zone, following measures are proposed to protect early crop (May-31st July). Zone 2 is proposed to be sub-divided into 7 subzones.

Proposed measures could be subdivided into main structures of the zone and structures related to the subzones.

3.1 Main structures Zone 2

The main structures of Zone 2 are:

(i) **Eastern front protection**

- Dike embankment/settlement areas/low level crossing /road along the right bank of the main diversion channel of Preik Ambel, designed at 10% protection level for early flood protection
- Two settlement areas along the right bank of the main drain designed at 100 year return period of four kilometer long each in between low level flood water crossing.
- The early flood protection dike embankment between Kouk Thlok and Kampong Krasaing
- Channel improvement of the Takeo canal (not put in the estimation cost)
- Water control structures, head regulators, cross regulator, low level crossing and pumping station.

(ii) **Stung Takeo protection**

For early flood protection, the Stung Takeo plays a major role for the Zone 2 drainage by draining out excess overland flow from the Western catchment of the Stung Takeo, the conveyance capacity of this river will be improved to a flow capacity of 500m3/s by dredging from Thnot Te reservoir to Kampong Krasaing at the border. The right bank of the Takeo river will be elevated to 100 year recurrence period for four settlement areas for a total length of 12 km.

(iii) **Boeung Choeung Luong reservoirs**

The Boeung Cheoung Luong will be used as flood retention for excess surface local rainfall and flood flow for early crop flood protection and water supply by surrounding dike embankment equipped with pumping station and water control structure linking with the main drain of Zone 1.

(iv) **Transport road nr3**.

- dike / road improvement between Angkor Borey and Stung Takeo along with an irrigation / drainage navigation canal
- improvement of dike/road between Borey Chulsa on Stung Takeo to Rominh-Kampong Chhrey including side irrigation/drainage/navigation canal

3.2 Water management structures in the subzones of Zone 2

For future operation and management, the zone 2 could be subdivided into 8 subzones based on existing and projected infrastructure in the zone which divide flood management options and supplement irrigation supply.

Subzone 6 (3735 ha):

This subzone is delimited to the north by the RN 2, to the west by the dike embankment of the northern shallow flooded area of the zone 2 (Preik Kampis) and the left embankment of the main drain channel to the east, to the south by the Preik Khmer road to Preik Touch. Flood management in this zone relies on the main drain, the head regulator at Preik Ho and the improved reservoirs. For supplement irrigation a network of irrigation/drainage canal including water control infrastructure are proposed.

Timely flood recession crops will be managed through the main drain and its water control structure. Supplement irrigation for early crop/recession crop and dry season crop will be supplied by the pumping from the main diversion canal and the reservoir.

Proposed structures SZ 6	**Unit**
The main link canal	
Internal drainage (main drain):	20 km
Retention reservoir:	6 km2
Pumping station	2
Irrigation/drainage canal network primary:	15 km
Irrigation/drainage canal network secondary	31 km
Culvert	3
Offtake sluice	2
Dike	23 km

Subzone 7 (8432 ha)

The Subzone 7 is delimited to the north and northwest by the Boeung Cheoung Luong dike embankment, to the east by the right embankment of the main diversion canal of the zone 1 and to the south by the road embankment Prey Kabbas-kampong Reap for early flood this zone is protected by right main diversion embankment Drainage for recession crop and supplement irrigation for early crop, recession crop and dry season crop will be drawn from the reservoir and the main drain channel by pumping.

For irrigation and drainage a network of irrigation/drainage canal will be proposed.

Proposed structures SZ 7	Unit
The main link canal	
Internal drainage (main drain):	18
Retention reservoir:	28
Pumping station	1
Irrigation/drainage canal network primary:	46 km
Irrigation/drainage canal network secondary	78 km
Culvert	6
Offtake sluice	4
Dike	47 km

Subzone 8 (7054ha)
The subzone 8 is delimited to the north by the road embankment kampong Reap-Prey Kabbas, to the west by the shallow flooded area flood protection dike Prey Kabbas-Angkor Borey, to the east by the right embankment of the main diversion canal. Main early flood risk to this subzone comes from the Bassac river, which will be protected by the right main drain diversion. Drainage for early recession crop will be made through the main diversion channel. Supplement irrigation water for early, recession and dry season crop will be drawn from the main diversion channel through a provided network of irrigation/drainage canals with numbers of water control structures. A network of irrigation/drainage canals is proposed.

Proposed structures SZ 8	Unit
The main link canal	
Internal drainage (main drain):	22 km
Retention reservoir:	5 km2
Pumping station	1
Irrigation/drainage canal network primary:	32 km
Irrigation/drainage canal network secondary	50 km
Culvert	7
Offtake sluice	3
Dike	32 km

Subzone 9 (15913 ha)
This subzone is delimited to the north by the most southern shallow flood protection dike of the subzone 15 and 16, to the east by the Prey Kabbas - Abgkor Borey road and the Angkor Borey - Borey Chulsa road and to the west and south west by the canal embankment Tlho Yol-Stung Takeo and Stung Takeo embankment. Flood risk to this zone comes from the Bassac river through the Takeo canal Angkor Borey and the takeo river
Early flood risk in this zone will be managed through:
1. Cross regulator on the Takeo canal at Angkor Borey,
2. The left embankment of the Stung Takeo and
3. The road embankment between Angkor Borey and Borey Chulsa
4. The Embankment of the canal Thlok Yol-Stung Takeo.

Supplement irrigation water for early crop, recession and dry season crop will be drawn by pumping from the Takeo canal, Stung Takeo, and a network of irrigation/drainage canals.

Proposed structures SZ 9	**Unit**
The main link canal	
Internal drainage (main drain):	27 km
Retention reservoir:	2 km2
Pumping station	2
Irrigation/drainage canal network primary:	72 km
Irrigation/drainage canal network secondary	174 km
Culvert	14
Offtake sluice	4
Dike	31 km
Low level crossing	6

Subzone 10 (2075 ha).
This subzone is located to the west of the upper part of the Stung Takeo and is delimited to the west by the Stung Takeo, to the north by the Subzone 13, to the east by the embankment of the Thlok Yol-Takeo river canal. Major flood water into this area comes from the Bassac river through the Takeo canal and from Slakou river through Thnot Te reservoir. Flood risk of this subzone will be managed by:

1. The Stung Takeo left embankment and the embankment
2. The Thlok Yol-Stung Takeo canal right embankment
3. The Takeo canal
4. The Stung Takeo and its left embankment.

Supplement irrigation will be drawn from the Takeo canal and Stung Takeo river by pumping distributed through a network of irrigation and drainage canals.

Proposed structures SZ 10	**Unit**
The main link canal	
Internal drainage (main drain):	8 km
Retention reservoir:	-
Pumping station	1
Irrigation/drainage canal network primary:	13 km
Irrigation/drainage canal network secondary	21 km
Culvert	4
Offtake sluice	1
Dike	21 km
Low level crossing	6

Subzone 11 (1961 ha)
The Subzone 11 is delimited to the north by the dike embankment of the Thnot Te reservoir, to the west by the shallow flooded area Subzone 17 flood protection embankment, to the east by the right embankment of the Stung Takeo, to the south by the embankment of the Borey Chulsa-Rominh-Kampong Chrey canal. Flood risk in this

zone comes from the Bassac river through the Takeo canal and the Stung Takeo. Flood protection of this subzone will be made through:

1. The right embankment of the Stung Takeo;
2. The road/canal/embankment of the Borey Culsa-Rominh-Kampong Chrey
3. The drainage/irrigation canal Boeung Tom reservoir-Kampong Chrey-Romih canal to drain out excess overland flow.

Supplement irrigation water supply will be drawn from the Stung Takeo through a network of irrigation/drainage canal. Three settlement areas are planned along the right embankment of the Stung Takeo.

Proposed structures SZ 11	**Unit**
The main link canal	
Internal drainage (main drain):	48 km
Retention reservoir:	3 km2
Pumping station	2
Irrigation/drainage canal network primary:	95 km
Irrigation/drainage canal network secondary	198 km
Culvert	20
Offtake sluice	4
Dike	58 km
Low level crossing	4

Subzone 12 (23892 ha)
The Subzone 12 is the most southern subzone, most isolated area of the West Bassac area delimited to the north by the shallow flooded area Subzone 19 and the Stung Takeo, to the south by the Cambodian-Vietnamese border and to the west by the RN 2. Flood water in this area comes from the Bassac through the Takeo canal and Stung Takeo. Flood control measure in this sub-area is to protect the early crop from early flooding by a low dike embankment along the Stung Takeo river and along the border area. This subzone has one protected area, the Cyrus crane sanctuary around Boeung Repeou (8461 ha).

This Subzone is sensitive to cross-border flood and dry season water use impacts. There exists one canal linking Stung Takeo with Vinh Te canal.
For drainage and supplement irrigation water supply a network of irrigation/drainage canals is being proposed including three settlement areas.

Proposed structures SZ 12	**Unit**
The main link canal	
Internal drainage (main drain):	35 km
Retention reservoir:	-
Pumping station	1
Irrigation/drainage canal network primary:	125 km
Irrigation/drainage canal network secondary	253 km
Culvert	9
Offtake sluice	2
Dike	74 km
Low level crossing	2

Subzone 13 (6337 ha)
The Subzone 13 is located partly in Takeo and partly in Kandal province, early flood water comes into this subzone from the Bassac river through the flood plain between Kouk Thlok and Kampong Krasaing, from the overbank flow from the Moat Chrouk canal, additionally major floods come also from the Stung takeo. This subzone is delimited to the east by the right embankment of the main drain (morat Chrouk canal), and the dike embankment between Kouk Thlok and Kampong Krasaing, to the south by the Stung Takeo and to the west by the proposed road improvement between Angkor Borey and Borey Chulsa.

Two settlement areas are proposed in this subzone one along the dike embankment between Kouk Thok-Kampong Krasaing and another one along the proposed road improvement between Angkor Borey and Borey Chulsa. A network of irrigation/drainage canals are also proposed for early crop and recession rice crops by pumping.

Proposed structures SZ 13	**Unit**
The main link canal	
Internal drainage (main drain):	12 km
Retention reservoir:	
Pumping station	1
Irrigation/drainage canal network primary:	48 km
Irrigation/drainage canal network secondary	45 km
Culvert	22
Offtake sluice	3
Dike	21 km
Low level crossing	4

4 DESIGN OF ZONE 3

The non flooded and shallow flooded area zone 3 is the most western part of the West Bassac integrated flood risk management area. Shallow flooded area of this zone extends from north to south along an approximate contour line of 5-6m. Flooding in this zone is caused by the Mekong flood from the Bassac. However, the western catchment west to the RN 2 occasionally caused flash flood to predominantly wet season rice crop of this area. Beside floods, this zone is also prone to droughts due to erratic rainfall regime in the region. The non flooded and shallow flooded area Zone 3, will be fully protected against peak flood all year round for rice crop. This zone could be subdivided into five sub-management zones

4.1 Main structures Zone 3

The main proposed structure in zone 3 is the main irrigation diversion canal extending between Boeung Cheoung Luong and Boeung Thlok Yol. The proposed canal will have a dual function as:

i) conveyance of part of flood season flow from Stung Preik Thnot and Bassac through Preik Ho Preik Thnot diversion canal and Stung Touch,

ii) supply irrigation water to the subzone 15 and 16. The canal is connected with Boeung Choeung Luong by a flow regulator and a pumping station. The canal is design for maximum capacity of 500 m3/s based on crop requirement for supplement irrigation in subzone 15 and 16.

4.2 Water management structures in the subzones of Zone 3

Subzone 14 (5991ha)

This subzone is delimited to the north and to the west by the RN 2, to the east by the proposed Preik Kampis flood protection dike and to the south by the left embankment of the Stung Touch. Flood water in this subzone comes from:

1. Preik Thnot river through the Stung Touch river;
2. The Preik Thnot river diverted across the RN 2 near Preik Kampis
3. The Bassac flood water

To protect his subzone from flooding for wet season rice crop, following measures are proposed:

i) Dike embankment between Preik Kampis and dike/road S'ang-Tonle Bati designed for 10 years return period ;

ii) Dike embankment along the right bank of the main diversion canal of the zone 1

Supplement irrigation water will be drawn from the Bassac through the main diversion canal. A network of irrigation and drainage canals is proposed.

Proposed structures SZ 14	Unit
The main link canal	
Internal drainage (main drain):	
Retention reservoir:	15 km
Pumping station	
Irrigation/drainage canal network primary:	37 km
Irrigation/drainage canal network secondary	73 km
Culvert	9
Offtake sluice	
Dike	17 km

Subzone 15 (33010ha)
This subzone is delimited to the north by the right embankment of the Stung Touch, to the west by the RN 2 and to the east by the proposed main irrigation diversion canal Boeung Choeung Loung-Boeung Thlok Yol, to the south by the proposed shallow area flood protection dike Thlok Yol-Thnot Te.

The following flood protection measures are proposed:

i) A drainage/irrigation (western drain) to intercept excess overland flow from the western sub-catchments with conveyance capacity of 500 m3/s;

ii) A shallow area flood protection dike Thlok Yol-Thnot Te to be designed to protect 10 year recurrence period against maximum flood.

Water for supplement irrigation will be drawn by pumping from the western drain, the main irrigation diversion canal and the Samrong reservoirs distributing by a network of proposed network of irrigation and drainage canals. A network of irrigation/drainage canal are proposed for early crop and wet season rice crop supplement irrigation in the area

Proposed structures SZ 15	Unit
The main link canal	
Internal drainage (main drain):	35 km
Retention reservoir:	15 km2
Pumping station	1
Irrigation/drainage canal network primary:	144 km
Irrigation/drainage canal network secondary	268 km
Culvert	21
Offtake sluice	5
Dike	42 km

Subzone 16 (20382 ha)
This subzone is delimited to the north by the Boeung Choeung Luong, to the west by the main irrigation diversion canal, to the east by the proposed shallow area flood protection dike embankment Boeung Choeung Luong - Angkor Borey, to the south by the proposed shallow flooded area flood protection dike embankment Angkor Borey – Thlok Yol. Shallow flooded area in the eastern and southern part of this sub-area is affected by annual flood and will be protected by a proposed dike embankment system designed for

10 year recurrence flood. Supplement irrigation water will be drawn from the main irrigation diversion canal by pumping supplying through a network of new and improved irrigation/drainage canal network.

Proposed structures SZ 16	**Unit**
The main link canal	
Internal drainage (main drain):	33 km
Retention reservoir:	3 km2
Pumping station	1
Irrigation/drainage canal network primary:	98 km
Irrigation/drainage canal network secondary	2310 km
Culvert	18
Offtake sluice	5
Dike	50 km

Subzone 17 (16987 ha)
The Subzone 17 is surrounded to the north and to the east by a shallow flooded area flood protection dike extending from Takeo town to the Kampong Chrey - Rominh canal. The shallow flooded area of this Subzone is flooded by the Bassac flood water and suffers also from water shortage in wet season. The subzone is also affected by flash flood from western catchments that should be drained by the Western Drain No 2 designed at for 500 m3/s capacity. The proposed ring dike is proposed to protect the area against 10 year recurrence maximum flood. For supplement irrigation water supply water will be drawn from the Stung Takeo and the Takeo canal by pumping.

Proposed structures SZ 17	**Unit**
The main link canal	
Internal drainage (main drain):	
Retention reservoir:	2 km2
Pumping station	
Irrigation/drainage canal network primary:	101 km
Irrigation/drainage canal network secondary	117 km
Culvert	30
Offtake sluice	4
Dike	27 km

Subzone 18
Subzone 18 consists of the Tanu village which is part of the S'ang Phnom Commune. No structural measures are foreseen in this area.

Subzone 19 (14537 ha)
The Subzone 19 is delimited to the north by the Rominh-Kampong Chrey canal and surrounded by a proposed shallow flood protection dike to the east and south of this zone to protect against the Bassac maximum annual flood. The existing Pich Sar polder covers part of the subzone (17, 11 and 19) with a total flood protection area of 17000 ha for wet season and support 2000 ha for dry season rice crop. Water supply to this subzone will be drawn from the Stung Takeo river through the Borey Chulsa - Rominh-Kampong Chrey canal a network of irrigation and drainage canals are also proposed.

Proposed structures SZ 19	Unit
The main link canal	
Internal drainage (main drain):	
Retention reservoir:	
Pumping station	
Irrigation/drainage canal network primary:	72 km
Irrigation/drainage canal network secondary	164 km
Culvert	13
Offtake sluice	3
Dike	48 km

5 COST ESTIMATE

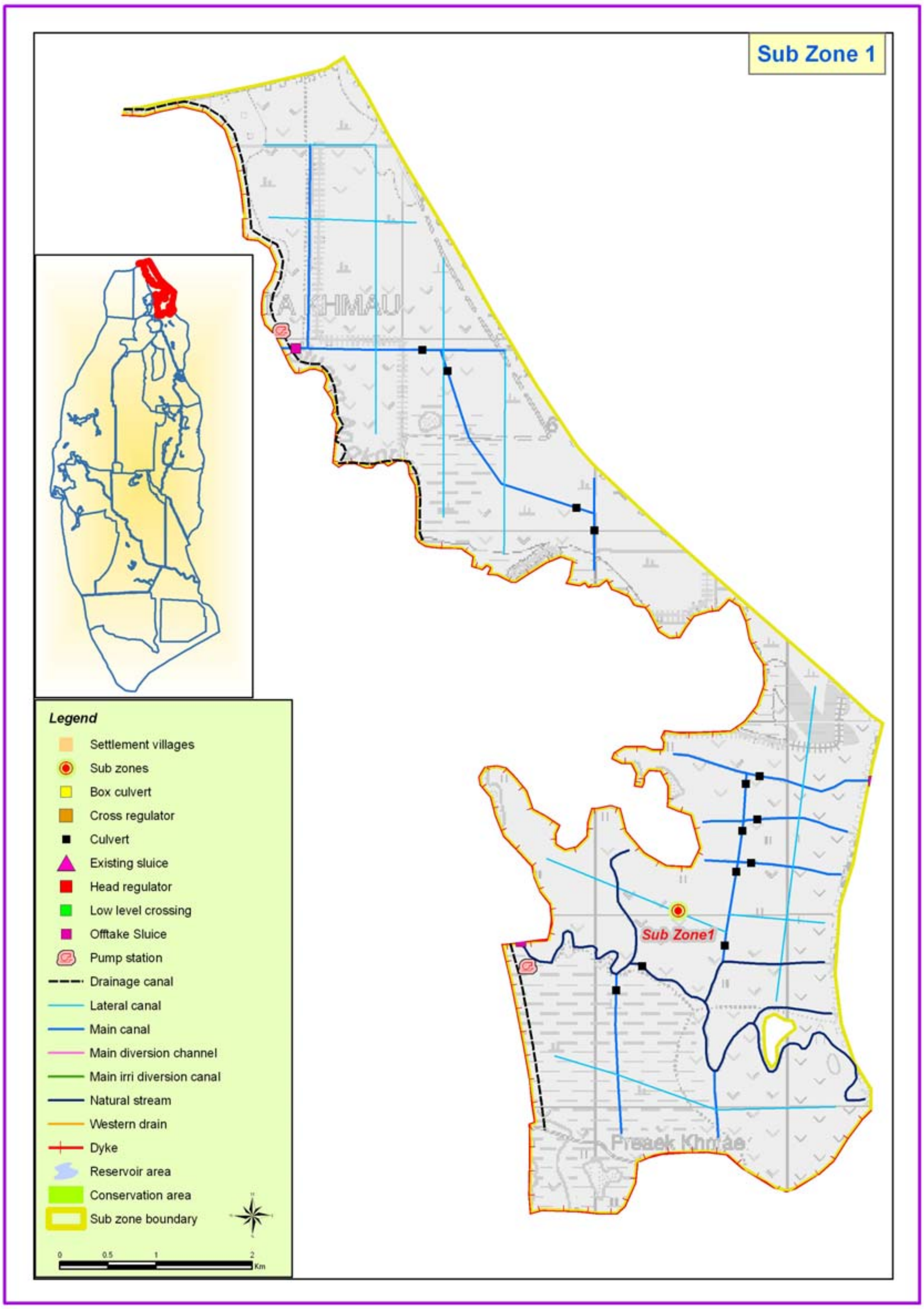
A cost estimate has been made for the entire project. Table 5.1 presents a summary of the total costs. Appendix 2 presents a cost breakdown per subzone and per main structure. The total costs are approximately 300 million dollar, including 5% contingencies, excluding VAT.

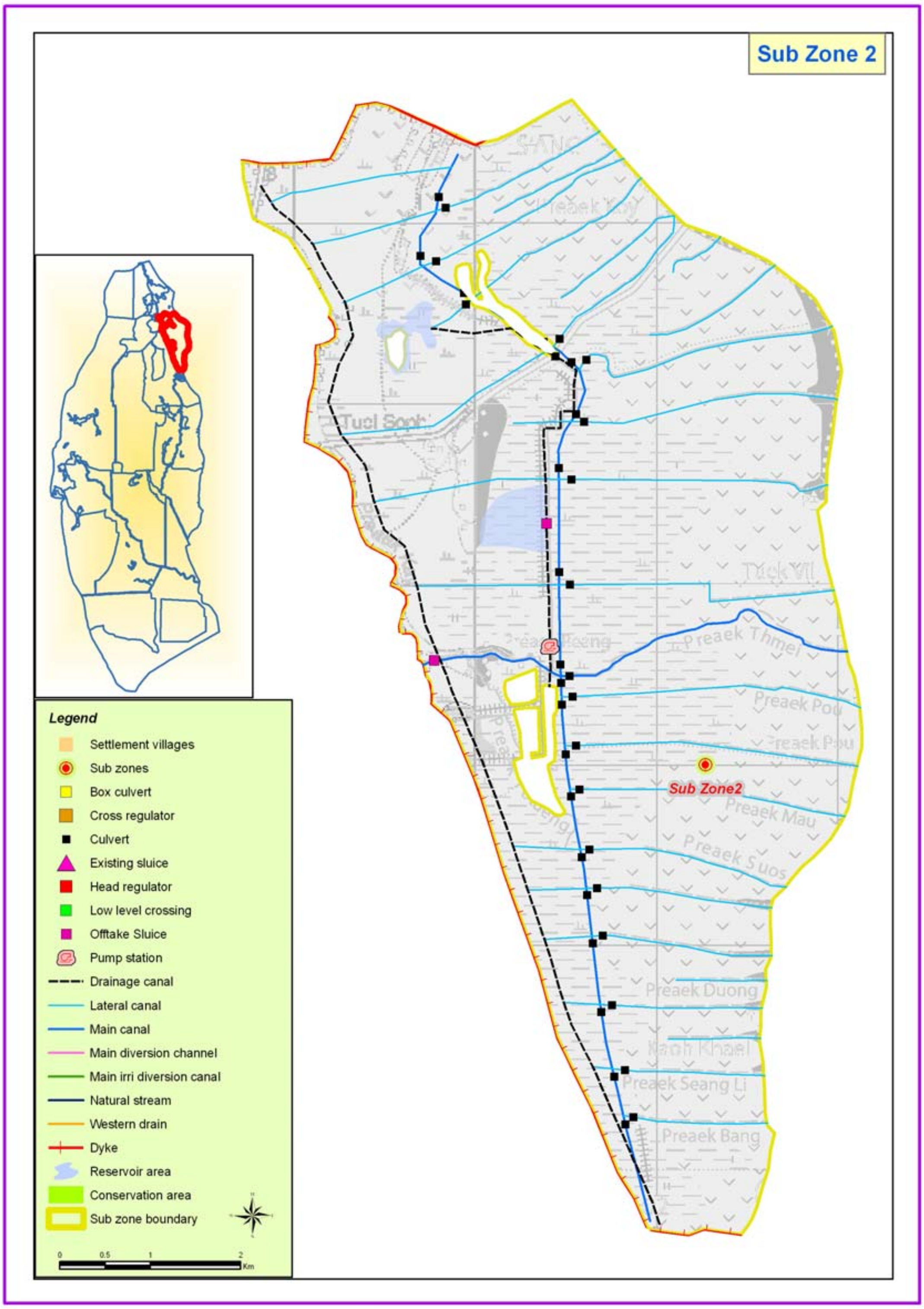
Table 5.1 Cost estimate (total costs)

Estimated Project Cost for Option 1

Descriptions	Unity	Qty	UnitPrice, USD	TotalPrice, USD
Irrigation/drainage canals	m3	48.334.868,0540	2	96.669.736,11
Polder dyke	m3	15.455.905,90	2	30.911.811,81
Villages	m3	1.165.500	2	2.331.000,00
Irri diversion canals	m3	15573447,5	1,5	23.360.171,25
Prek Ambel	m3	13.041.300	2	26.082.600,00
Stung Takeo	m3	18.894.500	2	37.789.000,00
Tertiary canals	m3	3.188.073	2	6.376.145,87
Irrigation canals from Stung Takeo to Rominh	m3	2.043.680	2	4.087.359,73
Subtotal for earth moving work volume =				**227.607.824,76**
Culvert	Unit	301,00	6.000	1.806.000,00
Offtake sluice	Unit	53,00	30.000	1.590.000,00
Head works	Unit	2	2.500.000	5.000.000,00
Cross regulators	Unit	12	50.000	600.000,00
Pump station	Unit	19,00	50.000	950.000,00
Box culverts	Unit	4	30.000	120.000,00
Gates for culverts	Unit	296	600	177.600,00
Gates for offtake	Unit	48	4.000	192.000,00
Gates for boxculverts	Unit	4	4.000	16.000,00
Gates for head-work structures	Unit	2	50.000	100.000,00
Low level crossings	Unit	35,00	20.000	700.000,00
Subtotal for concrete works =				**11.251.600,00**
Land acquisition cost	m2	95760000	0,3	28.728.000,00
Resettlement cost 20% of Land acquisition cost				5.745.600,00
Subtotal for land and resettlement impact =				**34.473.600,00**
Total cost =				**273.333.024,76**
Detailed design consultancy cost 5% of total cost				13.666.651,24
Contigency cost 5% of total cost				13.666.651,24
Grand total				**300.666.327,24**

Attachment 1 Maps of the subzones


Sub Zone 1
Legend
Settlement villages
Sub zones
Box culvert
Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary
0 0.5 1 2 Km
Sub Zone1
Preaek Khmae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Legend
Settlement villages
Sub zones
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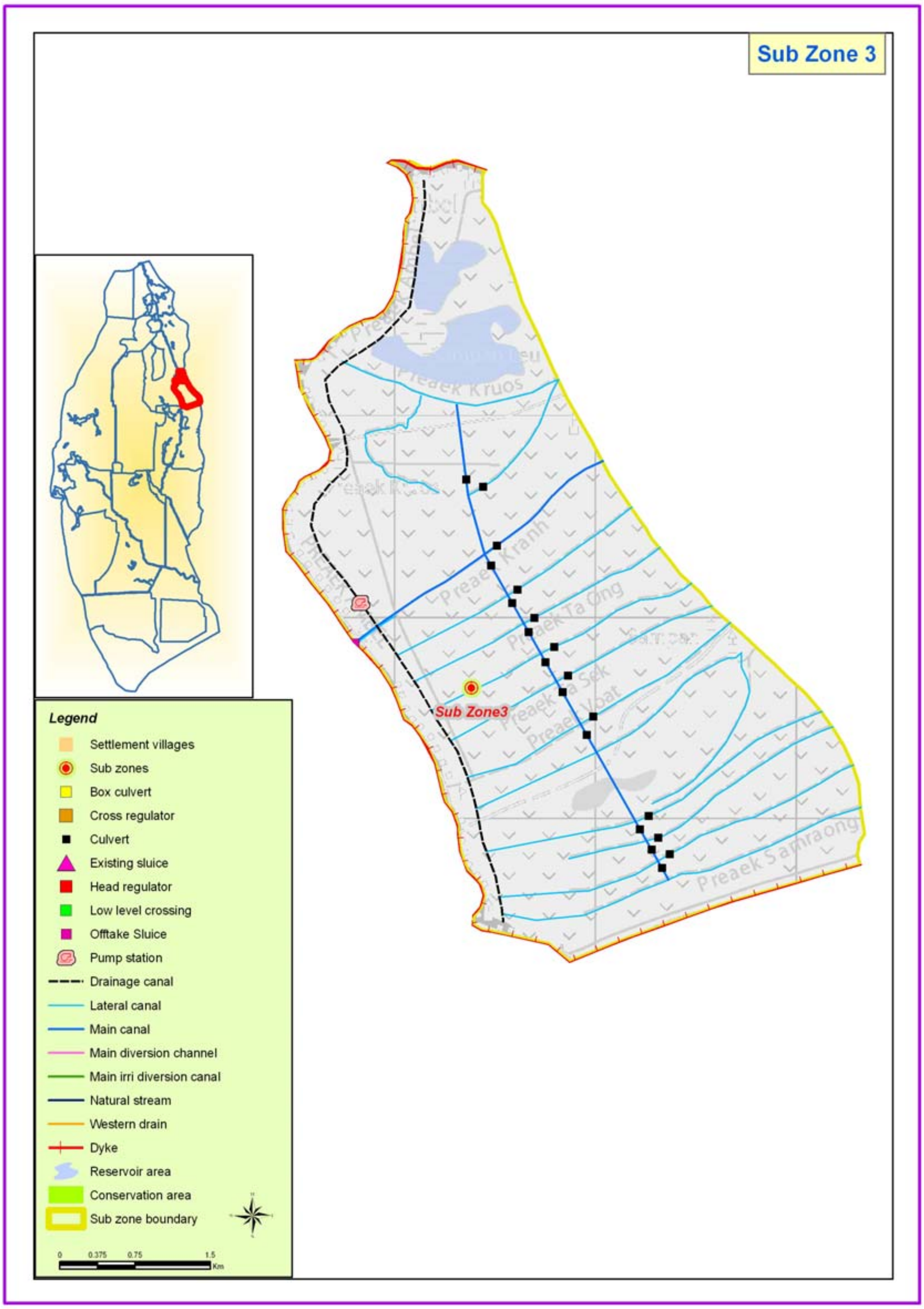
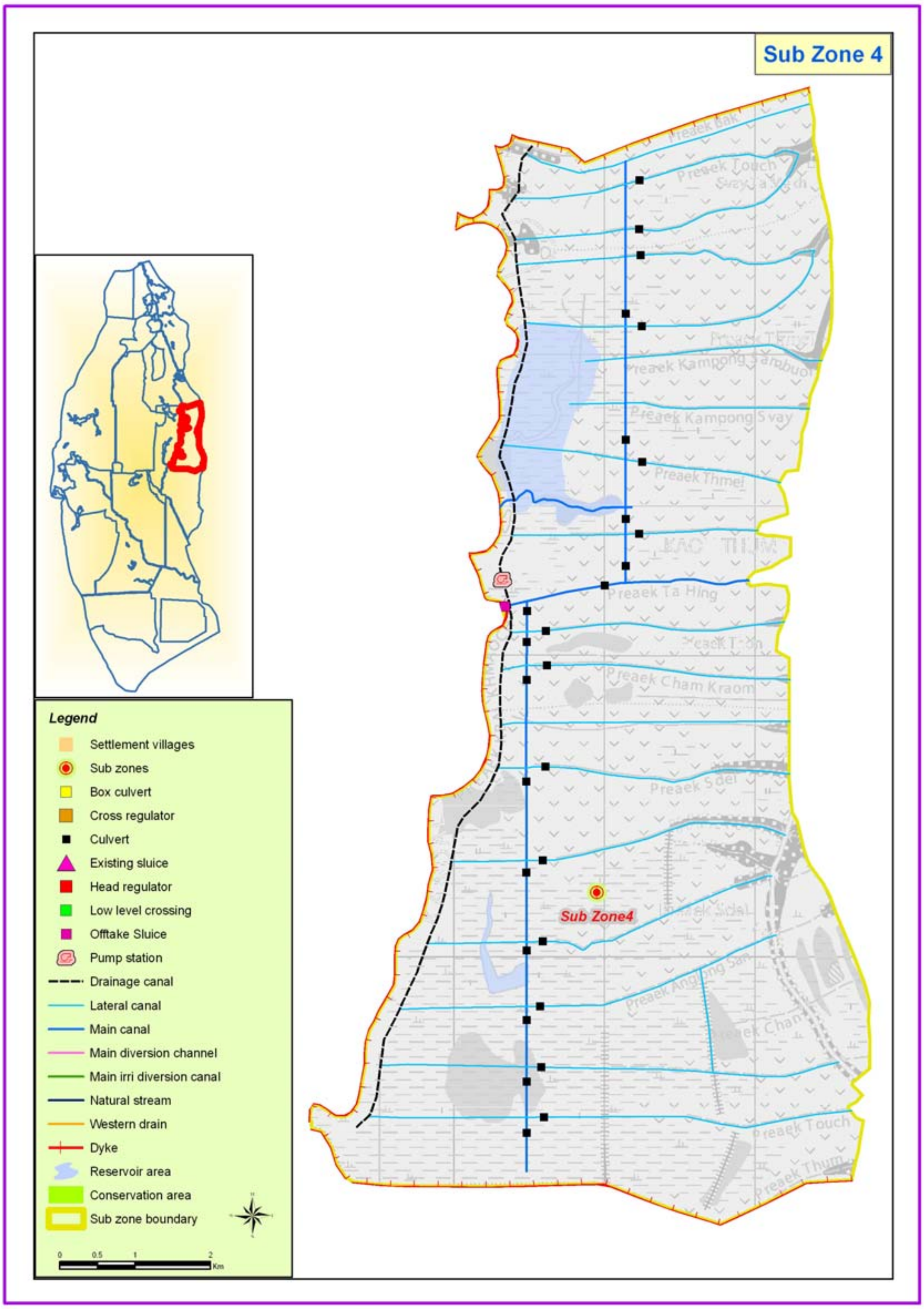
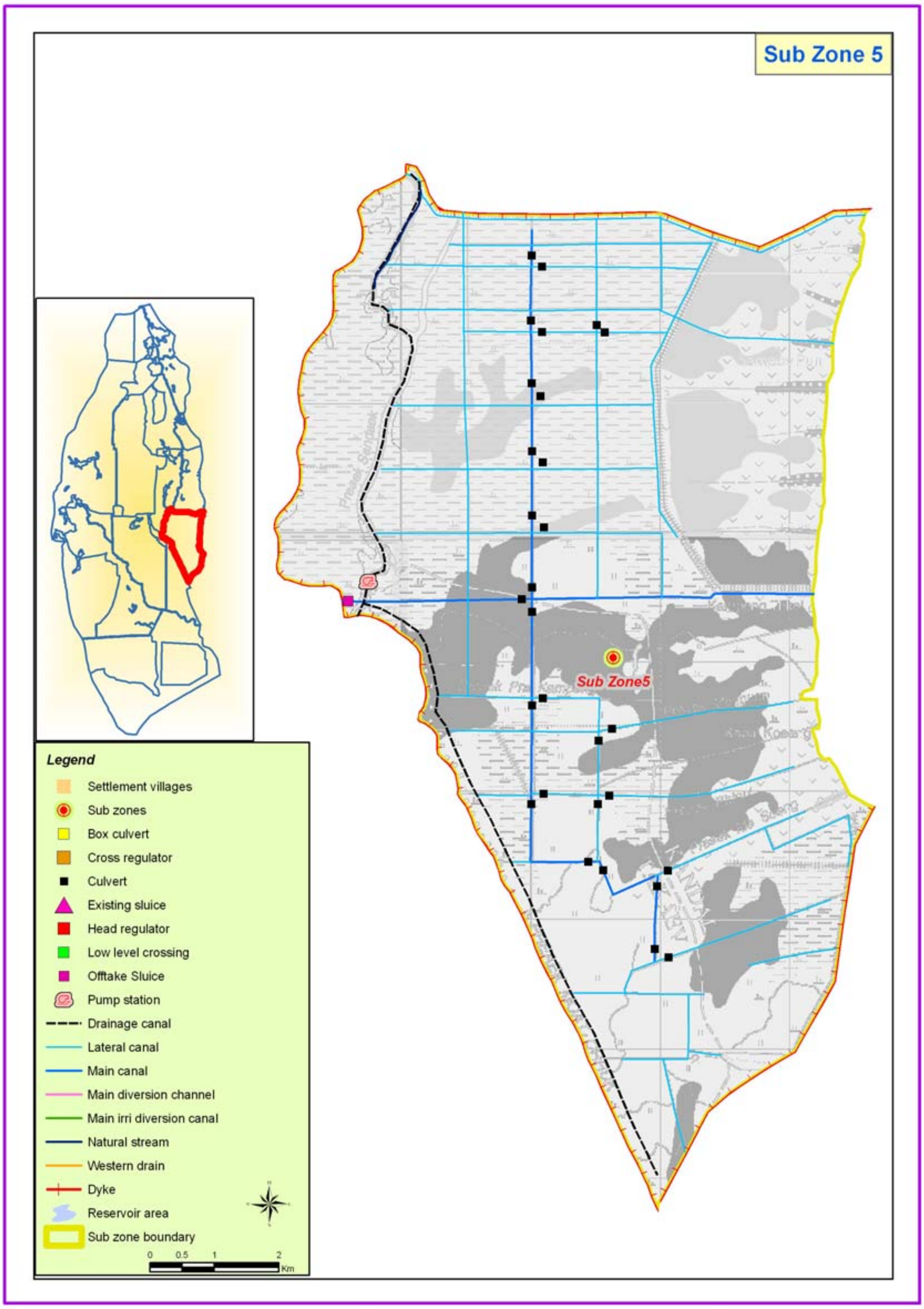
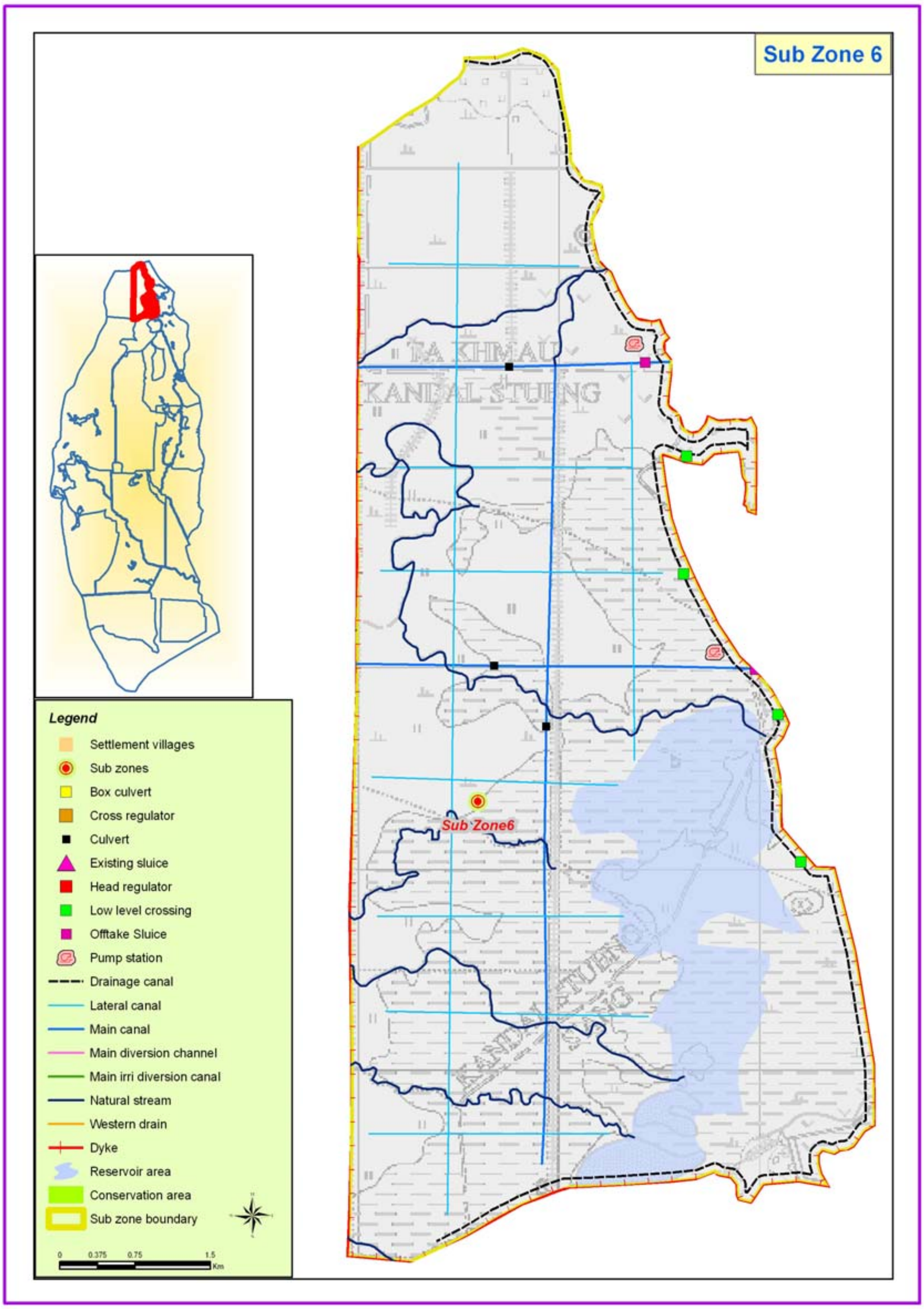
Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary
Sub Zone2
Preaek Thmei
Preaek Mau
Preaek Suos
Preaek Duong
Preaek Seang Li
Preaek Bang
Tuol Sophi


Sub Zone 3
Preaek Kruos
Preaek Kranh
Preaek Ta Ong
Preaek Ta Sek
Preaek Voat
Preaek Samraong
Sub Zone3
Legend
Settlement villages
Sub zones
Box culvert
Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary
0
0.375
0.75
1.5
Km


Sub Zone 4
Preaek Kampong Sambuor
Preaek Kampong Svay
Preaek Thmei
Preaek Ta Hing
Preaek Cham Kraom
Preaek Sdei
Sub Zone4
Preaek Touch
Legend
Settlement villages
Sub zones
Box culvert
Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary


Sub Zone 5
Sub Zone5
Legend
Settlement villages
Sub zones
Box culvert
Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Sub zone boundary
0 0.5 1 2
Km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TA KHMAU
KANDAL STUENG
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Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
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1.5
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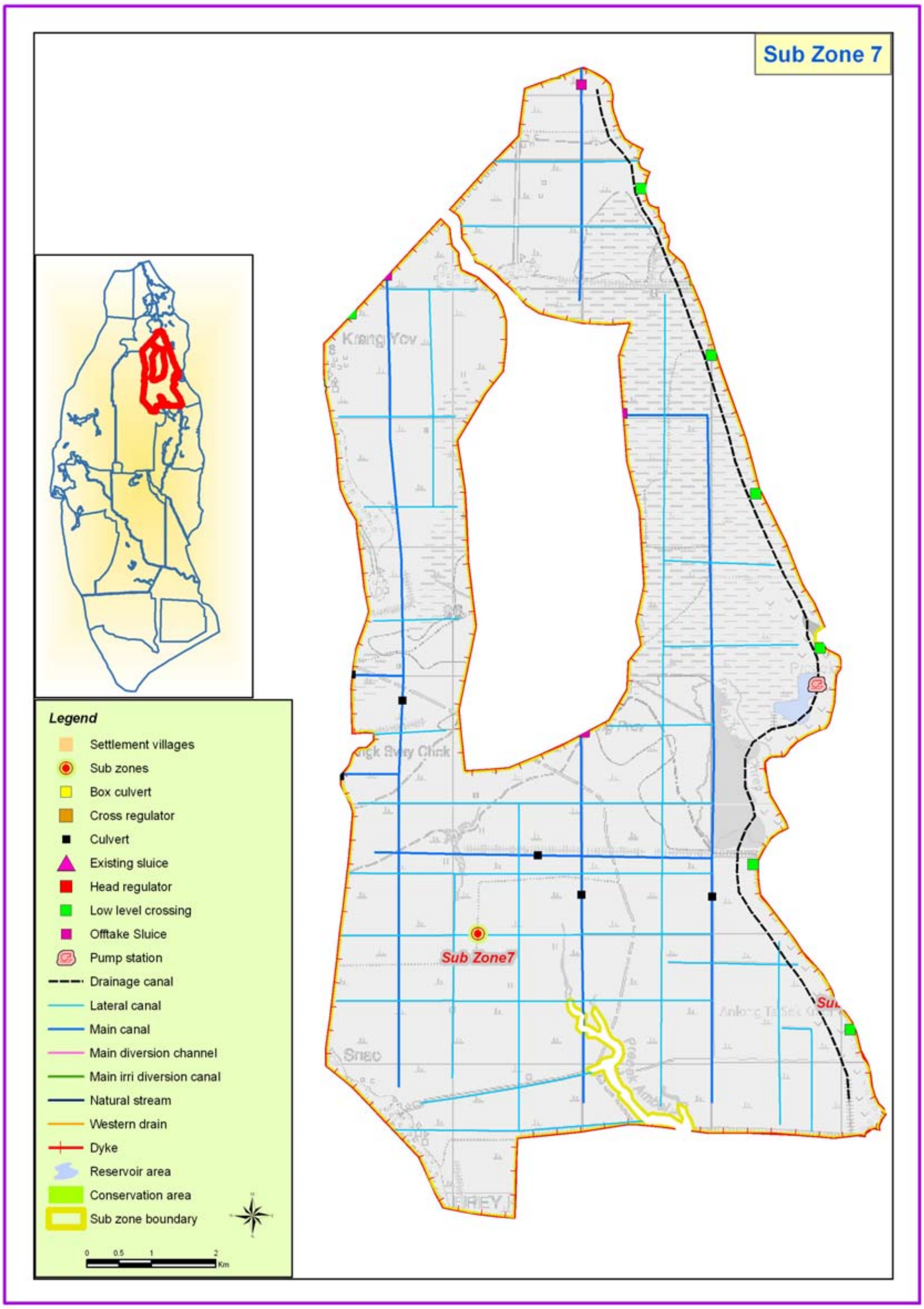
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Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary
Sub Zone7
Krang Yov
Sneo
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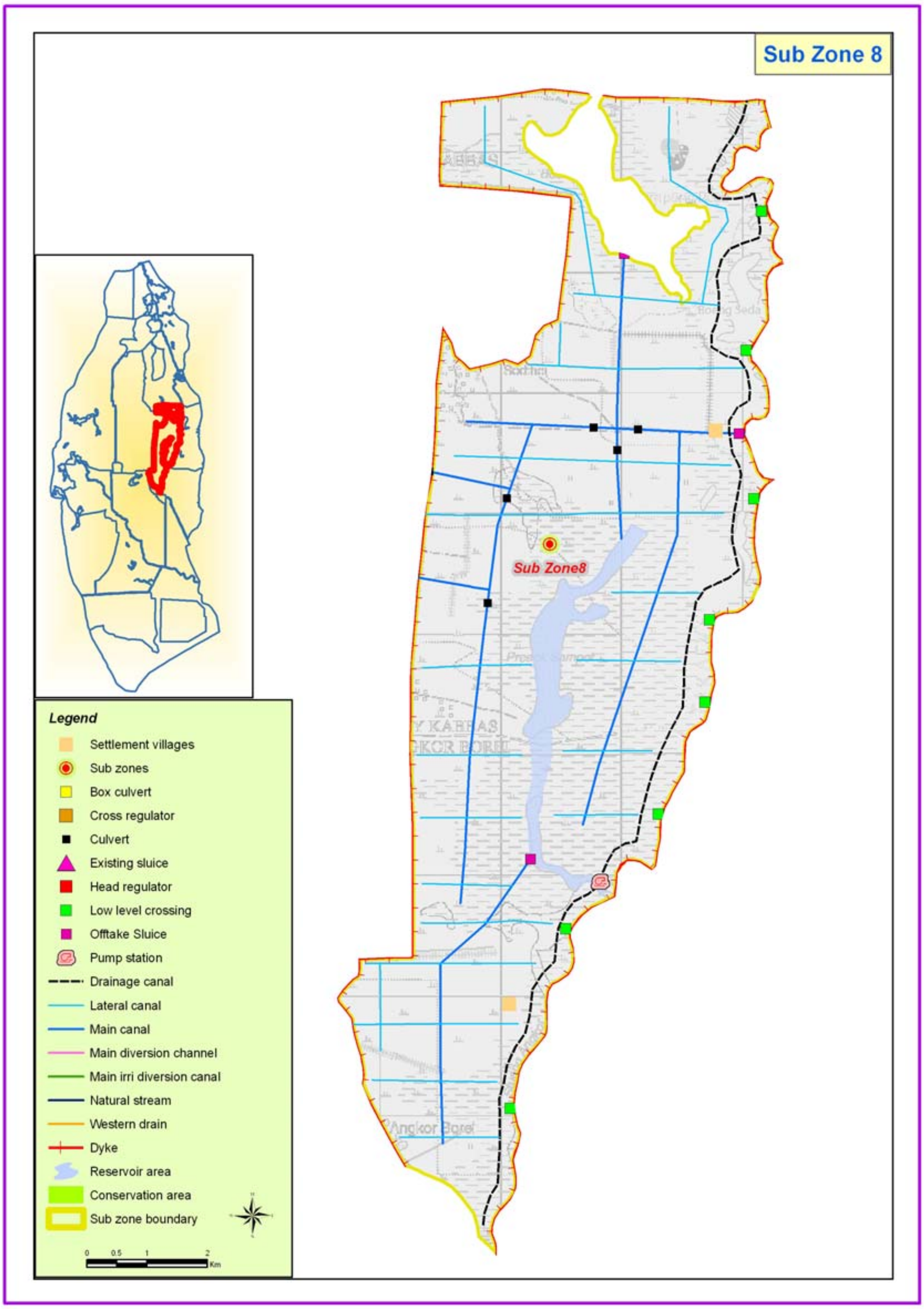
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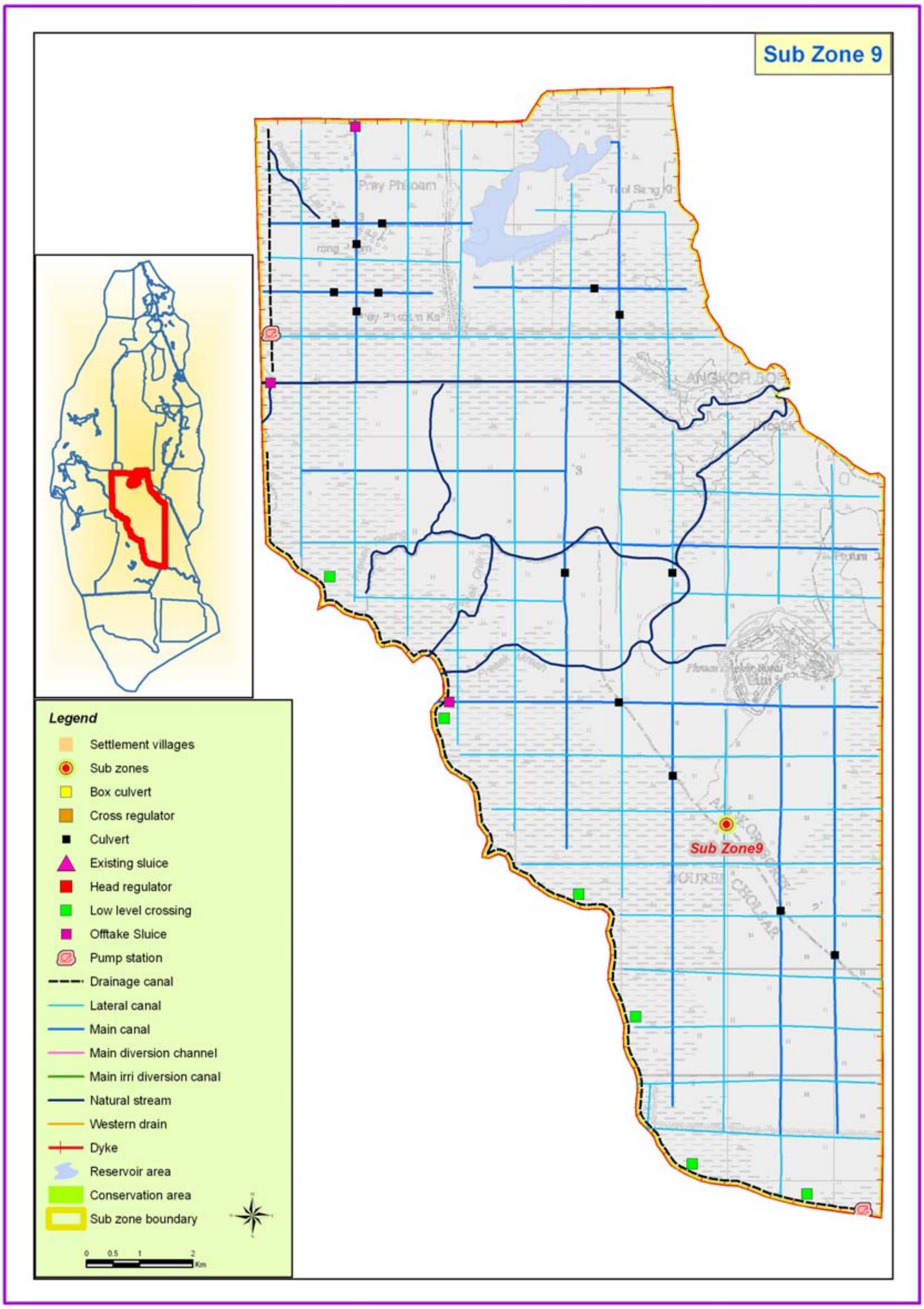
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary
0 0.5 1 2 Km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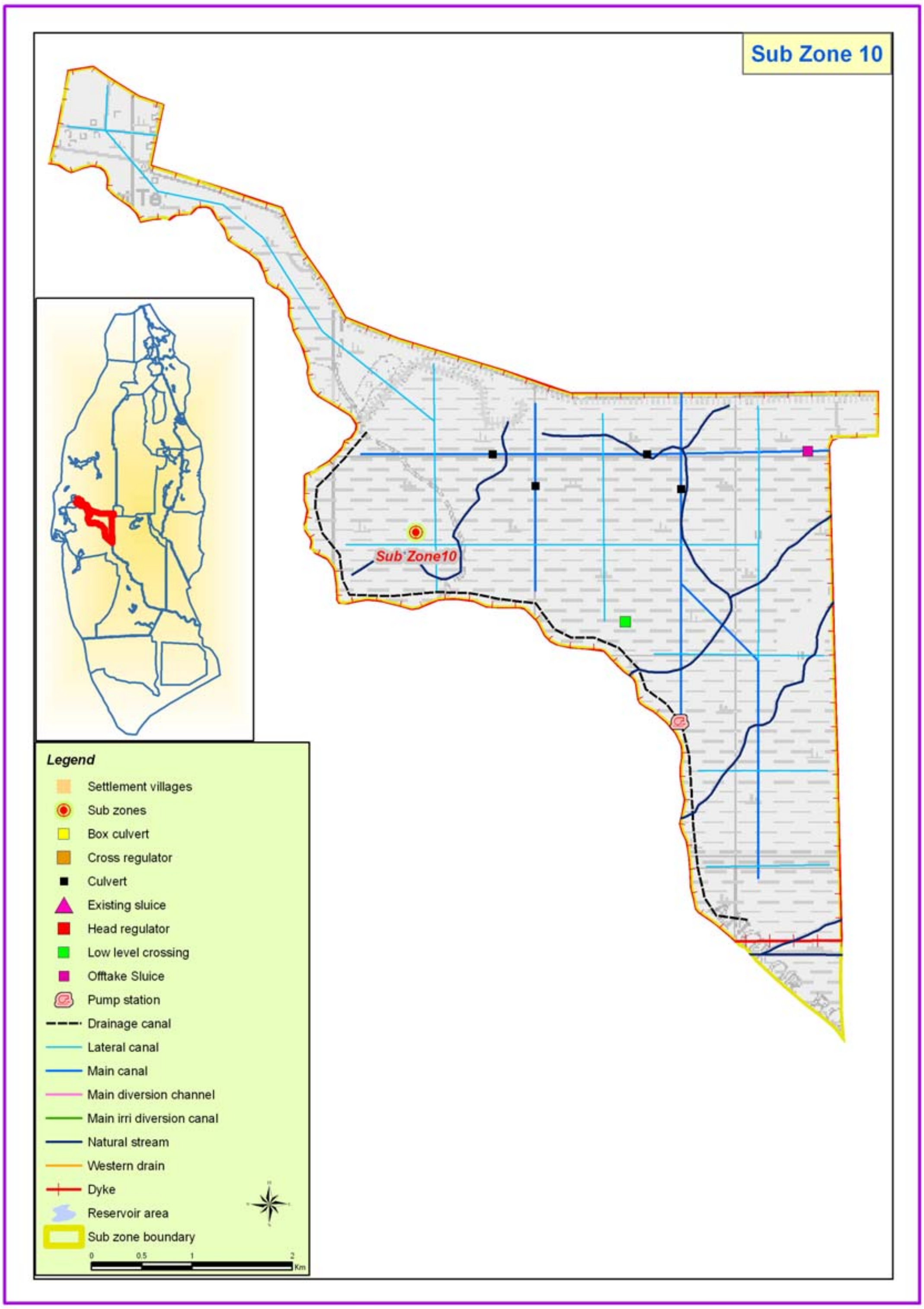
Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary
0 0.5 1 2 Km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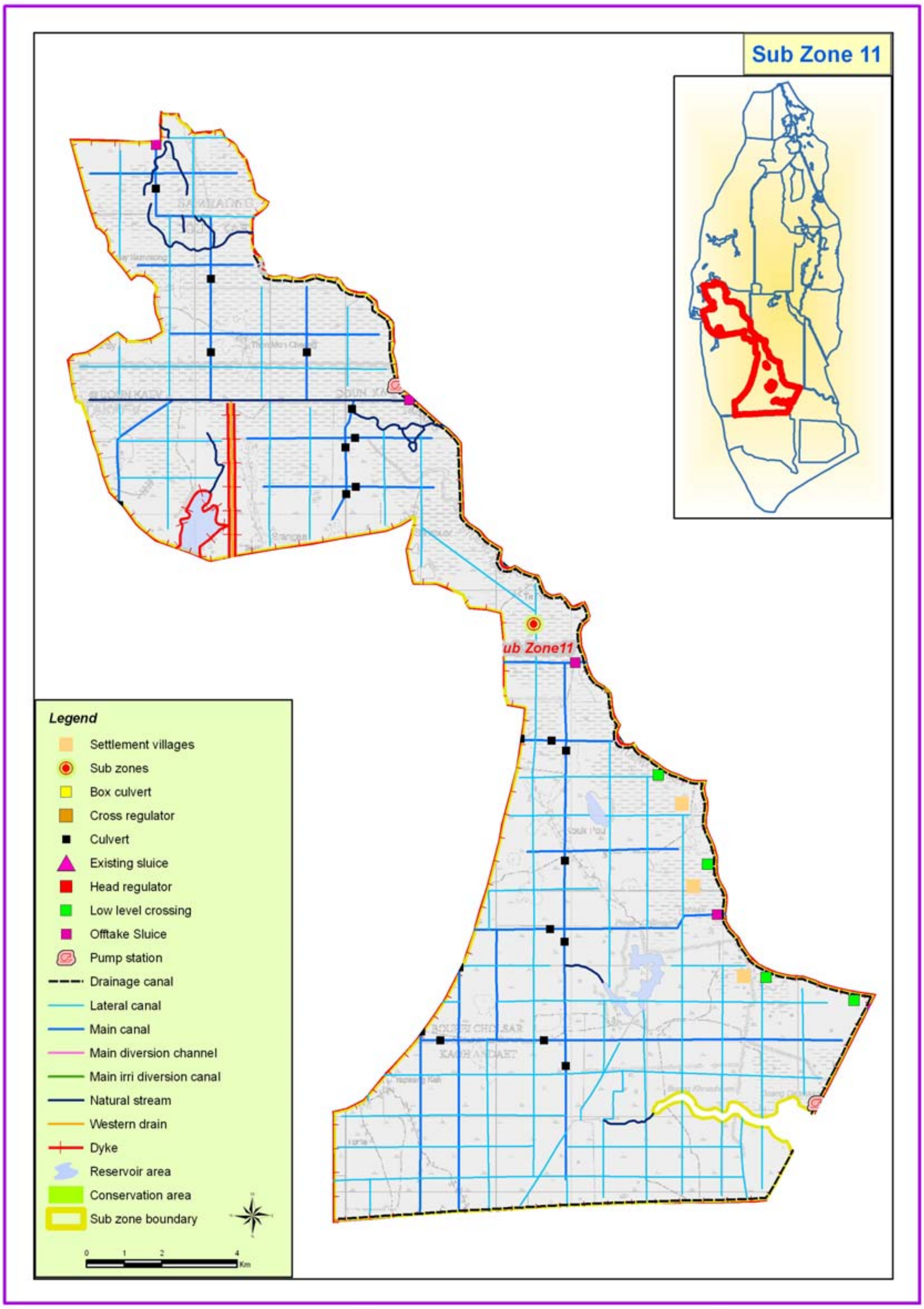
Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Sub zone boundary
0
0.5
1
2
Km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Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
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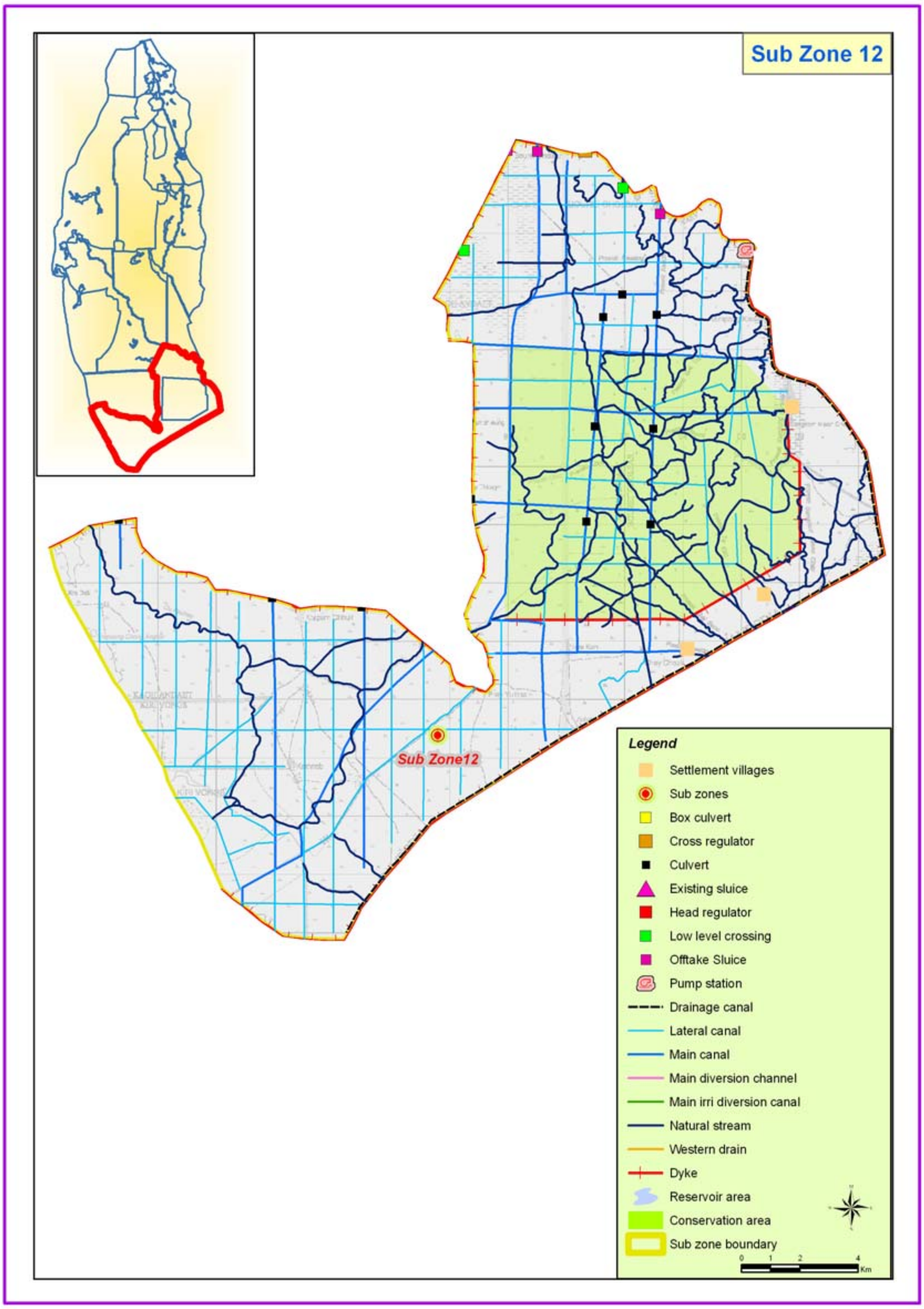
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary
0 1 2 4
Km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Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
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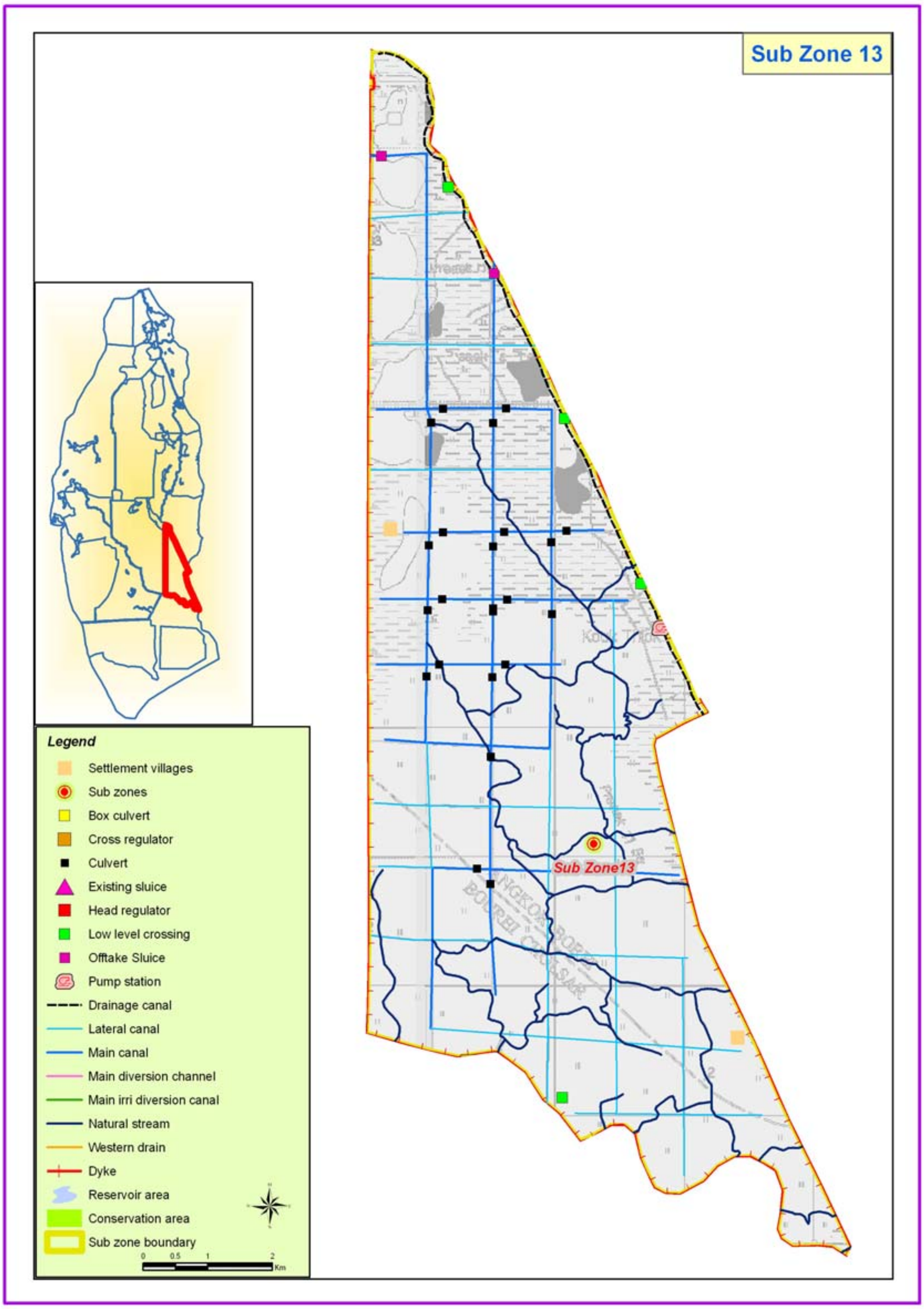
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary


Sub Zone 13
Legend
Settlement villages
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Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
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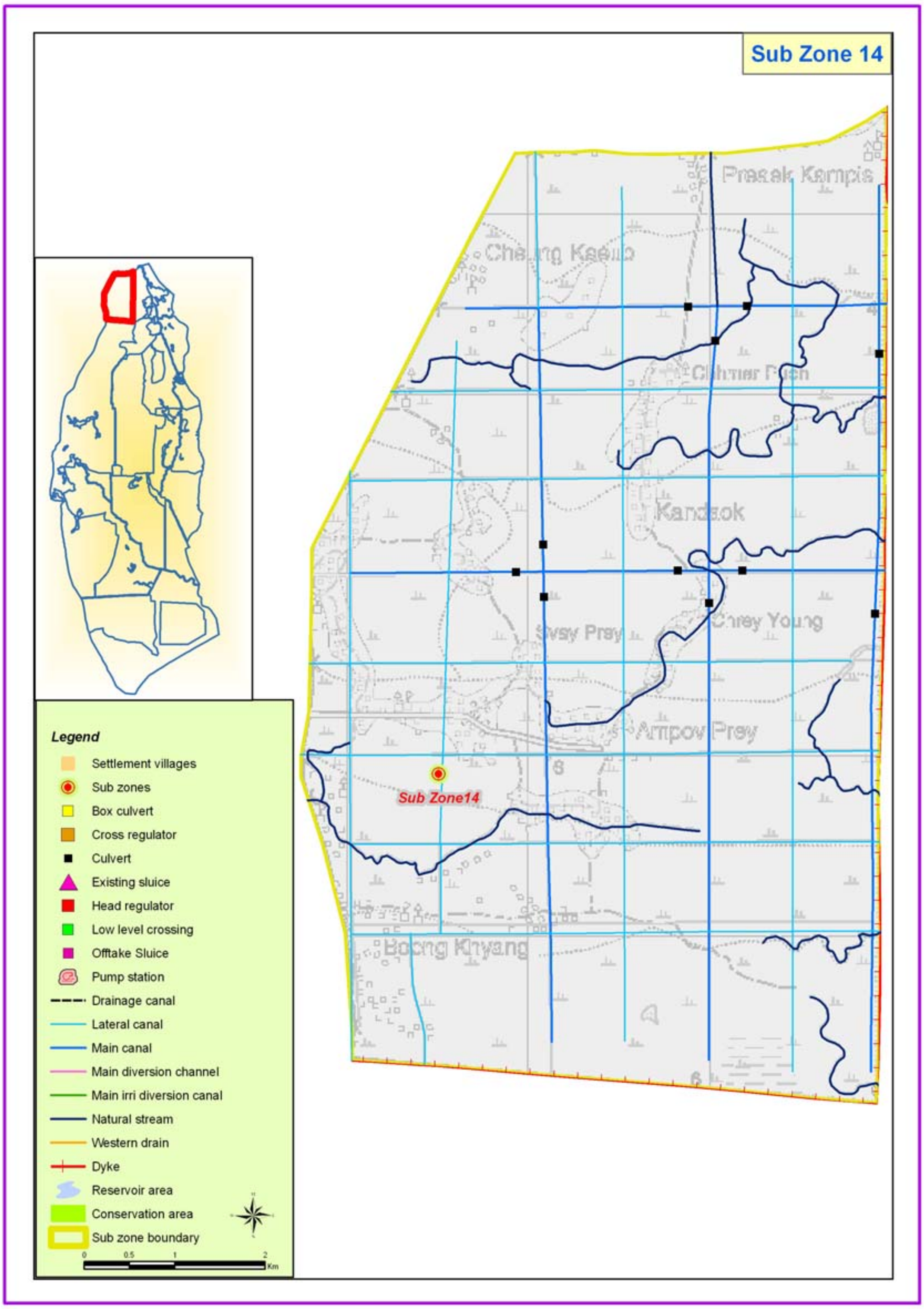
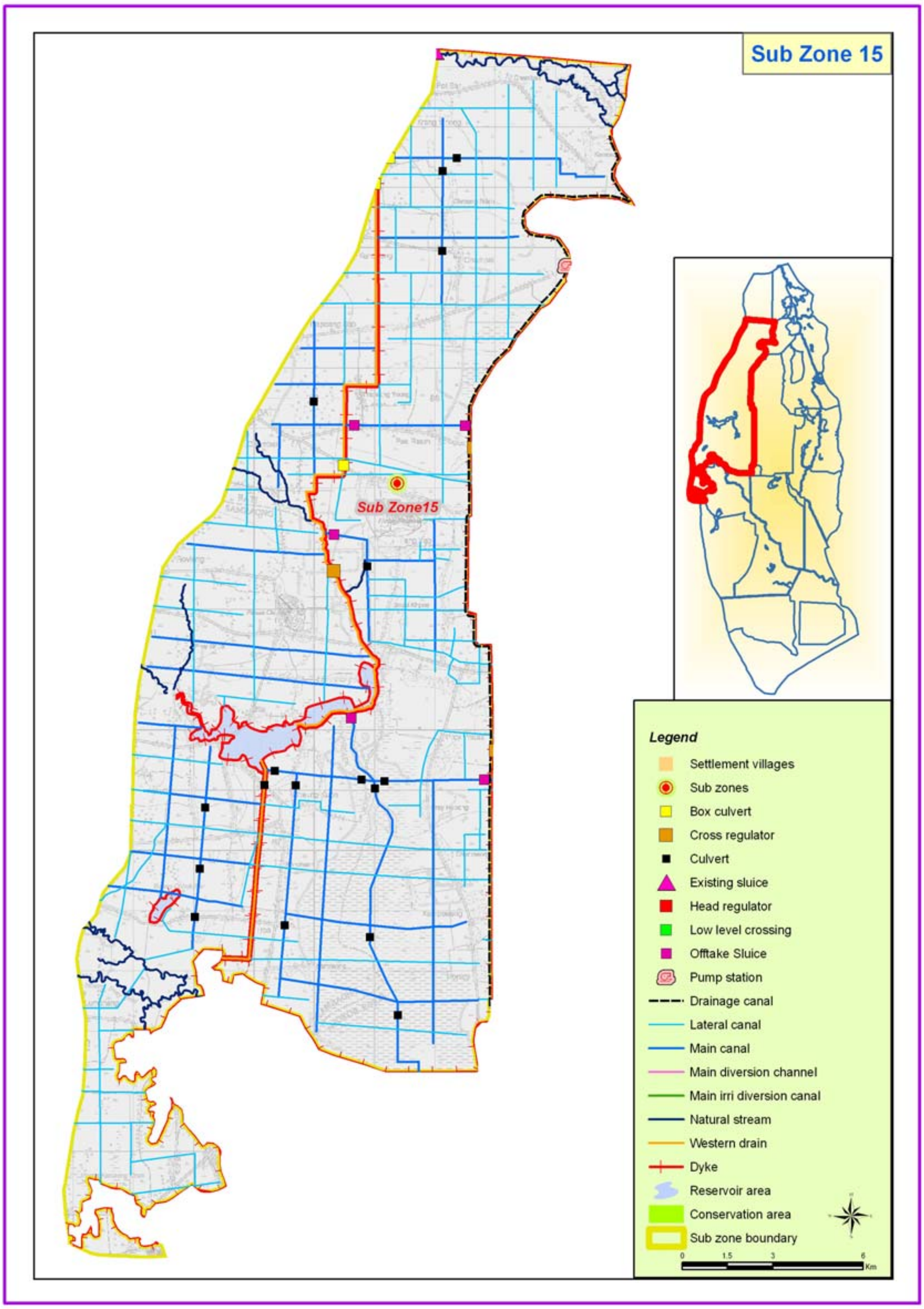
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary
0 0.5 1 2
Km
Sub Zone13



Sub Zone 14
Prasak Kampis
Cheung Kaeub
Chhmar Pean
Kandaok
Chrey Young
Svay Prey
Ampov Prey
Sub Zone14
Boeng Khyang
Legend
Settlement villages
Sub zones
Box culvert
Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary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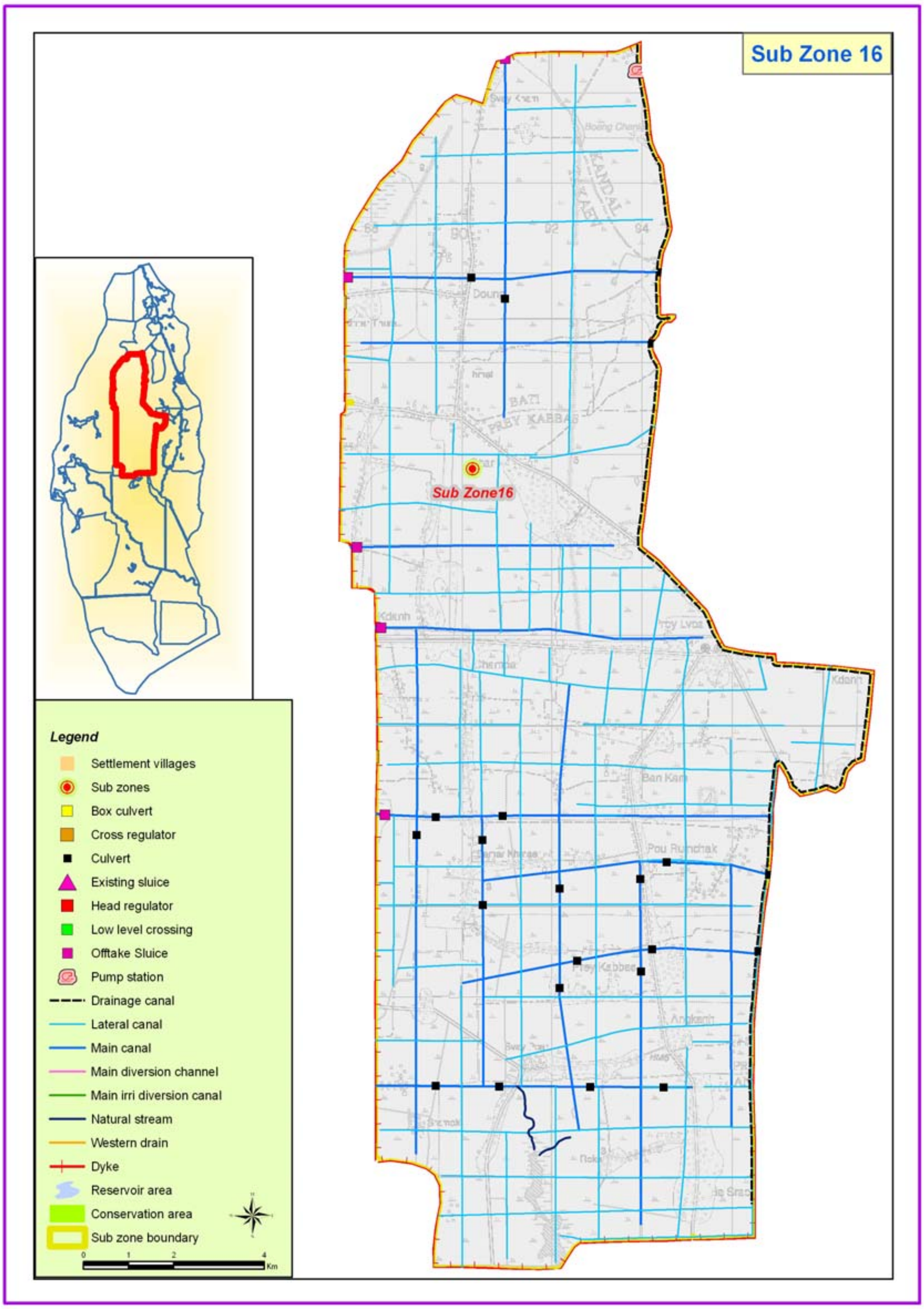
Sub Zone15
Legend
Settlement villages
Sub zones
Box culvert
Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary
0 1.5 3 6
Km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Legend
Settlement villages
Sub zones
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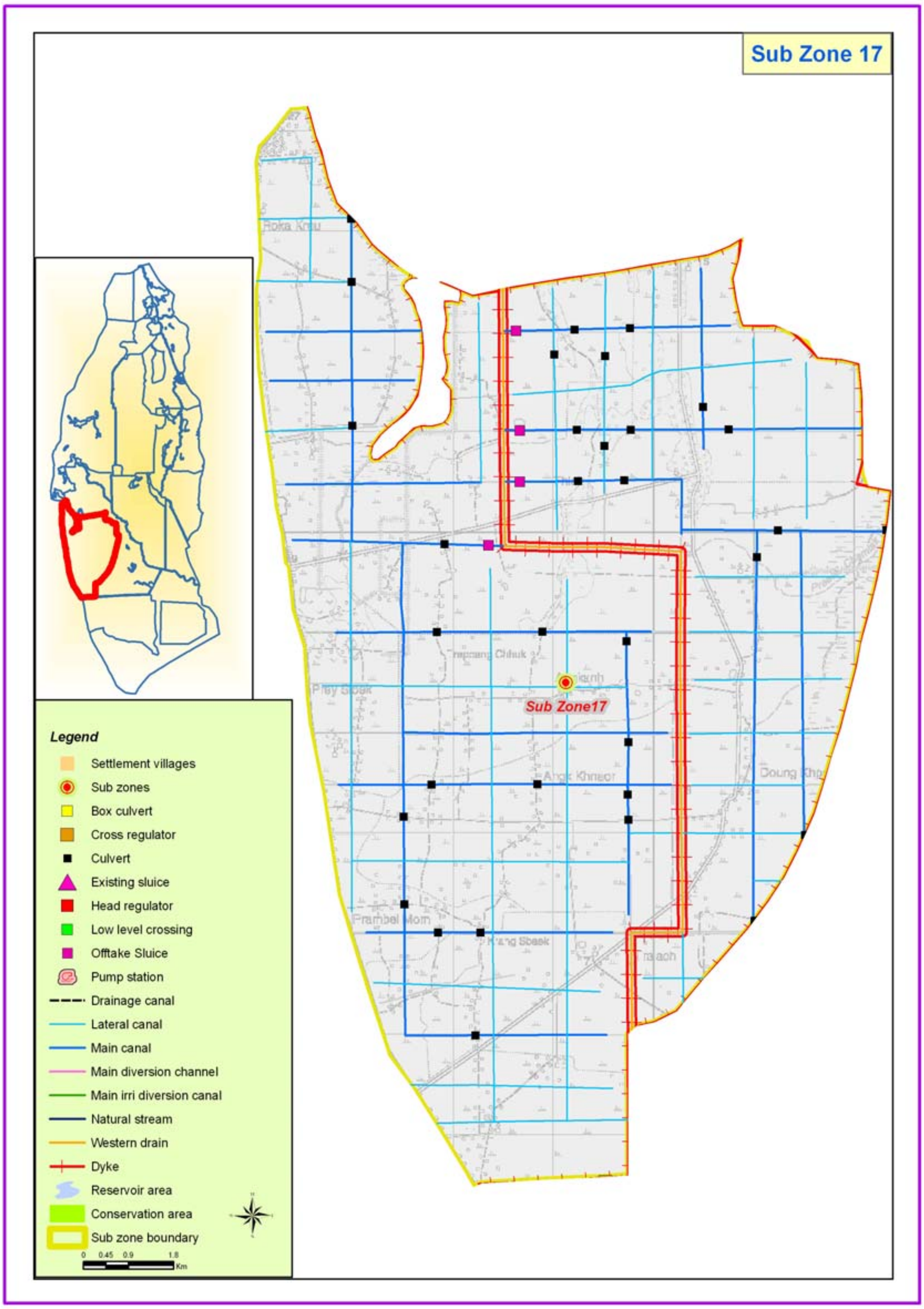
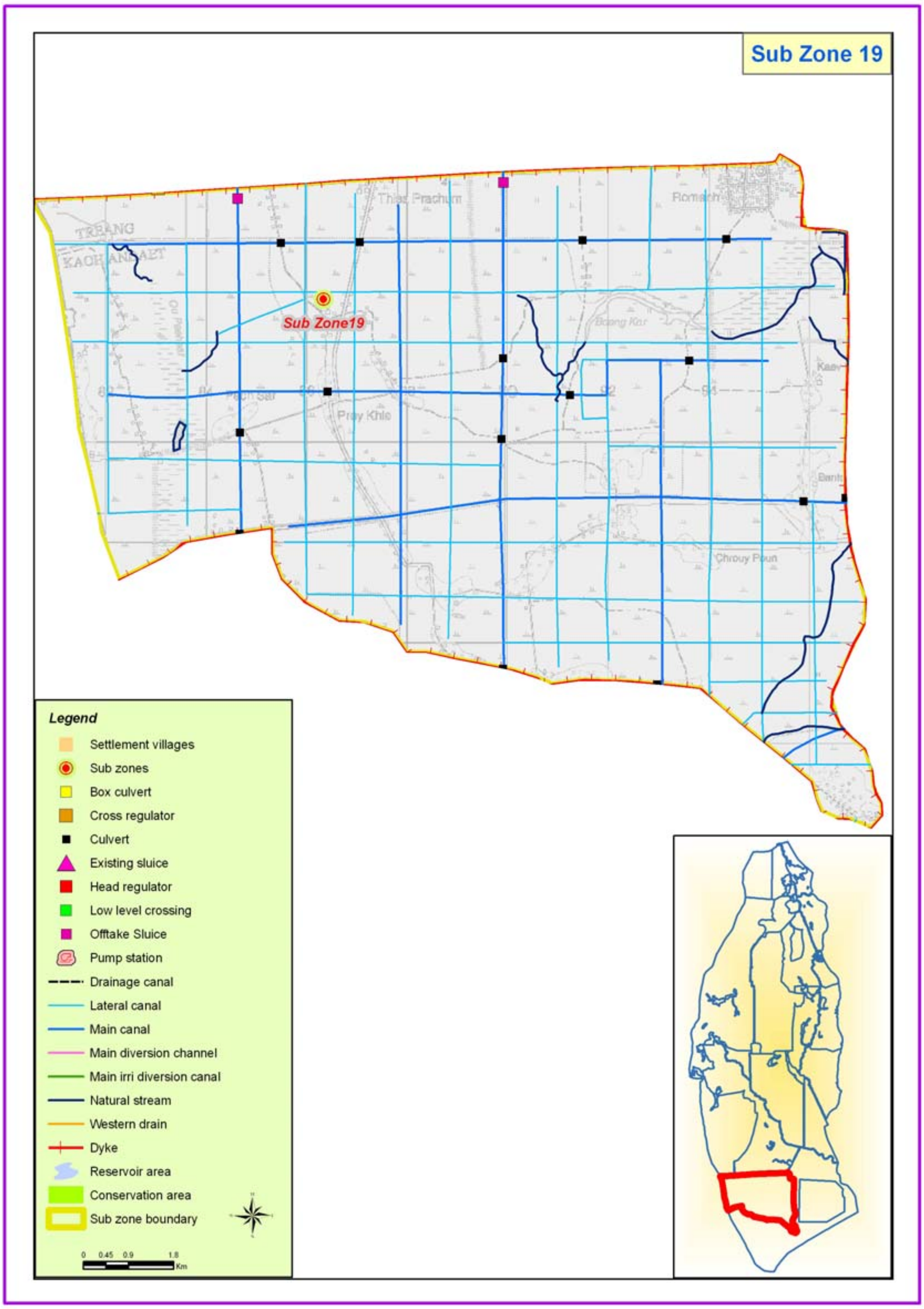
Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary
0
1
2
4
Km


Sub Zone 17
Sub Zone17
Legend
Settlement villages
Sub zones
Box culvert
Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary
0 0.45 0.9 1.8
Km


Sub Zone 19
Sub Zone19
Legend
Settlement villages
Sub zones
Box culvert
Cross regulator
Culvert
Existing sluice
Head regulator
Low level crossing
Offtake Sluice
Pump station
Drainage canal
Lateral canal
Main canal
Main diversion channel
Main irri diversion canal
Natural stream
Western drain
Dyke
Reservoir area
Conservation area
Sub zone boundary

Appendix 2 Cost estimate per subzone and per main structure

Estimated Project Cost for Option 1

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and latral and link canals	m3	48,334,868	2	96,669,736
Polder dyke	m3	15,659,603	2	31,319,206
Villages	m3	1,295,000	2	2,590,000
Irri diversion canals	m3	15,573,448	1.5	23,360,171
Prek Ambel	m3	13,041,300	2	26,082,600
Stung Takeo	m3	18,894,500	2	37,789,000
Tertiary canals	m3	3,188,073	2	6,376,146
Irrigation canals from Stung Takeo to Rominh	m3	2,043,680	2	4,087,360
	Subtotal for earth moving work volume =			**228,274,219**
Culvert	Unit	301	6,000	1,806,000
Offtake sluice	Unit	53	30,000	1,590,000
Head works	Unit	2	2,500,000	5,000,000
Cross regulators	Unit	12	50,000	600,000
Pump station	Unit	19	50,000	950,000
Box culverts	Unit	4	30,000	120,000
Gates for culverts	Unit	301	600	180,600
Gates for offtake	Unit	53	4,000	212,000
Gates for boxculverts	Unit	4	4,000	16,000
Gates for head-work structures	Unit	2	50,000	100,000
Low level crossings	Unit	35	20,000	700,000
		Subtotal for concrete works =		**11,274,600**
Land acquisition cost	m2	95,760,000	0.3	28,728,000
Resettlement cost 20% of Land acquisition cost				5,745,600
	Subtotal for land and resettlement impact =			**34,473,600**
			Total cost =	**274,022,419**
Detailed design consultancy cost 5% of total cost				13,701,121
Contigency cost 5% of total cost				13,701,121
			Grand total	**301,424,661**

Cost Break Down for Sub Zone 1

Descriptions	Unity	Qty	UnitPrice, USD	TotalPrice, USD
Main and latral and link canals	m3	7,170,440	2	14,340,880
Polder dyke	m3	10,265,617	2	20,531,235
Villages	m3	0	2	0
Main diversion channel	m3	13,041,300	2	26,082,600
Tertiary canal	m3	399,471	2	798,943
Subtotal earth moving work volume =				**61,753,657**
Culvert	Unit	128.00	6,000	768,000
Offtake sluice	Unit	13.00	30,000	390,000
Cross regulators	Unit	3.00	50,000	150,000
Head works	Unit	2.00	2,500,000	5,000,000
Pump station	Unit	6.00	50,000	300,000
Gates for culverts	Unit	128.00	600	76,800
Gates for offtake	Unit	13.00	4,000	52,000
Gate for head-works	Unit	2.00	50,000	100,000
Low level crossing	Unit	0.00	20,000	0
Subtotal for structural works =				**6,836,800**
SubTotal cost =				**68,590,457**
Land acquisition cost	m2			0.00
Resettlement cost 20% of Land acquisition cost				0.00
Subtotal for land and resettlement impact =				**0.00**
Total cost =				**68,590,457.46**
Detailed design consultancy cost 5% of total cost				3,429,522.87
Contigency cost 5% of total cost				3,429,522.87
Grand total				**75,449,503.21**

Cost Break Down for Sub Zone 2

Descriptions	Unity	Qty	UnitPrice, USD	TotalPrice, USD
Main and latral and link canals	m3	8,660,146	2	17,320,293
Polder dyke	m3	4,764,183	2	9,528,367
Villages	m3	1,295,000	2	2,590,000
Stung Takeo	m3	18,894,500	2	37,789,000
Tertiary canal	m3	1,385,070	2	2,770,140
Borei Chulsa Rominch-Kchrey canal	m3	2,043,680	2	4,087,360
Subtotal earth moving work volume =				**74,085,159**
Culvert	Unit	87.00	6,000	522,000
Offtake sluice	Unit	23.00	30,000	690,000
Cross regulators	Unit	5.00	50,000	250,000
Head works	Unit	0.00		0
Pump station	Unit	11.00	50,000	550,000
Gates for culverts	Unit	87.00	600	52,200
Gates for offtake	Unit	23.00	4,000	92,000
Gate for head-works	Unit	0.00	50,000	0
Low level crossing	Unit	35.00	20,000	700,000
Subtotal for structural works =				**2,856,200**
SubTotal cost =				**76,941,359**
Land acquisition cost	m2			0.00
Resettlement cost 20% of Land acquisition cost				0.00
Subtotal for land and resettlement impact =				**0.00**
Total cost =				**76,941,359.16**
Detailed design consultancy cost 5% of total cost				3,847,067.96
Contigency cost 5% of total cost				3,847,067.96
Grand total				**84,635,495.07**

Cost Break Down for Sub Zone 3

Descriptions	Unity	Qty	UnitPrice, USD	TotalPrice, USD
Main and latral and link canals	m3	32,504,282	2	65,008,563
Polder dyke	m3	629,803	2	1,259,605
Villages	m3	0	2	0
Main irri diversion canal	m3	15,573,448	1.5	23,360,171
Tertiary canal	m3	1,403,532	2	2,807,063
Subtotal earth moving work volume =				**92,435,403**
Culvert	Unit	86.00	6,000	516,000
Offtake sluice	Unit	17.00	30,000	510,000
Cross regulators	Unit	4.00	50,000	200,000
Head works	Unit	0.00	2,500,000	0
Box culvert	Unit	4.00	30,000	120,000
Pump station	Unit	2.00	50,000	100,000
Gates for culverts	Unit	86.00	600	51,600
Gates for offtake	Unit	17.00	4,000	68,000
Gate for head-works	Unit		50,000	0
Gate for box culvert	Unit	4.00	4,000	16,000
Subtotal for structural works =				**1,581,600**
SubTotal cost =				**94,017,003**
Land acquisition cost	m2	95760000	0.3	28,728,000.00
Resettlement cost 20% of Land acquisition cost				5,745,600.00
Subtotal for land and resettlement impact =				**34,473,600.00**
Total cost =				**128,490,602.67**
etailed design consultancy cost 5% of total cost				6,424,530.13
Contigency cost 5% of total cost				6,424,530.13
Grand total				**141,339,662.94**

301,424,661.22

Sub zone1

Total area, ha	2754.49		
Irr/Drainage requirement	3.00	l/s.ha	
Main canal	Leng_km	Area,ha	Disch,m3/s
1	2.12	1377.25	4.13
2	2.44	1377.25	4.13
3	2.56	1377.25	4.13
4	0.95	1377.25	4.13
5	1.98	1377.25	4.13
6	2.27	1377.25	4.13
	8.62	Length reduce by 30%	
7	1.52	918.16	2.75
8	1.42	918.16	2.75
9	1.65	918.16	2.75
10	0.69	918.16	2.75
	3.70	Length reduce by 30%	
Total length, km =	**12.32**		
Drainage canal =	9.29		
Dyke =	**30.07**		
Culvert =	13.00		
Offtake sluice =	4.00		
Pump station =	2.00		

Earth volume for main canals:

Q =	4.50	m3/s
b =	2	m
m =	1.5	m
h =	2.11	m
Length =	8.62	
A =	11	m2
Volume =	**93,986**	**m3**
Total, m3 =	**188,690**	

Earth volume for main canals:

Q =	3.00	m3/s
b =	1.5	m
m =	2	m
h =	1.73	m
Length =	3.70	
A =	9	m2
Volume =	**31,715**	**m3**

Earth volume for lateral:

Q =	0.52	m3/s
b =	0.6	m
m =	2	m
h =	1.12	m
Length =	19.80	
A =	3	m2
Volume =	**62,989**	**m3**

Computation of earth volume for polder dyke

Topwidth =	4	m
m =	2	
h =	5.4	m
A =	79.92	m2
Length =	30.07	km
Volume =	**2,403,194**	**m3**

Irri req		3.00	l/s.ha
	Length, km	Area, ha	Dish,m3/s
Lateral	1.17	174	0.52
Lateral	1.53	174	0.52
Lateral	3.00	174	0.52
Lateral	2.12	174	0.52
Lateral	3.01	174	0.52
Lateral	2.69	174	0.52
Lateral	3.29	174	0.52
Lateral	2.02	174	0.52
Lateral	9.46	174	0.52
	19.80		

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and lateral canals	m3	188,690	2	377,379
Polder dyke	m3	2,403,194	2	4,806,389
Villages	m3	0	2	0
	Subtotal earth moving work volume =			**5,183,768**
Culvert	Unit	13.00	6,000	78,000
Offtake sluice	Unit	4.00	30,000	120,000
Pump station	Unit	2.00	50,000	100,000
Gates for culverts	Unit	13.00	600	7,800
Gates for offtake	Unit	4.00	4,000	16,000
	Subtotal earth moving work volume =			**321,800**
Total cost =				**5,505,568**

Total area		4824.12	ha	
Irri requirement		3.00	l/s.ha	

RangNo	Leng_km	Area,ha	Dish,m3/s
1	13.03	4824.12	14.47
2	5.49	4824.12	14.47
Total length, km =	**12.96**		
Lateral, km =	**46.88**		

Drainage canal	**12.67**
Dyke	**30.23**
	No.
Culvert	**38.00**
Offtake sluice	**3.00**
Pump station	**1.00**

Earth volume for colmatag canals:

Q =	91.00	m3/s
b =	50	m
m =	2	m
h =	3	m
Length =	5.49	km
A design =	168	m2
Volume =	**922,320**	**m3**

Earth volume for main canals:

Q =	14.50	m3/s
b =	3.5	m
m =	2	m
h =	3.03	m
Length =	13.03	km
A =	28.9668	m2
Volume =	**377,437**	**m3**

Earth volume for lateral

Q =	1.28	m3/s
b =	1	m
m =	2	m
h =	1.45	m
Length =	46.88	km
A =	5.655	m2
Volume =	**265,101**	**m3**

Total volume = 1,564,858

Computation of earth volume for polder dyke

Topwidth =	4	m
m =	2	
h =	5.4	m
A =	79.92	m2
Volume =	**2,415,982**	**m3**

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and latral and link canals	m3	1,564,858	2	3,129,716
Polder dyke	m3	2,415,982	2	4,831,963
Villages	m3	0	2	0
Subtotal earth moving work volume =				**7,961,679**
Culvert	Unit	38	6,000	228,000
Offtake sluice	Unit	3	30,000	90,000
Pump station	Unit	1	50,000	50,000
Gates for culverts	Unit	38	600	22,800
Gates for offtake	Unit	3	4,000	12,000
Subtotal earth moving work volume =				**402,800**
Total cost =				**8,364,479**

Total area	2187.34	ha
Irri requirement	3.00	l/s.ha

RangNo	Leng_km	Area,ha	Dish,m3/s
1	5.24	2187.34	6.56
5	0.00	2187.34	6.56
Total length, km =	3.67		
Lateral, km =	27.13		
Link canal =	3.42		
Drainage canal=	8.47		
Dyke =	10.40		
Dyke =	6.84	For link canal	
Total length, km =	17.24		

	No.
Culvert	20.00
Offtake sluice	2.00
Pumpstation	1.00

Earth volume for comatag canal (Link canal):

Q =	306.00	m3/s
b =	60	m
m =	2	m
h =	5	m
Length =	3.42	km
A design =	350	m2
Volume =	**1,197,000**	**m3**
Total volume =	**1,360,505**	

Earth volume for main canals:

Q =	7.00	m3/s
b =	2.5	m
m =	2	m
h =	2.38	m
Length =	3.67	km
A =	17.2788	m2
Volume =	**63,379**	**m3**

Earth volume for lateral

Q =	0.40	m3/s
b =	0.6	m
m =	1.5	m
h =	0.96	m
Length =	51.13	km
A =	1.9584	m2
Volume =	**100,126**	**m3**

b =	4						
m =	2						
FrBoard =	1.8						
Section	**GrnElv**	**WsEl**	**h**	**A**	**Ave**	**Length,km**	**Volume, m3**
0	3.12	7.75	6.44	108.65			
1	3.12	7.70	6.38	106.90	107.77	5.20	560,529.90
2	5.26	7.68	4.21	52.35	79.63	5.18	412,616.80
					106.90	6.84	731.19
						10.38	**973,877.89**

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and latral and link canals	m3	1,360,505.0	2.0	2,721,009.9
Polder dyke	m3	973,877.9	2.0	1,947,755.8
Villages	m3	0.0	2.0	0.0
	Subtotal earth moving work volume =			**4,668,765.7**
Culvert	Unit	20.0	6,000.0	120,000.0
Offtake sluice	Unit	2.0	30,000.0	60,000.0
Pump station	Unit	1.0	50,000.0	50,000.0
Gates for culverts	Unit	20.0	600.0	12,000.0
Gates for offtake	Unit	2.0	4,000.0	8,000.0
	Subtotal earth moving work volume =			**250,000.0**
			Total cost =	**4,918,765.7**

SZ3

Total area	2187.34	ha	
Irri requirement	3.00	l/s.ha	

RangNo	Leng_km	Area,ha	Dish,m3/s
2	5.59	1093.67	3.28
3	7.58	1093.67	3.28
Main canal =	9.22		
Link canal =	4.23		172.00
Lateral, km =	55.65		
Drainage canal	13.85		
Dyke	33.95		

	No.
Culvert	28.00
Offtake sluice	2.00
Pumpstation	1.00

Earth work volume for colmatage canal

Q =	172.00	m3/s
b =	50	m
m =	2	m
h =	4	m
Length =	4.23	km
A design =	232	m2
Volume =	**981360**	**m3**
Total volume =	**1302455.6**	

Earth volume for main canals:

Q =	3.00	m3/s
b =	1.5	m
m =	2	m
h =	1.73	m
Length =	13.17	
A =	8.5808	m2
Volume =	**113009.136**	**m3**

Earth volume for lateral

Q =	0.78	m3/s
b =	1	m
m =	2	m
h =	1.14	m
Length =	55.65	km
A =	3.7392	m2
Volume =	**208086.5**	**m3**

SZ4

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and latral and link canals	m3	1,302,455.6	2.0	2,604,911.2
Polder dyke	m3	1,703,735.1	2.0	3,407,470.2
Villages	m3	0.0	2.0	0.0
	Subtotal earth moving work volume =			**6012381.465**
Culvert	Unit	28.0	6,000.0	168,000.0
Offtake sluice	Unit	2.0	30,000.0	60,000.0
Pump station	Unit	1.0	50,000.0	50,000.0
Gates for culverts	Unit	28.0	600.0	16,800.0
Gates for offtake	Unit	2.0	4,000.0	8,000.0
	Subtotal earth moving work volume =			**302800**
			Total cost =	**6315181.465**

b =	4
m =	2
FrBoard =	1.8

Section	**GrnElv**	**WsEl**	**h**	**A**	**Ave**	**Length,km**	**Volume, m3**
0	5.26	7.7	4.4	77.9			
1	5.01	7.6	4.6	82.9	80.4	5.6	450,047.8
2	5.07	7.4	4.4	76.4	79.7	5.4	431,019.6
3	3.17	7.4	6.2	153.9	115.2	6.5	747,770.9
					4.6	16.5	74,896.9
						34.0	**1,703,735.1**

Total area	9039.60	ha		
Irri requirement	3.00	l/s.ha		
RangNo	Leng_km	Area,ha	Dish,m3/s	
Main canal =	9.43	4519.80	13.56	
Link canal =	8.20			
Lateral =	66.85			
Drainage canal	18.18			
Dyke	37.60			
	No.			
Culverts	29.00			
Offtake sluice	2.00			
Pumpstation	1.00			

Earth volume for comatag canal (Link canal):			Earth volume for main canals:			Earth volume for lateral		
Q =	180.00	m3/s	Q =	14.00	m3/s	Q =	2.88	m3/s
b =	50	m	b =	3.5	m	b =	1.6	m
m =	2	m	m =	2	m	m =	2	m
h =	4	m	h =	3.03	m	h =	1.78	m
Length =	8.20	km	Length =	8.20		Length =	66.85	km
A design =	232	m2	A =	28.9668	m2	A =	9.1848	m2
Volume =	**1,902,400.0**	**m3**	**Volume =**	**237,527.8**	**m3**	**Volume =**	**614,003.9**	**m3**
Volume total =	**2,753,931.6**							

Descriptions	Unity	Qty	UnitPrice, USD	TotalPrice, USD
Main and latral and link canals	m3	2,753,931.6	2.0	5,507,863.3
Polder dyke	m3	2,768,828.3	2.0	5,537,656.5
Villages	m3	0.0	2.0	0.0
		Subtotal earth moving work volume =		**11,045,519.81**
Culvert	Unit	29.0	6,000.0	174,000.0
Offtake sluice	Unit	2.0	30,000.0	60,000.0
Pump station	Unit	1.0	50,000.0	50,000.0
Gates for culverts	Unit	29.0	600.0	17,400.0
Gates for offtake	Unit	2.0	4,000.0	8,000.0
		Subtotal earth moving work volume =		**309,400.0**
			Total cost =	**11,354,919.8**

b =	4							
m =	2							
FrBoard =	1.8							
Section	**GrnElv**	**WsEl**	**h**	**A**	**Ave**	**Length,km**	**Volume, m3**	
0	3.17	7.38	6.00	144.14				
1	3.41	5.98	4.37	76.42	110.28	6.00	662,140.93	
2	2.60	5.98	5.18	107.37	91.90	7.88	723,779.23	
3	2.74	5.52	4.58	83.94	95.66	7.16	684,614.60	
		Dike from Chhrey Thom to Moat Chhruk =			95.66	7.30	698,293.50	9.26
					83.94	9.26	777,305.18	
						37.60	**2,768,828.26**	

Total area, ha	3735.78		
Irri requirement	3.00	l/s.ha	
RangNo	Leng_km	Area,ha	Dish,m3/s
1	3.11	1867.89	5.60
2	7.95	1867.89	5.60
3	4.14	1867.89	5.60
Main canal =	**10.64**		
Lateral =	**21.98**		
Drainage channel =	**19.74**		
Dyke =	**22.53**		
Culvert =	**3.00**		
Offtake sluice =	**2.00**		
Pump station =	**2.00**		
Low level crossing =	**4.00**		

Earth volume for main canals:

Q =	6.00	m3/s
b =	2	m
m =	2	m
h =	2.14	m
Length =	10.64	
A =	13.4392	m2
Volume =	**142,993.1**	**m3**
Total volume, m3 =	**157,308.4**	

Earth volume for lateral

Q =	0.68	m3/s
b =	0.8	m
m =	2	m
h =	1.13	m
Length =	31.37	
A =	3.4578	m2
Volume =	**14,315.3**	**m3**

SZ6

Computation of earth volume for polder dyke

Topwidth =	4.0	m
m =	2.0	
h =	0.5	m
A =	2.5	m2
Length =	22.5	km
Volume =	**56,325.0**	**m3**

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and lateral canals	m3	157,308.4	2.0	314,616.8
Polder dyke	m3	56,325.0	2.0	112,650.0
Villages	m3	0.0	2.0	0.0
	Subtotal earth moving work volume =			**427266.76**
Culvert	Unit	3.0	6,000.0	18,000.0
Offtake sluice	Unit	2.0	30,000.0	60,000.0
Pump station	Unit	2.0	50,000.0	100,000.0
Gates for culverts	Unit	3.0	600.0	1,800.0
Gates for offtake	Unit	2.0	4,000.0	8,000.0
Low level crossing	Unit	4.0	20,000.0	80,000.0
	Subtotal earth moving work volume =			**267,800.00**
			Total cost =	**695,066.76**

Irri req	3.00	l/s.ha	
	Length, km	Area, ha	Dish,m3/s
Lateral	10.48	228	0.684
Lateral	3.95	228	0.684
Lateral	1.89	228	0.684
Lateral	2.37	228	0.684
Lateral	2.81	228	0.684
Lateral	2.45	228	0.684
Lateral	2.45	228	0.684
Lateral	2.61	228	0.684
Lateral	15.81	228	0.684
	31.37		

Total area	8432.60	ha	
Irri requirement	3.00	l/s.ha	
RangNo	Leng_km	Area,ha	Dish,m3/s
	5.70	2108.15	6.32
	5.22	2108.15	6.32
	12.58	2108.15	6.32
	11.96	2108.15	6.32
	3.75	2108.15	6.32
	0.81	2108.15	6.32
	0.91	2108.15	6.32
	5.22		
Main canal =	**32.31**	km	
Lateral =	**54.67**	km	
Drainage channel =	**17.56**		
Dyke =	**47.48**	km	
Culvert	**7**		
Offtake sluice	**4**		
Pumpstation	**1**		
Low level crossing =	**7**		

Earth volume for main canals:

Q =	6.00	m3/s
b =	2	m
m =	2	m
h =	2.14	m
Length =	32.31	km
A =	13.4392	m2
Volume =	**434153.356**	**m3**
Total volume =	**608047.692**	

Earth volume for lateral

Q =	0.60	m3/s
b =	0.6	m
m =	2	m
h =	1.12	m
Length =	54.67	
A =	3.1808	m2
Volume =	**173894.336**	**m3**

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and lateral canals	m3	608,047.7	2.0	1,216,095.4
Polder dyke	m3	1,885,185.9	2.0	3,770,371.8
Villages	m3	0.0	2.0	0.0
	Subtotal earth moving work volume =			**4986467.18**
Culvert	Unit	7.0	6,000.0	42,000.0
Offtake sluice	Unit	4.0	30,000.0	120,000.0
Pump station	Unit	1.0	50,000.0	50,000.0
Gates for culverts	Unit	7.0	600.0	4,200.0
Gates for offtake	Unit	4.0	4,000.0	16,000.0
Low level crossing	Unit	7.0	20,000.0	140,000.0
	Subtotal earth moving work volume =			**372,200.0**
			Total cost =	**5,358,667.2**

SZ7

Sub dyke 1:

b = 4

m = 2

FrBoard = 0.5

Section	**rnElvNatur**	**GrnElvRaise**	**h**	**A**	**Ave**	**Length,km**	**Volume, m3**
0	4.99	5.40	2.41	23.31			
1	3.59	5.33	3.75	56.10	39.70	20.82	826,654.81
					39.70	26.66	1,058,531.09
						47.48	**1,885,185.90**

Total area	7053.59	ha	
Irri requirement	3.00	l/s.ha	

RangNo	Leng_km	Area,ha	Dish,m3/s
1	4.73	3526.80	10.58
2	4.00	3526.80	10.58
3	8.07	3526.80	10.58
4	1.34	3526.80	10.58
5	1.21	3526.80	10.58
6	6.77	3526.80	10.58
7	6.05	2351.20	7.05
Main canal =	**22.52**		
Lateral =	**35.098**		
Drainage channel =	**22.07**		
Dyke =	**31.66**		
Culvert =	**7.00**		
Offtake sluice =	**3.00**		
Villages =	**2.00**		
Pump =	**1.00**		
Low level crossing =	**8.00**		

Earth volume for main canals:

Q =	11.00	m3/s
b =	2.5	m
m =	2	m
h =	2.81	m
Length =	22.52	km
A =	22.8172	m2
Volume =	**513,820.5**	**m3**
Total volume =	635,182.4	

Earth volume for lateral

Q =	0.68	m3/s
b =	0.8	m
m =	2	m
h =	1.13	m
Length =	35.10	km
A =	3.4578	m2
Volume =	**121,361.9**	**m3**

Villages	1.0	
Length	4.0	km
Heigth	3.5	m
Topwidth	4.0	m
sideslope	1.5	
A =	32.4	m2
Volume =	129,500.0	m3

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**	
Main and lateral canals	m3	635,182.4	2.0	1,270,364.8	
Polder dyke	m3	506,560.0	2.0	1,013,120.0	
Village	m3	129,500.0	2.0	259,000.0	
Villages	m3	129,500.0	2.0	259,000.0	259,000.0
	Subtotal earth moving work volume =			**2,801,484.8**	
Culvert	Unit	7.0	6,000.0	42,000.0	
Offtake sluice	Unit	3.0	30,000.0	90,000.0	
Pump station	Unit	1.0	50,000.0	50,000.0	
Gates for culverts	Unit	7.0	600.0	4,200.0	
Gates for offtake	Unit	3.0	4,000.0	12,000.0	
Low level crossing	Unit	8.0	20,000.0	160,000.0	
		Subtotal for concrete work =		**358,200.0**	
			Total cost =	**3,159,684.8**	

SZ8

b =	4
m =	2
FrBoard =	0

Section	**GrnElvNatural**	**GrnElvRaise**	**h**	**A**	**Ave**	**Length,km**	**Volume, m3**
1	0.00	0.00	2.00	16.00	16.00	31.66	506,560.00
						31.66	**506,560.00**

Total area	15913.20	ha	
Irri requirement	3.00	l/s.ha	

RangNo	Leng_km	Area,ha	Dish,m3/s
2	3.82	1554.00	4.66
3	3.17	1554.00	4.66
5	3.98	1554.00	4.66
7	4.94	1554.00	4.66
8	4.47	1554.00	4.66
9	5.90	1554.00	4.66
11	7.57	1554.00	4.66
12	8.03	1554.00	4.66
13	8.01	1554.00	4.66
Main canal 1 =	**34.92**		
1	5.04	3978.30	11.93
4	4.65	3978.30	11.93
6	8.79	3978.30	11.93
10	8.98	3978.30	11.93
Main canal 2 =	**15.69**		
Total length =	**50.62**		
Lateral =	**121.947**		
Drainage channel =	**26.55**		
Dyke	**31.30**		
Culvert	**14.00**		
Offtake sluice	**4.00**		
Pumpstation	**2.00**		
Village	**0.00**		
Low level crossing =	**5.00**		

Earth volume for main canals:

Q =	12.00	m3/s
b =	3	m
m =	2	m
h =	2.91	m
Length =	15.69	km
A =	25.6662	m2
Volume =	**402,805.3**	**m3**
Volume total =	**1,099,962.8**	

Earth volume for main canals:

Q =	4.50	m3/s
b =	2	m
m =	2	m
h =	2.11	m
Length =	34.92	km
A =	13.1242	m2
Volume =	**458,336.4**	**m3**

Earth volume for lateral canals:

Q =	0.40	m3/s
b =	0.6	m
m =	1.5	m
h =	0.96	m
Length =	121.95	km
A =	1.9584	m2
Volume =	**238,821.0**	**m3**

Computation of earth volume for polder dyke

Topwidth =	4.0	m
m =	2.0	
h =	0.5	m
A =	2.5	m2
Length =	31.3	km
Volume =	**78,250.0**	**m3**

Villages	0.00	
Length	4	km
Heigth	3.5	m
Topwidth	4	m
sideslope	1.5	
A =	32.375	m2
Volume =	0	m3

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and lateral canals	m3	1,099,962.8	2.0	2,199,925.6
Polder dyke	m3	78,250.0	2.0	156,500.0
Village	m3	0.0	2.0	0.0
			Subtotal earth moving work volume =	**2356425.568**
Culvert	Unit	14.0	6,000.0	84,000.0
Offtake sluice	Unit	4.0	30,000.0	120,000.0
Pump station	Unit	2.0	50,000.0	100,000.0
Gates for culverts	Unit	14.0	600.0	8,400.0
Gates for offtake	Unit	4.0	4,000.0	16,000.0
Low level crossing	Unit	5.0	20,000.0	100,000.0
			Subtotal for concrete work =	**428,400**
			Total cost =	**2,784,826**

SZ9

	Length,km	Area,m2	Dish,m3/s
Lateral	1.91	130	0.39

Total area	2075.44 ha		
Irri requirement	3.00 l/s.ha		
RangNo	Leng_km	Area,ha	Dish,m3/s
Main canal 1 =	3.325	2075.44	6.23
2	3.26	691.81	2.08
3	3.25	691.81	2.08
4	6.61	691.81	2.08
Main canal 2 =	9.184		
Main canal =	**12.509**		
Lateral =	**20.99**		
Drainage channel =	**8.05**		
Dyke =	**21**		
Culverts =	**4**		
Offtake sluice =	**1**		
Pumpstation =	**1**		
Village =	**0**		
Low level crossing =	**1**		

Earth volume for main canals:

Q =	6.00	m3/s
b =	2	m
m =	2	m
h =	2.14	m
Length =	3.33	km
A =	13.4392	m2
Volume =	**44685.3**	**m3**
Volume total =	**142,189.3**	**m3**

Earth volume for main canals:

Q =	2.00	m3/s
b =	1	m
m =	2	m
h =	1.52	m
Length =	9.18	km
A =	6.1408	m2
Volume =	**56,397.1**	**m3**

Earth volume for lateral

Q =	0.42	m3/s
b =	0.6	m
m =	1.5	m
h =	0.96	m
Length =	20.99	km
A =	1.9584	m2
Volume =	**41,106.8**	**m3**

Computation of earth volume for polder dyke

Topwidth =	4.0	m
m =	2.0	
h =	2.0	m
A =	16.0	m2
Length =	21.0	km
Volume =	**336,000.0**	**m3**

Villages	0.00	
Length	4	km
Heigth	3.5	m
Topwidth	4	m
sideslope	1.5	
A =	32.375	m2
Volume =	0	m3

SZ10

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and lateral canals	m3	142,189.3	2.0	284,378.5
Polder dyke	m3	336,000.0	2.0	672,000.0
Village	m3	0.0	2.0	0.0
	Subtotal earth moving work volume =			**956,379**
Culvert	Unit	4.0	6,000.0	24,000.0
Offtake sluice	Unit	1.0	30,000.0	30,000.0
Pump station	Unit	1.0	50,000.0	50,000.0
Gates for culverts	Unit	4.0	600.0	2,400.0
Gates for offtake	Unit	1.0	4,000.0	4,000.0
Low level crossing	Unit	1.0	20,000.0	20,000.0
		Subtotal for concrete work =		**130,400.0**
Total cost =				**1,086,778.5**

Irri req 3.00 l/s.ha

	Length, km	Area, ha	Dish,m3/s
Lateral	4.11	140	0.42
Lateral	2.06	140	0.42
Lateral	2.27	140	0.42
Lateral	0.87	140	0.42
Lateral	4.96	140	0.42
Lateral	1.68	140	0.42
Lateral	1.28	140	0.42
Lateral	1.22	140	0.42
	20.99		

Dish,m3/s
4.34
4.34
4.34
4.34
4.34
4.34
4.34
4.34
4.34
4.34
4.34
4.34
4.34
4.34
6.35
6.35
12.69

Earth volume for main canals:

Q =	4.50	m3/s
b =	2	m
m =	2	m
h =	2.11	m
Length =	42.88	km
A =	13.1242	m2
Volume =	**562,700.1**	**m3**
Total volume =	**1,906,509.6**	

Earth volume for main canals:

Q =	7.00	m3/s
b =	2.5	m
m =	2	m
h =	2.38	m
Length =	7.62	km
A =	17.2788	m2
Volume =	**131,595.3**	**m3**

Earth volume for main canals:

Q =	13.00	m3/s
b =	3	m
m =	2	m
h =	3	m
Length =	15.93	km
A =	27	m2
Volume =	**429,975.0**	**m3**

Earth volume lateral

Q =	0.99	m3/s
b =	1	m
m =	2	m
h =	1.45	m
Length,km =	138.33	km
A =	5.655	m2
Volume =	**782,239.2**	**m3**

Computation of earth volume for polder dyke

Topwidth =	4.0	m
m =	2.0	
h =	0.5	m
A =	2.5	m2
Length =	58.0	km
Volume =	**145,075.0**	**m3**

Villages	3.0	
Length	4.0	km
Heigth	3.5	m
Topwidth	4.0	m
sideslope	1.5	
A =	32.4	m2
Volume =	388,500.0	m3

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and lateral canals	m3	#########	2.0	3,813,019.2
Polder dyke	m3	145,075.0	2.0	290,150.0
Village	m3	388,500.0	2.0	777,000.0
	Subtotal earth moving work volume =			**4,880,169**
Culvert	Unit	20.0	6,000.0	120,000.0
Offtake sluice	Unit	4.0	30,000.0	120,000.0
Pump station	Unit	2.0	50,000.0	100,000.0
Gates for culverts	Unit	20.0	600.0	12,000.0
Gates for offtake	Unit	4.0	4,000.0	16,000.0
Low level crossing	Unit	4.0	20,000.0	80,000.0
		Subtotal for concrete work =		**448,000.0**
Total cost =				**5,328,169.2**

SZ11

Irri req 3.00 l/s.ha

	Length, km	Area, ha	Dish,m
Lateral	0.87	330	0.99
Lateral	0.63	330	
Lateral	3.05	330	
Lateral	4.86	330	
Lateral	7.01	330	
Lateral	1.55	330	
Lateral	1.82	330	
Lateral	1.03	330	
Lateral	0.82	330	
Lateral	3.84	330	
Lateral	1.51	330	
Lateral	10.99	330	
Lateral	2.30	330	
Lateral	4.74	330	
Lateral	0.92	330	
Lateral	5.02	330	
Lateral	2.14	330	
Lateral	1.67	330	
Lateral	1.80	330	
Lateral	1.53	330	
Lateral	4.65	330	
Lateral	2.11	330	
Lateral	2.23	330	
Lateral	4.34	330	
Lateral	4.01	330	
Lateral	2.74	330	
Lateral	3.64	330	
Lateral	5.98	330	
Lateral	5.22	330	
Lateral	3.85	330	
Lateral	3.47	330	
Lateral	2.52	330	
Lateral	3.54	330	
Lateral	3.76	330	
Lateral	2.08	330	
Lateral	3.76	330	
Lateral	3.04	330	
Lateral	12.89	330	
Lateral	2.94	330	

Lateral	2.11	330
Lateral	4.78	330
Lateral	2.76	330
Lateral	1.27	330
Lateral	8.14	330
Lateral	2.07	330
Lateral	0.89	330
Lateral	2.76	330
Lateral	2.64	330
Lateral	3.33	330
Lateral	7.29	330
Lateral	1.96	330
Lateral	6.10	330
Lateral	5.50	330
Lateral	2.82	330
Lateral	6.94	330
Lateral	1.91	330
	138.70	

Total area	23892.59 ha		
Irri requirement	3.00 l/s.ha		
RangNo	Leng_km	Area,ha	Dish,m3/s
2	4.52	3300.00	9.90
3	4.39	3300.00	9.90
4	10.13	3300.00	9.90
5	12.36	3300.00	9.90
6	10.42	3300.00	9.90
8	6.19	3300.00	9.90
9	6.32	3300.00	9.90
10	5.39	3300.00	9.90
Main canal 1 =	**41.80**		
1	30.89	5973.15	17.92
7	15.45	5973.15	17.92
11	8.97	5973.15	17.92
12	9.79	5973.15	17.92
Main canal 2 =	**45.57**		
Total main canal =	**87.37**		
Lateral =	**176.75**		
Drainage channel =	**34.90**		
Dyke =	**73.62**		
Culverts =	**10.00**		
Offtake sluice =	**2.00**		
Pumpstation =	**1.00**		
Village =	**3.00**		
Low level crossing =	**2.00**		

Computation of earth volume for irrigation canals:

Q =	11.0 m3/s	Q =	18.0 m3/s
b =	2.5 m	b =	3.5 m
m =	2.0 m	m =	2.0 m
h =	2.8 m	h =	3.3 m
Length =	41.8 km	Length =	45.6 km
A =	22.8 m2	A =	33.2 m2
Volume =	**953,850.2 m3**	**Volume =**	**1,511,247.0 m3**
Volume total =	**3,550,483.7**		

Earth work for lateral

Q =	2.1 m3/s
b =	1.0 m
m =	2.0 m
h =	1.5 m
Length =	176.8 km
A =	6.1 m2
Volume =	**1,085,386.4 m3**

Computation of earth volume for polder dyke

Topwidth =	4.0 m
m =	1.5
h =	2.5 m
A =	19.4 m2
Length =	73.6 km
Volume =	**1,426,387.5 m3**

Villages	3.0
Length	4.0 km
Heigth	3.5 m
Topwidth	4.0 m
sideslope	1.5
A =	32.4 m2
Volume =	388,500.0 m3

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and lateral canals	m3	3,550,483.7	2.0	7,100,967.3
Polder dyke	m3	1,426,387.5	2.0	2,852,775.0
Village	m3	388,500.0	2.0	777,000.0
	Subtotal earth moving work volume =			**10,730,742**
Culvert	Unit	10.0	6,000.0	60,000.0
Offtake sluice	Unit	2.0	30,000.0	60,000.0
Pump station	Unit	1.0	50,000.0	50,000.0
Gates for culverts	Unit	10.0	600.0	6,000.0
Gates for offtake	Unit	2.0	4,000.0	8,000.0
Low level crossing	Unit	2.0	20,000.0	40,000.0
		Subtotal for concrete work =		**224,000.0**
Total cost =				**10,954,742.3**

Total area		6337.87 ha		
Irri requirement		3.00 l/s.ha		
RangNo		Leng_km	Area,ha	Dish,m3/s
	1	10.10	3168.94	9.51
	2	11.49	3168.94	9.51
Main canal 1 =		15.11		
	3	5.22	600.00	1.80
	4	2.71	600.00	1.80
	5	3.09	600.00	1.80
	6	3.83	600.00	1.80
	7	2.84	600.00	1.80
	8	2.55	600.00	1.80
	9	6.37	600.00	1.80
Main canal 2 =		18.63		
Total length =		33.74		
Lateral =		31.829		
Drainage channel =		11.96		
Dyke =		20.65		
Culverts =		22		
Offtake sluice =		3		
Village =		2		
Pumstation =		1		
Low level crossing =		4		

Earth volume for irrigation canals:

Q =	10.0 m3/s
b =	2.5 m
m =	2.0 m
h =	2.8 m
Length =	15.1 km
A =	22.8 m2
Volume =	**344,836.3 m3**
Volume total =	**560,462.7**

Earth volume for irrigation canals:

Q =	2.0 m3/s
b =	1.0 m
m =	2.0 m
h =	1.5 m
Length =	18.6 km
A =	6.1 m2
Volume =	**114,384.7 m3**

Earth work for lateral

Q =	0.6 m3/s
b =	0.6 m
m =	2.0 m
h =	1.1 m
Length =	31.8 km
A =	3.2 m2
Volume =	**101,241.7 m3**

Villages		2.0
Length		4.0 km
Heigth		3.5 m
Topwidth		4.0 m
sideslope		1.5
	A =	32.4 m2
Volume =		259,000.0 m3

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and lateral canals	m3	560,462.7	2.0	1,120,925.4
Polder dyke	m3	330,400.0	2.0	660,800.0
Village	m3	259,000.0	2.0	518,000.0
Subtotal earth moving work volume =				**2,299,725.42**
Culvert	Unit	22.0	6,000.0	132,000.0
Offtake sluice	Unit	3.0	30,000.0	90,000.0
Pump station	Unit	1.0	50,000.0	50,000.0
Gates for culverts	Unit	22.0	600.0	13,200.0
Gates for offtake	Unit	3.0	4,000.0	12,000.0
Low level crossing	Unit	4.0	20,000.0	80,000.0
		Subtotal for concrete work =		**377,200.00**
			Total cost =	**2,676,925.42**

Sub dyke 1:

b = 4

m = 2

FrBoard = 0.5

Section	**GrnElvNatural**	**GrnElvRaise**	**h**	**A**	**Ave**	**Length,km**	**Volume, m3**
0	5.32	5.32	2.00	16.00			
1	3.75	3.92	2.00	16.00	16.00	7.88	126,016.00
2	3.13	3.70	2.00	16.00	16.00	4.25	68,064.00
					16.00	8.52	136,320.00
						20.65	**330,400.00**

Total area, ha	5991.84		
Irri requirement	3.00	l/s.ha	
RangNo	Leng_km	Area,ha	Dish,m3/s
Main canal 1 =	**12.71**	5991.84	17.98
2	4.67	2995.92	8.99
3	5.93	2995.92	8.99
4	8.12	2995.92	8.99
Main canal 2 =	**13.10**		
Total length =	**25.809**		
Lateral =	**50.939**		
Drainage channel =			
Dyke =	**17**		
Culvert =	**11**		
Offtake sluice =	**0**		
Pumpstation =	**0**		
Village =	**0**		

Earth volume for irrigation canals:

Q =	18.0	m3/s
b =	3.5	m
m =	2.0	m
h =	3.3	m
Length =	12.7	km
A =	33.2	m2
Volume =	**421,338.5**	**m3**
Volume total =	**903,715.4**	**m3**

Earth volume for irrigation canals:

Q =	10.0	m3/s
b =	2.5	m
m =	2.0	m
h =	2.8	m
Length =	13.1	km
A =	22.8	m2
Volume =	**298,996.6**	**m3**

Earth work for lateral

Q =	0.6	m3/s
b =	0.6	m
m =	2.0	m
h =	1.2	m
Length =	50.9	km
A =	3.6	m2
Volume =	**183,380.4**	**m3**

Computation of earth volume for polder dyke

Topwidth =	4.0	m
m =	1.5	
h =	0.5	m
A =	2.4	m2
Length =	17.0	km
Volume =	**40,375.0**	**m3**

Villages	0.00	
Length	4	km
Heigth	3.5	m
Topwidth	4	m
sideslope	1.5	
A =	32.375	m2
Volume =	0	m3

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and lateral canals	m3	903,715.4	2.0	1,807,430.9
Polder dyke	m3	40,375.0	2.0	80,750.0
Village	m3	0.0	2.0	0.0
	Subtotal earth moving work volume =			**1,888,180.9**
Culvert	Unit	11.0	6,000.0	66,000.0
Offtake sluice	Unit	0.0	30,000.0	0.0
Pump station	Unit	0.0	50,000.0	0.0
Gates for culverts	Unit	11.0	600.0	6,600.0
Gates for offtake	Unit	0.0	4,000.0	0.0
		Subtotal for concrete work =		**72,600.0**
			Total cost =	**1,960,780.9**

Total area	33010.67 ha		
Irri requirement	3.00 l/s.ha		
RangNo	Leng_km	Area,ha	Dish,m3/s
1	8.23	6000	18.00
2	6.13	6000	18.00
3	14.36	6000	18.00
Main canal 1 =	**20.10**		
4	2.50	1800	5.40
5	5.08	1800	5.40
6	2.28	1800	5.40
7	2.37	1800	5.40
8	2.10	1800	5.40
9	4.61	1800	5.40
10	7.29	1800	5.40
11	7.39	1800	5.40
12	2.07	1800	5.40
13	5.74	1800	5.40
14	3.66	1800	5.40
15	6.75	1800	5.40
16	3.59	1800	5.40
17	3.93	1800	5.40
18	3.80	1800	5.40
19	4.48	1800	5.40
20	2.15	1800	5.40
21	4.39	1800	5.40
22	7.59	1800	5.40
23	13.48	1800	5.40
24	6.03	1800	5.40
25	7.40	1800	5.40
26	6.66	1800	5.40

Earth volume for irrigation canals:

Q =	18.0	m3/s
b =	3.5	m
m =	2.0	m
h =	3.3	m
Length =	20.1	km
A =	33.2	m2
Volume =	**666,713.0**	**m3**
Volume total =	**2,810,665.9**	**m3**

Earth volume for irrigation canals:

Q =	6.0	m3/s
b =	2.0	m
m =	2.0	m
h =	2.1	m
Length =	80.7	km
A =	13.4	m2
Volume =	**1,085,054.1**	**m3**

Earth volume for lateral canals:

Q =	0.9	m3/s
b =	1.0	m
m =	2.0	m
h =	1.5	m
Length =	187.3	km
A =	5.7	m2
Volume =	**1,058,898.8**	**m3**

Computation of earth volume for polder dyke

Topwidth =	4.0	m
m =	1.5	
h =	0.0	m
A =	0.0	m2
Length =	42.1	km
Volume =	**0.0**	**m3**

Villages	0.0	
Length	4.0	km
Heigth	3.5	m
Topwidth	4.0	m
sideslope	1.5	
A =	32.4	m2
Volume =	0.0	m3

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and lateral canals	m3	15,470,665.9	2.0	30,941,331.7
Polder dyke	m3	0.0	2.0	0.0
Village	m3	0.0	2.0	0.0
	Subtotal earth moving work volume =			**30,941,331.7**
Culvert	Unit	17.0	6,000.0	102,000.0
Offtake sluice	Unit	5.0	30,000.0	150,000.0
Pump station	Unit	1.0	50,000.0	50,000.0
Boxculvert	Unit	4.0	30,000.0	120,000.0
Gates for culverts	Unit	17.0	600.0	10,200.0
Gates for offtake	Unit	5.0	4,000.0	20,000.0
Gates for boxculverts	Unit	4.0	4,000.0	16,000.0
		Subtotal for concrete work =		**468,200.0**
			Total cost =	**31,409,531.7**

Main canal	**80.74**
Total lengt	**100.842**
Lateral =	**187.25**
Polder dyke =	**42.1**
Culvert =	**17**
Box culvert =	**4**
Offtake sluice =	**5**
Pumpstation =	**1**
Villages =	**0**
Cross regu	**1**
Western dr	**33.76**

Earth work for western drain

For discharge of	500.0	m3/s
b, m =	35.0	
h, m =	7.5	
m =	2.0	
A =	375.0	
Length,km =	33.8	
Volume, m3 =	12,660,000.0	

Total area	20382.30 ha		
Irri requirement	3.00 l/s.ha		
RangNo	Leng_km	Area,ha	Dish,m3/s
2	5.65	1500.00	4.50
3	6.47	1500.00	4.50
7	7.48	1500.00	4.50
8	5.99	1500.00	4.50
9	7.30	1500.00	4.50
10	6.65	1500.00	4.50
11	8.03	1500.00	4.50
12	5.80	1500.00	4.50
13	9.91	1500.00	4.50
14	5.98	1500.00	4.50
Main canal 1 =	48.48		
1	7.93	5095.58	15.29
4	5.88	5095.58	15.29
5	7.35	5095.58	15.29
6	7.55	5095.58	15.29
Main canal 2 =	20.10		
Total length =	68.579		
Lateral =	161.7		
Drainagae channel =	0		
Dyke =	49.66		
Culvert =	18		
Offtake sluice =	5		
Villages =	0		
Pumpstation =	1		
Boxculvert =	0		

Earth volume for irrigation canals:

Q =	4.5	m3/s
b =	2.0	m
m =	2.0	m
h =	2.1	m
Length =	48.5	km
A =	13.1	m2
Volume =	**636,287.5**	**m3**
Volume total =	**2,132,846.7**	**m3**

Earth volume for irrigation canals:

Q =	14.5	m3/s
b =	3.5	m
m =	2.0	m
h =	3.0	m
Length =	20.1	km
A =	29.0	m2
Volume =	**582,145.8**	**m3**

Earth work for lateral

Q =	0.9	m3/s
b =	1.0	m
m =	2.0	m
h =	1.5	m
Length =	161.7	km
A =	5.7	m2
Volume =	**914,413.5**	**m3**

Computation of earth volume for polder dyke

Topwidth =	4.0	m
m =	1.5	
h =	0.5	m
A =	2.4	m2
Length =	49.7	km
Volume =	**117,942.5**	**m3**

Villages	0.0	
Length	4.0	km
Heigth	3.5	m
Topwidth	4.0	m
sideslope	1.5	
A =	32.4	m2
Volume =	0.0	m3

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and lateral canals	m3	2,132,846.7	2.0	4,265,693.5
Polder dyke	m3	117,942.5	2.0	235,885.0
Village	m3	0.0	2.0	0.0
	Subtotal earth moving work volume =			**4501578.488**
Culvert	Unit	18.0	6,000.0	108,000.0
Offtake sluice	Unit	5.0	30,000.0	150,000.0
Pump station	Unit	1.0	50,000.0	50,000.0
Boxculvert	Unit	0.0	30,000.0	0.0
Gates for culverts	Unit	18.0	600.0	10,800.0
Gates for offtake	Unit	5.0	4,000.0	20,000.0
Gates for boxculverts	Unit	0.0	4,000.0	0.0
		Subtotal for concrete work =		**338,800.0**
			Total cost =	**4,840,378.5**

SZ16

Total area	16987.63 ha		
Irri requirement	3.00 l/s.ha		
RangNo	Leng_km	Area,ha	Dish,m3/s
1	4.52	4246.91	12.74
2	7.16	4246.91	12.74
3	4.62	4246.91	12.74
4	4.81	4246.91	12.74
5	5.08	4246.91	12.74
6	3.60	4246.91	12.74
7	7.81	4246.91	12.74
8	6.06	4246.91	12.74
9	6.46	4246.91	12.74
10	3.10	4246.91	12.74
11	2.87	4246.91	12.74
12	3.89	4246.91	12.74
13	4.23	4246.91	12.74
14	9.82	4246.91	12.74
15	6.28	4246.91	12.74
16	5.05	4246.91	12.74
17	6.08	4246.91	12.74
18	4.90	4246.91	12.74
19	4.01	4246.91	12.74
20	0.54	4246.91	12.74
Main canal =	**70.623**		
Lateral =	**81.795**		
Drainagae channel =	0.00		
Dyke =	82.62		
Culvert =	**30**		
Offtake sluice =	**4**		
Villages =	0.00		
Pumpstation =	0.00		
Boxculvert =	0.00		
Western drain =	**26.37**		

Earth volume for irrigation canals:

Q =	13.0 m3/s
b =	3.0 m
m =	2.0 m
h =	3.0 m
Length =	70.6 km
A =	27.0 m2
Volume =	**1,906,821.0 m3**
Total volume =	2,369,371.7

Q =	m3/s
b =	m
m =	m
h =	m
Length =	km
A =	0.0 m2
Volume =	**0.0 m3**

Earth volume for irrigation canals:

Q =	0.9 m3/s
b =	1.0 m
m =	2.0 m
h =	1.5 m
Length =	81.8 km
A =	5.7 m2
Volume =	**462,550.7 m3**

Computation of earth volume for polder dyke

Topwidth =	4 m
m =	2
h =	0.5 m
A =	2.5 m2
Volume =	**206550 m3**

Villages	0.0
Length	4.0 km
Heigth	3.5 m
Topwidth	4.0 m
sideslope	1.5
A =	32.4 m2
Volume =	0.0 m3

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and lateral canals	m3	12,258,121.7	2.0	24,516,243.5
Polder dyke	m3	206,550.0	2.0	413,100.0
Village	m3		2.0	0.0
			Subtotal earth moving work volume =	**24,929,343.45**
Culvert	Unit	27.0	6,000.0	162,000.0
Offtake sluice	Unit	4.0	30,000.0	120,000.0
Pump station	Unit	0.0	50,000.0	0.0
Boxculvert	Unit	0.0	30,000.0	0.0
Gates for culverts	Unit	27.0	600.0	16,200.0
Gates for offtake	Unit	4.0	4,000.0	16,000.0
Gates for boxculverts	Unit	0.0	4,000.0	0.0
			Subtotal for concrete work =	**314,200.00**
			Total cost =	**628,400.00**

Earth work for western drain

For discharge	500.0 m3/s
b, m =	35.0
h, m =	7.5
m =	2.0
A =	375.0
Length,km =	26.4
Volume, m3 =	9,888,750.0

SZ17

Area SZ19

Total area	14537.90	ha
Irri requirement	3.00	l/s.ha

RangNo	Leng_km	Area,ha	Dish,m3/s
1	8.67	7268.95	21.81
2	13.02	7268.95	21.81
Main canal 1 =	**15.18**		
3	13.21	3000.00	9.00
4	6.16	3000.00	9.00
5	13.05	3000.00	9.00
6	6.42	3000.00	9.00
7	11.12	3000.00	9.00
Main canal 2 =	**34.97**		
Total length =	**50.155**		
Lateral =	**114.954**		
Drainagae channel =	**0**		
Dyke =	**48.17**		
Culvert =	**13**		
Offtake sluice =	**3**		
Villages =	**0**		
Pump =	**0**		
Boxculvert =	**0**		

Earth volume for irrigation canals:

Q =	20.0	m3/s
b =	3.5	m
m =	2.0	m
h =	3.3	m
Length =	15.2	km
A =	33.7	m2
Volume =	**511,132.7**	**m3**
Total volume =	1,738,931.8	

Earth volume for irrigation canals:

Q =	10.0	m3/s
b =	2.5	m
m =	2.0	m
h =	2.8	m
Length =	35.0	km
A =	22.8	m2
Volume =	**797,963.1**	**m3**

Earth volume for lateral canals:

Q =	0.8	m3/s
b =	1.0	m
m =	2.0	m
h =	1.1	m
Length =	115.0	km
A =	3.7	m2
Volume =	**429,836.0**	**m3**

Computation of earth volume for polder dyke

Topwidth =	4	m
m =	1.5	
h =	1	m
A =	5.5	m2
Length =	48.17	km
Volume =	**264,935**	**m3**

Villages	0.0	
Length	4.0	km
Heigth	3.5	m
Topwidth	4.0	m
sideslope	1.5	
A =	32.4	m2
Volume =	0.0	m3

Descriptions	**Unity**	**Qty**	**UnitPrice, USD**	**TotalPrice, USD**
Main and lateral canals	m3	#########	2.0	3,477,863.5
Polder dyke	m3	264,935.0	2.0	529,870.0
Village	m3	0.0	2.0	0.0
Subtotal earth moving work volume =				**4,007,733.5**
Culvert	Unit	13.0	6,000.0	78,000.0
Offtake sluice	Unit	3.0	30,000.0	90,000.0
Pump station	Unit	0.0	50,000.0	0.0
Boxculvert	Unit	0.0	30,000.0	0.0
Gates for culverts	Unit	13.0	600.0	7,800.0
Gates for offtake	Unit	3.0	4,000.0	12,000.0
Gates for boxculverts	Unit	0.0	4,000.0	0.0
Subtotal for concrete work =				**187,800.0**
			Total cost =	**4,195,533.5**

SZ19

Appendix 5 Public Participation Plan

CONTENTS

LIST OF ATTACHMENTS

1 INTRODUCTION

The MRC is aware that stakeholder involvement in decision-making is fundamental to achieving feasible, equitable and lasting solutions in water management and that the quality of decisions can be improved by the inclusion of a broad range of stakeholders who can bring important local knowledge and relevant perspectives to the process[1]. The MRC further recognizes both internal stakeholders (Government bodies in MRC structure such as MRC Council, Joint Committees, NMCs and Line agencies in each countries) and external stakeholders (non-state bodies such as NGOs, implementing partners, civil society organizations, policy advocates, media or any other who have stake to lose or gain). MRC emphasizes that for the participation to be genuine, all relevant stakeholders should have an opportunity to directly or indirectly influence project design, implementation and effects. Participation should be also inclusive of women, elderly, young people and minority groups.

Information on the benefits of public participation, forms of public participation and how they need to be facilitated at various stages is already available in the MRC system.

The FMMP-C2 Stage 1 Evaluation Report provides an outline of the need for public participation in the demonstration projects based on the public participation principles recognized at MRC.

In Stage 2 of FMMP-C2, five demonstration project areas have been selected for e.g. planning structural measures for flood protection or flood risk assessment. Apart from reducing the risk of damage to houses, property, and creating better living conditions for the people, they will bring economic benefits to the people mainly through better land use and agriculture. A concrete public participation plan is crucial to ensure that the needs of community and stakeholders supporting the community are incorporated in the design of the demonstration project and support systems are put in place to adapt to these changes.

[1] MRC – Public Participation in Lower Mekong Basin

2 OBJECTIVE OF PUBLIC PARTICIPATION IN COMPONENT 2

The objectives of Public Participation Strategy in stage 2 planning of the structural flood protection measures demonstration project are to:

1. Develop Public Participation Plan for the structural flood protection measures demonstration projects to ensure inputs from stakeholders are incorporated in the design and that any potential negative impact on stakeholders is minimized;
2. Prepare Best Practice Guidelines to help the facilitators in conducting Public consultation exercises;
3. Training of NMC and Line Agencies in facilitating public participation during the implementation of the demonstration project.

3 PRELIMINARY STAKEHOLDER CONSULTATION

The Lower Mekong Basin Development Plan has defined broad groups of key stakeholders. In conducting a preliminary stakeholders' analysis in February and March 2009 by the Public Participation Specialist, the list of stakeholders defined by the BDP was used. From this list, the MRC, NMC, Water Resources Department, Agriculture Department, and fisheries administration are identified as the key internal stakeholders. Community groups, Water User's Association, Commune committees and Civil Society Organizations such as NGOs are identified as key external stakeholders.

This list provided a basis for conducting a preliminary consultation with these stakeholders to understand the issues that are important for different stakeholders in the West Bassac Demonstration project areas in Cambodia. Attachment 3 provides the detailed schedule implemented during this mission

3.1 Specific Purpose of preliminary exploratory stakeholders' consultations

1. Assess existing participatory processes in place;
2. Identify stakeholders that should be engaged at various stages of the project planning and implementation;
3. Understand the type of public participation activities that would be feasible;
4. Gather information at community level on the problems due to flooding and to understand the need for integrating support systems to capitalize on the benefits of structural flood protection measures;
5. Get a preliminary feedback on the proposed structural measures for flood protection.

Attachment 2 highlights the summary of consultations with the key stakeholders. The key highlights are related to problems due to flooding in the area, present livelihoods options, any existing structural flood protection measures and the extent of public participation and a preliminary feedback on the demonstration project ideas.

These preliminary consultations were conducted together with the CNMC representative, and Irrigation Engineers from FMMP-C2 Consultant groups in West Bassac, Cambodia.

Since this was a preliminary consultation, the stakeholder groups were consulted individually to gain in-depth understanding of the problems, issues and opportunities. The consultation process involved first understanding the existing situation with floods, coping mechanisms, community profile, vulnerability analysis, existing agriculture and fisheries practices and sharing the FMMP-C2 structural measures project design and objective to get a preliminary feedback.

The information gathered from these consultations will help in preparing the best practice guidelines for public participation and developing a training plan for the NMC, Line agencies and Civil Society Organizations who would potentially be involved in conducting or facilitating the actual consultations.

3.2 West Bassac Demonstration Project area, Cambodia

The West Bassac area covers portions of Takeo and Kandal provinces, extending along the right bank of the Bassac River from south to the town of Ta Khmao to the Cambodia-Vietnam border. The area is delimited to the north and the west by RN2, to the east by the RN21 and to the south by the Vietnam-Cambodian border.

Based on annual flooding conditions (deep and shallow flooded area), existing infrastructures and actual land and water use conditions (road as flood protection embankment, existing natural and man made drainage network), the West Bassac area could be subdivided into three zones for effective flood risk management:

<u>Zone 1:</u> Deep flooded currently cash crop area immediately left to the RN21 and the deepest part of the flood plain to the west following the same alignment of the Preik Ambel. This zone is conceived to be a full flood protection area consisting of four large polder systems. The main crop in this area is cash crop in higher ground near to the road and recession rice paddy in low lying area near to the Preik Ambel. After the flood protection measures and irrigation systems are implemented, it will be possible to grow two additional crops in this area.

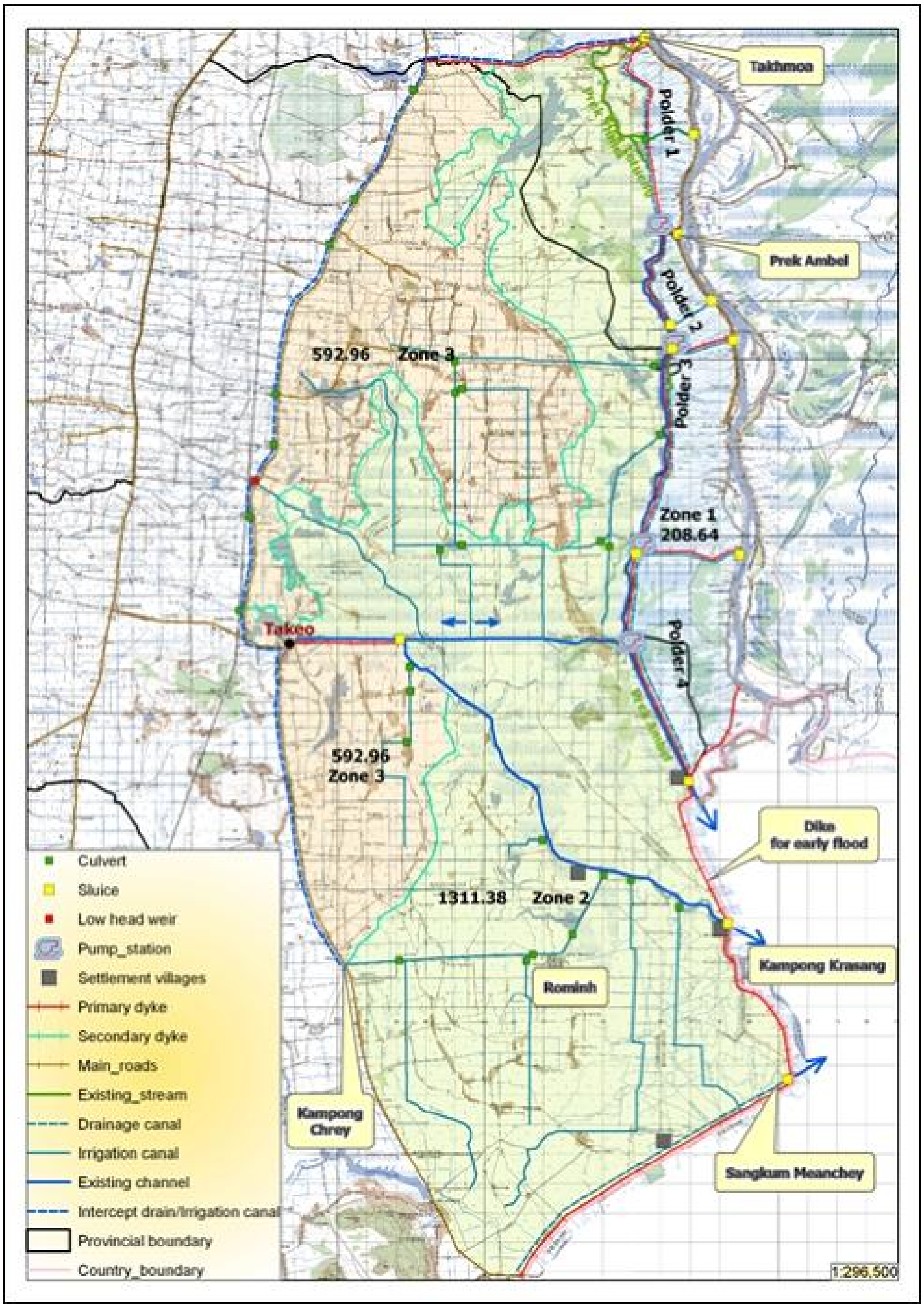
<u>Zone 3:</u> Shallow flooded area immediately to the east of the RN2 will be protected against peak flood from the Mekong flood by a dike system and from the western catchment by a drainage/irrigation canal along the RN2.

<u>Zone 2:</u> Deep flooded area in between the Zone 3 and Zone 1. This zone is proposed to be protected against the early flood up to 31 of July. The area will be flooded after this date. This area can grow one additional crop with the help of irrigation. The overall objective of structural flood protection measures in this area is to delay the onset of flooding in deep-flooded areas so that farmers can plant an early rice crop as well as the recession crop.

The specific objectives of the demonstration project are:

(i) reduce peak flows and extreme deep flooding by providing additional flood conveyance;
(ii) create a small flood-free area;
(iii) improve water supply for dry season agriculture, reducing the frequency of early- and mid-season drought damage;
(iv) reduce flash flooding and related damages in the western portion of the focal area; and,
(v) improve inland water navigation and road transport modes.

The location of the area is shown in the following figure:



3.2.1 Stakeholders consulted in West Bassac, Cambodia

1. Provincial Department of Water Resources and Management (PDWRM), Takeo
2. Provincial Department of Agriculture (PDA), Takeo
3. Water User Association, Thnot Té village
4. Provincial Fisheries Administration, Takeo
5. Provincial Department of Water Resources and Management, Kandal
6. Water User Association, Prey Kabbas
7. Cambodia Centre for Study and Development in Agriculture (CEDAC), an NGO based in Phnom Penh

From the long list of stakeholders, the above key stakeholders to consult in the available time was decided based on the understanding of PDWRM and project consultants as to which stakeholders are likely to support or oppose the structural measures.

In general, it appears that majority of the stakeholders including the community groups are in favour of the structural flood protection measures in West Bassac area because of the potential agricultural benefits through micro level irrigation schemes and potential positive benefits on fisheries as well.

In this consultation process, it was interesting to note that the PDWRM was of the impression that the fisheries administration might oppose such a project because of the potential negative impact on fish migration and fish stock reduction. However, the fisheries administration had a different insight into the fish migration and dwindling fish stock in the area due to various other factors. They, on the contrary, see a possibility of protecting the fishing areas, creating fish sanctuaries, improving fish stock through better connecting the flood plains with Bassac River and the distributaries.

A public participation process not only provides and opportunity to check the assumptions of the stakeholders, but also provides opportunity to gather suggestions for protecting their stakes through design changes or designing additional elements. Similar insights are brought by other stakeholders as well. For example, access of boats to the river or channels is important for farmers when a dike is constructed along the river and there could be potential conflict between people depending on fishing and agriculture when reservoirs are constructed etc.

The NGOs, on the other hand, might have a critical view on the project in terms of potential environmental damage. For example, CEDAC, sees flood to be good for soil and that any measure to change the flood period will have adverse impact on the soils, its productivity in the long run and ultimately have a negative impact on the farmers. Upon explaining the project details and the advantages of controlling flood in Zone 2, they are supportive of this early flood protection measures. However, they don’t seem to be convinced of the full protection measures in Zone 1, which will eliminate flooding completely and let the farmers grow crops all round the year. If the NGOs are working in the area and know the area and people well, their views can be important for smooth implementation of the project. Hence, consulting the NGOs in the initial stages will avoid any potential opposition during implementation stage. NGOs can also contribute in terms of social mobilization, facilitating community consultations and bringing farmers’ and environmental concerns in a multi-stakeholder forum. When all the views are incorporated in the design of the project, it will result in a win-win situation.

As a matter of fact the proposed system was conceived in such a way that the area could be flooded as desired allowing for a learning process on interval and conditions required to maximize maximum benefit from flood (e.g. case of North Vam Nao in Viet Nam).

3.2.2 Highlights of Stakeholder Consultation in the West Bassac area

Problem due to flooding

The main environmental problem related to flooding in this area is deterioration of water quality when the flood starts early and lasts long. Since over 30% of the population depend on surface water as a source for domestic use, skin disease, rashes and diarrhoea are common during such floods.

Feedback on West Bassac Demonstration Project

- Farmer groups, PDWRM, PDA and Fisheries administration all perceive the benefits of the project.
- Two crops in Zone 2 & 3 and three crops in Zone 1 will create economic benefits for the farmers and the area as perceived by these stakeholders.
- On the potential reduction of fishing opportunity due to issues with migration of fish, the stakeholders perceive that benefits due to agriculture will outweigh any negative impact on fishing.
- Most of the fishing in the area is small scale and at household level and is not likely to impact them too much.
- Commercial fishing lots are located towards the south in Zone 2 and are also not likely to be impacted so much as the fishing is on the river branch connecting directly to Bassac River. It does not depend on fish migration through flood water.
- Fisheries Administration view on this project is that the creation of Agriculture benefits to the farmers will reduce the pressure on farmers encroaching into flooded forest for fishing. This is a fragile zone.
- There are issues related to change in land use and resulting conflict in terms of water use for community level fishing or agriculture, dike through some people's field, land speculators entering in the area to buy land etc., which can be easily tackled through education, awareness raising among people and negotiation.
- Full flood protection measures will not be good for this area as it is likely to have negative impact according to CEDAC (NGO in Phnom Penh). The suggestion is to plan for more irrigation rather than full protection. According to their experience, one good crop of rice and floods is better than two or three crops of rice with no floods.

Issues to consider

- *Community level:* Creating irrigation and drainage channels, polders, reservoir will lead to changes in land use. There could be potential conflict with people depending on agriculture and people depending on fishing in reservoirs. Consultation should map the present land use and livelihoods dependence and explain the potential changes due to project.
- *Fisheries:* Fisheries Administration plans to construct fish breeding sanctuaries on the upstream Bassac. This should be considered in the project design and feasibility
- *Bird Sanctuary near Vietnam border in the South in Zone 2: Any* potential negative impact on the bird sanctuary should be considered in the project design and feasibility
- Department of Agriculture will need to organize quality seeds resulting from increase in area under rice and other crops and also marketing. An integrated plan to support agriculture and fisheries development needs to be incorporated.
- Since land holding is low (1 ha / family on an average), continuous use of land for agriculture can lead to problems in the future. Sustainable Agriculture development becomes crucial. Again, an integrated plan and appropriate policy on land use will be important.

Key Stakeholders Identified

- Farmer groups, e.g water users association
- Commune leaders

- Commercial fishing lot owners
- District and Provincial Line Agencies (water resources, agriculture, fisheries, environment, and rural development)
- Potential NGOs (CEDAC, OXFAM, Red Cross, GRET[2], Sre Khmer, FLD[3])
- CNMC.

[2] Association de solidarité et de cooperation internationale
[3] Farmers Livelihood Development

4 PUBLIC PARTICIPATION PROCESS SUMMARY

The preliminary consultation has given an opportunity to highlight issues that will be important to consider for designing the demonstration project. Some of the issues are already known, but there may be issues which have not been considered. At this stage, there are assumptions as to the needs of the communities and perceptions about various stakeholders in supporting or opposing this project.

A broader consultation with key stakeholders in the area will provide inputs for the design of the project as well as highlight what resources each stakeholder can bring into this project at various stages.

As has been highlighted before, the needs of the communities and within the community for men and women vary considerably. This cannot be known unless a proper stakeholder analysis is done in participation with the communities. Similarly, the internal and external stakeholders can contribute considerably in integrating agriculture, fisheries and environment impact of the project. Facilitating to gather these inputs constructively can lead to the contribution of this input into the project preparation.

Participation can range from simply informing people about the project, wherein people or stakeholders have no opportunity to influence the decision making, up to empowerment of stakeholders in the design and implementation of the structural measure, wherein people and stake holders have an opportunity to influence the decision making. Various types of public participation between these two extremes can be consultations, participation and creating ownership. The level of participation desired should be clearly defined before starting the consultation process. The tools and methods adopted are different for these different types of participatory process.

Empowering the community and stakeholders in joint decision making is the ideal participation process. More often than not the facilitators end up simply informing the people and stakeholders about the project and conduct consultation exercise that may not give enough room for decision making by the people and stakeholders. This can have serious consequences when the project is at implementation stage. Hence, training the facilitators in appropriate training tools and methods to undertake public participation process, which is inclusive and empowers or at least creates ownership opportunities for influencing the decision making process becomes crucial.

The next step is how to integrate the inputs from consultation into design changes or adding elements to the design. Multi-stakeholders facilitation skills can be important for this process.

The Best Practice Guideline on Public Participation and Training materials will provide the required tools and methods to conduct these exercises effectively.

The public participation process is described in detail in Attachment 1. The following is the summary of public participation process envisaged for Stage 2 and project implementation stage

<u>Project Conceptualization Stage – Demonstration phase FMMP-C2</u>

The public participation specialist will train the NMC, Line Agencies, Social Sector Specialist and Project Consultant Engineers by equipping them with the right tools and skills to conduct public consultation exercises. A Best Practice Guidelines will be prepared to help the facilitators in conducting the public consultation. The following is the summary of steps that will be followed in stage 2

- Prepare Fact Sheets describing the project, area covered, intended benefits, potential impacts in local language to be used to inform and educate the communities as well as line agencies and NGOs
- Facilitate consultation sessions at community level to identify vulnerable groups and issues important for women, agriculture and fisheries. These sessions should be facilitated by local external facilitator and separately with women by women facilitators
- Facilitate consultation sessions with Line agencies and NGOs separately. This will be done by trained facilitators at NMC or Line agencies.
- Conduct multi-stakeholder workshop with representatives from farmer groups, communes, district and provincial level line agencies and representatives from ministries
- The outputs of these consultations will be used by the project design team to incorporate the needs and wishes of the community and stakeholders in the design.

Project Design Stage

- Identify NMC and key staff of project executing agency and also NGOs to lead consultation session on structural design
- Train the facilitators in participatory tools (land use mapping, resource mapping, seasonality, timelines and visioning) after conducting training needs assessment of these facilitators
- Conduct focus group interviews of all stakeholders explaining the detailed project at local level to understand how to mitigate the negative impacts, if still any after incorporating the wishes and needs of community. Identify contentious issues that needs to be resolved further by negotiation and bring to the multi-stakeholders platform
- Conduct multi-stakeholder workshop to incorporate the needs and wishes of the communities and other stakeholders and communicate the final project design

Project Execution Stage

- Communicate the project design, launch and progress made during the implementation through mass media
- Communicate the project design to executing agency staff at various level
- Conduct sessions at community level to identify participation in the construction of the structural flood control measures.
- Train the community in operation and maintenance and create user groups for efficient management and use of structures

5 PROPOSED WORK PLAN – PUBLIC PARTICIPATION SPECIALIST

Based on the fist mission in Stage 2 in Feb-March 2009, which provided understanding of the local stakeholder context and also needs assessment of the facilitation required to conduct public consultation, the following plan is proposed for the next missions

Period	Time Required	Activities
April 2009	2 weeks	Prepare Best Practice Guidelines
April 2009	1 week	Prepare Training Session plan, training material, case studies to be used in training of identified facilitators
May/June 2009	4 weeks	Conduct training of facilitators with hands on experience in consultation

Attachment 1: Public Participation Plan for Structural Flood Protection Measures

Stakeholder Groups

Involved in project preparation exercise: Project implementing agency National and provincial line agencies Contractors Provincial governments	*For consultation:* Local governments (province, district, commune) Village leaders, village members Community-based organizations (Farmers' groups, Water-User Groups, Conservation / Forest User Groups) Civil society organizations or mass organizations (eg. Women's Union)

Project type	**Structural Flood Protection Measures**		
Stages	**Activities**	**Events**	**Resource required**
During Stage 2: Demonstration Phase			
Project Conceptualization:	1.1 Prepare a clear fact sheet describing the project, its expected location and coverage, and the estimated costs. The language and terminology used in the description should be accessible to those people who will be affected by the project. Provide information on who to contact to know more about the project. 1.2 Conduct stakeholder analysis with project implementing agency, line agencies (national and provincial), and concerned local governments to determine which groups, household, settlements will be most affected by the project, in particular vulnerable groups. 1.3 Distribute the fact sheet in the affected area as widely as possible through leaflets, and posting in community spaces. 1.4 Organize a public information session open to all to inform the community about the project and answer questions. 1.5 At the public information session, collect contact information from those that consider themselves affected or inform them of how to notify the	Stakeholder inception workshop Public information session.	.5 mth International PP Spec. 1 month National SS Specialist Leaflets / Information poster Workshop and travel costs.

Project type	Structural Flood Protection Measures		
Stages	**Activities**	**Events**	**Resource required**
	project that they wish to attend future consultations. 1.6 Map out the communities to be consulted in the design based on most affected settlements, and representation of different types of geographic/ethnic areas that will be affected. 1.7 Assess the important characteristics of communities in the target area that must be considered in assessments and consultations. These will include: ▪ Language and cultural practices for community decision-making ▪ Opportunities and constraints to women's participation in planning ▪ Potential sources of conflict / competition for resources that need to be considered in the participatory process.		
2. Project Design: Assessment	2.1 Identify key NMC and/or Project Executing Agency personnel or Sub-contractors (Mass organizations / NGOs) that can be trained to lead consultation and planning exercises in communes and villages. This group would be the Community Facilitators 2.2 Conduct a rapid training needs assessment of the Community Facilitators. 2.3 Adapt sets of participatory development and social tools to be relevant to structural project design preparation. ▪ Participatory Hazard, Vulnerability and Capacity Assessment, including assessing negative and positive impacts of flooding, traditional coping mechanisms, and needs for external support in flood protection and		.5 mth International Public Participation Specialist 1 mth National SS Specialist

Project type	Structural Flood Protection Measures		
Stages	**Activities**	**Events**	**Resource required**
	disaster management. ▪ Participatory Rural Appraisal Tools for Mapping land use and community resources and assets, historical changes, ▪ Social Assessment: Key informant interviews and Focus Groups with Affected populations to contribute to assessment of social impacts: on land-use, forest use, water use, Gender assessment, Ethnic profile as per the guidelines. 2.4 Establish a format for summarizing information from the consultations for use by the Project Executing Agency in the design process. 2.5 Conduct a Training of Community Facilitators. ▪ Day 1 of Training would be Introduction to design of Structural Flood Protection Works in the LMB ▪ Day 2 - 3: Training on tools and facilitation skills for participatory planning, including practicum in one of the communities to be consulted within the project preparation.		
3. Project Design: Analysis of Impacts and Mitigation	3.1 Based on mapping from 1.6 Community Facilitators conduct consultations, focus groups sessions and key information interviews in targeted localities with support from National SS. 3.2 Identify one person (e.g. leader of a community-based organization) in each settlement cluster to be a focal point for continued feedback on the design and progress of the project.		.5 mth Int. PP Spec 1 mth National SS to supervise the CF and assist in compilation of results. CFs : Travel allowances

Project type	Structural Flood Protection Measures		
Stages	**Activities**	**Events**	**Resource required**
	3.3 Hold debriefing session of National SS Specialist and Community Facilitators at mid-way point between consultations to review quality of information collection and summarization. 3.4 Finish consultations and document results of social impacts and community priorities for flood protection / livelihood development and their inputs on how to mitigate negative impacts of the proposed project. 3.5 Use information from the communities in finalizing the project design. Develop options for compensation of negative impacts of the project, or options to support communities to be able to take advantage of positive impacts (eg. Diversifying cropping patterns based on flood protection; training on alternatives to agricultural production in areas of potential increased flooding). 3.6 Design resettlement plans and land compensation in keeping with government / donor regulations. 3.7 Hold community consultations to either i) validate the options that will be included in the project design for compensation or ii) select among the options according to community priorities. Whether the purpose is validation or selection will depend on the nature of the project, and the resources available to compensate affected people. 3.8 Identify other supports in the community (other projects, NGOs, Government programs) that can support communities to mitigate negative impacts or take advantage of positive impacts of changes brought by the project. 3.9 Identify existing community-based organizations (Water User Groups,		Travel costs Workshop and meeting costs

Project type	**Structural Flood Protection Measures**		
Stages	**Activities**	**Events**	**Resource required**
	Mass Organizations, Co-operatives, Disaster Management Committees) that could play a role in Operation and Maintenance.		
4. Dissemination of Public Participation Practice in other NMCs.	4.1 Review and refinement of public participation process and tools based on the experience by National SS and International PP. 4.2 Experience sharing workshop / training on Public Participation in each country by National SS Spec. (could also be held at the regional level). 4.3 Finalization of Public Participation in Toolkit and documentation of recommendations for its future use in project design.	Experience Sharing Workshop	.5 mth International PP Spec. .5mth National SS Spec.
During full implementation of Structural Measure			
Stage	**Activities**	**Events**	**Resources**
5. 4. Project Implementation & Monitoring	The process of public participation in the implementation of structural projects would be elaborated in more detail within the final project based on the specific type of project, location, and following the Guidelines on Public Participation, and Environment, Economic and Social Impact. The important steps in this process would be : 5.1 Disseminate information about the project final design, start-up and progress through media, local broadcasts and other available means. 5.2 Refresher training on facilitation skills with Community Facilitators to re-engage them in the process. 5.3 Mobilize existing or new Community-based organizations (Women's Union, Water User Groups, Farmer Groups) for participatory monitoring	Press releases, Press conferences Workshops with stakeholder groups. Community monitoring meetings.	International Public Participation Specialist National Social Sector / Public Participation Specialists Allowances for Community Facilitators Travel costs Workshop and meeting costs

Project type	Structural Flood Protection Measures		
Stages	**Activities**	**Events**	**Resource required**
	of project implementation. 5.4 Establish checklist to monitor: ▪ Access routes, waste disposal, use of land, environmental impacts during construction ▪ Quality of construction when appropriate ▪ Monitoring and reporting of negative impacts on land and natural resources as construction progresses ▪ Implementation of compensation packages ▪ Implementation of resettlement plan 5.5 Community facilitators provide training on project design and activities to be monitored by the community. 5.6 Establish feedback mechanism with Project Executing Agency, Contractors, relevant Government Authority to address problems during construction, or adjust design for unanticipated negative impacts. Establish mechanism for reporting and solving problems related to resettlement and compensation packages.		
6. Project Implementation: Operation and Maintenance	6.1 Provide training on Operation and Maintenance to final Project Holder (local government, line agency, etc.). 6.2 Identify in the training how the community can be involved in the Operation & Maintenance, depending on the type of structural work, size, location and anticipated maintenance requirements. 6.3 Based on information from consultations, work with Project Holder to form community O & M groups. 6.4 Provide training and support to Operation & Maintenance groups organizational development (Statutes of operation, Schemes to recover	Training on O & M - to Community Facilitators / Project Holders - to community	

Project type	Structural Flood Protection Measures		
Stages	**Activities**	**Events**	**Resource required**
	costs of maintenance where appropriate, small supports for operations) depending on the type of structure. 6.5 Prepare materials and organize community meetings on what they should do or not do to contribute to maintenance of the structure.		

Attachment 2: Stakeholder Consultation

Cambodia

Stakeholder consultation Interviews in West Bassac Demonstration Project Area: Feb 25 to 27, 2009

During the three days field visit, the Provincial Department of Water Resources and Management (PDWRM), Provincial Department of Agriculture (PDA) and community water user associations were interviewed.

The interviews focused on the following aspects:
1. Role and function of the department & water users association
2. Damage due to floods and existing coping mechanisms
3. Existing flood protection measures in the area
4. Extent and type of public participation in flood protection measures implemented in the area
5. Stakeholders' Analysis: Identifying stakeholders who are likely to support or oppose the structural flood project measures demonstration project

Summary of Discussions:

1. Provincial Department of Water Resources and Management (PDWRM), Takeo

Mr. Bun Huor, Director
Mr. Suan Sophai
Mr. Sam No
Mr. Ven Sovann

<u>Role of PDWRM</u>
- Manage & develop all water resources in the province including irrigation schemes and dams
- Record water level and rainfall for flood management
- Warning is issued when flood water level is 4.5 mts (based on the 2000 floods) and local government bodies are informed

<u>Existing Flood Protection Measures</u>
- In Treang, Kaoh Andeth, Kirivong, Bourei Cholsa
- 23 km long dike of 2 to 3 mts height
- Before dike: Rice cultivation in 2,800 ha. After Dike: Rice cultivation in 17,000 ha
- Inception: 2002 – World Bank. Feasibility study: by the dept. Implementation: 2004 by MOWRAM

<u>Selection Criteria</u>:
- Near National Road
- Budget limitation
- Cost / benefit
- Population density
- Full protection of the area

<u>Benefits</u>:
- 2 crops are possible: wet season paddy and dry season paddy. Some farmers also cultivate vegetables in the summer
- People don't need to migrate for off-farm income generation to major towns or Thailand.

Extent of Public consultation:

- PRA was conducted during the feasibility study to take people's need in the planning
- Some farmers who were losing part of the land to dike protested, but this issue was solved through negotiation when the farmers understood the potential benefit

Stakeholders' Analysis:

The West Bassac Demonstration project will be very beneficial for the farmers as it will control floods and bring economic benefits to the people in the area. The PDWRM is in agreement with the project idea.

PDWRM suggest to focus on the following stakeholders:

- Consult Vietnam authorities as it might have some effect on their side as well
- Protecting the bird Sanctuary near Cambodia / Vietnam border should be considered when planning the project
- Fishing might be affected in terms of reduced fish stock or fish migration. Fisheries administration might have some objection to the demonstration project
- Community should be consulted for detailed planning

2. Provincial Department of Agriculture, Takeo

Mr. Eith Sarun, Director

Role of PDA

- Technical support to farmers on seed, pesticides and fertilizers
- Training to farmers on agronomic practices
- Training to District staff

Flood Related Issues

- Floods combination of water from the river and rain
- Dike on the Vietnam side of the border. Spill way is 300mt., which backs up water on the Cambodia side.

Demonstration Project

- Will be very beneficial to farmers; 2 crops can be grown and will also support livestock and fisheries
- PDA will be in a position to support the farmers with additional crops
- Total Area under Wet Season Rice in Takeo province: 170,000 ha. Out of this, 11,000 ha is planted two times. Present yield: Wet Season Rice 2.9 tons/ha. Area under dry season rice: 4.5 to 6 tons/ha. IR-66 variety planted.
- Rice seed is not enough for the area. If the area under rice is to expand, more seeds will be required. Seed improvement research required

3. Thnot Té Village Water Users Association

Village background

- No. of households: 200 families
- Population: 1,000
- Main Occupation: Dry season recession rice. Some farmers also grow wet season rice. Many farmers have subsidiary crops like taro, morning glory, and few chicken, pigs and cattle

- Land holding: Average 1 ha/family. No formal land title, but land holding is recognized by farmers, village chief and Govt. authorities. Agri. land sale is done by informing the village chief and neighbouring farmers.
- Spill way constructed by ADB in 1993 for controlling floods and create water storage to cultivate dry season rice and also fishing

Flood Related Issues
- From both rain and upstream river
- Floods usually start in July and the water flows on top of the spill way. Sometimes, floods are in as early as April
- Flood water from the river does not come into the village as it is located on higher grounds. Rain water can create flood in the village
- Floods are good, because they bring fertile silt which increases the yield.
- Flood period: 2 to 3 months from July onwards

Agriculture and Livelihoods
- Seed purchased from PDA. Not sufficient for the village
- Rice: IR-66 variety. Yield: 4.5 tons to 6 tons/ha. When they use their own seeds, yield is lower
- Seed improvement is required. They use 70 kg seed/ha and broadcast method is used as Transplanting is not feasible due to lack of land. Also, lack of labour for transplanting
- Income from rice is not sufficient for the family. About 50% families are fishing in the reservoir
- Many young girls migrate to Phnom Penh to work in Garment factories

Water User Association
- Established in 1999
- Distribute water to farmers and collect irrigation service fee (70 kg rice/ha). Three categories of fees: Gravity water: 70 kg/ha. Own pump + gravity: 45 kg/ha. Own pump only: 30 kg/ha
- Fee is used for O&M of the spill way
- Average collection: USD 2,500 per year
- Chairmen elected by the committee every 5 years. No woman has been the Chairperson yet.

Feedback on West Bassac Demonstration Project
- Will be highly beneficial: 2 crops per year. They will be able to grow wet season paddy by using water from reservoir
- They don’t see any conflict with fishing.
- Presently, they have sometimes conflict with farmers who want to grow rice on the upper side of the reservoir when they irrigate rice in this village in the dry season and empty the reservoir. Also, sometimes conflict with farmers who want to retain water in the reservoir for fishing
- When designing the demonstration project, communities all around the reservoir who have differing levels of dependence on it should be consulted

4. Ang Kanh Commune, Prey Kabbas, Takeo Province

Chief: Rokh Tre

Village background
- Household: 120
- Population: 6,000

- Main crop: Rice
- Land holding: 35% own less than 1 ha, 50% own 1 ha and 15% own more than 2 ha. Very few own about 10 ha.
- People are moving to deep flooded area in search of new land to cultivate recession rice
- 60% has sufficient rice for family consumption.
- Shortage of cash. There are few micro-credit programs like AMRETH, PRASAK, ACLEDA who charge about 2% interest per month.
- Seasonal migration to Thailand border for labour
- Youth usually migrate to Phnom Penh in search of opportunities
- Fishing only for family consumption

Feedback on Demonstration project
- Cultivating two crops will bring benefits
- Labour and transportation of agriculture produce is a constraint
- Investment in rural roads is necessary
- Water ways for transportation could be developed
- Quality of ground water is not good for irrigation

5. Cantonment of Fisheries Administration, Takeo Province

Vice Chief: Ou Sophan

Role
- Manage the flooded forest
- Managing the Reservoirs
- Law enforcement on fishing practices such as forbidden fishing instrument e.g. electric fishing rod.
- Promote aquaculture at family scale; distribute fish fry to the population
- Community fisheries
- Commercial fishing lot along the Takeo River in Borei Cholsa through license, which is renewed every two years. 56% fishing lot managed by communities
- Developing fish sanctuaries along Kampong Reap with OXFAM Australia

Issues
- Total catch of fish in the province is declining; 1,800 tons fish harvested from commercial fishing lots in 2008. Family fishing, aquaculture and fishing in rice field not included in this figure
- Small scale conflict in upper part between fishing and irrigation
- Fish reproduction is through local source along the river and also come from Bassac through canals.
- Local fishing was more important. Farmers block the flood plains between Bassac and also from Tributary, so less migration of fish already happening and fish stock has reduced

Feedback on Demonstration Project
- Canals connecting Bassac and d tributary might improve the fish migration and at the same time increase rice production. So, the project is likely to have positive impact on both. However, they need to see the detailed project design to understand the impact more precisely
- Suggest to make an integration plan for fish stock protection and fish sanctuaries
- Commercial fishing along Takeo River may not be affected as fish from Bassac will be available in the flow even if the flood plains are blocked for a while

- It will be easier to protect flooded forest if farmer are going for two crops
- Fisheries can be conserved better with integrated planning
- Control gates can help to retain the tidal water

6. OXFAM Australia

Nop Nsamnang

Working in two districts; Prey Kabbas and Treang

Social Issues

- Illiteracy is the root cause of poverty, more prevalent among women
- Health
- High birth & high mortality
- Gambling
- Migration to other areas for employment
- Some areas which are very remote are also very poor
- Women are more vocal than before, but still dominated by men
- Although men bring money to wife as part of the culture, spending is discussed jointly and for bigger expenses men take lead

Feedback on Demonstration Project

- There will be benefits to the farmers, but will need to follow up on bringing equity within the household
- Participation should be functional rather than only for conflict management or conflict avoidance

7. Provincial Department of Water Resources and Management (PDWRM), Kandal, Cambodia

1. Chun Peng Leng, Director
2. Soun Dong Keo, Irrigation Engineer

Role

- Participate in organization of provincial committee for Disaster Mitigation
- District Level data collection of flood levels and prepare flood mitigation plans
- Don't have forecasting capability at present and use the flood forecasting from MRC, and Department of Hydrology and River Works (DHRW)
- Survey damage after the floods

Existing Flood Protection Structures

- Built structures on the lower Preik Thnot River on N.W. of Phnom Penh. This protects Phnom Penh city and the Industrial area.
- Dikes constructed in 2002-03 of 1mt height
- Structure maintained by a mixed working group consisting of Ministry and Provincial department
- Monitor river bed rise, sedimentation and possible breach of embankments
- When this structure was constructed, the plan was to create agriculture benefits. But, this area was turned into an Industrial area.
- AFD pilot project

Demonstration Project

- Positive benefits for Agriculture and fisheries apart from flood control
- It is in line with their thinking

Attachment 3: Mission Plan

In order to develop the public participation plan, the first mission was undertaken by the public participation specialist from February 17 to March 6, 2009 in Cambodia and Laos PDR.

In consultation with the Team Leader, a detailed mission plan was made. In the available time, it was decided to visit two demonstration project areas; West Bassac in Cambodia and Se Bang Fai in Laos PDR to understand the local context in which the public participation plans should be developed.

The first one week spent on reading the project background documents and understanding the two demonstration projects.

Mission Schedule: February – March 2009

Date	Place	Activity
Feb 15	Ottawa – Phnom Penh	Travel to Phnom Penh from Ottawa, Canada
Feb 17	Phnom-Penh	Arrival in Phnom Penh. Meeting with the Team Leader
Feb 18 to 24	Phnom-Penh	Reading and understanding FMMP-C2 Demonstration project, MRC structure, Public Participation principles adopted at MRC, Stage 1 report outline on public participation, preparing a preliminary stakeholder consultation – identification and making travel plan to West Bassac and Se Ban Fai areas
Feb 25 & 26	Takeo province	Meeting with PDWRM, PDA, Fisheries Administration, Water User Association
Feb 27	Kandal province	Meeting with PDWRM, visit to pilot project in fully controlled area
Feb 28	Phnom Penh	Analysing finding and preparing outline of report
Mar 1	Vientiane	Travel to Vientiane from Phnom Penh
Mar 2	Vientiane	Stakeholder consultation meeting at LNMC
Mar 3 & 4	Nongbok district	Field visit to Se Bang Fai demonstration project area; meeting with provincial and district SWC and community groups, water user association
Mar 5	Phnom Penh	Work at office – analysing findings from Laos PDR visit & Report writing
Mar 6	Phnom Penh	Meeting with CEDAC (NGO), Report writing, debriefing to Team Leader and FMMP coordinator
Mar 7	Phnom Penh – Ottawa	Travel back to Ottawa, Canada
Mar 8	Ottawa	Arrive in Ottawa, Canada
Mar 9 & 10	Ottawa	Final Mission Report – Develop Public Participation Plan

Attachment 6 Implementation Public Participation Plan

CONTENTS

LIST OF ATTACHMENTES

1 INTRODUCTION

A preliminary stakeholder analysis and consultation was conducted in March 2009 to identify the key stakeholders for consultation on structural flood protection measures in the West Bassac and understand the issues that the communities want to prioritize for dealing with floods.

Subsequently, the Best Practice Guideline on Public Participation was updated to help the NMC and Line Agencies facilitators conduct stakeholder consultation exercise in the demonstration projects. The stakeholder consultation schedule was prepared and implemented in the West Bassac in Takeo Province (Prey Kabbas and Koh Andet districts) and Kandal province (Koh Thom and S'ang district) from June 1 to 4, 2009 (Attachment 1). Given the time and budget, the focus of public participation was on community consultation.

The participation of communities in giving feedback on the ideas for demonstration project is aimed to better understand the situation and take into account the priorities of the communities, especially the vulnerable groups within the community. The consultation helped in validating the assumption regarding benefits and concerns of the communities when the project is implemented.

1.1 Objective of Stakeholder consultation

The objectives of Stakeholder consultation in stage 2 planning of the structural flood protection measures demonstration project are to:

1. Better understand the priorities and needs of the community in flood risk management
2. Get feedback on the demonstration project and incorporate the needs and priorities into the project
3. Build capacity of NMC and Line Agencies in facilitating community consultation during the implementation of the demonstration project.

1.2 Scope of Stakeholder consultation

The West Bassac area demonstration project covers a large area; Takeo and Kandal provinces. This stakeholder consultation was restricted to two districts in each provinces given the time and budget. Some of the areas that were not easily reachable were not considered and if required additional consultations can be held in these areas, if need be at a later date.

The consultation educates the Line agencies and communities on the demonstration project ideas and sets the stage for future participation. The consultation should be seen to build the rapport with the community, while getting initial feedback on the structural measures, its benefits and impacts on agriculture, fisheries, livelihoods and environment. While the time required to explain and knowledge level of communities may, at times, be insufficient to foresee the impact on environment issues. The output of this consultation captures the needs and priorities of the communities and Line agencies representatives based on their experience in the area. This needs to be integrated into the design and the results of other studies related to environmental examination, agricultural development scenarios and economic impact studies.

2 CAPACITY BUILDING OF LINE AGENCIES IN COMMUNITY CONSULTATION

The public participation plan developed in Stage 1 envisaged that the consultation with the community would be done by the Line agencies representatives and they be trained in conducting community consultation session. This plan has been implemented in May 2009.

The CNMC and Line Agencies facilitators who have responsibility for making consultation at community level were selected by CNMC to implement public participation plan in the demonstration project areas.

In West Bassac, representatives from CNMC, and Line agencies representatives from Prey Kabbas and Koh Andet districts in Takeo province and Koh Thom and S'ang district in Kandal provinces were trained to facilitate community consultation on getting feedback on structural measures for flood protection. A community consultation facilitation guide was also prepared and translated in Khmer language and the Line agencies representatives were trained to facilitate community consultation (Attachment 1).

2.1 Learning Objective of Capacity building of Line Agencies

The objective of the capacity building exercise was that at the end of the implementation of the community consultation exercise, the line agency participants are able to:

1. Explain the need for public participation in structural flood protection project
2. Explain how to conduct stakeholder analysis
3. Conduct stakeholder consultation using participatory methods
4. Summarize findings from stakeholder consultation exercise and propose alternative solution

2.2 Participants

Based on the experience in preliminary stakeholder consultation in March 2009, the following participants (Attachment 3) were proposed for consultation in West Bassac field area in Kandal and Takeo provinces:

1. Two NMC representatives responsible for public participation or stakeholder consultation
2. Fisheries Administration representatives each from Takeo and Kandal province
3. Line Agency representatives each from Takeo and Kandal Provinces responsible for facilitating at community level
    a. One representative each from PDWRM
    b. One representative each from Dept. of Agriculture
    c. One representative each from Dept. responsible for Environment and Nature reserves
    d. One representative each from Dept. responsible for Provincial Disaster Committee
    e. One representative each from Dept of Rural Development
4. Line Agency representatives responsible for facilitating at community level in Prey Kabbas and Koh Andet Districts in Takeo province and Koh Thom and S'ang districts in Kandal Province
    a. One representative each from PWDRM
    b. One representative each from Dept. of Agriculture
5. Two NGO representatives each from Takeo and Kandal provinces
6. FMMP-C2 Social Sector / National Public Participation Specialist, Mr. Bona

2.3 Consultation with Line Agencies and capacity building

The capacity building focused on the need for community consultation and some of the tools that would be used in community consultation. The exercise also served to get feedback on the demonstration project from the Line agencies participants.

The concept of vulnerability analysis was introduced and the participants discussed in four groups – how flood affects people and their assets. Is it the same or different?

An interesting discussion on how the rich and poor families will be affected revealed different perspective of looking at damage. A few line agencies participants disputed that the poor will be more affected. Their argument was that the rich people are more affected because they have agriculture land and hence the damage to crops will be much larger for them as compared to poor families who have less land or no land. It was clear that the line agencies participants were focusing on economic damage alone and do not have the perspective of damage to people and their assets. After a discussion on social perspective, how people who do not have any land and houses in vulnerable location, no capacity to store food and move their animals lose everything in the event of the flood. They cannot recover from the damage quickly, while the rich families can still recover. The participants then discussed in four groups vulnerabilities.

The following is the summary of presentations

- All will be affected equally, but damage is different
- Damage to economic, social infrastructure depends on what resource people have
- Houses on higher ground and lower ground affected differently
- Poor families will not be able to move their animals
- Rich have access to boat and can move easily during floods
- Rich families have wooden bridge and residence on higher land and can keep their animals
- Poor families usually have more children who will be at risk during floods
- Flood damage on roads, schools, infrastructure
- Landless cannot find job during floods
- Widow, aged, disabled, families with many children will be the most affected

The participants then discussed in four groups the hazards and the solution they would propose. The main hazards they highlighted is Flood, which causes damage to houses and other village assets, agriculture land, loss of livelihood (labour, fishing, marketing etc), health, environment and economy in general.

The solution proposed covers both structural and non-structural measures and creating financial and market support and linkages. Except for Group 1, the other groups proposed only non-structural measures as their preferred solution that would improve the coping mechanism of the families and repairing existing infrastructures to reduce the effect of flooding. Group 1 proposed construction of dike in Takeo province to protect the area from flooding. This group also proposed other non-structural measures

Group Presentation: Summary of Solutions against flood hazard

Group 1	Group 2	Group 3	Group 4
1. Construct flood protection dike 2. Move to safe shelter on higher ground 3. Provide seed 4. Encourage farmers to go for dry season crop 5. Health education 6. construct health centre 7. Awareness raising on flood Dike from Prey Kabbas district centre to Angkor Borai district	1. construct houses on higher ground 2. Strengthen the existing houses 3. Reserve food stock for flood season 4. Find new employment 5. Provide medicines 6. Provide rice seed 7. Move animals 8. Construct schools and health centres 9. Roads	Similar to other groups Early warning system Make a diversion channel from National Road 13	1. Kandal being a flat area, make a diversion channel 2. Repair the existing Colmatoge canals 3. People make dike to protect, but these canals are shallow as they are already silted 4. water gate

The structural measures with flood protection dikes and polder system will make the area flood free and with 2 to 3 crops per year will bring in economic benefits.

On the negative side, the concern of the line agencies representatives is that there might conflict on ownership of land for fishing and agriculture between villages. The villages on higher ground might find it difficult to get water during the dry season for cultivation. They believe that flood is required because it deposits silt, which contributes to improving soil structure and hence soil fertility. With increased cropping intensity from one to two or three crops per year, pest problem will increase. There might be impact on fish in the flooded forest and also impact on fish migration as the water flow through the flood plain will be cut off or change. This can have negative impact on fishing. The project will require pumping and maintenance of these structures can become an issue in the future and can get more expensive.

Suggestion to Minimize Impact

1. Conflict with drainage and irrigation (upstream and downstream). Study the drainage and irrigation system.
2. When constructing dike, provide access to water on both side of the dike – otherwise farmers will break the dike to access water.
3. Compensation for land acquisition and resettlement policy should be incorporated
4. Multiple benefits – road, navigation etc. should be considered.
5. Promote Aquaculture.
6. Fish sanctuaries – protected area
7. Respect fishing period regulation

Participants recapped the steps in consultation and how creating structure of discussing in pairs and groups ensured that each and everyone in the group could participate to share their ideas. The participants expressed that the advantage of taking everyone's idea was that a comprehensive set of solution could be discussed and when implemented it will satisfy everyone's needs.

2.3.1 Instructions on Community Consultation Steps

This set the stage for discussing how to conduct community consultation session. The community consultation guide was introduced (Attachment 2). Are there different needs of people in the community in the event of flood? Are the people affected equally? Poverty, location of the house in the village, type of houses, women and children were some of the factors that would determine the way in which people would be impacted. All these groups of people would be affected differently and hence it is important to discuss with them separately in groups. How to conduct vulnerability analysis was explained.

The focus of the session was exploring with the participants their understanding of vulnerability or sensitivity of the people in the village to floods. The Line agency participants had not been thinking of different effects of floods on different groups of people. This session helped them to understand the meaning of vulnerability and how to conduct vulnerability analysis and identify these groups in the community consultation session by exploring based on some criteria such as location within the village, age, gender, coping mechanism, and poverty level.

The steps in conducting vulnerability analysis were explained to the participants. This was followed by exploring the tools that would be employed by them in the community consultation. Group Discussion (separately with men, women, poverty groups), time Line (floods and its severity, other hazards), village asset mapping (location of schools, temples, govt. offices, houses, fields, irrigation infrastructure etc.) to understand vulnerability was explained.

The steps in conducting community consultation exercise were explained to the participants. The logistics was finalized and the team was divided into four groups and villages were assigned.

3 IMPLEMENTATION OF COMMUNITY CONSULTATION

3.1 West Bassac, Cambodia

The West Bassac area covers portions of Takeo and Kandal provinces, extending along the right bank of the Bassac River from south to the town of Ta Khmao to the Cambodia-Vietnam border. The area is delimited to the north and the west by RN2, to the east by the RN21 and to the south by the Vietnam-Cambodian border.

Based on annual flooding conditions (deep and shallow flooded area), existing infrastructures and actual land and water use conditions (road as flood protection embankment, existing natural and man made drainage network), the West Bassac area could be subdivided into three zones for effective flood risk management:

Zone 1: Deep flooded currently cash crop area immediately left to the RN21 and the deepest part of the flood plain to the west following the same alignment of the Prek Ambel. This zone is conceived to be a full flood protection area consisting of five large polder systems. The main crop in this area is cash crop in higher ground near to the road and recession rice paddy in low lying area near to the Prek Ambel. After the flood protection measures and irrigation systems are implemented, it will be possible to grow two additional crops in this area.

Zone 2: Deep flooded area in between the Zone 3 and Zone 1. This zone is proposed to be protected against the early flood up to 31 of July. The area will be flooded after this date. This area can grow one additional crop with the help of irrigation. The overall objective of structural flood protection measures in this area is to delay the onset of flooding and timely drain flood water in deep-flooded areas so that farmers can plant an early rice crop as well as the recession crop.

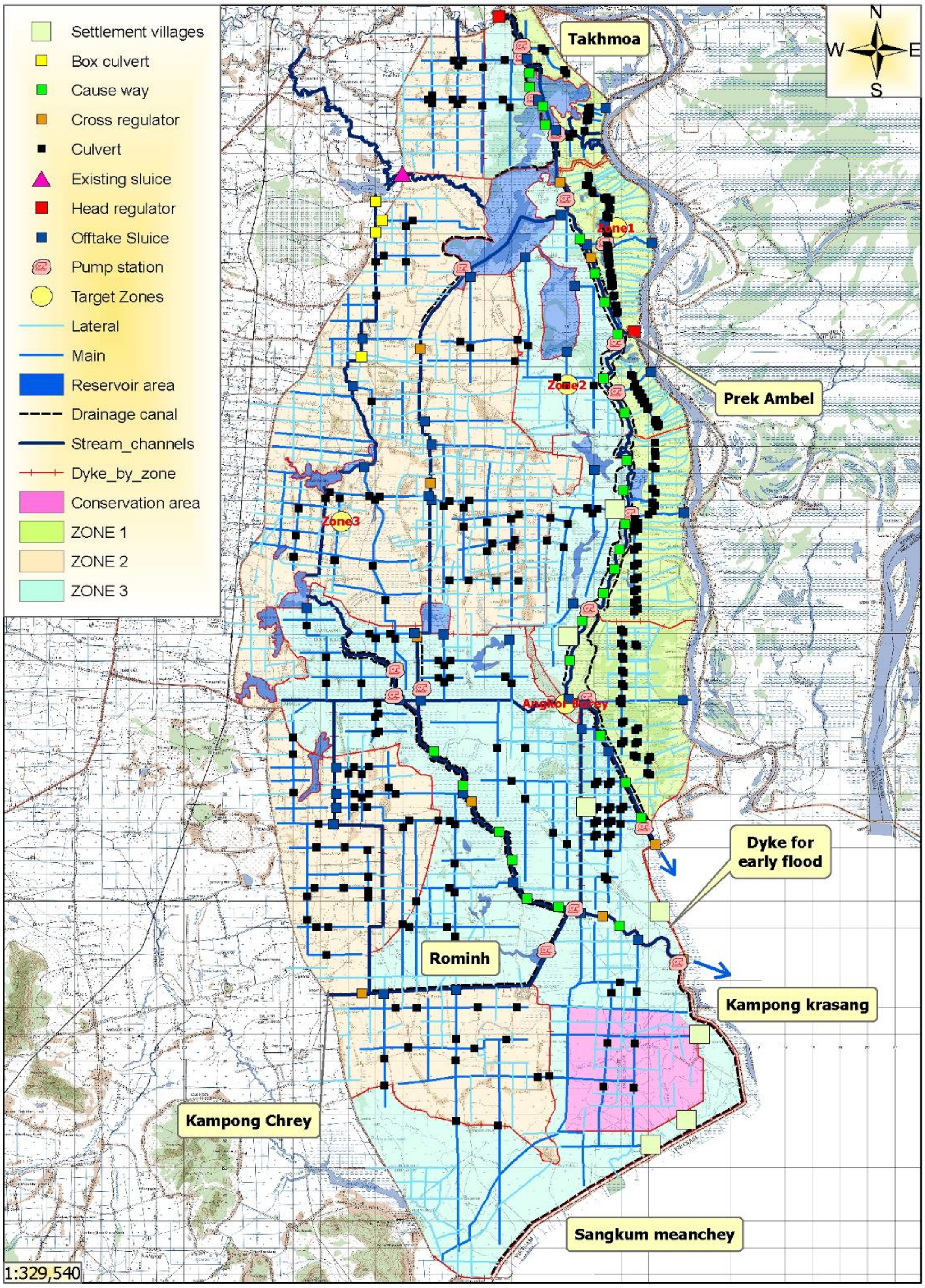
Additional components of the project include establishment of flood proof settlement clusters in the deep flooded areas along the border, improvement of the communication infrastructure (early warning) and improvement of rural roads and navigation canals to improve the livelihood of the people living in the area

Zone 3: Shallow and non flooded area immediately to the east of the RN2 will be protected against peak flood from the Mekong flood by a dike system along the zone 2 and from the western catchments by a drainage/irrigation canal along the RN2. A drainage/irrigation canal parallel to RN2 is proposed to collect surface runoff from the western catchments and to convey water from the Bassac for supplementary irrigation. With full flood protection and provision of water for irrigation two to three rice crops per year could be produced in this zone.

The specific objectives of the demonstration project are:

(i) protect deep flooded area from early flood by providing additional flood conveyance and early flood protection dike; building polder systems and protection dike and drainage system in shallow flooded area
(ii) improve water supply for early and recession season agriculture, reducing the frequency of early flood and early- and mid-season drought damage;
(iii) reduce flash flooding and related damages in the western portion of the focal area; and,
(iv) improve inland water navigation and road transport modes and creation flood proofing areas in isolated deep flooded area.

The location of the area is shown in the following figure:



3.2 Selection of Villages

The West Bassac focal area encompasses portions of the provinces of Takeo and Kandal, extending along the west bank of the Bassac River from south of the town of Ta Khmao to the Cambodia-Viet Nam border. The area is bounded by the RN 2 to the west and the flood free RN 21 to the east along the Bassac This focal area is essentially flat, with elevations ranging from 1-10 meters (asl). The flood season lasts from July to October. As water rises above 5.0 m in the Bassac, it flows across the RN21 through some 90 colmatage canals linking the Bassac with its western flood plain including two major river branches, the Prek Ho and Prek Ambel Overland flows into the floodplain also come from the Stung Prek Thnot and Stung Sla Kou Rivers in the northern portion of the focal area. The floodplain includes a shallow-flooding area located immediately behind the Bassac levees above the 5-m contour line and the area bordering the non flooded areas along the RN 2, a deep flooded area in between extending along the Bassac flood plain from Ta Khmao town to the Cambodia-Viet Nam border.

A total of 24 villages were selected, 16 villages in Takeo province and 8 villages in Kandal province. The villages were selected based on the vulnerability characteristics and to represent the three zones. Some villages which are more flood prone, but could not be reached easily in the given time constraint could not be selected.

West Bassac Community Consultation Village list

Village Name	Commune Name	District	Province
Beng	Krapum Chhuk	Koh Andaet	Takeo
Romenh Tboung	Romenh	Koh Andaet	Takeo
Trapeang Tonle	Krapum Chhuk	Koh Andaet	Takeo
Romenh Cheung	Romenh	Koh Andaet	Takeo
Ta Phin	Prey Yuthka	Koh Andaet	Takeo
Daeum Pou	Romenh	Koh Andaet	Takeo
Pong Andaeuk	Prey Yuthka	Koh Andaet	Takeo
Samraong	Romenh	Koh Andaet	Takeo
Chumnik	Kampong Reab	Prey Kabbas	Takeo
Prey Kabbas Ka	Prey Kabbas	Prey Kabbas	Takeo
Kampong Leav	Kampong Reab	Prey Kabbas	Takeo
Prey Kabbas Ko	Prey Kabbas	Prey Kabbas	Takeo
Roka	Snao	Prey Kabbas	Takeo
Prey Robang	Prey Phdau	Prey Kabbas	Takeo
Thomm Viney	Snao	Prey Kabbas	Takeo
Prey Chheu Teal	Prey Phdau	Prey Kabbas	Takeo

Village Name	Commune Name	District	Province
Preik Louk	Preik Sdei	Koh Thom	Kandal
Preik Ta Mem	Preik Sdei	Koh Thom	Kandal
Preik Sueng	Sampov Pun	Koh Thom	Kandal
Koh Teav Kha	Sampov Pun	Koh Thom	Kandal
Anlong Tasek Kraom	Preik Ambel	S’ang	Kandal
Peam Prachum	Preik Ambel	S’ang	Kandal
Kouk Sandeik	S’ang Phnom	S’ang	Kandal
Kampong Trea	S’ang Phnom	S’ang	Kandal

The majority of the population in Koh Thom and Koh Andet districts speak Khmer, about 87 and 98% respectively according to Social Survery (March 2008). In Koh Thom, a community of Vietnamese (11% of the population), can be found and they live on fishing along the shores of the Bassac River. While the population in the focal area is largely socially and culturally homogeneous, there are high proportions of people who live below the poverty line, including 23% in Koh Andet and 30% in Koh Thom.

The implications for social vulnerability include:

(i) The social and cultural homogeneity of the population increases resilience to flooding in that it supports social and community networks.

(ii) Poverty, however, is a key indicator of vulnerability to the impacts of flooding. Poor people tend to live in housing of inferior quality located in more vulnerable areas which means they may experience greater damages and losses due to flooding. Poor people have lower cash incomes and rely more on loans that they may have difficulty to repay; they are more at risk of having to sell produce at lower prices (not able to store until prices are better) or to sell off land and other assets to pay for extra expenses due to floods.

The Provincial Government works with districts, commune councils and village chiefs to notify and warn people about flood levels; and, issue warnings on radio and TV. Commune councils, in particular, play an important role by advising village chiefs at least a month prior to the expected flood so that they can take steps such as evacuating people and animals to safe areas; commune councils also work with village chiefs to ensure accurate reporting of flood damages and relief requirements. Commune/Village Committees for Disaster Management have been established although they are not fully effective due to lack of financial and technical support.

The Provincial Government collaborates with (and relies heavily on) the Cambodian Red Cross (CRC), CARE and other NGOs to deal with the requirements of emergency response and flood recovery:

Various NGOs have developed small lending/micro-credit programs for agricultural production, although they often have very limited coverage. Some weaknesses include: (i) a lack of transparency and accountability in terms of who benefits from initiatives and (ii) low participation by poor households because they lack labour and funds.

3.3 Community Consultation in West Bassac

The consultation in 24 villages was done in two days time by six teams consisting of 3 to 4 members each from Line agencies. Each team consisting of Line agencies participants conducted community consultation exercise in four villages in two days time. The Public Participation specialist supervised through the consultation by continuously monitoring the progress with the group through the national public participation specialist.

The teams followed the steps in consultation, conducting vulnerability analysis and dividing the groups on this basis. About 20 villagers pre-selected by the village chief on the basis of criteria of equal representation of women and vulnerable people participated in the consultation.

The groups were either divided as men and women or poor and rich depending on the situation in the village.

3.3.1 Summary of Group Presentations

The six groups presented summary of consultation in the respective villages. The presentation was organized according to the consultation form. It was organized as follows: exploring hazards and disasters, solutions proposed by communities, feedback on demonstration project, its benefits and negative impact, and what changes they would bring in agriculture and other livelihoods after the demonstration project.

The consultation brought out different perspectives of the community as it was done in diverse location. However, there were many similarities.

The feedback of all the groups in the 24 villages was that the demonstrated project of controlling the flood with dikes, water gates and drainage channels will be very beneficial to them.

The communities recognize the benefits of demonstration project in terms of agriculture production, increased cropping intensity, ease of transportation, no damage to houses and properties, less disease and overall increase in economic benefits. However, they also recognize that there will be some negative impact like conflict between upstream and downstream farmers, especially water use for fishing & agriculture, land acquisition for construction of dike, reduction in fish possibly due to

reduction of fish migration and also negative environmental impacts such as reduction in bird population, especially along the Vietnam – Cambodia border in Koh Andet, increase in pest and disease incidence due to continuous cropping, loss of fertilization effect of silt which happens in case of floods and flushing of toxic elements from the soil may not happen, which may further deteriorate soil quality.

The communities also proposed some of the solutions to minimize the negative impact of the demonstration project. The conflict between upstream and downstream farmers or neighbouring villages could be solved by forming water users committee when the project is implemented so that through their participation, the issue can be addressed right at the initial stage. They are willing to contribute land or willing to lose some trees to construction of dikes and roads. However, if the loss is high, they expect compensation. They also expect to participate in the Operation & Maintenance of the structures. The communities in Koh Andet also propose dike around the village to protect the villages from flooding in the event of bigger floods

The detailed consultation result is presented in the following table.

Presentation of Community Consultation
Province: Takeo and Kandal
District: Koh Andet, Prey Kabbas, Koh Thom and S'ang
Villages: 24 villages
Groups: 6

Description	**Group I**	**Group II**	**Group III**	**Group IV**	**Group V**	**Group VI**
I. Community Background:						
Province :	**Takeo**				**Kandal**	
District :	**Koh Andet**		**Prey Kabbas**		**Koh Thum**	**Sa Ang**
Commune:	1. Krapum Chhuk	1. Romenh	1. Kampong Reab	1. Prey Kabbas	1. Preik Sdei	1. Prk Ambel
	2. Prey Yuthka		2. Snao	2. Prey Pdao	2. Sampov Pun	2. S'ang Phnom
Village :	1.1 Beng 1.2 Trapeang Tonle	1.1 Romenh Tboung 1.2 Romenh Cheung 1.3 Daeum Pou 1.4 Samraong	1.1 Chumnik 1.2 Kampong Leav	1.1 Prey Kabbas Ka 1.2 Prey Kabbas Ko	1.1 Preik Louk 1.2 Preik Ta Mem	1.1 Anlong Tasek Kraom 1.2 Peam Prachum
	2.1 Ta Phin 2.2 Pong Andeuk		2.1 Roka 2.2 Thomm Viney	2.1 Prey Robang 2.2 Prey Chheu Teal	2.1 Praek Sueng 2.2 Koh Tiev Kha	2.1 Kouk Sandaek 2.2 Kampong Trea
Vulnerable Analysis - Grouping	- vulnerable men, - vulnerable women - better off men - better of women	- vulnerable men, - vulnerable women - better off men - better of women	- vulnerable men, - vulnerable women - better off men - better of women	- vulnerable men, - vulnerable women - better off men - better of women	- vulnerable men, - vulnerable women - better off men - better of women	- vulnerable men, - vulnerable women - better off men - better of women
Most Vulnerable Group	- Widow, disabled, aged, landless household and poor (many children and orphan). - Poor household: small house and no resources would mean difficulty in carrying out flood mitigation steps.	- Widow, disabled, poor and landless h/h, aged household head without young labour support and orphan. - Poor household is likely the household who have more children and single household head.	- Widow, family with many children, aged, disabled, poor and landless household.	- Widow, disabled, aged, orphan, very poor and landless household.	- Widow, disabled, aged, orphan, poor and landless household.	- Difficult for widows to take care of their children; - Disabled and aged people are jobless; - Poor families are landless household.

Description	Group I	Group II	Group III	Group IV	Group V	Group VI
II. Problems:						
Hazard	- Flood: river and strong rain (Jul to Nov); - Drought (Jul to Aug) - Storm (wet season)	- Flood: river and strong rain (Jul to Nov); - Drought (Jun to Sep); - Storm (wet season).	- Flood - Drought	- Flood - Drought - Storm	- Flood: river and strong rain; - Drought - Storm and lightning	- Flood - Drought - Storm
Flood event	- In 2000 & 2001 – It was big flood, other year normal flood. Flood duration is 5 months. - Flood is the most important hazard. - This year, flood from the rainwater is already big.	- Most important hazard is flood. - Flood water level is 1.2 to 1.5 meters on the rice field. - In 2000, it was big flood with 1.8 m of water level in the field, and at the same time the river in Phnom Penh it was 11.20 meters.	NA	NA	NA	- Flood started from Aug – Oct; - Drought: from Dec to Apr; - Storm: July to Nov.
Disaster by flood hazard	- Damage to agriculture (rice); - Some people died, - Affects livestock, more disease; - Damage to dike and road.	- Some people died; - Affects livestock, more diseases; - Affects agriculture land; their productivity - Assets and transport, - Affects fodder for animal, - Irrigation system damaged; - Fishing boat Immersed in flood water - destroyed.	- Animal disease - Insect: impacted on rice crops (agriculture land and production), - People's health: skin, diarrhoea, etc. -Impact on livelihood – cannot go far away from village to find a job during the season - Impact on road, bridge	- Animal disease; - Destroyed infrastructure in the village; - Lack of occupation - Lack of seed varieties - Health problem for people and animal.	- Impact on agriculture; - Embankment erosion (calmatage canals and river); - Impact on house, other asset and animals; - Damage on public infrastructure; - And in 2000 during June to Aug, all social services were cut off.	- Damage on road, agriculture (rice and crop), water well, latrine, school, health center, houses, livestock, etc. - Destroy irrigation system; - Difficult to find a job, loss daily income; - River embankment erosion.
III. Effect of flooding on people						
For better off or general people	- Affects assets and transportation means. - Agricultural land and productivity (rice, crop and tree).	- Affects assets and transportation means. - Agricultural land and productivity (rice, crop and tree).	- Rice farming and rice productivity - Animal raising - People healthy - Impact on livelihood, daily income;	- Affects rice and other crops; - Health problem: people and animal; - Impact on livelihood, daily income;	- Most people lose their job, some family lack food, also difficult to make social contact - Impact on environment, water quality due to	- Affects rice crops and other crops; - Livestock, more disease; - People's health; - Daily income;

Description	Group I	Group II	Group III	Group IV	Group V	Group VI
			- Public infrastructure in the villages.	- Affects houses.	increase animal disease and people illness.	- Houses collapsed due to embankment erosion; - Road was destroyed by embankment erosion
For vulnerable people	- Houses (lack of shelter). - Agricultural land, rice, crop, and tree (lack of food). - Lack of transport means (boat, etc.), difficult for children to go to school. - Difficult to find a job during the season. - Some fishermen take more risk with flood and lightning. - People have more illness (lack of medicines). - More disease for animals due to difficult to find higher ground for them.	The same as the other groups.	- Jobless migrate to other towns. - Houses - Health problem: people and animals.	- Affects houses; - Lack of food and medicine; - Health problem for both people and animal; - Lack of job.	- Jobless become loss daily income; - Lack of food and medicine; - Impact on environment, water quality due to increase animal disease and people illness. - Social services cut off.	The same as the other groups.
Coping mechanism against floods and others hazard	- Raise level of house and house site - Construct a road and drainage - Canal cleaning up - Set up a Farmer Water User Community and Road Maintaining Community.	- For general people: - Raise level of house site; - Fill up land for dike protection; - Canal and water gate construction; - Maintain roads, bridges and culverts. In additional for vulnerable people: - Prepare food, tents, medicine,	- Raise house level site; - Find out safe shelter for people and animals; - To make a shelf for keeping other things for using; - Using a boat (Chumnik & Kampong Leav villages); Additional for vulnerable people: - Need help from outside.	- Prepare food and medicine before flood season; - Prepare seed; - Raise house level; Additional for vulnerable people: - Need help from local authority; - Selling labour.	- Early warning; through radio, T.V. or local authority; - Construct polder dike around the village; - Fill up land to make safety place, during flood; - Make diversion canal; - Reserve some food, medicine and other requirement tools;	- Fill up land to make safety place, during flood; - Raise level of house site; - Vulnerable group needs help from outside and government; - Prepare boat, raft, food and medicine.

Description	Group I	Group II	Group III	Group IV	Group V	Group VI
					- Prepare boat or raft.	
IV. Community proposed structures						
Community need	1. Krapum Chhouk commune: - Rehabilitation of dike is about 5 km (including water gate, station, and bridge) from Canal 93 (Trapeang Tonle village) to Canal 87 (Prey Mlou village). - A Preak Louk canal, in southern village (about 3.5 Km) and Thneu Cham canal (about 2 km) including drainage structures. 2. Prey Yuthka commune: - Paratnat dike is 4.8 Km with canals on both sides (covers 2 communes: Prey Yuthka and Krapum Chhouk). - One dike is about 5 Km with canals on both sides from Pong Andeuk village to Kamnab commune (Kirivong district) - A dike from Deum Doung village to Prey Yuthka is about 4 Km with canals on both sides.	Romenh commune: - Ang Kork Reservoir for dry season rice can irrigate 1,250 ha, also fishing for h/h consumption. - Rehabilitation of Tuol Ta Klok reservoir. - Tuol Kamnab and Arch Prachiev dikes. - Culverts and canals need to be rehabilitated for managing water during or after flood. - Tertiary canal about 3.5 km long; - Road rehabilitation. - Set up a Water User Committee.	- A polder around the Chumnik village; - To block calmatages in Kampong Leav village; - Need rehabilitation of existing canal in their villages (Thorm Vinei and Roka village).	- Rehabilitate Tumnob Srok dike; - Irrigation system rehabilitation.	- Set up flood early warning system; - Rehabilitation of existing dike, canal, culvert, bridge, etc; - Flood protection along the river embankment from erosion (Preik Seung and Koh Tiev villages); - To block (water gate) all calmatages along road 21 (Koh Thom and S'ang district) to protect early flood season; - Safety place for public use; - Rehabilitate irrigation system.	- Make dike bigger around the village to protect from flood and use as road; - Make road, canal system deeper; - Construct water supply system; - School and health center; - Rehabilitation of existing dike, canal, culvert, bridge; - Construct water gate for controlling water flow in and out of reservoirs.
Advantage of the requested structures	- Dike can protect flood, reduce flood damage, and make more income for people, reduce illness, diseases and	- Increase season of rice farming (two crops of rice for dry season) because there will be enough water	- Constructing a dike can reduce house and crop damages by flooding; - Easy to travel along the	- Flood protection system and road access; - Irrigation system; - Fish will increase	- Reduce flood damage on house, other assets, animal and agricultural sector;	- Reduce flooded on house and other assets; - Having safety place

Description	Group I	Group II	Group III	Group IV	Group V	Group VI
	poverty in the community. - Increase season of rice farming (two crops of rice for dry season) because there will be enough water to irrigate and water fee will be lower. - Dike can also be uses as road to transport the agricultural products, as a shelter for people and animals during flood season and safety place for fishermen during storm.	to irrigate and water fee will be lower - Road access is better, transport service is more improved; - Reduce flood damages - Increase rice production through flood control in wet season and 2 rice crop in dry season through irrigation system;	dike; - Block calmatages as early flood protection to let farmers harvest crops on time and then let flood come; - Rehabilitation of existing canals to let people farm two crops of rice for a dry season;	- Will have enough water for rice farming.	- Reduce some risk when they get the information before flood; - Will have enough water for rice farming and others crops; - Two crops of rice for dry season, rice yield and rice production will increase; - Travelling will be easy and time saving; - Economic activities will be conducted smoothly.	for people who affected by flooded - Increase rice production (2 crop times in dry season) and other crops; - Will be easy to travel around the village - Increase job opportunity.
Disadvantage of the requested structures	- Small private land acquisition may be required, but it can be solved by the community. - Increased cropping intensity with dry rice season, will increase the use of chemical fertilizer and pesticide that will have negative impact on the environment and increase the cost of production. - No flood means, no silt deposit so rice field will become less fertile due to loss of soil structure. - Construction of dike may interrupt fish migration. - Conflict between people who	- Small private land acquisition may be required, but it can be solved by the community; - Conflict between people who have land in the reservoir and people who have land outside the reservoir. But the problem can be solved through a Farmer Water User Community. - Construction of dike may interrupt fish migration. - Embankment erosion could lead to silting of canal.	- All participants responded there will be no negative impacts at all.	- Small private land acquisition may be required, but it can be solved by the community; - Low land area may get flooded and cause conflict with neighbouring village.	- Fish may decrease - No flood, it may have many insects and rats that can destroy rice crops. - No flood, it means no silt, more weeds, soil fertility will be less; - Environment may be changed causing no flood for flushing toxic elements in rice field.	- More pest, rat; - Fertilization effect of flood will be missing; - Land acquisition will be a problem.

Description	Group I	Group II	Group III	Group IV	Group V	Group VI
	have land in the reservoir and people who have land outside the reservoir. But the problem can be solved through a Farmer Water User Community.	- They also use canal for navigation, which makes waves causing erosion of embankments and canal cannot take high volume of water; - Canals could be destroyed by livestock, poultry feeding near by.				
V. Feed back on demonstration project options - Structural measures						
Positive points	- It is a good flood protection measure and reduced much of the flood damages; - Having enough water for rice farming, - Water fee will be lower, - Two crops for dry season, - Easy to travel to the fields and transportation of agricultural produce. - Flood diversion.	- Will have enough water for rice farming, - Fish will increase, because of water remaining; - More vegetable planting; - On the dike can plant some trees; - Water fee will be lower. Now, private sector provides pumping and charge for high water fee; - It is a good flood protection measure and will reduce much of the flood damages.	- Easy to travel to another area; - Will reduce flood damages; - Create more opportunity for rice and other crops cultivation; - No any conflict with other village by the project; - Project is big scale, so it can reduce flood damage and improve agricultural sector.	- Flood protection and reduce damage on infrastructure, houses and other assets; - Two crops for dry season; - More fish;	- Can protect all public infrastructures in the village, so the economy will be good and also protect agriculture; - People agree with the project, but ask some more like polder around the village; - Good to protect river embankment from erosion, so that it can prevent house, tree and road collapse * All participants are ready to contribute their land or trees if it will be affected by project during construction. If the loss will be bigger, compensation will be required. - People will contribute	- Will have enough water for rice farming; - More fishes; - Improved livelihood options; - If the project s done, they can do rice farming two times a year, cultivate vegetable and other crops; - Opportunity for labour will increase; - Reservoir rehabilitation will help in irrigating rice - They can contribute labour for project O&M.

Description	Group I	Group II	Group III	Group IV	Group V	Group VI
					cost for O & M; - Set up WUG for O&M	
Negative points	- Will have small effect on private land; - Reduce silt - Will affected fish migration, - It may create conflict between fisherman and farmers.	- Will have small effect on private land; - It may create conflict between fisherman and farmers. - Land along dike will degrade in quality; - Increase in dry rice season cultivation, will increase the use of chemical fertilizer and pesticide that causes negative environmental impact and will be costly for people.	- Will have small effect on private land; - It may have conflict interest between fisherman and farmers;	- Will have small effect on private land; - Conflict between local people and neighbouring village/area.	- Water gate will block colmatage from flood. No flood would mean less fertilization effect, less flushing of toxic elements in rice field; more insect, rats etc. - Navigation with small boat may not be possible in calmatage after water gate; - Fish might also decrease; - People are concerned about river embankment erosion, will destroy road 21, some houses also collapsed in the river, particular village close to Vietnam border because in Vietnam side, they have fish cages (aquaculture), which causes water to come back on Cambodia side. About 10 m erosion every year. - Very concerned about bird population if the	- More pest, rat; - Fertilization effect of flood will be missing; - Land acquisition will be a problem; - In some areas, people may be negatively affected.

Description	Group I	Group II	Group III	Group IV	Group V	Group VI
					fish population is decreasing. The birds are very important for pest control in rice fields.	
VI. Other Information						
Existing structures in villages	- Paratant dike & canal; - Prassak canal, 1998-1999; - Preik Thmei dike (Cambodia - Vietnam border), - Health centers, - Rural road in village - School and Pagoda, play a good role for safety place during flood season, - Some old bridges and culverts, - Commune road is under flood level.	- Thnoat Kanchroung, Kouk Kandoal and Arch Prachiev dike; - Canals, calmatages and culverts; - Roads and bridges; - School, pagoda and health center;	- Canals, calmatages, bridges and culverts.	- Tumnob Srok dike is about 11 km long; - 3 canals in total 6 km long; - O'Cham Noam reservoir has two functions: First is to collect water from the village during heavy rain avoiding flooding in the lower area, and 2nd is to supplement water irrigation in Aug and early September (small drought).	- National road #21 as a dike protection; - San Dor dike; - Most of local people have TV and Radio – easy to get information; - Safety place: pagoda, school and health center can be used as shelter during flooding; - Dike, canal, lake, river, reservoir that can relief water to protect village from flooding.	- Preik Ambel calmatage canal is about 30 km; - There are 34 calmatage canals in total; - There are dikes is about 60km; - There are 6 Reservoirs.
Household occupation	- 95% - farming rice, - 0.30% - fishing and Livestock, - Other rest are selling labor in or outside village, a construction worker, a trader, a Government officers and teachers, etc	- 84% - farming rice, - Other rest is animal raising, fishing and small business.	Kampong Reab com.: - 75% - farming rice and other crops such as maize, bean, potato and vegetables - 8.43% - fishing for h/h consumption. - 3.25% - livestock - Other rest - labour, weaving, construction Snao commune:	Prey Kabbas commune - 96% - farming rice and other crops; - Other rest – small business, weave, construction and labor selling. Prey Phdau commune: - 92% - farming rice and other crops; - Other rest – fishing,	- 91% are farmers; - 2% - Fisherman; - Other rest – labour, construction and small business.	- 83% are Farmers; - 1% - Fishing for h/h consumption; - 1% - livestock; - Other rest - labour selling and small business.

Description	Group I	Group II	Group III	Group IV	Group V	Group VI
			- 97% - farming rice and other crops such as maize, bean, potato and vegetables - 1.11% - fishing for h/h consumption.	livestock, etc.		
Evaluation: - Participants know well about the benefit and issues of the demonstration project now. They are very interested in the project. They also understood the consultation process.						

3.3.2 Feedback on Consultation Process

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Consultation Process	Very useful. Information on vulnerability very useful for planning equitable development. Potential upstream and downstream conflict better understood Communities want to express poverty when they see Govt. officers	Exact requirement of the people and problem faced by people useful for planning Facilitation skill is very important. Capacity building required.	In previous project, there was no consultation on flood. People are concerned about flood now.	economic profile and flood damage and other difficulty how people cope with the flood, existing structures etc. One village was not informed properly… only widows were invited.	agree with other group. feedback from people is updated and more exact participants try to focus on road instead of flood	participant selection – village leader always focus on vulnerable group village selection – not correct… there are villages that have more damage by flood… but are difficult to access. project description not very clear
Questionnaire		Not enough time for questionnaire. Simplify the questionnaire	Some questions are similar, so the answers are repeated. Some questions were difficult. Training time short	Some questions were difficult to understand. Training time short.		
Logistics			Transportation to Prey Kabbas district, was difficult.	Transportation was difficult in Koh Andet). Short time for consultation and more time for travel.	transportation to village was difficult in Koh Andet	
Expectation	All of the Line agencies participants would like to have facilitation skills training on such consultation process and questionnaire. They like to do such consultations. Suggestion is to prepare a guide with examples for next training					

Attachment 1: Stakeholder Consultation Implementation Schedule

Facilitator: Mr. Dilip Chinnakonda, Public Participation specialist supported by Mr. Nhean Bona, National Public Participation Specialist

Day 1: June 1, 2009
Location: Phnom Penh
Venue: RFMMC, Phnom Penh
Purpose: Instructions on Stakeholder Consultation Process

Time	Topic	Resource / Method
08:30 to 9:00	Registration	Registration sheet
9:00 t0 9:15	Welcome and Opening	NMC
9:15 to 9:45	Introduction to the Consultation process and Expectations	Input
9:45 to 10:30	Introduction to the West Bassac Demonstration Project Options	Input
10:30 t0 10:45	Break	
10:45 to 11:30	Explore Participants' understanding of the need for Public Participation	Open Questions
11:30 to 12:00	Introduction to Public Participation Methods	Input
12:00 to 13:00	Lunch	
13:00 to 13:30	Introduction to Stakeholder Analysis	Input
13:30 to 14:30	Discuss a. Stakeholder Analysis Matrix b. Type of Information c. Questions to ask the Stakeholders Prepare Stakeholder Consultation plan for Day 2 and 3	Group Work
14:30 to 15:30	Presentation and discussion: How to conduct stakeholder consultation by participants	Plenary
15:30 to 15:45	Break	
15:45 to 16:30	Prepare Field Visit Consultation Logistics – Divide in 4 groups - Materials required - Transport - Tea / Lunch in the field - Number of stakeholders to be consulted by each group and expected outcome - ensure participation of all men, women and excluded communities	Plenary
16:30 to 17:00	Wrap Up	

Day 2: June 2, 2009
Location: Communities in Takeo and Kandal Provinces
Tea and Lunch to be managed during field visit
Purpose: Consultation at community level

Time	Activity	Resource / Method
7:30	Depart for field	
9:00 to 10:00	Consultation with District level stakeholders	Information sharing, focused group discussion
10:00 to 10:30	Travel to field	
10:30 to 13:00	Community Consultation (first community) - Present West Bassac demonstration project - Vulnerability, Social analysis and impact on environment - Potential benefits and negative impact discussion - Alternative solution for potential problems from perspective of different stakeholders (men, women, vulnerable groups separately) - Development Vision of stakeholder	Information sharing – Visual Flip Charts, Maps PRA tools Transect walk Focused Group Discussion Visioning Exercise
13:00 to 13:30	Travel to second community	
13:30 to 16:00	Community Consultation (second community) Same as First Community	
16:00 to 17:00	Travel back	

Day 3: June 3, 2009
Location: Communities in Takeo and Kandal Provinces
Tea and Lunch to be managed during field visit
Purpose: Consultation at community level

Time	Activity	Resource / Method
7:30	Depart for field	
09:00 to 09:30	Travel to field	
09:30 to 12:00	Community Consultation (third community) - Present West Bassac demonstration project - Vulnerability, Social analysis and impact on environment - Potential benefits and negative impact discussion - Alternative solution for potential problems from perspective of different stakeholders (men, women, vulnerable groups separately) - Development Vision of stakeholder	Information sharing – Visual Flip Charts, Maps PRA tools Transect walk Focused Group Discussion Visioning Exercise
12:00 to 12:30	Travel to second community	
12:30 to 13:00	Community Consultation (fourth community) Same as above	
13:00 to 16:00	Travel back	
16:00 to 17:00	Summarize findings	

Day 4: June 4, 20009
Location: Phnom Penh
Venue: RFMMC, Phnom Penh
Purpose: Analysis of Community consultation

Time	Topic	Resource / Method
8:30 to 9:00	Introduction to day's activities and status check	
9:00 to 10:00	Prepare Presentation of Consultation	
10:00 t0 10:15	Break	
10:15 to 11:15	Group 1 Presentation - Consultation process - What was the experience - Summary of findings - What are the anticipated changes in the project - Discussion	Charts, Pens, Boards,
11:15 to 12:15	Group 2 Presentation	
12:15 to 13:00	Lunch	
13:00 to 14:00	Group 3 Presentation	
14:00 to 15:00	Group 4 Presentation	
15:00 to 15:15	Break	
15:15 to 16:00	Summary and Further Consultation and Communication mechanism	
16:00 to 16:30	Wrap Up and Closing	

Attachment 2: Community Consultation Guide: West Bassac Demonstration Project, Takeo (Prey Kabbas and Koh Andet districts) and Kandal Province (Koh Thom and S'ang district)

1 Purpose of Consultation

The purpose of the consultation with the community is to get feedback on the structural measures options for flood control in the West Bassac demonstration project options area. The project is at conceptualization stage; hence it might be difficult to outline the detailed structures at village level. However, participation of stakeholders in discussing the conceptualized options can help in better design and planning of flood risk management in the subsequent stages.

This should be seen as an initial consultation to develop a common understanding about the options for flood control measures. It will lay the foundation for future consultations and greater participation of all stakeholders in decision making.

2 Village Selection

The consultations will be done in two days time by six teams consisting of 3 to 4 members each. The team should be able to manage to visit at least two villages in a day. A total of 24 villages be selected; 16 villages in in Takeo Province (Prey Kabbas and Koh Andaet districts) and 8 villages in Kandal province (Koh Thom and Sa Ang district).

The villages selected should be representative of the area and should consider all the three zones equally. Villages should also be selected on flooding & vulnerability criteria. The villages selected should be more prone to flooding compared to other villages in the district and should have more poor and vulnerable people.

3 Community Selection

While selecting the people in the village for consultation, equal representation of men, women, ethnicity and vulnerable groups should be considered. A village socio-economic profile can be used to randomly select the community members for participation.

3.1 Identifying Vulnerable Groups

Vulnerability is the term used to describe exposure to hazards or shocks. People are more vulnerable if they are more likely to be affected by events that are beyond their control like floods, storm, drought, earthquake etc.

Different people in a community will be affected differently by hazards. While planning for options to check the likelihood of occurrence of hazard or reduce the chances of occurrence of hazard, it is important to consult with different groups of people in the community who will be affected to hazards differently.

A vulnerability analysis should be conducted before conducting stakeholder consultation for getting feedback on the demonstration project options to ensure that the feedback from the community represents opinion of all groups of people, and especially the vulnerable group.

If vulnerability analysis for a village community was already conducted, then use the results from that analysis to do stakeholder consultation for the demonstration project options.

3.2 Steps

1. Introduce the purpose of meeting
2. Explain what information will be collected and how will it benefit the community
3. Explain how the information will be collected.
4. Explain the need for talking to all the groups in the village
5. Explain what is vulnerability and participatory vulnerability analysis

3.3 Vulnerability Analysis

The following information will help in vulnerable analysis
1. Vulnerable levels by groups, location etc.
2. Identifying flooding and other hazards, when they occurred and how often.
3. Differences in vulnerabilities by gender, age, ethnicity, location etc.
4. How does each group cope with various hazards?
5. Identify the Govt. supported structures (like dikes, safe shelters etc) and systems (early warning

3.4 Tools

- Group Discussion (separately with men, women, ethnicity, vulnerable groups)
- Time Line (floods and its severity, other hazards)
- Village asset mapping (location of schools, temples, govt. offices, houses, fields, irrigation infrastructure etc.)

3.5 Key Questions

1. What are the major hazards that the village has been faced with in the past. When did it occur, what was the level of damage
2. Which groups of households are more exposed to flooding and other hazards in the village?
3. Why were some groups able to cope better than the others?
4. What are the existing structures and systems for coping with floods and other hazards?

4 Steps in Community Consultation

1. Divide the group into smaller groups based on the vulnerability analysis
2. Present the demonstration project options
3. Explain the likely structure in the village
4. Explain the intended benefits; which people are likely to benefit and in what way
5. Facilitate focused group discussion (smaller interest groups based on vulnerability) to collect feedback on the demonstration project options using PRA tools
6. Note down on the chart paper, concerns expressed by the smaller interest groups and discuss.
7. Note down solutions suggested by them to address the concerns
8. Analyze the options with the community and conclude which option is likely to work and which one is not likely to work and why

9. Use the questions in the consultation analysis form, note down on chart paper and fill the form

Community Consultation Analysis Form

Community Background	
Name of Country :	
Name of District :	
Name of Village :	
No. of Households :	
Name of Group consulted : (e.g vulnerable men, vulnerable women, better off men, better of women)	
Vulnerability Analysis	
• What are the major hazards that the village has been faced with in the past. When did it occur, what was the level of damage? • How was this group of households affected by flooding and other hazards in the village? • How was this group able to cope with flooding and other hazards? • What are the existing structures and systems for coping with floods and other hazards? • What is the livelihood for this group (e.g. rice, fishing, labour, business etc.)	
Feed back on Demonstration project Options	
Structural Measures	
• Which option is preferred by this group • Does this group perceive any clash with neighbouring village or community because of the structures? • What is the major concern about each of the options • What solution does this group suggest for the problems with flooding in relation to the proposed options • What type of flood control or mitigation structure would this group want for their village, where should they be located in the village and why?	
Intended Benefits	
• Does this group perceive the	

same intended benefit of the demonstration project options? • What negative impacts does this group perceive (on agriculture, fisheries, environment)? • How will the different demonstration project options impact their present livelihood? • What changes in cropping, fishing or any other livelihood activity will this group make if the demonstration project option is implemented and why?	
Development Vision	
• What type of development does this group want to see in the village and why? • What additional support systems would be required to capitalize on the benefits of the demo project options – if this group is in favour of demo project options	
Future Participation	
• How does this group want to be engaged in the demo projects in future? • What resource can this group bring to the demo project	
Evaluation of Consultation	
• To what extent did the group understand the demonstration project options and their purpose? • What additional information does this group require to answer the questions in a better way?	

Attachment 3: List of Line Agencies Participants

Attachment 4: Excel file of Consultation by sub-groups within the 24 villages

Flood Management and Mitigation Program, Component 2

ROYAL HASKONING

ATTENDANCE SHEET

HASKONING NEDERLAND B.V.
WATER

COUNTRY: CAMBODIA PROVINCE: Kandal

PURPOSE OF MEETING: TRAINING ON COMMUNITY CONSULTATION

DATE AND TIME: 01 June 2009

No	Name	Position /Department	Telephone	Signature
1	[illegible]	[illegible]	012476968	[illegible]
2	[illegible]	[illegible]	016851462	[illegible]
3	[illegible]	[illegible]	017509504	[illegible]
4	[illegible]	[illegible]	012871559	[illegible]
5	[illegible]	[illegible]	089.844546	[illegible]
6	[illegible]	[illegible] CNMC	012885172	[illegible]
7	[illegible]	[illegible]	092824766	[illegible]
8	[illegible]	[illegible]	012624119	[illegible]
9	[illegible]	[illegible]	012918900	[illegible]
10	[illegible]	[illegible] PCDM	012 889477	[illegible]
11				
12				
13				
14				
15				
16				

National social specialist (verifies and signs)

Flood Management and Mitigation Program, Component 2

ROYAL HASKONING

ATTENDANCE SHEET

HASKONING NEDERLAND B.V.
WATER

COUNTRY: CAMBODIA PROVINCE: Takeo

PURPOSE OF MEETING: TRAINING ON COMMUNITY CONSULTATION

DATE AND TIME: 01 June 2009

No	Name	Position /Department	Telephone	Signature
1	[illegible]	[illegible]	[illegible]0269041	[illegible]
2	[illegible]	[illegible]	092278634	Sokhany
3	[illegible]	[illegible]	016510280	[illegible]
4	[illegible]	[illegible]	012606049	[illegible]
5	[illegible]	[illegible]	011713698	[illegible]
6	[illegible]	[illegible]	012550569.	[illegible]
7	[illegible]	[illegible]	012 681378	[illegible] MOURAM
8	[illegible]	[illegible]	012391593	[illegible]
9	[illegible]	[illegible]	012924451	[illegible] CNMC
10	[illegible]	([illegible]) T.k	097774550	[illegible]
11				
12				
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14				
15				
16				

National social specialist (verifies and signs)

Flood Management and Mitigation Program, Component 2

ROYAL HASKONING

ATTENDANCE SHEET

HASKONING NEDERLAND B.V.
WATER

COUNTRY: CAMBODIA PROVINCE: Kandal

PURPOSE OF MEETING: TRAINING ON COMMUNITY CONSULTATION

DATE AND TIME: 09 June 2009

No	Name	Position /Department	Telephone	Signature
1	OUK VANTHA	Deputy Director WRaM	012918900	
2	Ly. MAPONG.	Acricultur Kandal	089.844346	
3	HAS VUTHY	— " — Kandal	016854462	
4	OUK SOKUN	— " — SAANG	017509504	
5	[illegible]	[illegible]	092824766	
6	[illegible]	— " — [illegible]	012624119	
7	[illegible]	[illegible]	012889477	
8	[illegible]	[illegible]	011797778	
9	[illegible]	[illegible]	012871559	
10				
11				
12				
13				
14				
15				
16				

National social specialist (verifies and signs)

Flood Management and Mitigation Program, Component 2

ROYAL HASKONING

HASKONING NEDERLAND B.V.
WATER

ATTENDANCE SHEET

COUNTRY: CAMBODIA PROVINCE: Takeo

PURPOSE OF MEETING: TRAINING ON COMMUNITY CONSULTATION

DATE AND TIME: 04 June 2009

No	Name	Position /Department	Telephone	Signature
1	[illegible]	[illegible]	012 696141	
2	[illegible]	[illegible]	092278634	
3	[illegible]	[illegible]	011713698	
4	[illegible]	[illegible]	012681378	
5	[illegible]	[illegible]	016510286	
6	[illegible]	[illegible]	012391593	
7	[illegible]	(OAUS) T-K	0977747550	
8	[illegible]	[illegible]	012606049	
9	[illegible]	[illegible]	012550569	
10				
11				
12				
13				
14				
15				
16				

National social specialist (verifies and signs)

COUNTRY: CAMBODIA

PROVINCE					
DISTRICT				KOH ANDAET	
COMMUNE	Krapum Chhuk		Prey Yuthka		
VILLAGE	Beng	Trapeang T	Ta Phin	Pong Andae	Romenh Kh
Population					
Household - Total	283	116	131	175	268
Male - Total	619	290	296	380	707
Female - Total	671	303	299	409	757
Major Hazards					
Flood	Yes	Yes	Yes	Yes	Yes
Drought	Yes	Yes	Yes	Yes	No
Storm	Yes	Yes	Yes	Yes	No
Other					
The main hazard in the village	Flood	Flood	Flood	Flood	Flood
Disaster of the main hazard on					
Houses	Yes	Yes	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes
Road	Yes	Yes	Yes	Yes	Yes
Irrigation system	Yes	Yes	Yes	Yes	Yes
School	Yes	Yes	Yes	Yes	Yes
Health center	Yes	Yes	Yes	Yes	Yes
Pagoda	Yes	Yes	Yes	Yes	No
Well/clean water	Yes	Yes	Yes	Yes	Yes
Latrine/sanitation	Yes	Yes	Yes	Yes	Yes
Fish	No	No	No	No	No
Environment	Yes	Yes	Yes	Yes	Yes
Bank erosion	No	No	No	No	No
Occupation/job	Yes	Yes	Yes	Yes	Yes
Coping mechanisms					
Raise a level of house site	Yes	Yes	Yes	Yes	Yes
Raise a house level	No	Yes	Yes	Yes	Yes
Move to safe protected site	Yes	Yes	Yes	Yes	Yes
Prepare a food/medecine/crops	Yes	Yes	Yes	Yes	Yes
Canal/ culvert cleaning	No	Yes	Yes	Yes	Yes
Prepare a boat	Yes	Yes	Yes	No	Yes
Plant trees/ Prepare bags for bank protection	No	No	Yes	No	No
Existing structures for coping					
Dike	No	Yes	No	Yes	Yes
Canal/ Calmatage canal	Yes	Yes	Yes	Yes	Yes
Reservoir	No	No	No	No	No
Water gate/ Culvert	No	No	No	No	No
Bridge	No	No	No	No	No
Road access	Yes	Yes	Yes	Yes	Yes
Occupation/job					

COUNTRY: CAMBODIA

PROVINCE					
DISTRICT				KOH ANDAET	
COMMUNE	Krapum Chhuk		Prey Yuthka		
VILLAGE	Beng	Trapeang T	Ta Phin	Pong Andae	Romenh Kh
Farmer	Yes	Yes	Yes	Yes	Yes
Fishing	Yes	Yes	Yes	Yes	Yes
Labor	Yes	Yes	Yes	Yes	Yes
Livestock	Yes	Yes	Yes	Yes	Yes
Other(small business)	Yes	Yes	Yes	Yes	No
What are people needed?					
Road	No	No	Yes	Yes	Yes
Dike	Yes	Yes	Yes	Yes	Yes
Canal	Yes	Yes	Yes	Yes	Yes
Reservoir	No	No	No	No	Yes
Pond	Yes	No	No	No	Yes
Water gate	Yes	Yes	Yes	Yes	Yes
Bridge	No	No	No	No	No
Pumping station	Yes	No	No	No	No
Advantage of the proposed structures by people					
People	No	Yes	Yes	Yes	No
House and other assets	Yes	Yes	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes
Fishing	Yes	No	No	No	Yes
Transport	No	No	Yes	Yes	Yes
Environment	Yes	No	Yes	No	No
Disavantage of the proposed structures by people					
People	No	No	No	No	No
House and other assets	No	No	No	No	No
Agriculture	Yes	Yes	No	Yes	Yes
Fishing	Yes	Yes	No	Yes	No
Livestock	No	No	No	No	No
Land ownership	Yes	Yes	No	No	No
Environment	No	No	No	No	No
Clash with neighbored village	No	No	No	No	No
Feed back on demonstration project options (DPO)					
Satisfy	Yes	Yes	Yes	Yes	Yes
Dissatisfy	No	No	No	No	No
Positive point of the DPO					
People	Yes	Yes	Yes	Yes	Yes
House and other assets	Yes	Yes	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes
Fishing	Yes	Yes	Yes	Yes	Yes
Livestock	Yes	Yes	Yes	Yes	Yes

COUNTRY: CAMBODIA

PROVINCE					
DISTRICT				**KOH ANDAET**	
COMMUNE	**Krapum Chhuk**		**Prey Yuthka**		
VILLAGE	Beng	Trapeang T	Ta Phin	Pong Andae	Romenh Kh
Environment	Yes	Yes	Yes	Yes	Yes
Negative point of the DPO					
People	No	No	No	No	No
House and other assets	No	No	No	No	No
Agriculture	Yes	Yes	No	No	Yes
Fishing	Yes	Yes	Yes	Yes	No
Livestock	No	No	No	No	No
Land ownership	Yes	No	Yes	No	No
Environment	No	No	No	No	No
Clash with neighbored village	No	No	No	No	No
Future participation or Contribution in O&M					
Cash	Yes	Yes	Yes	Yes	Yes
Kind	Yes	Yes	Yes	Yes	Yes
Labor	Yes	Yes	Yes	Yes	Yes
Set up association for O&M	Yes	NA	Yes	Yes	NA
Evaluation of consultation					
Understand the demonstration project options & purpose	Yes	Yes	Yes	Yes	Yes
Need additional information to answer the question	NA	NA	NA	NA	Yes

Note: For the need additional information to answer the question is **Yes**, it mean the participants want to see the demor

COUNTRY: CAMBODIA

PROVINCE	TAKEO				
DISTRICT					
COMMUNE	Romenh			Kampong Reab	
VILLAGE	Romenh Kh	Samraong	Daeum Pou	Chumnik	Kampong L
Population					
Household - Total	418	162	173	396	207
Male - Total	1,072	439	358	801	468
Female - Total	1,170	431	438	815	457
Major Hazards					
Flood	Yes	Yes	Yes	Yes	Yes
Drought	Yes	Yes	Yes	Yes	Yes
Storm	No	No	Yes	No	No
Other					
The main hazard in the village	Flood	Flood	Flood	Flood	Flood
Disaster of the main hazard on					
Houses	Yes	No	No	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes
Road	Yes	Yes	Yes	Yes	Yes
Irrigation system	Yes	Yes	Yes	Yes	Yes
School	No	Yes	Yes	Yes	Yes
Health center	Yes	Yes	Yes	Yes	Yes
Pagoda	No	Yes	Yes	Yes	Yes
Well/clean water	Yes	No	Yes	Yes	Yes
Latrine/sanitation	Yes	No	Yes	Yes	Yes
Fish	No	No	No	No	No
Environment	Yes	Yes	Yes	Yes	Yes
Bank erosion	No	No	No	No	No
Occupation/job	Yes	Yes	Yes	Yes	Yes
Coping mechanisms					
Raise a level of house site	Yes	Yes	Yes	Yes	Yes
Raise a house level	Yes	Yes	No	Yes	Yes
Move to safe protected site	Yes	Yes	Yes	Yes	Yes
Prepare a food/medecine/crops	Yes	Yes	Yes	Yes	Yes
Canal/ culvert cleaning	Yes	No	No	No	No
Prepare a boat	Yes	Yes	Yes	Yes	Yes
Plant trees/ Prepare bags for bank protection	No	No	No	No	No
Existing structures for coping					
Dike	Yes	Yes	Yes	No	No
Canal/ Calmatage canal	Yes	Yes	Yes	Yes	Yes
Reservoir	No	No	No	No	No
Water gate/ Culvert	No	No	No	Yes	Yes
Bridge	No	No	No	Yes	No
Road access	Yes	Yes	Yes	Yes	Yes
Occupation/job					

COUNTRY: CAMBODIA

PROVINCE	**TAKEO**				
DISTRICT					
COMMUNE	**Romenh**			**Kampong Reab**	
VILLAGE	Romenh Kh	Samraong	Daeum Pou	Chumnik	Kampong L
Farmer	Yes	Yes	Yes	Yes	Yes
Fishing	Yes	Yes	Yes	Yes	Yes
Labor	Yes	Yes	Yes	Yes	Yes
Livestock	Yes	Yes	Yes	Yes	Yes
Other(small business)	No	No	No	No	Yes
What are people needed?					
Road	Yes	Yes	Yes	Yes	Yes
Dike	Yes	Yes	Yes	Yes	Yes
Canal	Yes	Yes	Yes	Yes	Yes
Reservoir	Yes	Yes	Yes	No	No
Pond	No	No	No	No	No
Water gate	Yes	Yes	Yes	Yes	Yes
Bridge	Yes	Yes	No	No	No
Pumping station	No	No	No	No	No
Advantage of the proposed structures by people					
People	No	Yes	Yes	Yes	Yes
House and other assets	Yes	Yes	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes
Fishing	Yes	Yes	Yes	No	Yes
Transport	Yes	Yes	Yes	Yes	Yes
Environment	No	No	Yes	No	No
Disavantage of the proposed structures by people					
People	No	No	No	No	No
House and other assets	No	No	No	No	No
Agriculture	No	No	Yes	Yes	Yes
Fishing	No	No	No	Yes	Yes
Livestock	No	No	No	No	No
Land ownership	Yes	Yes	No	No	No
Environment	No	No	No	No	No
Clash with neighbored village	No	No	No	No	No
Feed back on demonstration project options (DPO)					
Satisfy	Yes	Yes	Yes	Yes	Yes
Dissatisfy	No	No	No	No	No
Positive point of the DPO					
People	Yes	Yes	Yes	Yes	Yes
House and other assets	Yes	Yes	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes
Fishing	Yes	Yes	Yes	Yes	Yes
Livestock	Yes	Yes	Yes	Yes	Yes

COUNTRY: CAMBODIA

PROVINCE	TAKEO				
DISTRICT					
COMMUNE	Romenh			Kampong Reab	
VILLAGE	Romenh Kh	Samraong	Daeum Pou	Chumnik	Kampong L
Environment	Yes	Yes	Yes	Yes	Yes
Negative point of the DPO					
People	No	No	No	No	No
House and other assets	No	No	No	No	No
Agriculture	Yes	No	No	No	Yes
Fishing	No	No	No	No	Yes
Livestock	No	No	No	No	No
Land ownership	Yes	Yes	Yes	No	No
Environment	No	No	No	No	No
Clash with neighbored village	No	No	No	No	No
Future participation or Contribution in O&M					
Cash	Yes	Yes	Yes	Yes	Yes
Kind	Yes	Yes	Yes	Yes	Yes
Labor	Yes	Yes	Yes	Yes	Yes
Set up association for O&M	NA	NA	Yes	NA	NA
Evaluation of consultation					
Understand the demonstration project options & purpose	Yes	Yes	Yes	Yes	Yes
Need additional information to answer the question	Yes	NA	Yes	NA	Yes

Note: For the need additional information toıstarion project design (during community consultation meeting).

COUNTRY: CAMBODIA

PROVINCE					
DISTRICT	PREY KABBAS				
COMMUNE	Prey Kabbas		Prey Phdau		Sn
VILLAGE	Prey Kabba	Prey Kabba	Prey Roban	Prey Chheu	Roka
Population					
Household - Total	137	146	152	146	291
Male - Total	368	325	370	354	642
Female - Total	403	348	373	338	702
Major Hazards					
Flood	Yes	Yes	Yes	Yes	Yes
Drought	Yes	Yes	Yes	Yes	Yes
Storm	Yes	Yes	Yes	No	No
Other					
The main hazard in the village	Flood	Flood	Flood	Flood	Flood
Disaster of the main hazard on					
Houses	No	No	No	No	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes
Road	Yes	Yes	Yes	Yes	Yes
Irrigation system	Yes	Yes	Yes	Yes	Yes
School	No	No	No	No	No
Health center	Yes	Yes	Yes	Yes	Yes
Pagoda	No	No	No	No	Yes
Well/clean water	Yes	Yes	Yes	Yes	Yes
Latrine/sanitation	Yes	Yes	Yes	Yes	Yes
Fish	No	No	No	No	No
Environment	Yes	Yes	Yes	Yes	Yes
Bank erosion	No	No	No	No	No
Occupation/job	Yes	Yes	Yes	Yes	Yes
Coping mechanisms					
Raise a level of house site	Yes	Yes	Yes	No	Yes
Raise a house level	No	No	No	No	Yes
Move to safe protected site	Yes	Yes	Yes	Yes	Yes
Prepare a food/medecine/crops	Yes	Yes	Yes	Yes	Yes
Canal/ culvert cleaning	No	No	No	No	No
Prepare a boat	Yes	Yes	Yes	No	Yes
Plant trees/ Prepare bags for bank protection	No	No	No	No	No
Existing structures for coping					
Dike	Yes	Yes	NA	NA	No
Canal/ Calmatage canal	Yes	Yes	NA	NA	Yes
Reservoir	No	No	NA	NA	No
Water gate/ Culvert	No	No	NA	NA	Yes
Bridge	No	No	NA	NA	Yes
Road access	Yes	Yes	NA	NA	Yes
Occupation/job					

COUNTRY: CAMBODIA

PROVINCE					
DISTRICT	**PREY KABBAS**				
COMMUNE	**Prey Kabbas**		**Prey Phdau**		**Sn**
VILLAGE	Prey Kabba	Prey Kabba	Prey Roban	Prey Chheu	Roka
Farmer	Yes	Yes	Yes	Yes	Yes
Fishing	Yes	Yes	Yes	Yes	Yes
Labor	Yes	Yes	Yes	Yes	Yes
Livestock	Yes	Yes	Yes	Yes	Yes
Other(small business)	No	No	Yes	Yes	Yes
What are people needed?					
Road	Yes	Yes	Yes	Yes	Yes
Dike	Yes	Yes	Yes	Yes	Yes
Canal	Yes	Yes	Yes	Yes	Yes
Reservoir	No	No	No	No	No
Pond	No	No	No	No	No
Water gate	Yes	Yes	Yes	Yes	Yes
Bridge	No	No	No	No	No
Pumping station	No	No	No	Yes	No
Advantage of the proposed structures by people					
People	Yes	Yes	No	No	No
House and other assets	Yes	Yes	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes
Fishing	No	No	Yes	No	Yes
Transport	Yes	Yes	Yes	Yes	Yes
Environment	No	No	No	No	No
Disavantage of the proposed structures by people					
People	No	No	No	No	No
House and other assets	No	No	No	No	No
Agriculture	Yes	No	No	No	No
Fishing	No	No	No	No	No
Livestock	No	No	No	No	No
Land ownership	No	No	No	No	No
Environment	No	No	No	No	No
Clash with neighbored village	No	No	No	No	No
Feed back on demonstration project options (DPO)					
Satisfy	Yes	Yes	Yes	Yes	Yes
Dissatisfy	No	No	No	No	No
Positive point of the DPO					
People	Yes	Yes	Yes	Yes	Yes
House and other assets	Yes	Yes	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes
Fishing	Yes	Yes	Yes	Yes	Yes
Livestock	Yes	Yes	Yes	Yes	Yes

COUNTRY: CAMBODIA

PROVINCE					
DISTRICT	**PREY KABBAS**				
COMMUNE	**Prey Kabbas**		**Prey Phdau**		**Sn**
VILLAGE	Prey Kabba	Prey Kabba	Prey Roban	Prey Chheu	Roka
Environment	Yes	Yes	Yes	Yes	Yes
Negative point of the DPO					
People	No	No	No	No	No
House and other assets	No	No	No	No	No
Agriculture	Yes	No	Yes	No	Yes
Fishing	No	No	No	No	No
Livestock	No	No	No	No	No
Land ownership	No	No	No	No	No
Environment	No	No	No	No	No
Clash with neighbored village	No	No	No	No	No
Future participation or Contribution in O&M					
Cash	Yes	Yes	Yes	Yes	Yes
Kind	Yes	Yes	Yes	Yes	Yes
Labor	Yes	Yes	Yes	Yes	Yes
Set up association for O&M	Yes	NA	Yes	NA	NA
Evaluation of consultation					
Understand the demonstration project options & purpose	Yes	Yes	Yes	Yes	Yes
Need additional information to answer the question	Yes	Yes	Yes	Yes	NA

Note: For the need additional information to

COUNTRY: CAMBODIA

PROVINCE		**KAN**			
DISTRICT		**KOH THUM**			
COMMUNE	**ao**	**Praek Sdei**		**Sampov Lun**	
VILLAGE	Thomm Vin	Praek Louk	Praek Tame	Koh Tiev Kh	Praek Suen
Population					
Household - Total	149	390	589	276	445
Male - Total	359	1043	1551	682	1014
Female - Total	398	1026	1455	783	1083
Major Hazards					
Flood	Yes	Yes	Yes	Yes	Yes
Drought	Yes	Yes	Yes	Yes	Yes
Storm	No	No	Yes	No	Yes
Other					
The main hazard in the village	Flood	Flood	Flood	Flood	Flood
Disaster of the main hazard on					
Houses	No	No	No	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes
Road	Yes	Yes	Yes	Yes	Yes
Irrigation system	Yes	Yes	Yes	Yes	Yes
School	No	Yes	Yes	Yes	Yes
Health center	Yes	Yes	Yes	Yes	Yes
Pagoda	No	No	No	Yes	Yes
Well/clean water	Yes	Yes	Yes	Yes	Yes
Latrine/sanitation	Yes	Yes	Yes	Yes	Yes
Fish	No	No	No	No	No
Environment	Yes	Yes	Yes	Yes	Yes
Bank erosion	No	Yes	Yes	Yes	Yes
Occupation/job	Yes	Yes	Yes	Yes	Yes
Coping mechanisms					
Raise a level of house site	Yes	Yes	Yes	Yes	Yes
Raise a house level	Yes	Yes	No	No	Yes
Move to safe protected site	Yes	Yes	Yes	Yes	Yes
Prepare a food/medecine/crops	Yes	Yes	Yes	Yes	Yes
Canal/ culvert cleaning	No	No	No	No	No
Prepare a boat	Yes	Yes	Yes	Yes	Yes
Plant trees/ Prepare bags for bank protection	No	No	No	No	Yes
Existing structures for coping					
Dike	Yes	No	Yes	No	No
Canal/ Calmatage canal	No	Yes	Yes	Yes	Yes
Reservoir	No	No	No	No	No
Water gate/ Culvert	Yes	Yes	Yes	Yes	Yes
Bridge	Yes	No	No	No	No
Road access	Yes	Yes	Yes	Yes	Yes
Occupation/job					

COUNTRY: CAMBODIA

PROVINCE		**KAN**			
DISTRICT		**KOH THUM**			
COMMUNE	**ao**	**Praek Sdei**		**Sampov Lun**	
VILLAGE	Thomm Vin	Praek Louk	Praek Tame	Koh Tiev Kh	Praek Suen
Farmer	Yes	Yes	Yes	Yes	Yes
Fishing	Yes	Yes	Yes	Yes	Yes
Labor	Yes	Yes	Yes	Yes	Yes
Livestock	Yes	Yes	Yes	Yes	Yes
Other(small business)	Yes	No	No	No	No
What are people needed?					
Road	Yes	Yes	Yes	Yes	Yes
Dike	Yes	Yes	Yes	Yes	Yes
Canal	Yes	Yes	Yes	Yes	Yes
Reservoir	No	No	Yes	No	No
Pond	No	No	No	No	No
Water gate	Yes	Yes	Yes	Yes	Yes
Bridge	No	No	Yes	Yes	Yes
Pumping station	Yes	No	No	No	No
Advantage of the proposed structures by people					
People	No	No	No	No	Yes
House and other assets	Yes	Yes	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes
Fishing	Yes	Yes	No	No	No
Transport	Yes	Yes	Yes	Yes	Yes
Environment	No	No	No	No	No
Disavantage of the proposed structures by people					
People	No	No	No	No	No
House and other assets	No	No	No	No	No
Agriculture	No	Yes	Yes	Yes	No
Fishing	No	Yes	No	Yes	No
Livestock	No	No	No	No	No
Land ownership	No	No	No	No	No
Environment	No	No	No	No	No
Clash with neighbored village	No	No	No	No	No
Feed back on demonstration project options (DPO)					
Satisfy	Yes	Yes	Yes	Yes	Yes
Dissatisfy	No	No	No	No	No
Positive point of the DPO					
People	Yes	Yes	Yes	Yes	Yes
House and other assets	Yes	Yes	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes	Yes
Fishing	Yes	Yes	Yes	Yes	Yes
Livestock	Yes	Yes	Yes	Yes	Yes

COUNTRY: CAMBODIA

PROVINCE					**KAN**
DISTRICT		**KOH THUM**			
COMMUNE	**ao**	**Praek Sdei**		**Sampov Lun**	
VILLAGE	Thomm Vin	Praek Louk	Praek Tame	Koh Tiev Kh	Praek Suen
Environment	Yes	Yes	Yes	Yes	Yes
Negative point of the DPO					
People	No	No	No	No	No
House and other assets	No	No	No	No	No
Agriculture	No	Yes	No	No	No
Fishing	No	No	No	No	No
Livestock	No	No	No	No	No
Land ownership	No	No	No	No	No
Environment	No	No	No	No	No
Clash with neighbored village	No	No	No	No	No
Future participation or Contribution in O&M					
Cash	Yes	Yes	Yes	Yes	Yes
Kind	Yes	Yes	Yes	Yes	Yes
Labor	Yes	Yes	Yes	Yes	Yes
Set up association for O&M	Yes	Yes	NA	Yes	NA
Evaluation of consultation					
Understand the demonstration project options & purpose	Yes	Yes	Yes	Yes	Yes
Need additional information to answer the question	Yes	Yes	Yes	NA	Yes

Note: For the need additional information to

COUNTRY: CAMBODIA

PROVINCE	**DAL**			
DISTRICT	**S'ANG**			
COMMUNE	**Praek Ambel**		**S'ang Phnum**	
VILLAGE	Anlong Ta S	Peam Prach	Kampong T	Kouk Andaet
Population				
Household - Total	515	247	345	178
Male - Total	1203	677	739	373
Female - Total	1490	672	845	432
Major Hazards				
Flood	Yes	Yes	Yes	Yes
Drought	Yes	Yes	Yes	Yes
Storm	No	No	No	No
Other				
The main hazard in the village	Flood	Flood	Flood	Flood
Disaster of the main hazard on				
Houses	No	No	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes
Road	Yes	Yes	Yes	Yes
Irrigation system	Yes	Yes	Yes	Yes
School	Yes	Yes	Yes	Yes
Health center	Yes	Yes	Yes	Yes
Pagoda	No	Yes	Yes	Yes
Well/clean water	Yes	Yes	Yes	Yes
Latrine/sanitation	Yes	Yes	Yes	Yes
Fish	No	No	No	No
Environment	Yes	Yes	Yes	Yes
Bank erosion	Yes	Yes	Yes	Yes
Occupation/job	Yes	Yes	Yes	Yes
Coping mechanisms				
Raise a level of house site	Yes	Yes	Yes	Yes
Raise a house level	Yes	Yes	No	No
Move to safe protected site	Yes	Yes	Yes	Yes
Prepare a food/medecine/crops	Yes	Yes	Yes	Yes
Canal/ culvert cleaning	No	No	No	No
Prepare a boat	Yes	Yes	Yes	Yes
Plant trees/ Prepare bags for bank protection	Yes	Yes	Yes	Yes
Existing structures for coping				
Dike	No	No	No	No
Canal/ Calmatage canal	Yes	Yes	Yes	Yes
Reservoir	No	No	No	No
Water gate/ Culvert	Yes	No	Yes	Yes
Bridge	No	No	No	No
Road access	Yes	Yes	Yes	Yes
Occupation/job				

COUNTRY: CAMBODIA

PROVINCE	DAL			
DISTRICT	S'ANG			
COMMUNE	Praek Ambel		S'ang Phnum	
VILLAGE	Anlong Ta S	Peam Prach	Kampong T	Kouk Andaet
Farmer	Yes	Yes	Yes	Yes
Fishing	Yes	Yes	Yes	Yes
Labor	Yes	Yes	Yes	Yes
Livestock	Yes	Yes	Yes	Yes
Other(small business)	No	No	No	No
What are people needed?				
Road	Yes	Yes	Yes	Yes
Dike	Yes	No	Yes	Yes
Canal	Yes	Yes	Yes	Yes
Reservoir	No	Yes	No	No
Pond	No	No	No	No
Water gate	Yes	Yes	Yes	Yes
Bridge	No	No	No	No
Pumping station	No	No	No	No
Advantage of the proposed structures by people				
People	Yes	No	No	No
House and other assets	Yes	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes
Fishing	No	No	No	No
Transport	Yes	Yes	Yes	Yes
Environment	No	No	No	No
Disavantage of the proposed structures by people				
People	No	No	No	No
House and other assets	No	No	No	No
Agriculture	Yes	Yes	Yes	Yes
Fishing	No	No	No	No
Livestock	No	No	No	No
Land ownership	No	No	Yes	No
Environment	No	No	No	No
Clash with neighbored village	No	No	No	No
Feed back on demonstration project options (DPO)				
Satisfy	Yes	Yes	Yes	Yes
Dissatisfy	No	No	No	No
Positive point of the DPO				
People	Yes	Yes	Yes	Yes
House and other assets	Yes	Yes	Yes	Yes
Agriculture	Yes	Yes	Yes	Yes
Fishing	Yes	Yes	Yes	Yes
Livestock	Yes	Yes	Yes	Yes

COUNTRY: CAMBODIA

PROVINCE	**DAL**			
DISTRICT	**S'ANG**			
COMMUNE	**Praek Ambel**		**S'ang Phnum**	
VILLAGE	Anlong Ta S	Peam Prach	Kampong T	Kouk Andaet
Environment	Yes	Yes	Yes	Yes
Negative point of the DPO				
People	No	No	No	No
House and other assets	No	No	No	No
Agriculture	Yes	Yes	Yes	Yes
Fishing	No	Yes	No	No
Livestock	No	No	No	No
Land ownership	No	No	Yes	No
Environment	No	No	No	No
Clash with neighbored village	No	No	No	No
Future participation or Contribution in O&M				
Cash	Yes	Yes	Yes	Yes
Kind	Yes	Yes	Yes	Yes
Labor	Yes	Yes	Yes	Yes
Set up association for O&M	Yes	NA	NA	NA
Evaluation of consultation				
Understand the demonstration project options & purpose	Yes	Yes	Yes	Yes
Need additional information to answer the question	NA	Yes	NA	Yes

Note: For the need additional information to

Appendix 7 Initial Environmental Examination

CONTENTS

1 INTRODUCTION

1.1 Purpose of the report

During Stage 1 of the FMMP-C2, strategic directions were developed for the West Basac focal area with the aim to investigate options for flood risk reduction and agricultural development. The proposed options for flood protection consist of embankments and polders. These options are currently considered as alternatives that are being investigated in the demonstration project for the development of an Integrated Flood Risk Management Plan for the West Bassac area in Stage 2 of FMMP-C2.

The alternatives are tested concerning their impact on the flooding hazard and flood damage reduction.

In parallel, a Public Participation Plan was prepared and is will be implemented in May – June 2009 in order to involve all stakeholder groups in this planning exercise to better understand and take into account their interests and point of views.

The alternatives developed in Stage 1 of FMMP-C2 constitute rather large-scale structural measures for flood risk reduction. The potential environmental impacts of the measures can be substantial, therefore this Environmental Examination report was prepared already at an early stage of the Demonstration Project preparation in order to guide and influence the technical analysis of these alternatives. It will also aid in developing other alternative measures that are likely at a smaller scale to possibly better suit the local social and ecological environment.

1.2 Extent of the Environmental Examination

This report presents the results of the Environmental Examination of one of the Demonstration Projects, the Integrated Flood Risk Management Plan for the West-Bassac area, proposed within the framework of the Flood Management a Mitigation Program, Component 2, Structural Works and Flood Proofing, Stage 2 Implementation. The Assessment was carried out applying, and at the same time testing, the Best Practice Guidelines for Integrated Flood Risk Management Planning and Impact Evaluation, Environmental Evaluation, developed under the project.

The examination was carried out in April-May 2009 by Royal Haskoning of the Netherlands and associates. The current study of the West Bassac Demonstration Project in the Kandal, Takeo and Kampot Provinces of south-western Cambodia is based on limited field studies. As such, the study had to rely heavily on secondary data, as well as data collected during the social survey.

The West Bassac project area is located in the extreme south-western part of the Basin Development Plan (BDP) Sub-area 10C. The northern boundary of the project area is formed by the Strung Preik Thnot, the Bassac River forms the eastern boundary. To the south the area extents to the Cambodia-Vietnam border, to the west National Road no 3 forms the boundary Figure 1.1 shows the location of the project area.

The report will be updated and finalized after the proposed plan that is being developed has advanced t the stage that the proposed works have been worked out so that the physical impacts of the works can be assessed more precisely.

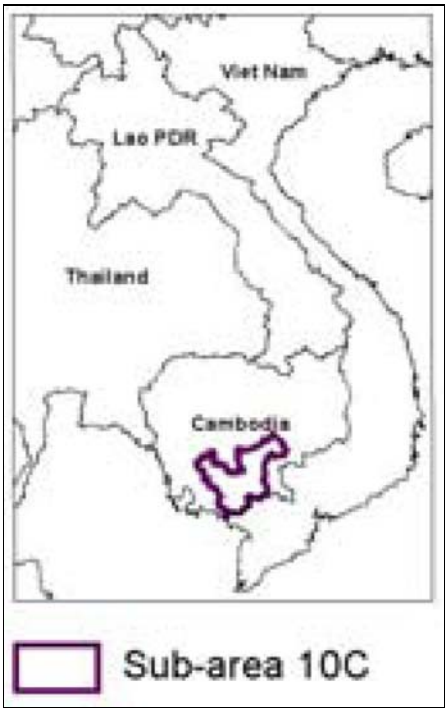

Figure 1.1 **Location of the West Bassac Focal Area in south-west Cambodia**

1.3 Contents of the report

The results of the study are presented in the general format of an environmental impact assessment as presented in the Best Practice Guideline. Following this introduction, the balance of the report addresses the following topics:

- Chapter 2 gives a description of the project and the distinguished project alternatives. The type of project is discussed, as well as the need for the project. Besides the size and magnitude of the operation and the proposed schedule for implementation receive attention;
- Chapter 3 briefly addresses the Cambodian legislative framework of EIA;
- Chapter 4 describes the environment, not only the physical resources (topography, soils, climate, surface water, and ground water), but also the ecological resources (aquatic biology, wildlife, forests and rare endangered species), the human and economic development in the project area (population and communities, industries, infrastructural facilities, transportation, land use, fisheries and agricultural development), and the quality of life values (socio-economic values, public health);
- Chapter 5 discusses the environmental screening of the project, summarized in a screening table;
- Chapter 6 describes the potential environmental impacts of the project as well as a first assessment of their significance. Possible measures to mitigate the adverse impacts of the project or to enhance the distinguished positive impacts are addressed as well. Not only environmental problems due to the project location are discussed, but also impacts related to implementation and construction activities, as well as impacts that could arise during the project's operational phase; and
- Chapter 7 gives the summary and conclusions.

2 DESCRIPTION OF THE PROJECT

In designing the project, it was realized that successful flood management in West Bassac area can only be achieved with a holistic, integrated approach, taking into account all economic sectors and aiming for a balance between land and water management, development and conservation. It was also realized that the concept of 'living with floods' has been practiced for generations in the area and that complete flood control would be rather expensive, with no guarantee of success, and probably a considerable loss of benefits related to flooding.

Agriculture is, and will remain for decades to come, the backbone of the economy of the region. Rice is the main crop and there is a need for intensification and increased production. At present only one rainfed (recession) rice crop is grown in the area in the period November-February. Early flooding from the Bassac River and the Strung Preik Thnot and its tributaries prevents growing of a second crop in the area in the period April to August. A delay of the flood with about one month would enhance the possibilities for a second crop considerably. The main objective of the project is therefore to delay the early flooding in the deep flooded areas of the floodplain of the West Bassac area with about one month.

At the same time the project aims to:

- Create a small flood free area (polder) immediately west of the Bassac River;
- Reduce peak flows and extreme deep flooding by providing additional flood conveyance capacity. Either new diversion channels will be constructed or existing drainage will be improved;
- Improve the agricultural water supply in the dry season, thus reducing the frequently occurring early-season and mid-season drought damage to the crops. During the flood recession period water is rapidly drained out of the area, resulting in widespread shortage of water later in the season. There is only a limited number of water storage reservoirs. The diversion channels and drainage canals could be used in the dry season to bring water from the Bassac River to the drought prone areas;
- Reduce flooding and flood damage from flash floods of rivers draining the hilly area to the west of the project area. Flash floods from tributaries originating in the hills to the west of the project area, presently damaging the crops, could be intercepted and diverted; and
- Improve rural transportation by presenting possibilities for navigation on diversion and drainage canals and for overland transport on the dike embankments.

Preliminary flood risk assessments during Stage 1 of the FMMP Component 2 project showed, not surprisingly, that the actual risks in the area is relatively low. Actual land use is tuned to the prevailing flood conditions and traditional coping mechanisms are in place to reduce the vulnerability considerably. Based on analysis in two districts of the project area, Koh Andet and Koh Thom District, the total risk in the project area is estimated at USD 3 million per year. About half of this risk corresponds to agricultural risks. As far as the food situation in Cambodia is concerned, the Cambodian government recently (April 2009), in reaction on a FAO warning concerning the threat of food shortages, stated that Cambodia is producing a surplus of 2 million (milled rice) per year. This means that the additionally produced rice will have to be exported.

The project area is sub-divided in three zones. To reach the objectives of the project the following measures are proposed:

- Zone 1, the deep flooded area between the west bank of the Bassac River and the east bank of the Preik Ambel, This area will become fully flood protected by embankment and closing/gating of the existing colmatage canals. A sub-division in four polders will be made, each of the polders will have a main irrigation/drainage canal connecting the Bassac with the Preik Ambel. Excess rainfall and outfall from irrigation will be collected in each polder in a depression on the Preik Ambel side. Pumping stations will be constructed to pump out the water to an outfall drain. Soils in this area are very fertile and presently yielding one cash crop per year. After project implementation three crops per year are possible;
- Zone 2: the deep flooded area, running through the central, deepest part of the flood plain. The area consists of a number of permanent lakes and depressions and is presently only to a limited extent in use for agricultural production. Deep and prolonged flooding prevents agricultural intensification. It is proposed to protect this area against early flooding by construction of embankments. At the same time provisions for irrigation water supply will be made. By delaying the early flood and providing irrigation water, growing of two rice crops per year becomes possible. After August the area will be allowed to flood. Additional components of the project include establishment of flood proof settlement clusters in the deep flooded areas along the border, improvement of the communication infrastructure (early warning) and improvement of rural roads and navigation canals to improve the livelihood of the people living in the area; and
- Zone 3: shallow flooded areas located east of the RN2. Rice crops in these areas are subject to frequent damages caused by droughts and floods from the Bassac or a combination of Bassac flooding and flash floods of rivers draining the hilly area to the west of the project area. A drainage/irrigation canal parallel to RN2 is proposed to collect surface runoff from the western catchments and to convey water from the Bassac for supplementary irrigation. With full flood protection and provision of water for irrigation three rice crops per year could be produced in this zone.

Figure 2.1 **Location of the Project Area in the Kandal, Takeo and Kampot**

The project is basically a combined flood protection/drainage and irrigation water supply project. Main components of the project are:

- Dike construction and improvement;
- Construction/improvement of a number of diversion canals;
- Construction/improvement of a number of irrigation and drainage canals;
- Construction of control structures and bridges; and
- Construction if a number of pumping stations.

3 THE LEGAL AND POLICY FRAMEWORK

3.1 EIA Legislation in Cambodia

Cambodia introduced environmental impact assessments (EIA) in 1995. However, 15 years later, actual experience is still limited and the process of developing, screening and reviewing EIA reports is not yet well established in practice.

EIA requirements are laid down in Sub-decree on the Environmental Impact Assessment Process No 72 ANRK.BK dated August 11, 1999. It took till 2004 before the Sub-degree became enforced. The Sub-decree consists of 6 chapters with 34 articles. In an annex a list of projects requiring an Initial Environmental Impact Assessment (IEIA) or EIA is given. The defined projects are categorized as a) industrial sector; b) agricultural sector; c) tourism sector; and d) infrastructure projects. Retention reservoirs, river improvement works, diking and diversions are not mentioned specifically, but fall in either the industry, agricultural or infrastructure category, depending on the nature of the project. Projects that do require an environmental assessment mentioned in the annex are amongst others:

- Project in flooded land or the coastal zone (any size of project);
- Irrigation system development, ≥ 5,000 Ha;
- Drainage system development, ≥ 5,000 Ha;
- Bridge and road constructions, ≥ 30 tonnes weight; and
- Dredging, ≥ 50,000 m^3.

The steps required in the MoE's primary Environmental Assessment procedure are: submittal of an Environmental Screening Application to MoE for determination of whether a project is exempt for further EIA, submittal of an IEIA to MoE if the project is not exempt and submittal of a full-scale EIA to MoE if the project IEIA in its original or improved form does not meet the requirements of an EIA. EIA's have to be reviewed and evaluated by the Ministry of Environment before being submitted to the Royal Government of Cambodia or the Council for Development for approval.

In 1999 general guidelines for conducting Environmental Impact Assessment have been drafted with ADB assistance. These guidelines are still only in draft. A number of sectoral guidelines are also available in draft only and require further refinement before being endorsed. Draft guidelines have been developed for amongst others irrigation projects and riverbank protection. In the guidelines reference is made to the following national environmental standards: Declarations (Prakas) of the Ministry of Environment for the quality of water, air, soil, and noise/vibration. i) Sub-decree on Water Pollution Control (8 Chap., 39 Articles, and 5 Annexes), approved 6 April, 1999; ii) Sub-decree on Solid Waste Management (6 Chap., 32 Articles and 1 Annex), approved 27 April, 1999); and iii) Sub-decree on Air and Noise Pollution Control (8 Chap., 38 Articles and 8 Annexes), approved 10 July 2000.

Next to the draft sectoral guidelines the following EIA related guidelines can be mentioned:

- The Cambodian Road and Bridge Design Standard and Construction Specifications, which were developed by the Ministry of Public Works and Transport, have been established in 1999 and are to be used for the design and construction of all new roads and bridges and related rehabilitation works;
- Draft safeguards guidelines from the National Committee for Management of Decentralization and Deconcentration Reform of the Ministry of the Interior, were

made public in September 2007 for discussion. These safeguard guidelines address environmental impact at the communal level. These guidelines contribute to wetlands and landscape management;

- Draft guidelines on Communal land use planning as part of the commune development planning process were published in Sept 2007 for discussion. They serve mainly to support the preparation of commune investment programmes. They address communal land use mapping/zoning, planning, monitoring, evaluation and feedback. These guidelines do not directly address matters related to flood management, but they deal with location of proposed infrastructure.

3.2 Institutional, legal and policy frameworks for wetlands management

Wetlands cover about 30 per cent of the country and 20 per cent of these areas are recognized as wetlands of international importance. The project area, being part of the Mekong floodplain, has important wetland functions.

Management of wetlands in Cambodia is the responsibility of a number of sectoral agencies that each follow policies and laws specific to their mandates, resulting in poor coordination among agencies. In terms of conservation and management of wetland biodiversity, the both Ministry of Environment and the Ministry of Agriculture, Forestry and Fisheries are involved. The Ministry of Environment has a mandate to manage protected areas and is the administrative authority for Cambodia's commitments to the Ramsar Convention and the Convention on Biodiversity. The Ministry of Agriculture, Forestry and Fisheries is the National Management Authority for the Convention on International Trade in Endangered Species (CITES) and, through the Department of Fisheries, is responsible for the fisheries as defined by the Fisheries Law, including concessions, fish sanctuaries, inundated forests, swamps and other fish production areas.

While there is no legislation specific to wetlands, a number of ministries and departments have regulations pertaining to various sectoral uses of wetlands, mostly in the form of fisheries laws. Of importance are:

- Law on Environmental Protection and Natural Resource Management: the objectives of this law, approved by the National Assembly in 1996, are to protect, manage, and enhance the environment and to promote sustainable socioeconomic development. It places responsibility for environmental planning, protected area management, environmental impact assessment, environmental monitoring, pollution control and inspection, and public participation under the Ministry of Environment;
- Royal Decree on the Creation and Designation of Protected Areas: this legislation forms the basis for the protected area program in Cambodia and designates the Ministry of Environment as the agency responsible for planning for and development in the protected areas system;
- National Forest Law: promulgated in 1988, this law underwent extensive review and a new Forest Law was recently adopted by the national assembly; and
- Fisheries Law: fisheries conservation, management and development are the responsibilities of the Department of Fisheries. The new fisheries law, which is still in draft form, encourages integration of fisheries management with rural development by extending responsibilities for fisheries management to fishing communities and increasing the protection and sustainable use of fishery resources. The management of flooded forests is included in the draft and it is expected that other aspects of wetland use will similarly be included.

Major international agreements having implications for wetland management to which Cambodia is a party include:

- Convention on Biological Diversity: Cambodia acceded to this Convention on 9 February 1995. This convention calls on all countries to develop and implement national plans to ensure biological diversity;
- Convention on Wetlands (Ramsar, Iran, 1971): Cambodia acceded to the Convention on Wetlands on 23 October 1999. The Convention calls on all countries to set aside wetlands of international importance, especially those important to migratory waterfowl and waders;
- UNESCO Man and Biosphere Reserve Program: Cambodia has designated the Tonle Sap Lake as its first biosphere reserve. Since its designation and approval by UNESCO in 1997, there has been no agreement on how the reserve is to be managed; and
- Convention on International Trade in Endangered Species (CITES): Cambodia became a signatory on 2 October 1997. The Ministry of Agriculture, Forestry and Fisheries is designated as the CITES national management authority secretariat. The scientific responsibility lies with the Department of Forestry and the Department of Fisheries. The Convention establishes mechanisms that facilitate international cooperation on the regulation of wildlife trade.

3.3 Transboundary impacts

In the National Mekong River Commissions (NMRC's) of the four Lower Mekong Basin (LMB) countries it is realized that environmental effects do not respect political boundaries, certainly not in river basins. Sustainable development is high on the agenda and transboundary impacts of developments in the basin should be prevented. National environmental assessment legislation and procedures do not provide a framework for evaluation of transboundary impacts; therefore development of a common procedure could enhance cooperation and prevent disputes. MRC is committed to develop such a common approach.

The draft version of the Framework for Transboundary Environmental Impact Assessment (TbEIA, March 2006), developed by MRC for the Lower Mekong Basin, lists the following projects as having potential transboundary impacts:

- Hydropower projects;
- Irrigation schemes;
- Ports and riverworks;
- Industrial and mining projects;
- Aquaculture projects;
- Navigation projects; and
- Water abstraction projects for water supply.

This implies that flood protection dikes and dams are considered as potentially having transboundary impacts. Flood management and industrial water supply projects were originally on the list as well, but have been removed, since flood issues and industrial water supply are considered national issues.

4 DESCRIPTION OF THE ENVIRONMENT

The description of the environment in the West Bassac Demonstration Project area is mainly based on data given in the Planning Atlas of the Lower Mekong Basin (MRC, 2006), a description of the Cambodian Mekong floodplains provided by the Roads and Floods Project (Douven, 2008) and a field visit by the project's environmentalists.

4.1 Physical Resources

4.1.1 Topography and General Characteristics

The Bassac/Mekong floodplain in the project area is essentially flat. The elevation ranges from about 1 to 10 meters above mean sea level and at some locations the plains are bordered by low hills. The Bassac Rivers and the smaller tributaries are bordered by natural levees that are formed through silt depositing. The levees are intensively used for housing and transportation since they are the last to flood. The levees separate the rivers from depressions that flood during the flood season. A system of colmatage canals has been developed over the centuries to (partially) control the water flow in and out of the floodplain depressions to support the cultivation of rice. As compared to Vietnam the floodplains in Cambodia are largely undeveloped. The floodplains of Cambodia can be characterized as in Table 4.1 after Douven (2008).

Table 4.1 General characteristics of the West Bassac Floodplain

Floodplain	**still quite natural**
Infrastructure	**few roads, colmatage irrigation systems, a few small-scale irrigation schemes**
Housing and development	**mainly along levees bordering rivers**
Economy	**extensive agriculture and fisheries**
Land use and ecology	**no national parks, but floodplains and flooding essential for biodiversity in the region**
Hydraulics	**largely natural flooding, only obstructed by roads and to some extent levees**

4.1.2 Soils

The soils in the project area are mainly of alluvial origin. Four soil types can be distinguished: Cambisols occupy the natural levees in a small strip along the Bassac river, they have a good structure and favorable chemical properties. Their fertility is high and they are usually resilient to degradation and only moderately sensitive to yield decline. In the higher parts of the flood plains Acrisols predominate, these soils have a low fertility and require input of fertilizers and careful management to sustain agricultural production. The lower parts of the floodplains are occupied by Plinthisols, characterized by frequent waterlogging and low fertility. Leptosols, weakly developed shallow soils, with low fertility, are encountered on the higher grounds further from the river.

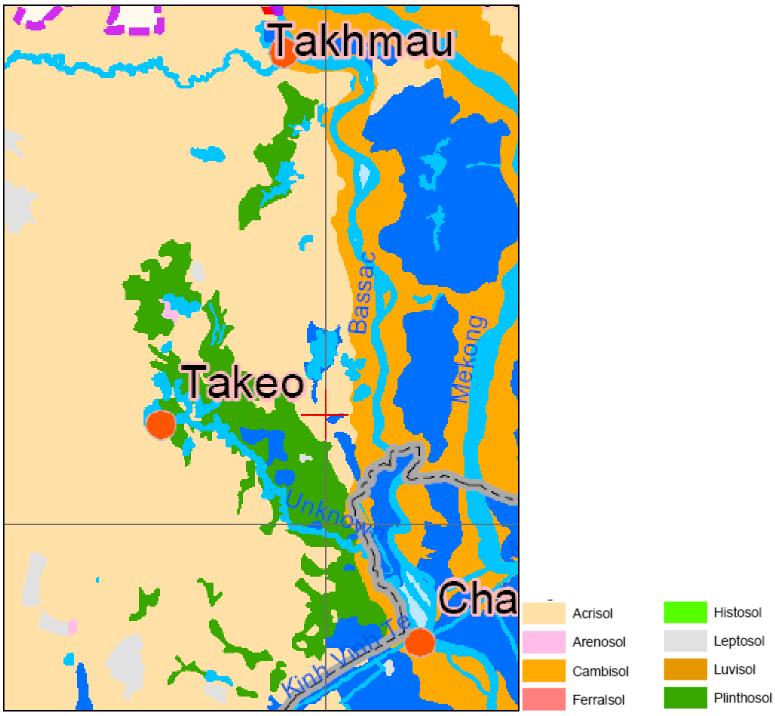

Figure 4.1 Soils in the project area
Souce: Planning Atlas, Basin Development Plan, MRD, 2006

4.1.3 Climate

The project area has a tropical monsoon climate. December and January are the coolest months, while March and April are the hottest. The rainy season extends from May to October when some 80% of the annual average rain is estimated to fall. The average annual temperature is about 27°C.

February is normally the driest month in this region. The average rainfall in the eastern part of the sub-area is high compared with other locations, ranging from 1,173 - 1,867 mm/year. The southwest zone generally has the least annual rainfall, ranging from 937 - 1,817 mm/year.

4.1.4 Flooding in the Area

The northern part of the West Bassac Demonstration Project area is effected by floods from the Strung Preik Thnot when heavy rainfall occurs in the upper part of this sub-catchment, which mostly coincides with high water levels of the Bassac River in the period August to October. On such occasions two affluents of the Preik Thnot, the Stung Toch and Stung Tonle Bati, back up by the Bassac flood water and flooding extends over large areas of this part of the West Bassac flood plain.

Further to the south the western part of the West Bassac area is occasionally effected by flash floods from rivers draining the hilly area to the west. The most important one is the Stung Sla Kou, which crosses National Road 2 just north of Takeo.

The Bassac River receives its water from the Mekong (mainly during the beginning of the flood season) and from the Tonle Sap Great Lake during the flood recession period when water is flowing back from the lake. During the last months of the dry season (March-April), there is no or extremely low flow from the Great Lake. At the same time there is no or very limited flow in the Bassac River.

During the flood season (July-September) the water level of the Bassac River rises sharply and when reaching a level of approximately 5.0 m at Koh Khel station, part of the flood flow is diverted to the flood plain through colmatage canals. The relatively high lying natural levees directly bordering the river are in some places protected by embankments and are only effected by shallow flooding during relatively short periods.

The areas most effected by the Mekong/Bassac flooding, classified as deep flooded area with respect to flood depth and duration, are located directly west of this shallow flooded area. Further from the river, land elevations rise and flooding is less deep. Typically the shallow flooded area is delimited by the 5.0 m contour line. Another deep flooded area extends from Takeo in south-eastern direction, covering most of the Cambodia/Vietnam border area. Elevation in this area varies between 3-4 m amsl. The surface water distribution in the zone near the border is very complex, many interconnected canals and natural streams store or convey flood water across the border. Currently there is limited data available concerning the functioning and characteristics of these streams.

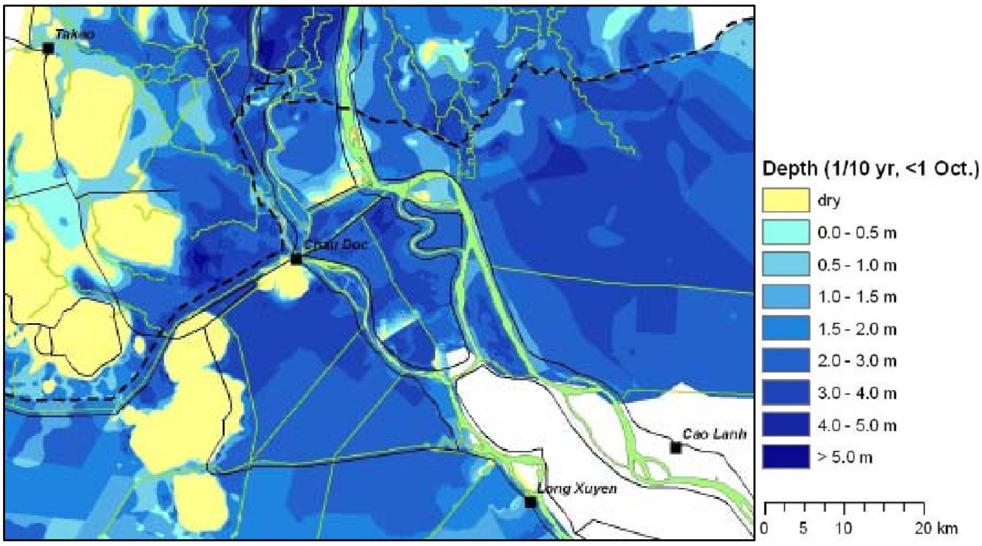

Figure 4.2 Location of the deep flooded areas

The most recent floods caused by high discharges in the Mekong/Bassac river system took place in the years 1961, 1966, 1978, 1991, 1996, 2000, 2001 and 2002, heavy flooding from the Stung Preik Thnot and other tributaries of the Bassac River is reported for the years 1922, 1991, 1994, 2000 and 2006.

During the 1991, 1994 and 2000 floods, heavy damages were caused to the railway line, National Roads 2 and 3 as well as other infrastructure (bridges, culverts) and crops.

Agriculture in the area is closely linked with the annual cycle of flooding. Normal floods improve soil moisture and fertility, restore ground and surface water resources, and replenish fisheries and forests. Normal floods likewise have no adverse physical impact on village settlements and only a limited effect on wet season rain-fed rice fields. Annual floods become disasters for rice farming only when they come too early or when they are too high or last too long. Floods that come too early in the crop growing cycle destroy the rice seedlings before transplanting. Too high floods or floods that last too long destroy established wet season rice crops.

4.1.5 Water quality

According to the BDP of MRC water quality in the Kandal and Takeo Provinces is fairly poor compared to other parts of Cambodia. Probably this relates to water quality of the Bassac River, problems here are caused by discharge of wastewater from small-scale industries, tourist cottages built along the bank of the river and wastewater from households, particularly the municipal wastewater of Phnom Penh. However, a recent MRC study (Diagnostic study of water quality in the Lower Mekong Basin MRC Technical Paper No. 15, March 2007) indicates that concentrations of metals in the lower Mekong River and its major tributaries water and sediment are mainly below any level of concern and that industrial contaminants and pesticides in water are all less than the detection limit and less than published criteria (where available) for biological effects.

There are also fears that agricultural chemicals are contaminating the shallow groundwater. Survey data from the International Rice Research Institute (IRRI) suggest that in lowland Cambodia, the percentage of wet season farmers using pesticides ranges from 8-50% depending on the province, with a range of 40-100% for dry season farmers (IRRI, 1997). The same study found that the most commonly-used pesticides in the country fall under the World Health Organization's "most hazardous" classification. Persistent pesticides are banned in the riparian countries, but it is clear that residual and illegally imported stocks continue to be used because residues of DDT, Dieldrin and similar chemicals have been found in fish across the basin. A case study in the Takeo area by (Chamroeun, Vann Kiet, and Votthy, 2001) confirms this (see Section 4.3.1 on the use of agro-chemicals).

4.1.6 Ground water

According to Pan Peng and Ngo Pin (1997) (Groundwater contamination in Cambodia, Paper presented at the Regional Workshop on groundwater Contamination, Phnom Penh, April 1997) the Mekong lowlands consist broadly of alluvial material overlying shale, slate and sandstone bedrock. The low hills and plateau areas are mostly underlain by igneous rocks and limestone. The depth of alluvium is 70 m. or more. The alluvium consists of sandy silt in the upper part and of clayey silt deeper down. Except for the occasional thin sandy beds and lenses, the alluvium has a low hydraulic conductivity and the yield is very low, typically 0.2 l/s. Yields from the sandy layer are higher, typically of the order of 1 l/s. Groundwater from alluvium is generally believed to be of good chemical quality and suitable for most purposes in Cambodia. In many areas, dug wells are important as sources of domestic water supply.

Groundwater is generally considered abundant throughout Cambodia. In the project area, groundwater is used as the main source of domestic water supply. In some areas of SA 10C where the intensity of irrigation has grown rapidly, the groundwater table has sunk, resulting in a lower supply for domestic uses. There are also fears that agricultural chemicals are contaminating some shallow groundwater tables.

4.2 Ecological resources

4.2.1 Fish and other aquatic fauna

The information presented in this section has been derived for a large part from Baran (2005), Cambodian inland fisheries, Facts, Figures and Context and the description of Basin Area 10C of the MRC BDP Atlas (2006).

The Mekong hosts over 1,000 species of fish, one of the highest species counts of any river system in the world. The continuing variation in hydrology and the variety of habitats allow the persistence of many species, which all require different conditions. Some species are most abundant on the floodplain and its wetlands, some flavor lowland rivers and some are found mainly in tributaries, but nearly all migrate within or between habitats to complete their life cycles. For Cambodia 477 fresh water fish species are recorded (Fish Base 2004) of which 40% is endemic. Ten species are endangered (see Section 4.2.3).

The fish fauna of the Mekong River is dominated by species of carp (Cyprinidae; 54%), catfish (Siluridae, Clariidae, Schilbeidae, Bagridae, Sisoridae and Akysidae; 19%) and murrels (Chanidae and Ophicephalidae; 8%). The remaining 19% consist of featherbacks (Notopteridae), herring (Clupeidae), climbing perch and gouramis (Anabantidae) and other miscellaneous groups.

Some 85-95% of the freshwater fish populations in the Mekong basin follow the inundation spawning pattern, undertaking lateral migrations from the mainstream and tributaries into the inundation zones to spawn and rear young between July and September.

Basically two groups of fish are distinguished: white fish and black fish. When floodplains drain at the end of the wet season, water remains in lakes and scattered depressions, which continue to shrink in size and number during the dry season. Floodplain water bodies become hot, oxygen is depleted and food and shelter diminish, with many ponds drying-out completely. So the fish which feed and grow on flooded areas must either return to the river as the waters recede, or remain and endure the poor conditions on the floodplain.

Species which leave flooded areas and return to rivers are referred to as ‘white fish’, as they spend most of their lives in turbid (white) river water. Most white-fish species migrate into flooded areas during the monsoon season and migrate over long distances to dry-season refuges at the end of the flood season. Representatives of this group are some of the cyprinids, such as *Cyclocheilichthys enoplos* (Soldier river barb or Chhkok) and *Cirrhinus microlepis* (Small mud carp or Prul/Kralang), as well as the river catfishes of the family Pangasiidae.

The species of fish which remain in lakes and swamps on the floodplain are known as ‘black fish’, as they spend their lives in relatively clear water that is tea-colored by chemicals dissolved from floodplain vegetation. Decomposition of vegetation causes floodplain water to be acidic and depleted in oxygen, stresses which black fish can tolerate. Most black fish can breathe air, while many species can survive out of the water for long periods, and most can move overland in search of new water bodies. A few species can bury themselves deep in the mud and wait until the next flood. Many black fish are used in aquaculture and are transported alive to markets.

They are normally referred to as non-migratory, although they perform short seasonal movements between permanent and seasonal water bodies. Examples of black-fish species in the Mekong are the climbing perch (*Anabas testudineus*), the clarias catfishes (e.g. *Clarias batrachus*) and the striped snakehead (*Channa striata*).

Welcome, 2002, distinguished an additional group, intermediate between black fish and white-fish: the so-called grey fish. Species of this group undertake only short migrations between floodplains and adjacent rivers and/or between permanent and seasonal water bodies within the floodplain.

The main migration routes in the Lower Mekong Basin are displayed in Figure 4.3.

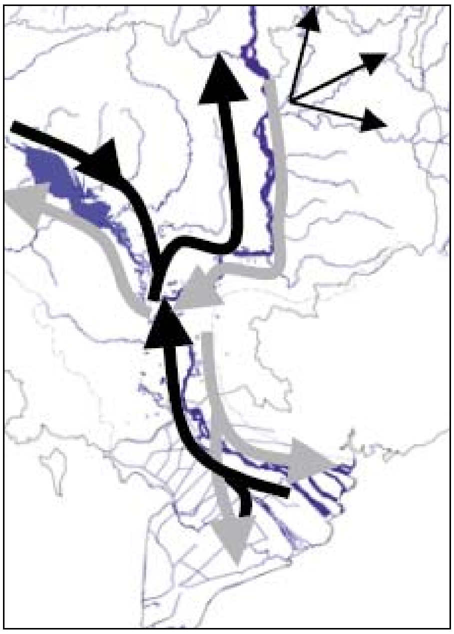

Figure 4.3 Main fish migration routes in the Lower Mekong Basin
Source: Poulsen et al., 2002

Apart from fish, inland waters support a high diversity of other aquatic animals including vertebrates - reptiles, birds, mammals and amphibians, and invertebrates, such as insects, crustaceans and mollusks, all of which depend upon maintenance of aquatic ecosystems.

4.2.2 Wetlands and terrestrial vegetation

Important habitats for conservation are described by BirdLife International in Indochina (Annual report on IBA management and conservation in Cambodia, July 2004 - August 2005):

Main river channels
Water height in the main river channels varies by up to 10 metres between the wet and dry season. These channels are vitally important for the seasonal longitudinal migration of white fish species. Although the main channels support a rich assemblage of aquatic species, they exhibit little endemism.

The Mekong River and its wider low gradient tributaries are important for a distinctive guild of riverine bird species. The Globally Vulnerable Indian Skimmer *Rynchops albicollis* may have already disappeared from this habitat in Cambodia and the Globally Vulnerable Black-bellied Tern *Sterna acuticauda* and Little Tern *Sterna albifrons* appear to be on the verge of doing so. Other significant species in this habitat include the

Globally Near-Threatened Grey-headed Fish Eagle, and Great Thick-knee *Esacus recurvirostris*, River Lapwing *Vanellus duvaucelii*, and Small Pratincole *Glareola lactea.*

Small islands and riverine sand-bars

Small islands and riverine sand-bars are common on stretches of the Mekong and its tributaries. They are formed by natural deposition during seasonal high river flow. The plant *Anogeissus rivularis* dominates the pioneer community of low-lying vegetated sandbars. The older, larger sandbars, built up into islands over many years, have more substantial vegetation similar to the neighbouring gallery forest.

The smaller sand bars and islands provide safe breeding sites for many species of waterbirds, some of which are globally rare and endangered. The only recent confirmation in Indochina for the breeding of the Globally Vulnerable Black-bellied Tern was recorded on such islands. They also support the largest numbers of Great Thick-knee, River Lapwing, and Small Pratincole in South East Asia.

Permanent and Seasonally-inundated Floodplain Wetlands

A number of permanent and seasonal lotic and lentic wetlands are found in the Lower Mekong Basin. The high wet season water levels of the Mekong inundate many of these wetlands seasonally; groundwater and seasonal monsoonal rains maintain others. These provide some of the most productive habitats in the Lower Mekong Basin and include reed and sedge beds, swamps, lotus ponds, inundated grasslands and inundated forest.

The seasonal changes in water level of the Mekong inundated plain drives a seasonal migration of large waterbirds between wetlands. In the dry season, many species move to permanent wetlands and grassy plains around Lake Tonle Sap and the Delta, while in the wet season they retreat to higher seasonal wetlands in northern Cambodia and southern Lao.

Seasonally-inundated riparian forest

One of the most important wetland habitats of the Lower Mekong Basin is the seasonally-inundated riparian forest found on the gently-sloping plains adjacent to lakes, rivers and tributaries and submerged by the seasonal 8-10 metre flood levels of the wet season.

The composition of this forest type shares little with swamp forests and mangrove systems. Over 200 species of plants have been found in these inundated forests. Major communities include *Barringtonia acutangula, Elaeocarpus madopetalus* and *Diospyros cambodiana*; floating and emergent herbs including *Brachiaria mutica, Eichornia crassipes*, *Polygonium barbatum, P. tomentosum* and *Sesbania javanica,* and a diverse mixed scrubland containing over 60 species. The woody species of this forest are often laden with fruits and seeds at the time of inundation, providing food for the 34 species of fruit-eating fish of the Lower Mekong Basin. Over 200 species of fish use this habitat as a feeding, breeding, and nursery ground and it is vitally important for breeding colonies of large waterbirds.

Marshes, small pools and seasonal wetlands in the lowland plain

Extensive seasonal and permanent marshes, small lakes, and other palustrine wetlands occur throughout the Lower Mekong Basin. They are usually shallow, filled by seasonal rainfall and typically are connected to river systems which in the wet season form the inundated plain of the Lower Mekong Basin. They contain a mosaic of wetland habitats including reeds, sedge, lotus beds and open water. Submerged communities are dominated by *Ceratophyllum demersum* and *Utricularia aurea*.

In the dry season, these wetlands are vital in maintaining breeding stocks of floodplain fish, including air-breathing species (e.g. gouramies, walking catfish), while in the wet season they function as breeding and nursery grounds for many fish species, the black fish. These wetlands are important for almost all waterbirds in the Lower Mekong Basin, particularly cormorants, Oriental Darter, Spot-billed Pelican, Greater and Lesser Adjutants, Milky Stork, Woolly-necked Stork *Ciconia episcopus*, Black-necked Stork *Ephippiorhynchus asiaticus*, Painted Stork, the Globally Endangered White-shouldered Ibis *Plegadis davisoni,* Glossy Ibis *P. falcinellus*, Black-headed Ibis *Threskiornis melanocephalus*, White-winged Duck, Pallas's Fish Eagle *Haliaeetus leucoryphus,* Grey-headed Fish Eagle, the Globally Vulnerable Masked Finfoot *Heliopais personata*, and the Globally Near-threatened Sarus Crane *Grus antigone*.

Inundated grasslands
Seasonally inundated grasslands are common on the floodplains of the Lower Mekong Basin. Close to the water edge, floating or emergent vegetation forms dense mats or stands up to 3 metres tall. As water levels rise, dense mats may dislodge and float, propelled by currents or the wind. The main species include *Achyranthes aquatica, Brachiaria mutica, Eichornia crassipes, Polygonium barbatum* and *Sesbania javanica*. Other plant species found on the upper reaches of the inundated plain include several grasses, including *Echinochloa stagina,* sedges including *Cyperus pilosis, Rhynchospora* sp., and dicotyledons such as *Aeschynomene indica, Impatiens sp., Ludwigia hyssopifolia* and *Nelumbo nucifera* (lotus).

These areas support Sarus Crane, White-shouldered Ibis and Greater and Lesser Adjutants. Although, in the Lower Mekong Basin, these areas are greatly disturbed, they do hold more substantial grasslands that other parts of S.E. Asia and thus are a priority for conservation. They are of crucial importance for the Globally Endangered Bengal Florican *Houbaropsis bengalensis*.

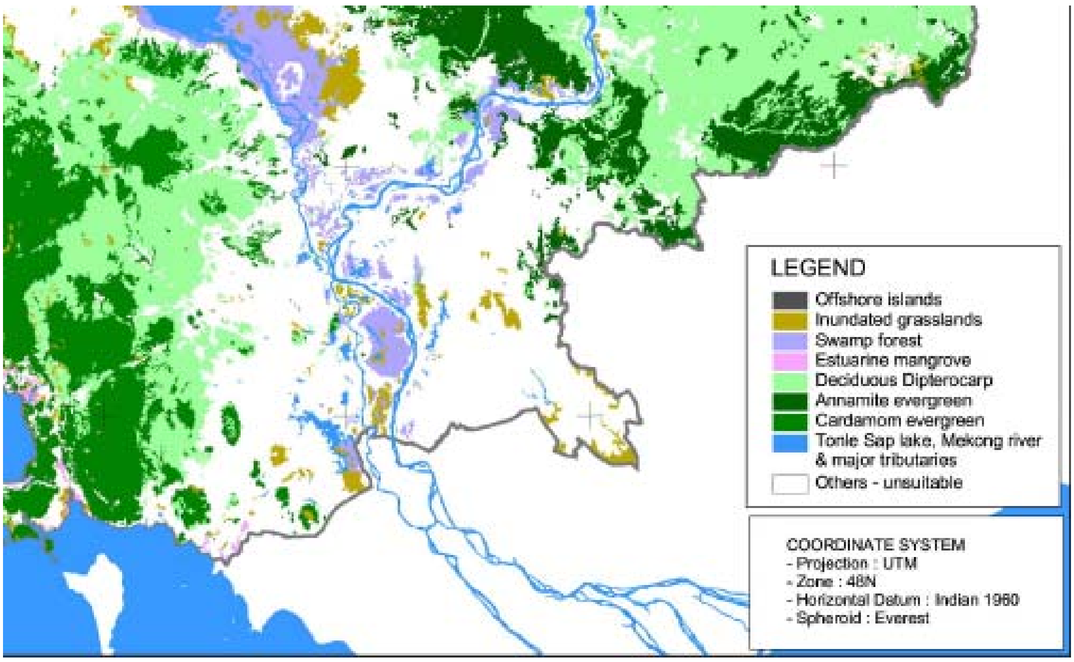

Figure 4.4 **Location of important wetland habitats in the project area**
Source: Birdlife International, http://www.birdlifeindochina.org

4.2.3 Wildlife and rare and endangered species

Wetland mammals known to occur in the project area include the Smooth-coated Otter *Lutra perspicillata* (quite rare) and Fishing Cat *Felis viverrina.*

According to Baran, 2005 (Baran, E, 2005, Cambodia inland fisheries: facts, figures and context. WorldFish Center and Inland Fisheries Research and Development Institute), the main endangered large fish species in Cambodia are the Giant Mekong catfish (*Pangasionodon gigas*), the Giant Mekong carp (*Catlocarpio siamensis*) and the seven-line barb (*Probarbus jullieni*). Other endangered species are *Balantiocheilos melanopterus, Botia sidthimunki, Chela caeruleostigmata, Dasyatis laosensis, Himantura chaophraya, Himantura oxyrhyncha, Scleropages formosus* and *Tenualosa thibaudeaui.*

The number of bird species found in Cambodia is 435 (Ministry of Environment, Wetland biodiversity of Cambodia, Workshop on National Wetlands Planning, October 2000). Of these 106 species are water birds. The wetland of the Lower Mekong Basin support 15 globally-threatened bird species, namely the Critically Endangered Giant Ibis *Pseudibis gigantea*, the globally Endangered Sarus Crane *Grus Antigone*, Greater Adjutant *Leptotilos dubius*, White-shouldered Ibis *Pseudibis davisoni*, White-winged Duck *Cairina scutulata*, Bengal Florican *Eupodotis bengalensis* and Nordmann's Greenshak *Tringer guttifer*, the Globally Vulnerable Spot-billed Pelican *Pelican Pelecanus Philippensis*, Lesser Adjutant *Leptoptilos javanicus*, Milky Stork *Mycteria cinerea*, Greater Spotted Eagle *Aquila clangula*, Green Peafowl *Pavo muticus*, Masked finfoot *Heliopais personatus*, Black-bellied Term *Sterna acuticauda*, and Indian Skimmer *Rynchops albicollis*.

Endangered mammals are the Irrawaddy Dolphin *Orcaella brevirostris* that is believed to be Critically Endangered globally. The population remaining in the Mekong is estimated at than 100 individuals, mostly between Phnom Penh and the Khone Falls in southern Lao.

Of the reptiles the Siamese Crocodile *Crocodilius Siamensis* is Critically Endangered. It was formerly widespread thoughout the Lower Mekong Basin but has declined drastically due to excessive hunting and habitat destruction. These populations are of extreme global importance as the last wild populations. Over twenty species of turtles occur in the Lower Mekong Basin, ten of which are listed in the Red Data book including the Chinese three-striped box turtle *Cuora trifasciata* that is critically endangered.

Not clear is which of these species that are endangered in Cambodia are actually present in the project area.

4.2.4 Protected areas

According to ICEM, 2003 (Cambodia National Report on Protected Areas and Development. Review of Protected Areas and Development in the Lower Mekong River Region) no protected or proposed protected areas are located in the West Bassac Demonstration Project area. However, the same report mentions that the Department of Fisheries established a so-called ‘fish sanctuary’ of 691 ha in the Takeo province.

According to BirdLife International in Indochina (Bauld, S, 2005, Ecotourism feasibility Study of Boeung Prek Lapouv Important Bird Area, Takeo Province) there is one important bird area located in the project area, the Boeung Preik Lapouv area close to the Vietnam border.

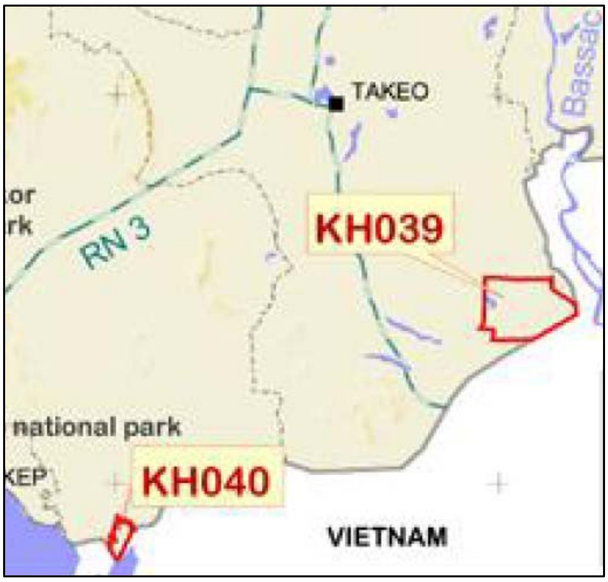

Figure 4.5 **Location of the Boeung Preik Lapouv (KH039) Important Bird Area**
Source: BirdLife International (http://birdlifeindochina.org

The Boeung Preik Lapouv area consists of seasonally inundated grasslands and is located in the Borey Chulsar and Koh Andeth districts. The site is an important dry season refuge for fish and birds and is inundated for about four months each year, during which some 30 species of aquatic vegetation can be found. It forms part of one of the largest areas of adjoining natural habitats remaining in the Mekong Delta. More importantly, the area provides critical wetland habitat to 25% of the world's population of Endangered, Non-breeding Eastern Sarus Cranes *(Grus antigone sharpii),* as well as numerous other globally threatened bird species.

The Eastern Sarus Crane (the tallest flying bird in the world) is present in the area from December to April. After Ang Tropeang Thmor, this area supports the largest non-breeding population in Cambodia. In the dry season from late November to April, the site provides an abundance of food for a variety of birds, including the Sarus Crane. During this time as many as 350 cranes may be present in the area. Populations of Egret, Pond Heron, Cormorant and Spot-billed Duck are present from July-March, with populations of the Painted Stork and Asian Openbill from November-March.

Surveys conducted in the area have recorded 58 bird species including 34 water bird species. In addition to bird diversity, the site also supports other wildlife and plants including species of reptiles, amphibians, mollusks, fish, aquatic vegetation, and inundated forest vegetation. Of the 58 bird species present, 6 are globally threatened: Sarus Crane (*Grus antigone*), Bengal Florican (*Houbaropsis bengalensis*), Spot-billed Pelican (*Pelecanus philippensis*), Painted Stork (*Mycteria leucocephala*), Darter (*Anhinga elanogaster*) and Black-headed Ibis (*Threskiornis melanocephalus*).

Due to the importance of the area, the Forestry Administration of the Ministry of Agriculture, Forestry and Fisheries, proposed Boeung Preik Lapouv with an area of 10.787 ha as a Sarus Crane conservation area to the Ministry of Agriculture, Forestry and Fisheries since August 2002. This proposed boundary is as follows:

- East: Thmor Bey Dum Canal and Cambodia-Vietnam frontier;
- West: Canal No.82, 98 and 99;
- North: Canal No.92; and
- South: Canal No. 81.

The aims are to protect this valuable natural resource for future generations and ensure sustainable use of the site.

Only quite recently (2007) a somewhat smaller area, 8,305 ha in total, a buffer area surrounding a core area of 919 ha, has been declared the ‘Boeung Preik Lapouv Sarus Crane and Various Other Birds Management and Conservation Area’ upon signing of a Prime Ministerial Decree.

4.3 Socio-Economic Development

4.3.1 Land use

The project area consists for 78% of agricultural land, grasslands cover a substantial part of the remaining 22%, together with minor areas of water/wetlands and wood- and shrubland. On the natural levees along the Bassac River from Phnom Penh to Chrey Thom at the Cambodia/Vietnam border seasonal cash crop are grown. This cash crop growing area extends from a couple of hundred meters up to some 2-3 km into the flood plain. The land gradually slopes down from the flood free National Road 21 embankment to the flood plain and is subject to occasional short duration flooding and benefits from silt deposition and land sanitation by flood water brought in by colmatage canal systems connecting the Bassac with the flood plain. Part of the area is protected against medium to low floods by embankments and gated colmatage canals. With easy access to water and transportation, the potential for crop diversification and intensification of this area is higher than in other areas further to the west. The agricultural potential of the area could be fully used by making this area flood free, as proposed under the project. In the dry season low head pumping of irrigation water might be required.

Away from the levee extends a wide flood plain, with a width varying between 10 to more than 30 km and an elevation that generally ranges between 3 to 5 m amsl.

A number of natural permanent and semi-permanent lakes occupy the deepest parts of the floodplain. These lakes are locally bordered by shrubs and trees, an important habitat for fish and other aquatic organisms. The lakes and deep parts of the flood plain play an important role for temporary water storage, as source of water supply for dry season irrigation, and fisheries as one of the most important source for livelihood of the people living in the surrounding areas. The deep flooded areas where land elevation varies between 5 to less than 3 m amsl are occupied mainly by flood recession rice cultivation. In areas above the 5 m contour line subsistence rice cultivation is practiced. This area is frequently effected by floods and droughts.

Current agricultural expansion is mainly focusing on rice production based on extension of cultivated areas and increasing the number of crops per year. In recent years vast areas of swampy lands in the deep flooded part of the floodplain, far from the settlement areas (up to several tens of kilometers), have been reclaimed for rice cultivation, especially for flood recession cropping. Flood recession rice cropping is labor intensive and requires high investments (weeding, watering, fertilizer application, pest control and high transport cost). Transportation costs are high because the road density in the remote areas is extremely low and most roads are in an extremely bad condition.

In the transition zone between the deep flooded area and the shallow flooded area, where water is commonly available and the risk of early flooding before the end of July is limited, early cropping is increasing. As a result, also given the limited water storage capacity, the competition for water for these two rice growing systems is increasing. Opportunities for reservoir construction in the upper catchments of this part of the Mekong basin are limited.

Construction of a canal network would service multiple purposes: diversion of floodwaters and provision of irrigation water as well as a means for transportation. In the early crop areas construction of low embankments could prevent flooding of the agricultural land until the end of July, so that harvesting could be done in the dry conditions. Pumping may be needed for an appropriate drainage.

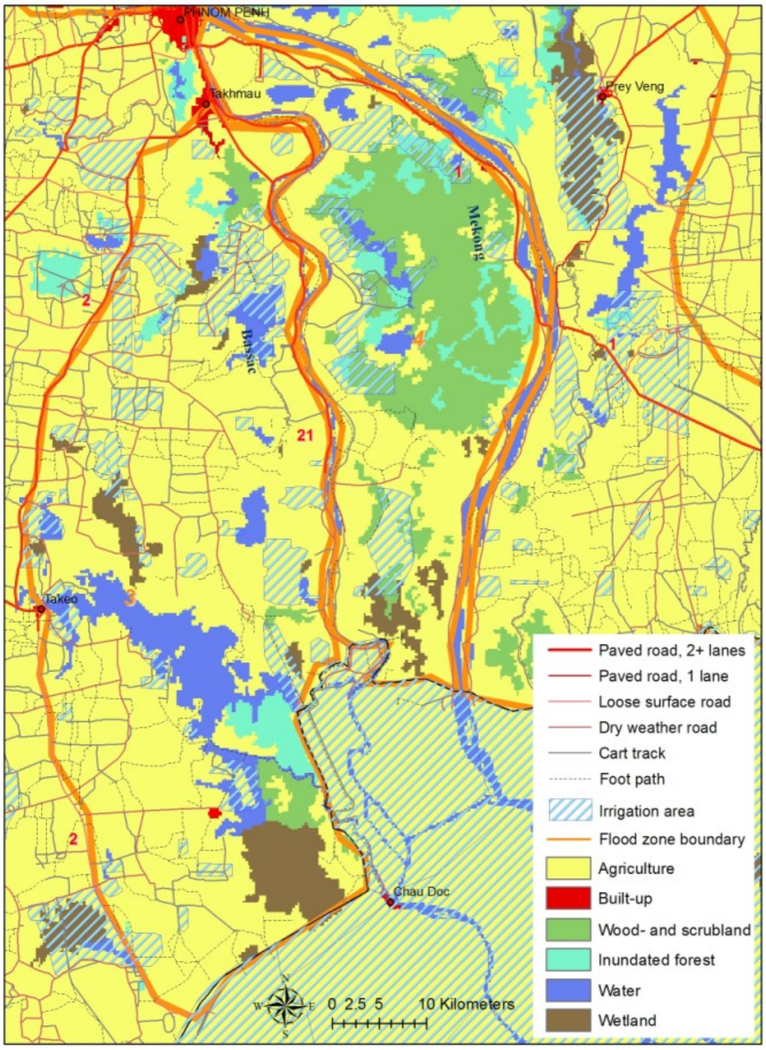

Figure 4.6 **Land use in the project area**
Source: Douven, 2008

4.3.2 Agriculture

Except for the small levee zone along the Bassac River, where cash crops are grown, rice is the main crop in the West Bassac area. Depending on soil type, elevation, flood frequency, flood depth and flood duration, different rice farming systems and rice varieties are used. The number of rice varieties is countless, but can be categorized into four main:

- wet season rainfed rice;
- wet season deep water rice;
- dry season recession rice and dry season irrigated rice; and
- upland rice (not present in the research area, not discussed any further).

The wet season rainfed rice is further classified into early, medium and late maturing varieties. The late maturing varieties, which have a long growth period and are sown and transplanted, are grown on the lowest fields. The higher fields, which are mostly drought prone, are used for early maturing varieties with a short growing period. Most rainfed rice varieties prefer floodwater depths between 0 to 0.25 m, but depths of 0.5 m or more can be tolerated for short periods. Some varieties of late maturing rainfed rice require rainwater during germination and early grow, while they require floodwater when they are taller.

Deepwater rice is grown in depressions that accumulate floodwater at a depth of 0.5 m or more for at least one month. Maximum water depth ranges to more than 3.0 m. Most varieties of deepwater rice are old traditional varieties. Ideally, these crops receive sufficient local rainfall to allow 6 or more weeks of growth before mid July. They are then at an advanced stage of maturity which allows them to grow fast enough to keep pace with the rising floodwater. Some of these rice varieties can grow 0.2 - 0.3 m per day and grow up to 4 m long. Deepwater rice is harvested in January or February. Deepwater rice cultivation is decreasing rapidly in favor of recession rice, double cropping or dry season rice. The risk of damage due to abnormal floods or droughts is high.

Recession rice uses the floodwater as source of moisture. As the water begins to recede, the receding water is blocked off with barriers erected by farmers. Crops are planted along the edges of the flooded areas and as the water recedes during the dry season, water is pumped back onto the fields where possible. A succession of crops follows the edge of the lakes or floodplains as the water recedes, hence the term ‘recession rice’.

Farmers normally have plots in at least two different rice ecosystems. In that way they spread the required labor force more evenly over the year and prevent the loss of the whole yield at once. Farmers can also adapt their sowing and transplanting dates to the actual circumstances. If the first rains are late, then nursery bed establishment and land preparation starts late. If a lack of rain in July or August delays transplanting, farmers can wait until the rain sets on and transplant older seedlings. Furthermore, if suddenly unexpected heavy rains occur farmers plant early maturing varieties in unused fields and enjoy an extra yield. Finally, when floods are extremely severe, fields in which the crops are destroyed are replanted with recession rice.

Since timing of agricultural activities depends on the rainfall and discharge pattern, and because rice is not equally sensitive to floods in all growth stages, comparable floods can result in different flood damages.

The demonstration project covers an area of 218,000 ha of which 167,700 ha (77%) is (potential) agricultural land. There are limited irrigation facilities in the area, a few small schemes extract water for irrigation from ponds/lakes and rivers. Besides, only a limited area is protected against early flooding. As a consequence a single cropping system is prevailing in the project area.

Two crop seasons can be distinguished: in the wet season the cultivated area is about 69,000 ha, in the dry season about 84,000ha is cultivated. Wet season crop are

- Early rice: planted in April and harvested in August (before the main flood);
- Medium rice: rice with long stem varieties is planted in May-June and harvested in November-December; and
- Late Rice: long stem and long duration varieties is planted in May-June and harvested in January-February.

The crops planting in the wet season are mainly rain-fed. Only 29% of wet season cropped area receives supplementary irrigation during dry spells.

The dry season crop is planted after the flood recedes, especially on low-lying land. Depending on the progress of the flood recession, the crop is planted in November-December and harvested in March-April. According to the 2006 census data 78% of the cultivated area was fully irrigated in the dry season.

General speaking, crop cultivation in the project area is very extensive with little use of fertilizers and pesticides, except crop in dry season with fully irrigation. Yields are low at about 2.0-2.4 ton/ha in wet season and about 3.0-3.8 ton/ha in dry season. The total production amounts to about 208,000 ton/year in the dry season and 147.000 ton in the wet season.

Upland crops such as corn, mung beans, peanuts, vegetables and sweet potatoes are mainly grown on the higher grounds along the Bassac river.

At present cropping intensity in the Demonstration project area is 115%. Without the project there is a small potential for developing commune irrigation schemes, this could increase the cropping intensity to 118%.

With the project providing irrigation facilities (canals, gates, pumping stations), and flood control measures (ring dykes, compartment dykes, gates), early flood protection in August and provision of irrigation water in the dry season makes double cropping possible in the area.

The first crop will be fully irrigated and can be planted in November-December and harvested in March-April. The second crop can be planted in April-May and harvested in July-August. The overall cropping intensity will increase from 115% at present to 172%. It is noted that this change needs to be supported by agricultural extension services, to support farmers in adopting new cultivation techniques and crop varieties, as well as the proper use of fertilizers and pesticides.

4.3.3 Agrochemical use in agriculture

Within the framework of the Economy and Environment Program for Southeast Asia (EEPSEA) project a case study on the use of fertilizers and pesticides has been carried out in the Takeo province in 2001. (Mary Chamroeun, Vann Kiet, and Sun Votthy, 2001, A survey on environmental and health effects of agrochemical use in rice production). Although the study is based on limited data, it indicated that more farmers (60 to over

90%) use chemical fertilizers in the dry season than in the wet season (less than 10%), when mixed and organic fertilizers are used by 30 to over 90% of the farmers.

The study also indicated that most farmers (15 to 50%) apply chemical fertilizers in amounts far exceeding the recommended levels, due to a lack of information on soil types and recommended application ranges, lack of agricultural training, and the inability of farmers to understand fertilizer product label instructions. Non of the farmers interviewed had ever received formal training in agro-chemical use.

Similar to chemical fertilizer use, pesticide application depends on the rice season, pesticide use is more common during dry season (70 to 100% of the farmers) than in the wet season (about 50%). The most frequently used pesticides were insecticides, followed by rodenticides and herbicides.

The World Health Organization (WHO) has classified pesticides by toxicity/hazard into Class I, II, and III with those in Class I considered the most toxic. Many countries including Cambodia have banned the use of pesticides classified as Ia or Ib. Nonetheless, the use of Class I pesticides remains common in Cambodia. The case study in the Takeo province indicated that 35 to 55% of the farmers use Class 1 pesticides in the dry season, in the wet season the figure drops to 15 to 30%.

Poor practices like smoking and eating while spraying, spraying against the wind, and not wearing protective clothing are commonplace. As a result, pesticide-related health problems appear widespread. Approximately 70% of the farmers surveyed sprayed pesticides during the wet and/or dry season, of which about 30% reported experiencing pesticide-related health problems. These problems, which occurred during or soon after spraying, included fatigue and dizziness, headaches, fever and chills, diarrhoea, stomachaches and vomiting, coughing, and eye and skin irritation. The farmers lost workdays due to these health problems in the range of 2 to 14 days per year and some farmers continue to experience health problems that they believe are pesticide related.

Most farmers spray pesticides when they notice their crops damaged by pests or see a large number of insects in their rice field. Since very few farmers can distinguish between beneficial insects and actual pests, they may be spraying pesticides unnecessarily. Farmers also reported spraying pesticides when they see other farmers do so, even if there is no evidence of crop damage or insects in their field. Such indiscriminate pesticide spraying may result in increasing pest resistance. Regarding the disposal of pesticide residuals, over 90% of farmers in Prey Sva and Prey Tamao dispose cans, bottles and wash sprayers in their rice fields and/or irrigated canals.

The overuse of pesticides and poor disposal practices also has an impact on fish and other aquatic resources. Few, if any, aquatic resources live in rice paddies where pesticides have been sprayed and it is noted that fish and aquatic species tend to be more abundant in rice paddies where organic, rather than chemical, fertilizers have been applied.

4.3.4 Fisheries

The productivity of the floodplain is the highest worldwide and ranges between 139 and 230 kg/ha/year. This is due to 3 uniquely interconnected factors: high biodiversity, large accessible floodplains, and a very high exploitation rate.

Cambodian people in rural areas rely heavily on fisheries for their subsistence. Fish provide from 40- 60% of animal protein intake for people in rural areas – even those living far from water. An average of 76 kg of fish is consumed per person/year (Baran, 2005). The total value of fish catches in SA 10C is estimated at approximately US$ 45 million. The value of the river fish capture is estimated at about US$ 0.68 per kilogram, while the value of aquaculture is approximately US$ 1.05 per kilogram.

During the flood, fish are dispersed in a large volume of water. A large proportion of the fish has not yet grown to catchable size and the use of medium and large-scale gears is prohibited during the official closed season (1 July to 31 October). When water levels recede, fish are forced off the floodplain and become concentrated in channels, streams and rivers. Various kinds of traps and large stationary trawls (dais) set across flowing waters in the flood recession season catch many fish and other aquatic organisms.

Capture fisheries are categorized as small-scale or subsistence, as middle-scale, or as commercial scale. Small-scale fisheries are family fisheries, based on small gears such as cast nets, dip nets, small gill nets and traps. Anybody can fish, and a license is not needed, but it is illegal to fish in fishing lots during the open season (October-May). Most households in the project area fish for some time each year on land they own, or in nearby water bodies, flooded forest and floodplain areas. Production from rice fields fisheries is very important to most rural families.

Middle-scale fisheries are based on larger gears, of at least 40 types, with the most popular being gill nets and seines. Anybody can fish, but a license is required. Middle-scale fisheries are not permitted inside commercial fishing lots.

Commercial-scale fishing is based on ‘lots’, fishing areas which are auctioned every two years. Large-scale fishing gears are only permitted in fishing lots, which can only be fished in the open season (October to May). Such gears include dais, fences with traps, and barrages. A dai is a stationary trawl or bag net, which filters the current, and is typically 25-45 m wide and 100 m long. Fences, up to several kilometers in length, are built across flooded areas or lakes to direct fish into traps. Barrages are smaller gears that block a stream and direct fish into traps.

The area of inland fishing lots in Cambodia has been reduced considerably in the year 2000 and the released fishing lots have been transferred to community fisheries. Elimination of the lots has provides an opportunity for villagers to better share the benefits of the fisheries. However, in the absence of management and enforcement of regulations such open access may lead to over fishing

Fisheries provide a possibility for income generation with very little capital investment and no land needed. In Cambodia as a whole 1995-96, 39% of households were involved in fishing and 77% of them were involved in farming as production and income-generating activities. More than 50% of the fishing households indicate that their supply of fish comes mainly from family fishing in rivers, lakes and in flooded rice fields. 10.5% of the households have fishing or a fishing related activity as the primary occupation while another 34.1% are engaged on a part-time basis.

More than 62,000 tons of fish are caught in natural water-bodies every year in SA 1OC, representing about 30% of the national total. In the Takeo Province 17,535 families in 62 communities (49% of all communities) are involved in fisheries, in Kandal province these figures are 3,190 and 17 respectively. Large companies are not operating in the area.

Fish production in the Takeo province is reported to be 11,182 ton/year, in Kandal Province 32,769 ton/year (McKenny & Tola, 2002).

4.3.5 Aquaculture

The capture fishery in Cambodia has been so productive that there has been little incentive for development of aquaculture. Moreover, until recently, poor infrastructure limited the distribution of fish feed, fingerlings and the produce of the industry. Nevertheless, aquaculture is a steadily increasing part of the economy. The Delta in Cambodia is considered to have huge aquaculture development potential. Pond culture and fish farming in rice fields have recently been introduced by the Department of Fisheries. An estimated 124,880 families in the Delta have their own fish ponds, which are increasingly contributing to water demand in the area. Consumption of water in Mekong Delta fish ponds for aquaculture is now estimated at 6,000 m^3/ha/month.

At present about 4,900 tons of fish are produced yearly in SA 10C. Production in the Takeo Province is 808 ton/y, for Kandal Province no aquaculture production is reported by (McKenny & Tola, 2002). Fish ponds and cage nets are rarely developed in the Mekong River itself, but many can be found along the tributaries.

4.3.6 Tourism

The Cambodian Delta is a very diverse region. Main tourist attraction in the Takeo Province are sites such as Phnom Chiso, Tonle Bati Temple, Angkor Borei and Tamao Mountain and Zoo.

4.3.7 Roads and infrastructure

The area contains quite a number of roads, though besides the national roads that form the boundary of the zone and a short section south of Takhmao all roads are dry weather roads, cart tracks and footpaths. The larger of these roads can effect small floods and floods in the early and latter stages when water levels are still low if they have been built on dykes, which is often the case.

In the West Bassac Focal Area here are numerous canals, flood control dikes and water control structures. A number of water retention reservoirs have been built in the low-lying areas for irrigation water supply to dry season flood recession crops.

Most infrastructure was built in the recent past, mainly during the Democratic Kampuchea period. Although some of the infrastructure has recently been rehabilitated, most of it is of little use for flood risk reduction or integrated water resources management purposes. Financial and technical capacity for operation and maintenance is lacking and many structures are incomplete. Significant investment is needed for rehabilitation and operation in a sustainable manner.

4.3.8 Navigation

In the Cambodian delta, water transport is traditionally the principal means of travel for much of the population. Locating their communities on or near waterways has enabled local population to trade with neighbouring communities up and downriver.

With Phnom Penh at its most northern point, the Delta sub-area includes a major water transport network. Navigation is crucial for shipment between Phnom-Penh and the Delta region for fish, agricultural produce and supplies, gasoline and heavy equipment.

For 89 kilometers from Phnom Penh to the Cambodia/Vietnam border the Bassac River is navigable for 50-ton ships year round, and for 200-ton vessels during the rainy season. The river links Phnom Penh with Chau Doc, the capital of Vietnam's An Giang Province and is connected to a network of tributaries and canals, mostly in Takeo Province. This tributaries and canals can take up to 100-ton boats at high water, but loads can be limited to 10 tons at low water. Most vessels on this network are in the 20-30-ton range, and are used for trade between Takeo and the Vietnam Delta area. There is a small international port at Kampong Ampil in Takeo Province, which is used by trucks from Phnom Penh.

4.3.9 Industry

Industrial development in the project area is very limited.

4.4 Social and Cultural Resources

4.4.1 Population and communities

Ta Khmao and Takeo are the main build up areas, along the rivers and along elevated roads many houses are built in the form of ribbon development. People in the region have a long experience in 'living with the flood, communities establish themselves in villages at the limits of the flood plain and build their houses on stilts.

Total population in the project area was about 606 thousand in 2006 (census data). There were nearly 114,000 families in the project area with average size of 5.32 persons. A small minority (1.4%) is Islamite, whereas 0.54% of the population is Vietnamese.

The main occupation in the project area is crop (rice) cultivation: 82% of the families are involved in agriculture, a small percentage of the population (1%) has fishing as its main occupation, part-time fishing is done by a much larger percentage of the population. About 15% of the families are involved in trading and services.

Most houses in the project area have tiled or zinc/fibro roofs (84%), the remainder of the houses has thatched roofs. The percentage of houses connected to the electricity net is quite low: only 11% of the households is connected. Most of the households (72%) use batteries for lighting, in 17% of the households gasoline is used for this purpose.

4.4.2 Water supply and sanitation

In the Takeo provinces only about 40% of the population has access to safe drinking water. During the dry season, the number of households with access to safe water even further declines in both urban and rural areas. It is estimated that for the poorest 20% of the rural population, the percentage drops to 4%. Only a small number of families has a connection to a water distribution net and receives purified water (5%), 37% use pumpwells and 6% use open (dug) wells. Nearly 50% of the population use surface water from lakes, ponds and rivers. Two percent use rain water storage facilities. According to the 2006 census data, 36% of the families have access to water at their house; 20% get water from public taps or wells within 150m of the house, and 44% of families has to get water at a distance of more than 150 m from the house.

Sanitation levels are extremely low, the latrine rate is very low with 19% of the houses. Urban concentrations are not equipped with wastewater treatment plants. Municipal liquid waste is directly discharged into rivers, streams and canals. Most industries also release wastewater into municipal sewers, which then empty into rivers and streams.

Diarrhoea and dengue fever are two of the major health issues in the area, and both are water-related.

4.4.3 Cultural, historical, archaeological sites

In the area around Angkor Borei remains of pre-Angkorian canals have been found. The archeological evidence indicates a flourishing local economy early in the first millennium AD. It is also suggested that the area experienced major re-organization or re-structuring in the early fifth to early sixth centuries. This restructuring probably did not involve major de-population, but a change from rice cultivation in bunded fields with dry season burning, to flood recession cultivation of rice (P. Bishopa, D. C.W. Sandersonb, and M. T. Starkc, 2003, OSL and radiocarbon dating of a pre-Angkorian canal in the Mekong delta, Southern Cambodia).

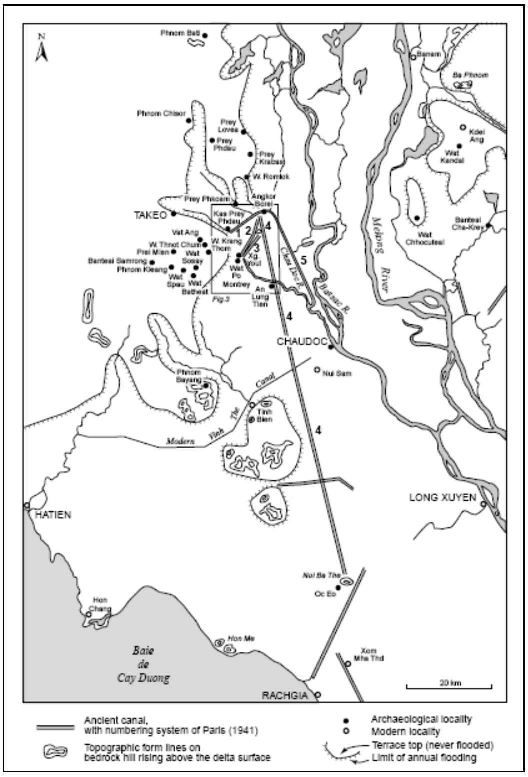

Figure 4.7 Archeological sites and ancient canals in the project area
Source: Bishopa et al., 2003

5 ENVIRONMENTAL SCREENING OF THE PROJECT

In an annex to the Cambodian Sub-decree on the Environmental Impact Assessment of 1999, it is stated that any project in flooded land, as well as irrigation system development of ≥ 5,000 Ha or drainage system development of ≥ 5,000 Ha, requires an (Initial) Environmental Assessment (I)EIA. As such an (I)EIA for the proposed project has to be made.

Also the outcome of the project screening, applying the project screening table as given in the BPG for IFRM Planning and Impact Evaluation, indicates the necessity of an environmental assessment (see

Table **5.1**). The screening indicates that the project is located in an area wih sensitive and valuable ecosystems (protected areas, wetlands), in an area with cultural heritage sites (archaeological), near watercourses that are used for potable water supply) and near waters containing valuable resources (fisheries). Also the project is likely to lead to permanent conversion of potentially productive and valuable resources (fisheries) and destruction of natural habitat and loss of biodiversity or environmental services provided by a natural system.

MRC (2006) in it's Framework for Transboundary Environmental Impact Assessment (TbEIA, March 2006) identified the construction of irrigation schemes and river works as potentially having transboundary environmental impacts.

Table 5.1 Results of the environmental screening of the West Bassac Integrated Flood Risk Management Plan

SCREENING QUESTION	Yes	No	Remark
A. PROJECT SITING Is the project area adjacent to or within any of the following environmentally sensitive areas?			
– in or near sensitive and valuable ecosystems (e.g., protected areas, wetlands, wild lands, coral reefs, and habitats of endangered species)	X		the area consists for a large proportion of wetlands harboring a number of protected species and of vital importance for maintaining the Lower Mekong fisheries. Boeung Prek Lapouv has been identified as an Important Bird Area (IBA) by BirdLife International.
– in or near areas with cultural heritage sites (e.g. archaeological, historical sites or existing cultural or sacred sites)	X		in the area pre Angkorian canals have been identified
– densely populated areas where resettlement may be required or pollution impacts and other disturbances may be significant		X	population is concentrated along canals and dikes, works will concentrate on these areas
– regions subject to heavy development activities or where there are conflicts in natural resource allocation		X	development in the region is limited
– watercourses, aquifer recharge areas, or reservoir catchments used for potable water supply	X		canal and river water is used as a source for domestic water by the majority of the population in the area.
– lands or waters containing valuable resources (e.g. fisheries, minerals, medicinal plants, prime agricultural soils)	X		the area is an important fisheries area, both for 'black fish' (floodplain residents) and 'white fish' (migratory) species, and as such has more than regional importance
B. POTENTIAL ENVIRONMENTAL IMPACTS Is the project likely to lead to:			
– permanent conversion of potentially productive or valuable resources (e.g. fisheries, natural forests, wild lands)	X		the yearly flooded grasslands, paddy fields and natural areas are important fish spawning and rearing areas
– destruction of natural habitat and loss of biodiversity or environmental services provided by a natural system	X		a reduction of the flooded area might effect the flora and fauna diversity (fish and water birds) and could have a negative impact on the fisheries resource
– risk to human health and safety (e.g. from generation, storage, or disposal of hazardous wastes, inappropriate occupational health and safety measures, violation of ambient water or air quality standards)		X	limited, some construction activities related health and safety risks are to be expected
– encroachment on lands or rights of indigenous peoples or other vulnerable minorities		X	-
– displacement of large numbers of people or businesses		X	-
– absence of effective mitigation or compensation measures		X	-

6 IDENTIFICATION AND ASSESSMENT OF THE POTENTIAL ENVIRONMENTAL IMPACTS

6.1 Introduction

For the identification of potential environmental impacts and mitigating measures the checklist of Environmental, Economic and Social Parameters for Flood Risk Management Projects, as given in the Best practice Guideline for IFRM Planning and Impact Evaluation has been used.

According to the checklists the relevant parameters can be classified as follows:

- Environmental concerns related to project siting;
- Environmental concerns related project implementation and construction activities;
- Environmental concerns related to project design, management, operation and maintenance; and
- Positive impacts related to project design, management, operation and maintenance.

In Attachment 1 the completed checklists are given.

In the following paragraphs the environmental parameters that are relevant within the framework of the proposed project will be discussed on an item by item base.

For the assessment of the significance of the impacts no formal assessment procedure was used and only a distinction between no significant impacts, small significant impacts, moderate significant impacts and major significant impacts was made. This assessment was based on expert judgment, taking into account the following general criteria to assess the significance of the impacts:

- Magnitude of the impact: the expected severity;
- The extent of the impacted area;
- The duration or frequency of the impact; and
- The risk involved; the probability of a serious impact occurring.

Where relevant a distinction is made between impacts occurring in the study area itself and off-site impacts, expected to manifest themselves in areas outside the proper project area. Possible mitigating measures to offset or reduce negative impacts and measures to enhance positive impacts are proposed. Possible transboundary impacts receive special attention.

6.2 Impacts and mitigating measures related to project siting

6.2.1 Land acquisition

The proposed project entails the construction/enlargement of a large number of embankments and irrigation/drainage canals. Lengths of planned canals and embankments are given in table. Assuming an average width of the canals of .. m and an average width of the embankments of .. m a rough calculation shows that approximately …. of land has to be acquired. Population in the project area is mainly located on the higher grounds, e.g. along existing embankments. Enlargement of these existing embankments will require displacement of a fairly large number of households and loss of gardens and fruittrees.

Mitigation:

The area to be acquired should be minimized by careful design. If land acquisition and resettlement is unavoidable, losses have to be compensated and assistance has to be provided to relocate and restore living conditions. Compensation and assistance have to be described in a carefully designed and implemented participatory Resettlement Action Plan.

6.2.2 Encroachment on historical monuments and cultural values

Large scale construction of canals and dikes will partly destroy the remains of the pre-Angkorian canals that have been found in the area around Angkor Borei. The existence of pagodas, temples, sacred sites and graves on or near proposed construction sites is not yet known.

Mitigation:

Avoid, minimise or offset activities by careful design and consultation with local communities. Compensate for damage to or displacement of sites, graves, etc.

6.2.3 Encroachment into forests, swamps, loss of precious ecology

Sensitive and valuable ecosystems that are encountered in the Cambodian Delta are seasonally-inundated riparian forests; seasonal wetlands, including marshes, small pools and lakes; and seasonally inundated grasslands. These ecosystems are important as a habitat of a variety of fish and waterbirds and for the sustenance of the inland fisheries.

Only one officially declared protected area the ‘Boeung Preik Lapouv Sarus Crane and Various Other Birds Management and Conservation Area’ is located in the project area. The area is one of the largest areas of adjoining natural habitats remaining in the Mekong Delta and has a high conservation value. Changing flood patterns or canal/dike construction could have a negative impact on the area and reduce the number of aquatic vegetation species and the area’s importance in providing critical wetland habitat to 25% of the world’s population of endangered, non-breeding Eastern Sarus Cranes *(Grus antigone sharpii).*

In total 58 bird species including 34 waterbird have been observed in the area, 6 species are globally threatened: Sarus Crane (*Grus antigone*), Bengal Florican (*Houbaropsis bengalensis*), Spot-billed Pelican (*Pelecanus philippensis*), Painted Stork (*Mycteria leucocephala*), Darter (*Anhinga elanogaster*) and Black-headed Ibis (*Threskiornis melanocephalus*).

Direct impacts of encroaching are probably limited. However, the indirect impact of the project on the natural areas and the Boeung Preik Lapuv area may be significant: construction of embankments and canals will open-up the area and increased protection against the early flood will encourage people to extent their agricultural activities to areas that are presently not used for rice growing. Encroachment into the forest/shrublands, wetlands and natural grasslands will be the result. Other important indirect impacts on natural areas and ecology are related to the changing flood pattern, see Chapter 6.3.3.

Mitigation:

Avoid, minimise or offset activities by careful design and consultation with local communities. Compensate or offset economic losses through replacement of recourses, identification of alternative income sources etc. Of extreme importance is to prevent encroachment into the Boeung Preik Lapouv Sarus Crane and Various Other Birds Management and Conservation Area. The presently existing patrolling by a Local Conservation Group should be intensified and an awareness campaign to inform the local communities of the importance of the area's biodiversity and the benefits of sustainable use should start.

6.2.4 Impediment to movement of wildlife, cattle and people, including obstruction to navigation and obstruction of fish migration paths

Canal construction will not significantly impede the movement of wildlife, cattle and people. The area is low-lying and already very rich in surface water and waterbodies, that presently do not hampering the movement of people and animals.

More serious may be the obstruction of fish migration paths. With the onset of the flood fish is distributed over the flood plain where they feed. Closing-off of the colmatage canals that presently connect the floodplain with the Bassac River will prevent dispersal of fish fry and migration of fish into the floodplain for spawning. At the end of the flood season the white fish species may not be able to leave the flooded areas and return to the rivers to migrate to their dry-season refuges up river.

Mitigation:

Careful planning, design, and operation. Construction of fish passages is advised, whereas the operation of the gates should be such that water flow between the Bassac River and the floodplain is possible in periods of maximum migration.

6.2.5 Loss of the aesthetic, visual or recreational amenity or value of the area.

No significant impacts are foreseen, since the area has limited aesthetical and recreational value. Construction of embankments will effect the openness of the typical floodplain landscape.

6.3 Potential impacts related to project implementation and construction activities

6.3.1 Soil erosion, increased turbidity and sedimentation of rivers and watercourses

Soil erosion during the construction phase may result from destruction of the vegetation or surface runoff over unprotected soil at the construction sites. Total magnitude of the works to be carried out is large and overall impact could be considerable. Runoff water from exposed soil will be sediment laden and result in an increase in turbidity of the receiving water bodies. Dredging, excavation and disposal of dredged materials can also increase turbidity in the area close to the activity, either by direct disturbance of the soil or due to spillage of sediment laden water. Increased turbidity will in turn intensify the existing sedimentation processes, as the sediments will resettle close to the construction areas. Increased turbidity has an adverse impact on all water organisms, not only on the fish but also on the invertebrate (zooplankton, zoobenthos) consumed by them. Benthic communities may smother as a result of re-sedimentation of suspended sediments and this may lead to a loss of species and a decrease in benthic biomass. Although high turbidity negatively influences vital functions of the organisms, and may lead to complete or partial extinction of plankton and benthic species in high turbidity areas, the impacts are localised and temporary.

Additionally, dredging and excavation can cause release of pollutants from bottom sediments into the water. This is especially relevant for areas with acid sulphate soils.

Mitigation:

> Soil losses and the consequent negative impacts on downstream water quality can be reduced by minimizing clearing activities, by compacting and protecting exposed soil as much as possible and by replanting areas where the vegetation has been damaged. If needed, construction activities should be limited to the dry season. Fencing may be applied to protect particularly sensitive areas. Removal of sediments (dredging) may be applied to maintain a certain water depth, e.g. for navigation purposes.

6.3.2 Loss of habitats/productive land by disposal of dredge spoil or solid waste/soil disposal

To be estimated.

6.3.3 Loss of soil fertility

No significant impact expected.

6.3.4 Worker accidents

The main health and safety issue during the construction phase is accidents of construction workers who are at risk at the workplace because they work with and near heavy machinery.

Mitigation:

> Construction stage hazards and severity and frequency of accidents can be reduced considerably when construction equipment is well maintained and safety regulations and procedures are strictly implemented in conformity with the prevailing Labor Law, safety gear is issued or worn, and when construction workers are trained on safety procedures.

6.3.5 Accidents from increased traffic (construction equipment)

Constant movement of vehicles and equipment to and from the construction sites will cause traffic volume along the national highway to increase considerably. This will increase the likelihood of accidents.

Mitigation:

> Alternative routes should be selected to avoid densely populated areas as much as possible. Where construction traffic has to cross communities driving speed limits should be set and enforced. Local population has to be informed by means of a community awareness program.

6.3.6 Disruption of access to villages, damage of local roads with heavy machinery

During the construction period access to villages may be temporary disrupted and local roads may be damaged by heavy machinery. This may result in loss of income from farming, fishing and processing activities and temporary disruption of local businesses and access to community services (schools, clinics).

Mitigation:

Alternative routes should be identified to facilitate continued access. Disruptions should be limited to periods with low economic activity. e.g. outside the harvesting period. Losses of business income or wages have to be compensated. If needed community facilities/services should be relocated to guarantee continue access. Local population has to be informed by means of a community awareness program.

6.3.7 Temporary obstruction to navigation

No significant impact expected.

6.3.8 Disruption of utility services

No significant impact expected.

6.3.9 Noise/vibration/air pollution (including dust) from construction activities

Noise, vibration and air pollution as a result of the construction activities will be temporary but significant.

At present, noise levels in the rural areas in the project communes are low. During the construction phase noise may be caused by generators, construction equipment and vehicles used for material transport. Noise of this type of activities can reach 90 dBA at 15 meters distance, which is generally above the permissible noise levels for public and residential areas. However, construction will not take place in public or residential areas. Only residential areas along the material transport routes may be effected by increased levels of noise due to project induced traffic. Already now, noise levels along the highway are above standards.

The major potential sources of vibration are heavy vehicles. The routes used for material transport will probably not pass through densely populated areas. Therefore, this impact will be negligible.

In the construction phase the air near the construction sites may be polluted by toxic gasses (SO_2, NO_X, CO, volatile organic compound (VOC) from construction machines and dust. With a fairly large volume of earth to be excavated and a considerable volume of construction materials to be transported to the construction sites, dust pollution will be significant during the construction phase, particularly in the dry months.

Mitigation:

Vehicles and construction equipment have to be well maintained and checked for operational noise levels, vibration and gas emissions to meet standards.

Mufflers should be installed and maintained as necessary to meet these standards. If the distance between the construction site and sensitive receptors (residential areas, schools, offices) is insufficient, special measures of noise prevention should be considered: e.g. installation of adequate barriers. The routes used for material transport should avoid densely populated areas as much as possible and when needed vehicles should proceed at reduced speed. Transport and construction have to be minimal during rest times. Dust production can be reduced by periodic watering of construction sites (important in the dry season) and access areas. Vehicles transporting construction material (sand, cement, stones) should be covered to prevent dust dispersion.

6.3.10 Soil/(ground)water contamination as a result of leakage and inappropriate storage of fuels and other chemicals, dumping of construction wastes or improper sanitation (worker camps)

Surface run-off water from construction sites, leakage of combustibles and greases from construction equipment and discharge of domestic wastewater and solid wastes at construction workers camp sites may form a source of soil and (ground) water pollution during the construction period. Loss of flora and fauna, and increased risk of health problems. e.g. skin rashes and eye infections from contaminated surface water may be the result. Contamination of drinking water sources may lead to health problems like diarrhoea and dysentery.

<u>Mitigation:</u>

(Ground) water and soil pollution at construction sites can be minimized by containment of fuels stored on site and off-site refuelling, by following appropriate procedures and by proper maintenance of equipment. Disposal of solid waste (construction waste, sand, stones etc.) and waste grease and oil from construction equipment to ponds, rivers or wells should be avoided: wastes have to be collected and transported to approve disposal sites. Sanitation facilities for construction workers should be provided to minimize the risk of transmission of diseases. The Contractor has to install adequate sanitation systems (for example mobile toilet facilities) for workers or require them to use public sanitation facilities to prevent untreated domestic waste discharge. Wastewater has to be collected and treated mechanically before being discharged to rivers, ponds or the soil.

6.3.11 Social/community disruption

Conflicts between construction workers and local people may be caused by differences in customs and traditions, differences in income and encroachment of workers into historical or traditional sites.

<u>Mitigation:</u>

To avoid problems between construction workers and local people, construction workers should be recruited as much as possible locally, as such they will be familiar with local customs and traditions. Goods and services have to be purchased as much as possible locally. If workers from other areas are recruited, they should receive a proper awareness program about local customs and appropriate behaviour.

6.3.12 Health impacts

Dust pollution may effect to health of workers and people living in the vicinity of the construction sites and transport routes. High concentrations of VOC, CO and NO_x in truck emissions may also have a negative impact on the health of construction workers and local residents. However, impacts on local population are expected to be limited: the exposure is only temporary and most of the construction sites are located far from residential areas. For impacts related to contaminated water see 6.3.12.

Influx of non-local workers for project construction and other people attracted by economic opportunities brings about an increased of risk of sexually transmitted diseases, including HIV/AIDS, and other infectious diseases.

Mitigation:

> The Contractor will be responsible for development and implementation of an occupational health and safety program for construction workers and for provision of medical facilities on the site. A proper domestic and human waste management should be implemented. A robust HIV/AIDS awareness and prevention program targeting workers and people in surrounding communities should be implemented and local health clinics need to be supported to meet the increased demands. For mitigating measures to reduce or offset impacts related to poor water quality see 6.3.12.

6.3.13 Increased pressure on water supply and sanitation facilities

Influx of non-local workers for project construction and other people attracted by economic opportunities may put pressure on the existing water supply and sanitation facilities. This may result in health risks related to poor drinking water and sanitation conditions.

Mitigation:

> Appropriate planning and design of water supply and sanitation facilities for worker camps.

6.3.14 Employment opportunities for local people

This is a positive impact of the project, to enhance this impact contractor contracts should specify employment for local workers and local purchase of goods and services.

6.4 Potential negative impacts related to project design, management, operation and maintenance

These impacts are mainly related to project induced changes in the hydrology/hydraulics: the timing, extent, depth and duration of flooding, which may result in a loss of flooding related benefits.

6.4.1 Loss of agricultural productivity

The importance of the annual flooding for the deposition of fertilizing sediment is illustrated by the results of the Focal Group discussions, held in Stage 1 of the project. It turned out that after a year with a good flood rice yields are about 1 ton/ha higher than in years after a year with a bad flood. In some areas an increase of 1,5 ton kg/ha was mentioned. Production cost was estimated to be the same in years after a year with a good flood as compared to years after a year with a normal flood. Overall benefit of the flood for agricultural production is estimated at 155 to 230 USD/ha. Not only the fertilizing of the soil with sediments is important, also the flushing of toxic materials and pollutants by the floodwaters, the sanitation of the soil (killing of pests and bugs) and possibly the replenishment of ground and surface waters. Impacts of delaying the flood on this benefit are not thought to be very significant, the highest sediment concentrations are observed during the main flood and sediment settling will be largest during the recession of the flood. The delayed replenishment of groundwater and surface water bodies will not effect the quantities of water available in the next season.

Mitigation:

Allow sufficient flooding to safeguard silt and water supply and prevent pests. Strengthen and provide agricultural extension and other technical assistance (provision of agro chemicals) to enhance agricultural productivity, diversify crop production, expand livestock raising, etc.

6.4.2 Loss of capture fisheries production

People in rural areas rely heavily on fisheries for their subsistence. With an average of 76 kg of fish is consumed per person/year, fish provide from 40 - 60% of animal protein intake. The productivity of the Lower Mekong Floodplains ranges between 139 and 230 fish kg/ha/year, which is very high compared with other river systems in the world. Fish productivity depends amongst others on accessibility of the floodplain for fish, the availability of food and the length of the period that the fish stay on the floodplain to grow. All these three factors could be influenced negatively by the project. Dispersal of ‘White fish’ fry over the floodplain with the flood water will be delayed. At the time of flooding the amount of fry in the floodwater may have diminished somewhat resulting in lesser stocks. At the same time the survival rate of ‘Black fish’ in the floodplain habitats will be reduced. Deterioration of the floodplain vegetation results in a lower food availability and the growth period of the fish during their stay on the floodplain is reduced with one month. These impact me have an effect on an area larger than the project area, downstream river fisheries might be effected as well.

Mitigation:

Allow sufficient flooding to maintain fish migration patterns and fish spawning, breeding, nursing and feeding areas.

6.4.3 Loss of wetland areas/productivity

The sensitive and valuable ecosystems encountered in the Cambodian Delta are all dependent on the seasonal flood. Protection against early flooding will mean an average delay of the onset of the flooding with about one month. Area and depth of flooding during the main flood are not expected to change. Direct impacts on the riparian forests, seasonal wetlands and seasonally inundated grasslands are probably limited, although species composition may change: some species will simply not be able to survive the prolonged drought. When also provisions for quicker drainage after the flood are made, the total period of flooding may become so short that wetlands dry out or change so much in species composition that they loose their ecological value.

As stated above prolonged drought may have an impact on the biodiversity in the area. Species composition of aquatic flora may change and the diversity and extent of marshes may reduce. In the dry season 'Black fish' species remain in lakes and swamps on the floodplain, where they are able to tolerate acidic and low oxygen conditions. The wetlands are vital in maintaining breeding stock. Prolonged drought en more floodplain lakes and ponds drying out completely could result in a decrease in numbers of for example climbing perch (*Anabas testudineus*), clarias catfishes (e.g. *Clarias batrachus*) and striped snakehead (*Channa striata*).

Eighty-five to 95% of the freshwater fish populations in the Mekong basin have an inundation spawning pattern and undertake lateral migrations from the mainstream and tributaries into the inundation zones to spawn and rear young between July and September. Representatives of this group are some of the cyprinids, such as *Cyclocheilichthys enoplos* (Soldier river barb or Chhkok) and *Cirrhinus microlepis* (Small mud carp or Prul/Kralang). Late access to the floodplain or blockage of migration routes will have an impact on the standing stocks of these migrating species.

Apart from fish, the wetland areas support a high diversity of other aquatic animals including vertebrates - reptiles, birds, mammals and amphibians, and invertebrates, such as insects, crustaceans and mollusks, all of which depend upon maintenance of aquatic ecosystems and could be effected if the total area of the wetlands reduces or when wetlands dry out completely during part of the year.

Desiccation could also lead to loss of seasonally-inundated riparian forest along the banks of lakes and rivers and the loss of some of the over 200 species of plants that are known to occur in these forests. The woody species of this forest are bearing fruits and seeds at the time of inundation, providing food for the 34 species of fruit-eating fish of the Lower Mekong Basin. Delay of the flooding could imply that the fruit is already fallen and decomposed before the fish arrive.

Loss of wetland areas could also effect the number and diversity of waterbirds, particularly cormorants, Oriental Darter, Spot-billed Pelican, Greater and Lesser Adjutants, Milky Stork, Woolly-necked Stork *Ciconia episcopus*, Black-necked Stork *Ephippiorhynchus asiaticus*, Painted Stork, The Globally Endangered White-shouldered Ibis *Plegadis davisoni,* Glossy Ibis *P. falcinellus*, Black-headed Ibis *Threskiornis melanocephalus*, White-winged Duck, Pallas's Fish Eagle *Haliaeetus leucoryphus,* Grey-headed Fish Eagle, the Globally Vulnerable Masked Finfoot *Heliopais personata*, and the Globally Near-threatened Sarus Crane *Grus antigone*.

Late inundation of the seasonally inundated grasslands might reduce the feeding areas of a number of birds, including the Sarus Crane, White-shouldered Ibis and Greater and Lesser Adjutants. They are also of crucial importance for the Globally Endangered Bengal Florican *Houbaropsis bengalensis*.

Mitigation:

Allow sufficient flooding to safeguard silt and water supply to the wetlands.

6.4.4 Reduced possibilities for navigation/transportation by boat

No negative impacts expected, on the contrary, extension of the canal system will greatly improve the possibilities for transportation by boat

6.4.5 Change in water availability in the dry season

Flooding in the major part of the area will be delayed with about one month. This implies that at the end of the dry season surface water bodies, ponds and lakes, will decrease in size considerably and less water will be available as compared to the present situation.

Mitigation:

An important element of the project is the construction of irrigation canals to provide the area with water during the dry season. As such the project will improve the water availability in the dry season.

6.4.6 Changes in river morphology, salt water intrusion and delta growth

Flood protection measures in the West Bassac area will result in a reduction of the storage of flood waters in these areas until the design level of the protection works has been reached. This reduction of floodplain storage results in the increase of the river discharges downstream of the protected area and, consequently in the increase of the river water levels.

Runs with the ISIS model have been made to simulate the impact of proposed measures in the West Bassac area on the water levels in the downstream area in Vietnam. The results show that the protection works in Cambodia only have a marginal (<0.1m) impact on the early flood levels in Long Xuyen Quadrangle. The impact on the maximum flood levels in the LXQ is negligible. In the Bassac river itself, the maximum flood levels may increase 1-3 decimetres at Chau Doc and about 1 decimetre under early flood conditions.

It may be concluded that river discharges only change to a very limited extent. Consequently impacts on river morphology, salt water intrusion in the delta and delta growth are expected to be negligible as well.

6.5 The positive impacts related to project design, management and operation and maintenance

6.5.1 Increased safety for population living in the flood prone areas

Overall the project will have a positive impact on human safety in the area. People will be better protected against flooding, and the likelihood of loss of life will decrease considerably.

6.5.2 Reduced sanitation and public health problems in the flood season

Overall the project will have a positive impact on human health situation in the area. The food situation in the area will probably improve, since rice production, will increase considerably. However, this may partly be off-set by a decrease of the amount of fish available in the flood season. Reduced water availability and poor water quality at the end of the (prolonged) flood free period may pose a threat to human health.

From the focal group discussions it became clear that main environmental problem related to flooding is the deterioration of the water quality, mainly in years with a bad flood that is a flood that starts early and lasts long. The water is reported to be stagnant for a long period in such years and to develop a bad smell and color. Since a large proportion (over 30%) of the population is dependent on surface water as a source for domestic use, frequent occurrence of skin diseases, rashes and diarrhoea is reported. During ‘good’ flood years, the water keeps flowing and stays clear, and there are no health problems.

In the Koh Andet District, where the survey was carried out, there are no water treatment facilities and no sewerage systems. Less than 10% of the households have their own toilet/latrine and most of the people defecate in the fields. During a flood these human wastes, together with animal wastes, effect the water quality, as does the decay of flooded plans and crop residues and ‘freshly added’ human and animal wastes.

The overall impact of the project will be a reduction of the number of years with a ‘bad flood’, as such impacts on water quality in the flood season and thus the public health situation will be positive. Reduced flooding will also reduce the risk of pollutant dispersal from flooded garages and workshops and storage facilities of agro chemicals.

6.5.3 Decrease in flood damages to crops, infrastructure and ecosystem

Preliminary flood hazards maps established by the FMMP-C2 based on long time series of flood magnitude records and flood damage curves has shown that flood risk in the West Bassac area is some US$ 3 million per year and agricultural damage account as high as 50% of the total damage for Cambodia, whereas damage to agriculture in Vietnam represents only 3% of the total damage, indicating the precarious agricultural condition in Cambodia, especially in the deep flooded area such as parts of the West Bassac demonstration area.

Flooding not only has an impact on floodplain ecology, also the ecology of the river channel itself and the riparian zone may be effected. Besides, estuarine ecosystems and even coastal marine biota may be influenced. The mechanisms through which these ecosystems are effected may vary from one case to another but generally they are related to either changes in water quality or direct physical disturbance.

The quality of river water may change considerably during a flood. Turbidity levels of the river generally raise sharply as compared to the turbidity in low flow periods. High turbidity is primarily the result of the contribution of sediment rich surface runoff to the flood and erosion of the river bed and banks. However, also an increased growth of algae, induced by increased levels of nutrients, may add to turbidity. High sediment contents may have a negative impact on aquatic organisms: fish gills may clog and decreased penetration of light in the water column results in decreased photosynthesis and lower water temperatures. As a consequence oxygen levels in the water may drop, a phenomenon that may be more serious when exotic plants that are intolerant of extended inundation are flooded, since decay of the organic matter extracts oxygen from the water.

Flooding of rural areas may result in increased levels of pesticides and herbicides and nutrients from fertilizers. This may certainly be the case when storage facilities of these agro-chemicals flood. Animal and human waste, either from open pit latrines or flooded septic tanks, contaminates the flood water with organic material and pathogens. High organic waste levels may result in reduced oxygen levels effecting aquatic life. Pathogen contamination is a threat to human health. Flooding of open solid waste dumps is another source of pollution, depending on the nature of the wastes this may result in increased levels of organic matter, chemical pollutants or microbiological pollutants in the flood water. Esthetical impacts, floating debris, may also result from flooding of dump sites.

Flooding of urban areas entails much higher environmental risks, sewage systems may overflow or break, resulting in contamination with organic matter and pathogens, industrial plants may flood, possibly resulting in the spread of toxic materials. Gas filling stations, garages/workshops etc. may form a source of pollution with hydro-carbons. Open solid waste dumps in or near urban areas are another source of organic, chemical and pathogen pollution, as well as of floating debris.

High nutrient contents, nitrogen and phosphorous, may be limiting to the growth of the native floodplain and riparian plants and may enhance the growth of invasive species. Poor water quality in general may result in fish kills and impact on other aquatic biota.

Impacts related to physical disturbance are often related to forces acting upon biota, for example, destruction of riparian vegetation (stripping) results in a decrease in size and connectivity of habitats and thus in reduced structural complexity of the riparian zone. Loss of the riparian vegetation has a negative impact on the stability of the river banks.

Another form of physical disturbance is the coverage of flora and sometimes fauna with a layer of sediment. This may result in mortality of floodplain plants and fauna. Mortality may also be the result of prolonged inundation.

Yet another form of physical processes inducing impacts is the spread of organisms with the flood water. Exotic species, e.g. floating weeds, can be flushed out of the river into the floodplains and become invasive in floodplain ecosystems over large areas. Flood events also may be important in the release of exotic fish species from outside aquaculture ponds.

From the focal group discussions it became clear that main environmental problem related to flooding is the deterioration of the water quality, mainly in years with a bad flood that is a flood that starts early and lasts long. The water is reported to be stagnant for a long period in such years and to develop a bad smell and colour. Since a large proportion (over 30%) of the population is dependent on surface water as a source for domestic use, frequent occurrence of skin diseases, rashes and diarrhoea is reported. During ‘good’ flood years, the water keeps flowing and stays clear, and there are no health problems.

In the Koh Andet District, where the survey was carried out, there are no water treatment facilities and no sewerage systems. Less than 10% of the households have their own toilet/latrine and most of the people defecate in the fields. During a flood these human wastes, together with animal wastes, effect the water quality, as does the decay of flooded plants and crop residues and ‘freshly added’ human and animal wastes.

No industrial enterprises are located in the District, but there are 4 hard ware shops and 28 garages/repair shops and 83 food processing enterprises. Flooding of the garages/repair shops may result in pollution with hydrocarbons.

Fertiliser and pesticide use in the district is relatively low, even more so in the wet season than in the dry season. The risk of pollution of the flood water with fertilisers /pesticides is therefore assumed to be low.

During prolonged flooding, perennial trees and fruit trees are reported to become damaged.

It will be clear that all these impacts of flooding on ecology and the environment will become less severe, one the project is implemented, since the frequency of bad flood years will decrease considerably.

6.5.4 Opportunities to increase agricultural production

The main objective of the project is to delay early flooding with about one month. Realizing this objective would already imply an increase in agricultural production. It has been estimated as part of the Stage 1 analysis the damages to crops after project implementation would be about half of the present average annual damage to crops, which is estimated at 1.5 million USD. This is equivalent to a prevented loss of about 4,000 ton rice per year.

Of more importance is the fact that implementation of the project will make a second rice crop possible in large parts of the area. Yields of this dry season crop are expected to be higher than the yields of the wet season crop. As a result, a doubling of the rice production in the area could be very well possible after project implementation.

6.5.5 Improvement mobility/better road transportation network

The extension of the canal and embankment network will very much improve the transport possibilities and so the mobility in the project area.

6.5.6 Poverty reduction and improved food security

Overall the project will have a positive impact on poverty reduction and food security. Food (rice) production, and so food security, will increase. This is not necessarily the case for the amount of fish available in the flood season.

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Attachment 1: Checklist of Environmental, Economic and Social Impacts

CHECKLIST OF ENVIRONMENTAL, ECONOMIC AND SOCIAL PARAMETERS FOR FLOOD RISK MANAGEMENT PROJECTS										
Environmental Concerns			Related Impacts		Recommended Feasible Mitigation Measures		No Significant Impact	Significant Impact		
								Small	Moderate	Major
A	Environmental concerns related to project sitting									
				Loss of productive land and/or sources of income. Displacement of households, and/or economic activities. Social/ community disruption.	1	Avoid or minimize by careful design. If not possible, compensate for losses and provide assistance to relocate and/or restore living conditions/livelihoods. Prepare & implement participatory Resettlement Action Plan.			**X**	
				Loss of valued sites. Disruption of social / community rituals. Indirect impacts: Loss of tourism potential. / income.	2	Avoid, minimise or offset activities by careful design and consultation with local communities. Compensate for damage to or displacement of sites, graves, etc.	**X**			
				Loss of biodiversity, rare and endangered species. Loss of forest/swamp / wetland related production functions. Indirect impacts: Increased household expenditures for food, building materials, medicines, etc., that were harvested. Reduced strategies to deal with food shortages. Increased risks of poverty.	3	Avoid or minimize by careful design and consultation with local communities. Compensate and/or offset economic losses through replacement of resources, identification of alternative income sources, etc.			**X**	
	4	Loss of agricultural/aquaculture land	4	Loss of household income from sales and/or work as hired labor (with different impacts for men and women, landless HH). Loss of business revenues and wage employment (commercial agriculture, agro- and fish	4	Consultation with effected communities and HH to identify and implement feasible alternative income sources. Training for new job skills, establish-		**X**		

CHECKLIST OF ENVIRONMENTAL, ECONOMIC AND SOCIAL PARAMETERS FOR FLOOD RISK MANAGEMENT PROJECTS										
Environmental Concerns			Related Impacts		Recommended Feasible Mitigation Measures		No Significant Impact	Significant Impact		
								Small	Moderate	Major
				processing, etc.) Indirect impacts: Increased HH expenditures for food; reduced food security. Distress sales of land and other assets. Increased risk of out-migration to look for work. Increased poverty.		ment of micro-enterprises. Compensation for economic losses.				
	5	Impediment to movements of wildlife,, including obstruction of fish migration paths	5	Impediment of wildlife, reduction in biodiversity and fish stocks Indirect impacts: Loss of income from fishery	5	Careful planning, design, and operation, construction of fish passages		**X**		
	6	Impediment to movements of people (e.g., navigation) and their animals	6	Disruption of economic activities and social movements.	6	Careful planning and design		**X**		
	7	Loss of aesthetic, visual or recreational value of the areas	7	Loss of precious values, economic losses	7	Careful planning and design	**X**			
B	**Environmental concerns related to project implementation and construction activities**									
	1	Soil erosion	1	Water quality impact, loss of productive soil, sedimentation problems Indirect impacts: Reduced drinking water quality; higher agricultural input costs / reduced productivity and incomes.	1	Minimise clearing activities, limit activities to dry season, optimise soil cover and apply soil management techniques to minimise soil loss		**X**		
	2	Increased turbidity	2	Impact on flora and fauna, sedimentation problems. Indirect impacts: Reduced drinking water quality (stream/rivers & water supply systems)	2	Apply fencing, use silt screens in sensitive areas		**X**		
	3	Sedimentation of river beds	3	Loss of habitat, problems with	3	Remove deposited sediments	**X**			

CHECKLIST OF ENVIRONMENTAL, ECONOMIC AND SOCIAL PARAMETERS FOR FLOOD RISK MANAGEMENT PROJECTS										
Environmental Concerns			Related Impacts		Recommended Feasible Mitigation Measures		No Significant Impact	Significant Impact		
								Small	Moderate	Major
				navigation Indirect impacts: Temporary restrictions on navigation/accessibility for economic activities, social networks						
	4	Loss of habitats	4	Loss of biodiversity, reduction in fish stocks Indirect impacts: Reduced incomes from fishing/fish processing (differential impacts on men and women); reduced food security	4	Careful planning and design of disposal sites		X		
	5	Loss of soil fertility	5	Loss of agricultural production Indirect impacts: Loss of income (potential differential impacts on men and women); reduced food security; increased poverty risks	5	Careful planning and design of soil movement, set aside fertile topsoil. Supply fertilisers	X			
	6	Worker accidents	6	Health impacts, economic losses due to injuries, loss of life; increased public health care costs	6	Implement safe working practices through training, site supervision and provision of safety equipment			X	
	7	Traffic accidents	7	Health impacts, economic losses due to injuries, loss of life; increased public health care costs	7	Identify alternative routes, limit & post driving speeds. Provide community awareness programs.		X		
	8	Disruption of access to productive land (e.g., farm land, fishing areas, forests) and/or to community facilities/services	8	Temporary loss of income from farming, fishing and processing activities (differential impacts on men and women); reduced food security. Temporary disruption of local businesses, business income, wage income for employees.	8	Identify alternative routes to facilitate continued access; limit disruptions to periods of low economic activity, e.g. outside harvest periods Compensate for loss of business income and employee wages		X		

CHECKLIST OF ENVIRONMENTAL, ECONOMIC AND SOCIAL PARAMETERS FOR FLOOD RISK MANAGEMENT PROJECTS										
Environmental Concerns			Related Impacts		Recommended Feasible Mitigation Measures		No Significant Impact	Significant Impact		
								Small	Moderate	Major
				Temporary disruption of community services (e.g., access to clinics)		Assist to temporarily relocate community facilities/services to maintain access.				
	9	Obstruction to navigation	9	Temporary restricted access and/or extra costs for transport related to economic activities; restricted fishing activities Temporary restricted and/or more expensive transport to support social network.	9	Identify alternative routes, limit to periods of low economic activity, e.g. outside main fishing periods	**X**			
	10	Disruption of utility services	10	Temporary disruption and/or extra costs for local businesses, economic activities (e.g., agricultural processing) and community facilities/services (e.g., health clinics)	10	Careful planning and quick repair in case of accidents. Provide community awareness and information programs.	**X**			
	11	Noise/vibration/air pollution	11	Temporary reduced living conditions (dust, noice); temporary increased risks of health impacts (e.g., due to dust)	11	Limit working hours in populated areas, use proper and well maintained equipment		**X**		
	12	Soil /water contamination related to leakage and inappropriate storage of fuels and other chemicals, dumping of construction wastes or improper sanitation	12	Loss of flora and fauna. Increased risks of health problems, e.g., skin rashes/eye infections from contaminated surface water, cuts, abrasions, etc., from unsafe dumping of construction wastes. Contamination of drinking water sources with related health risks (diarrhoea, dysentery).	12	Containment of fuels stored on site and off-site refuelling., follow appropriate procedures, proper maintenance of equipment, collection and proper handling of construction wastes, provision of proper sanitation facilities		**X**		
	13	Groundwater pollution related to leakage and inappropriate storage of	13	Contamination of drinking water	13	Containment of fuels stored on site		**X**		

CHECKLIST OF ENVIRONMENTAL, ECONOMIC AND SOCIAL PARAMETERS FOR FLOOD RISK MANAGEMENT PROJECTS										
Environmental Concerns			Related Impacts		Recommended Feasible Mitigation Measures		No Significant Impact	Significant Impact		
								Small	Moderate	Major
		fuels and other chemicals, dumping of construction wastes or improper sanitation		sources with related health risks (diarrhoea, dysentery).		and off-site refuelling., follow appropriate procedures, proper maintenance of equipment, collection and proper handling of construction wastes, provision of proper sanitation facilities				
	14	Influx of non-local workers for project construction and other people attracted by economic opportunities	14	Social tensions due to competition for paid work and other economic opportunities related to FRM project, inappropriate behaviour of non-local people, lack of knowledge/respect for local customs	14	Contractor contracts specify (i) employment of local workers, (ii) local purchase of goods and services, (iii) awareness programs about local customs and appropriate behavior		X		
	15	Health impacts/disease hazards due to influx of workers and other non-local people	15	Increased risks of sexually transmitted diseases including HIV/AIDS; increased risks of other infectious diseases	15	Contractor contracts specify robust HIV/AIDS awareness and prevention program targeting workers and people in surrounding communities. Plan proper domestic and human waste management. Support local health clinics to meet new demands		X		
	16	Pressure on water supply and sanitation due to influx of workers	16	Increased health risks related to poor drinking water and sanitation conditions (diarrhoea, dysentery) Possible loss of business income due to lack of adequate water supply/sanitation	16	Appropriate planning and design of water supply and sanitation facilities, including supplementary resources. Plan proper domestic and human waste management;. Support for local health clinics to meet new demands		X		

CHECKLIST OF ENVIRONMENTAL, ECONOMIC AND SOCIAL PARAMETERS FOR FLOOD RISK MANAGEMENT PROJECTS										
Environmental Concerns			Related Impacts		Recommended Feasible Mitigation Measures		No Significant Impact	Significant Impact		
								Small	Moderate	Major
	17	Employment opportunities for local people	17	Poverty reduction, improved welfare	17	Contractor contracts specify (i) employment of local workers, (ii) local purchase of goods and services, (iii) awareness programs about local customs and appropriate behavior			**X**	
C	Environmental concerns related to project design, management, operation and maintenance									
		Project induced changes in hydrology/hydraulics: the timing, extent, depth and duration of flooding, resulting in:								
	1	Loss of agricultural production (loss of flood benefits)		Increased input costs and reduced yields; loss of business revenue and household incomes; possible loss of jobs for agricultural workers Indirect impacts: reduced food security, increased incidence of distress sales of land and other assets, increased incidence of out-migration to lood for work, increased poverty risks		Allow sufficient flooding to safeguard silt and water supply and prevent pests Strengthen and provide agricultural extension and other technical assistance to enhance agricultural productivity, diversify crop production, expand livestock raising, etc. (includig services targeting men's and women's agricultural activities)			**X**	
	2	Loss of capture fisheries production (loss of flood benefits)		Loss of household incomes Indirect impacts: reduced food security, increased poverty risks		Allow sufficient flooding to maintain fish migration patterns and fish spawning, breeding, nursing and feeding areas				**X**
	3	Loss of wetland area/productivity (loss of flood benefits)		Ecological impacts; loss of biodiversity. Economic losses (loss of income, extra expenditures), decreased food		Allow sufficient flooding to safeguard silt and water supply				**X**

CHECKLIST OF ENVIRONMENTAL, ECONOMIC AND SOCIAL PARAMETERS FOR FLOOD RISK MANAGEMENT PROJECTS								
Environmental Concerns			Related Impacts	Recommended Feasible Mitigation Measures	No Significant Impact	Significant Impact		
						Small	Moderate	Major
			security, increased poverty risks					
	4	Hindrance to navigation/ transport by boat (loss of flood benefits)	Economic losses due to reduced accessibility and/or higher transport costs for businesses, marketing and other economic activities. Social impacts due to reduced mobility / travel to maintain social networks	Allow water levels high enough to make navigation possible		X		
	5	Reduced water availability in the dry season (loss of flood benefits)	Economic losses due to lack of water for agriculture, other economic activities. Social and health impacts due to lack of safe drinking water; decreased food security, increased poverty	Allow sufficient flooding to safeguard replenishment of groundwater and surface water storage			X	
	6	Changes in river morphology	Economic losses due to hindrance to navigation, impacts on sand mining industry	Dredging, construction of bank protection works	X			
	7	Changes in salt water intrusion	Damage to agriculture and aquaculture; loss of business revenue and household incomes; potential loss of jobs for agricultural/aquaculture workers	Maintain minimum flows	X			
	8	Decline in delta growth	Reduction in economic opportunities due to decline in land accretion	Maintain minimum (sediment carrying) flows	X			
D	**Positive impacts related to project design, management, operation and maintenance**							
	1	Increased safety	Improved well-being, reduced poverty					X
	2	Improved sanitation and health situation	Improved well-being, reduced poverty					X
	3	Decreased flood damage	Improved well-being, reduced poverty, improved food security					X

CHECKLIST OF ENVIRONMENTAL, ECONOMIC AND SOCIAL PARAMETERS FOR FLOOD RISK MANAGEMENT PROJECTS									
Environmental Concerns			Related Impacts		Recommended Feasible Mitigation Measures	No Significant Impact	Significant Impact		
							Small	Moderate	Major
	4	Increased agricultural production		Improved well-being, reduced poverty, improved food security					X
	5	Improved mobility/transportation network		Social and economic welfare, reduced poverty				X	
	6	Poverty reduction/improved food security		Improved well-being					X

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