CAMBODIA NATIONAL MEKONG COMMITTEE

Basin Development Plan Programme

Sub-Area Analysis and Development
Delta Sub-Area
SA – 10C

December 2004
Phnom Penh, Cambodia

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Acronyms and Abbreviations

ADB	:	Asian Development Bank
AIT	:	Asian Institute of Technology
ASEAN	:	Association of South East Asian Nations
BDP	:	Basin Development Plan (MRC)
CARDI	:	Cambodian Agricultural Research and Development Institute
CARE	:	CARE International in Cambodia
CARERE	:	Cambodia Area Rehabilitation and Regeneration Project
CDC	:	Council for the Development of Cambodia
CIAP	:	The Cambodia- IRRI-Australia Project
CNMC	:	Cambodia National Mekong Committee
DANIDA	:	Danish International Development Agency
DFW	:	Department of Forestry and Wildlife
DIT	:	Department of Industrial Technology
DOF	:	Department of Fisheries
DWSS	:	Department of Water Supply and Sanitation
EIA	:	Environmental Impact Assessment
EU	:	European Union
FAO	:	Food and Agriculture Organization
FWUCs	:	Farmer Water User Communities
GDP	:	Gross Domestic Product
GEF	:	Global Environmental Facility
GMS	:	The Greater Mekong Sub-region
HRD	:	Human Resource Development
HRM	:	Human Resource Management
I & D	:	Irrigation and Drainage
IDE	:	International Development Enterprises
IDRC	:	International Development Research Canada
IFReDI	:	Inland Fisheries Research and Development Institute
ILO	:	International Labor Organization
IOs	:	International Organizations
IRRI	:	International Rice Research Institute
IUCN	:	International Union for the Conservation of Nature
JICA	:	Japan International Cooperation Agency
Lao PDR	:	Lao People’s Democratic Republic
LMB	:	Lower Mekong Basin
MAFF	:	Ministry of Agriculture, Forestry and Fisheries
MIME	:	Ministry of Industry, Mines and Energy
MLMUPC	:	Ministry of Land Management, Urban Planning and Construction
MOE	:	Ministry of Environment
MOH	:	Ministry of Health
MOP	:	Ministry of Planning
MOT	:	Ministry of Tourism
MOWRAM	:	Ministry of Water Resources and Meteorology

MPWT	:	Ministry of Public Works and Transport
MRC	:	Mekong River Commission
MRCS	:	Mekong River Commission Secretariat
MRD	:	Ministry of Rural Development
MW	:	Mega Watt
NCAC	:	National Committee for Assisting the Community
NCHP	:	National Center for Health Promotion
NGOs	:	Non-Governmental Organizations
NRM	:	Natural Resources Management
NTFP	:	Non Timber Forest Products
PADEK	:	Partnership for Development in Kampuchea
PCD	:	Pollution Control Department
PDAFF	:	Provincial Department of Agriculture, Forestry and Fisheries
PDE	:	Provincial Department of Environment
PDIME	:	Provincial Department of Industry, Mines and Energy
PDT	:	Provincial Department of Tourism
PDWRAM	:	Provincial Department of Water Resources and Meteorology
PIPs	:	Public Investment Programs
PRASAC	:	Programme de Rehabilitation et d'Appui au Secteur Agricole du Cambodge
PRDC	:	Provincial Rural Development Committee
RGC	:	Royal Government of Cambodia
RWS	:	Rural Water Supply
SAWG	:	Sub-Area Working Group
SEDP I	:	First Five-Year Socio-Economic Development Plan
SEDP II	:	Second Five-Year Socio-Economic Development Plan
SEDRP	:	Socio-Economic Development Requirements and Proposals
SIDA	:	Swedish International Development Agency
SMEs	:	Small and Medium Enterprises
UN	:	United Nations
UNDP	:	United Nations Development Programme
UNICEF	:	United Nations Children's Fund
UNTAC	:	United Nations Transitional Authority in Cambodia
USAID	:	The United States Agency for International Development
WB	:	World Bank
WHO	:	World Health Organization
WRAM	:	Water Resources and Meteorology
WRM	:	Water Resources Management
WSM	:	Watershed Management
WUG	:	Water User Groups
WUP	:	Water Utilization Programme
WWF	:	World Wide Fund for Nature

Foreword

In partnership with the Mekong River Commission Secretariat (MRCS) Basin-wide initiative, the Cambodia National Mekong Committee (CNMC) is leading the effort in Cambodia on the Basin Development Plan (BDP) Programme. This programme seeks to develop both an *initial plan* as a guiding framework for basin-wide water and water-related resources development in a sustainable manner and a *sustainable planning process*.

It gives me great pleasure to introduce the Delta Sub-area Analysis and Development. This has been undertaken by the Sub-Area Working Groups of the Delta Sub-area, with a focus on eight sectors: *irrigated agriculture*; *watershed management*; *fisheries*; *hydropower*; *navigation, transport, river works*; *tourism and recreation*; *water supplies*; and *flood control and management* sub-sectors and four cross cutting themes: *socio-economies, human resource development, environment and participation.*.

The Sub-area Analysis and Development set the context for Basin-wide development strategies and formulation of cross-border sector development, the two first-stages of the five stages of the BDP planning process by defining the macro-issues at the country level. Amongst ten Sub-areas in the Lower Mekong Basin, five Sub-areas have been delineated in the Cambodian part of the Mekong River Basin. The report serves as a vital resource of reference for CNMC-BDP and MRCS-BDP Teams and Local Consultants in developing Basin wide management strategies and cross-border sector development.

This report is the second Cambodia Sub-area Report after the Tonle Sap Sub-area Report to be produced within the framework of the BDP planning process. Members of Sub-area Working Groups sourced from the concerned Provincial Departments in the Delta Sub-area, with overall guidance and coordination by the CNMC Secretariat. This approach ensured full ownership of each stage of production.

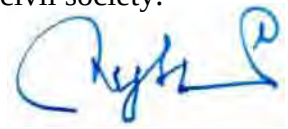
On behalf of the Chairman of the Cambodia National Mekong Committee (CNMC), I would like to extend my sincere thanks and profound gratitude to all leadership of the CNMC and Line Ministries for their persistent guidance and constructive recommendations and especially for full participation and support from Ministries concerned that gave rise to the success of this report.

Again, on behalf of the Chairman of the CNMC, I wish to thank and acknowledge the assistance of several local authorities within the Delta Sub-area and Delta Sub-Area Working Groups for their full collaboration and support, dedicated endeavors and enthusiasm that contributed greatly to the successful completion of this report.

I would also like to acknowledge and appreciate the efforts of the CNMCS-BDP Team, particularly *Mr. Watt Botkosal*, National BDP Coordinator and *Dr. An Pich Hatda*, National Specialist for their outstanding coordination, technical assistance and facilitation to the Delta Sub-area Working Group members in bringing out this valuable report.

Particular thanks are due to *Mr. Jeffrey Himel*, Short-term International Consultant to the CNMC for his technical assistance, valuable advice and guidance, to *Dr. Pichara Leang*, Support Local Consultant, and to *Mr. Yem Dararath*, Local Consolidating Editorial Consultant for his inputs to the successful finalization of the Delta Sub-area report. *Mr. Dararath YEM*, National Consultant, and,

I am of the belief that this report will become an important resource of document for development of Sub-area and Basin-wide management strategies, which will contribute ultimately to the development for the LMB. Additionally, I hope that this report will serve as Sub-area cross-sectoral references, which can be further used by any interested groups such as government agency, private sector and civil society.



Sin Niny
Vice Chairman of CNMC
Chairman of BDP Sub-Committee

Phnom Penh
December 2004

PART I

Executive Summary

CHAPTER 1: INTRODUCTION

1.1. Background

The Basin Development Plan (BDP) formulation started on 1st October 2001, as one of the three core programmes of the Mekong River Commission (MRC). The formulation involves the National Mekong Committees (NMCs) in each country, national planning and line agencies, and a wide range of other government, private sector and civil society actors. The work is supervised by the MRC Joint Committee and by National Sub-Committees.

The BDP seeks to develop both an *initial plan* as a framework for the basin-wide water and water-related resources development and a sustainable *planning process* in the four member states of the MRC, including Cambodia, Lao PDR, Thailand and Vietnam.

The BDP team in each country has been initiating studies and analysis in a number of Sub-areas making up the Lower Mekong Basin (LMB). This is the first stage of the BDP development process. Five Sub-areas have been delineated in the Cambodian part of the Mekong Basin (MB).

In Cambodia, the Cambodia National Mekong Committee (CNMC) is leading the efforts on the BDP. The overall process involves reviewing, collecting, analyzing relevant data and information and conducting forums at regional, national and provincial levels. Background study is being finalized at national level through sub/sectoral reviews by Technical Officials from line agencies involved.

The work in the Sub-areas is being divided into two components as following:

- **Component A: Review and Analysis**
  - Review of provincial and sector plans/data and insight collection; and
  - Analysis.
- **Component B: Scenario and Strategy Development**
  - Scenario development; and
  - Strategy development.

The Sub-area review and analysis will provide the basis for formulating the scenarios and strategies for water use in the sub-areas and subsequently in the region. It will therefore be essential that *the level of detail be tailored and targeted to facilitate macro thinking and analysis and the promotion of suitable oversight and vision in the subsequent stages*. The outcomes for each sub-area analysis will therefore be:

- Summary of present conditions and context for development;
- Summary of water availability, ecological demands and present water uses;

- Identification of opportunities, concerns and risks; and
- Formulation of development objectives.

1.2. Process of Sub-Area Study and Analysis

Sub-area studies involve:

- ***Preliminary review:*** Review of available information at regional, national and sub-area levels to provide overviews of keys issues, review of development plans/programmes (either already prepared or under preparation) and preparation of GIS and related information from MRC data sets;
- ***Identification of key issues and sectors;***
- ***Information collection****:* Identify information gaps, collate or collect required information (particularly from national and provincial agencies);
- ***Analysis:*** Identify sub-area development objectives, formulate scenarios and strategies and identify potential projects/programmes; and
- ***Public consultation:*** Include local knowledge and opinions.

It is proposed that the process of sub-area study and analysis should be orientated around two forums. The process can then be broken down into a number of steps as follows:

- ***Review:*** Mainly through activities coordinated at MRC Secretariat;
- ***Forum 1:*** A multi-stakeholder forum within the sub-area to consider sub-area information, identify key issues and information gaps, and prepare a work plan for further study and analysis;
- ***Implementation of work plan:*** Mainly collection of further information as defined at Forum 1; and
- ***Forum 2:*** A second multi-stakeholder forum to agree on sub-area development objectives, scenarios and strategies and to identify potential projects/programmes.

1.3. Development of Scenarios and Strategies

According to the BDP, scenarios are not about predicting the future; rather they are about perceiving the future in the present. A scenario is a hypothetical combination of events and physical conditions, describing a possible future situation. Development scenarios will be formulated in order to illustrate anticipated limits to the long-term basin development, as well as the significance of external driving forces and uncertainties about applied key assumptions.

Development strategies will be drafted as a tool for identification and assessment of development projects and programmes. Development and management strategies will be

formulated for each sub-area and each relevant water related sector. This will be done in a close dialogue with the stakeholders, and drawing on related MRC programmes.

The strategies need to be justified in terms of: (i) socio-economic implications; (ii) environmental implications; (iii) human resources development implications; and (iv) national priorities, strategies and plans.

1.4. Importance of the Report

The report might also be useful for governmental institutions, external support agencies, project evaluation teams, investors and technical specialists in helping them understand:

- The current condition of various development sectors at provincial levels around the Delta Sub-area;
- The trends within and future plans of the sectors within the Delta Sub-area;
- The linkages between one sector and another;
- The cross-cutting themes: socio-economic, environment, public participation and human resources aspects; and
- The Trans-boundary issues within the Delta Sub-area.

CHAPTER 2: OVERVIEW OF THE DELTA SUB-AREA

2.1. Baseline Description

The Delta sub-area of Cambodia, which covers an area of approximately 24,370.45 km^2, is located in the Southeast part of Cambodia. The Delta consists of eight provinces and one city, namely Takeo, Kandal, Kampong Speu, Prey Veng, Kampong Cham, Kampot, Koh Kong, and Phnom Penh city. Svay Rieng province has recently been included in the Sub-area Delta due to it is affected by flood from the Mekong River.

According to the MRC, the area is essentially flat with occasional older rock outcrops projecting above the floodplain. The floodplain shows evidence of numerous recent changes in river course, and, because of the flat terrain, large areas are submerged during the high flow period.

Delta population growth rate has been gradually increasing since 1981. Statistics by Ministry of Planning has shown that the Delta population increased from 4,930,320 in 1998 to 5,198,981 in 2002 implying an annual average growth rate of 1.33 percent. The population growth rate in Kampong Cham and Kandal province reaches higher than those in the other provinces.

Most people living in the Delta sub-area rely on agriculture for their livelihoods. Paddy rice is a main crop for most farmers. The paddy rice is grown twice a year (wet and dry season). A variety of vegetables and food crops is also grown, particularly in dry season. These kinds of crops are grown not only for their consumption but also for cash income.

Besides agriculture, trade is an important source of household income for people in the Delta, especially for those who are living in cities and towns. It has been indicated that about 48 percent of people living in the Phnom Penh city depends on trade and business.

Many sectors rely on water resources for their development. Theses sectors include irrigated agriculture, fisheries, water supply and sanitation, inland navigation, hydropower and tourism. The current trend is shortage of water supply in many areas, including domestic purposes. Serious competition for agricultural water use is intensifying between fast growing population and irrigation development. Pollution of both surface and underground water is extensively provoked by industrialization pressure, urbanization and absence of repressive law against environment destructors.

The rainy season occurs from May to October, which is the monsoon season. Annual mean of rainfall ranges from around 1,280 mm/year to 1,520 mm/year. There are two peak mean rainfalls: one takes place in October which is near the end of rainy season; and the other generally occurs in May. The driest month is February.

The average rainfall in Eastern part of the Sub-area Delta is high compared with other locations, ranging from 1,173.4 – 1,866.6 mm/year. The Southwest zone of the Sub-area generally has the smallest annual rainfall, ranging from 936.8 – 1,816.5 mm/year.

An estimate has indicated that the water availability per capita is approximately 6,220m³/year. The water demand for the Delta Sub-area has not been known due to lack of data and information. Anyway, the water demand per capita for Cambodians is estimated about 12 m³ per year (MRC, 2002i).

2.2. The Agenda for Development

After the July 1998 election, the Government of Cambodia adopted the Triangle Strategy in which the promotion of economic and social development composes the third side of the triangle. One of the numerous and urgent priorities identified was an extensive reform of the administrative system. Administration reform includes decentralization, military demobilization, legal and judiciary, gender equity, public financial management, anti-corruption, and natural resource management.

The long term Vision of the Government is *"to have a socially cohesive, educationally advanced, and cultural vibrant Cambodia without poverty, illiteracy, and disease, which will allow each person to be the best that it is in them to be"*.

The strategic message of the plan is that Economic growth is a prerequisite for poverty reduction and the key to growth is private sector development, which will be achieved largely through sustained improvement in the government environment. Specific strategies for civil service reform including decentralization, military demobilization, legal and judiciary, gender equity, public financial management, anti-corruption, and natural resource management. In pursuing a higher economic growth path Cambodia will be established as a popular ecological and culture tourism destination.

The Government recognizes that achieving national development objectives relies crucially on creation of a more positive and predictable business environment to facilitate the development of the private sector with a special consideration to the development of small and medium-sized enterprises, as the engine of increased investment, higher incomes and more employment.

Physical infrastructure development is another major area in which the RGC plays an important role. The limited coverage and poor condition of existing infrastructure constrain private sector-led development and access to health and education services, especially by the poor.

A numbers of key development issues have been identified, including irrigated agriculture, irrigation, fisheries, navigation, flood control and management, hydropower, watersheds management, tourism, and water supply.

PART II

Sub-Area Study and Analysis (Forum #1)

CHAPTER 3: INTRODUCTION

3.1. General

Literature and studies about the Cambodian Mekong Delta are profuse and richly documented. However, few adopted a trans-sectoral approach, emphasizing global trends, potentials-opportunities, constraints and threats. Another deficiency that can be noted is the lack of effort to provide a comprehensive reflection on the cross-cutting issues as well as on the trans-boundary issues by putting into evidence the relationships between the different components. The identification and analysis of the trans-boundary issues is of importance for planning and decision-making of the riparian Governments.

The purpose of this work is to attempt to provide an in-depth analysis of the development plan of the Cambodian Mekong Delta that has been delimited as the Delta Sub-Area 10C in the Basin Development Plan (BDP) of the Lower Mekong Basin.

This analysis emphasizes the challenges and implications of the development of the Delta Sub-area 10C. It mainly calls upon a critical review of existing documents produced by various relevant stakeholders, e.g. the Mekong River Commission (MRC), the Cambodia National Mekong Committee (CNMC) and the Provincial Sectoral Departments.

3.2. Objective

The objective of the Sub-area analysis is to provide the basis for formulating scenarios and strategies for water use in the sub-areas and region.

3.3. Tools and Methodology

3.3.1. Tools

A number of documents have been utilized in this in-depth analysis so that a wide and comprehensive view is made possible:

- The first category of documents reviewed is composed of Provincial Sectoral Department Planning and Reviews of 10 provinces/towns, i.e. Takeo, Kandal, Phnom-Penh, Kampong Speu, Prey Veng, Kampong Cham, Kampot, Koh Kong, Svay Rieng and Kampong Chhnang.
- The second category of materials includes the National Sector Reviews on Irrigation, Agriculture, Fisheries, Hydropower and Tourism Development. It also includes the Delta Sub-Area 10C studies and analysis conducted by a national consultant for CNMC that was released in March 2004.
- The third category encompasses MRC and CNMC materials including the Regional Sector Overviews prepared by the MRC-BDP team[1], the Draft

[1] These include documents BDP-09a and 09b, BDP-10a and BDP-12a, 12b, 12c, 12d, 12e, 12f, 12g, 12h, 12i, 12j and 17 covering agriculture, forestry, macroeconomics, fisheries, tourism, irrigation, watershed

Guidelines on Sub-area analysis (MRC, 2002c). It also includes additional materials compiled in the BDP Archive CD-ROM (MRC, April 2004).

- The fourth category of materials comprises the 2003 State of the Basin Report (MRC, 2003d) and the Social Atlas of the Lower Mekong Basin (Hook, Jacob; Novak, Susan and Johnston, Robyn, 2003, MRC). Additional maps and LandSAT imagery have been extracted from the People and the Environmental Atlas of the Lower Mekong Basin in order to enrich the analysis of spatial relationships and to assist with visualization of resources, environmental and land use, and connections between sub-areas.
- The fifth category includes various independent research publications such as: Poulsen, A.F. et al, 2000. Fish migration and spawning habits in the Mekong Mainstream- a survey using local knowledge. Assessment of Mekong Fisheries: Fish migrations and spawning and the impact of Water Management Project (AMFC), Vientiane.

As the Sub-area analysis will rely heavily on secondary data (derived and summarized from other sources), an important role of the first forum was to assess whether the data adequately reflected the real situation, identify information gaps and agree on a work plan to collect missing and needed information.

3.3.2. Methodology

The in-depth analysis is conducted through three complementary tasks:

- Document review and analysis (see references)
- Stakeholders consultation; and
- Analysis of the outcomes of the Informal Working Group Session in Kampong Cham in 14-15 November 2003 prior to the Forum 1 and the outcomes of the 22-23 January 2004 Forum 1.

3.3.2.1. Documents Review and Analysis

Materials are provided by MRC, CNMC and additional ones from CDRI, IFReDI, ADB, UNDP, and WB. The in-depth analysis relies heavily on secondary data – derived and summarized from other sources.

3.3.2.2. Stakeholders Consultation

The stakeholder consultation was conducted following a guide-question checklist designed by the Consultant, emphasizing critical issues to be addressed, trends, constraints, potential development plans and relevant projects in the Delta sub-area. For this, several key stakeholders - whom we acknowledge for their availability - have been met including:

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management, hydropower, navigation, domestic water and sanitation, industrial water use, flood management and mitigation and water use for agriculture.

- MRC: Dr Mak Solieng, Natural Resources Development Planning, Dr Tue Kell Nielson, Consultant and Mr Thim Ly, Junior Riparian Professional (JRP)
- CNMC: Dr An Pich Hatda, Dep. Director-BDP National Specialist and Mr Watt Botkosal, Dep. Director-Planning Dept. and National BDP Coordinator.
- IFReDI: Mr Lieng Sopha, Dep. Director-AMCF
- MAFF-DoF: Mr Sam Nuov, Deputy Director, Department of Fisheries
- MAFF: Mr Kith Seng, Director of Planning, Statistics and Intern. Coop. Dept.
- Seila Prog- UNOPS: Mr Scott Leiper, Senior Prog. Advisor
- Min. of Public Works & Transport: Mr Va Sim Soriya, Director of Planning Dept.
- Min. of Water Resources and Meteorology: Mr Pech Veasna

3.3.2.3. Analysis of Outputs of the Informal Working Session prior to Forum 2

This work is based on the proceedings of the informal working session prior to the Second Stakeholders' Forum that is further planned in 2004.

Basically, this analysis aims at assessing the level of understanding on the sub-area development planning and the ability of the working group in identifying development objectives and proposing a scenario formulation at the Forum 2.

CHAPTER 4: BASELINE DESCRIPTION

4.1. Geographical Features

4.1.1. *Coverage*

The Cambodian part of the Mekong Delta, which covers an area of approximately 26,420km^2, is located in the Southeast part of the country. It encompasses eight provinces and one city, namely *Takeo, Kandal, Kampong Speu, Prey Veng, Kampong Cham, Kampot, Koh Kong , Svay Rieng, and Phnom Penh City*. It is to be noted that parts of the provinces of Prey Veng and Svay Rieng have recently been included in the Delta Sub-area according to the MRC's letter No.0518 dated 21 May 2003 as proposed by the BDP Sub-committee (3rd February 2003).

The below maps show the updated Cambodia geographical coverage of the Delta Sub-area in terms of provinces and districts, due to its effects by the Mekong River floods.

In terms of district coverage, the Cambodian part of the Delta Sub-area (SA -10C) encompasses partly or entirely more than 70 districts, including those located in the provinces of Prey Veng and Svay Rieng that have been incorporated in May 2003 as shown in the above map.

Table 1: Numbers of Districts and Areas within the Delta Sub-Area

Province	No. of Districts(*) within the Delta Sub-area	Area (Km^2) within the Delta Sub-area(**)
Takeo	10	3,491
Kandal	11	3,152
Phnom Penh	03	256
Kampong Speu	08	5,764
Prey Veng	12	4,708
Kampong Cham	13	4,912
Kampot	06	1,948
Koh Kong	No data	No data
Svay Rieng	05	2,027
Kampong Chhnang	02	162
Total	**More than 70**	**More than 26,421**

Note: (*) Partly or entirely
(**) Source: MRC "*Districts in Cambodian Sub-areas-Using new boundaries (2003) and BDP Sub-areas as of January 2004* "

The total area of the Delta Sub-area 10C represents approximately 15% of the total area of Cambodia.

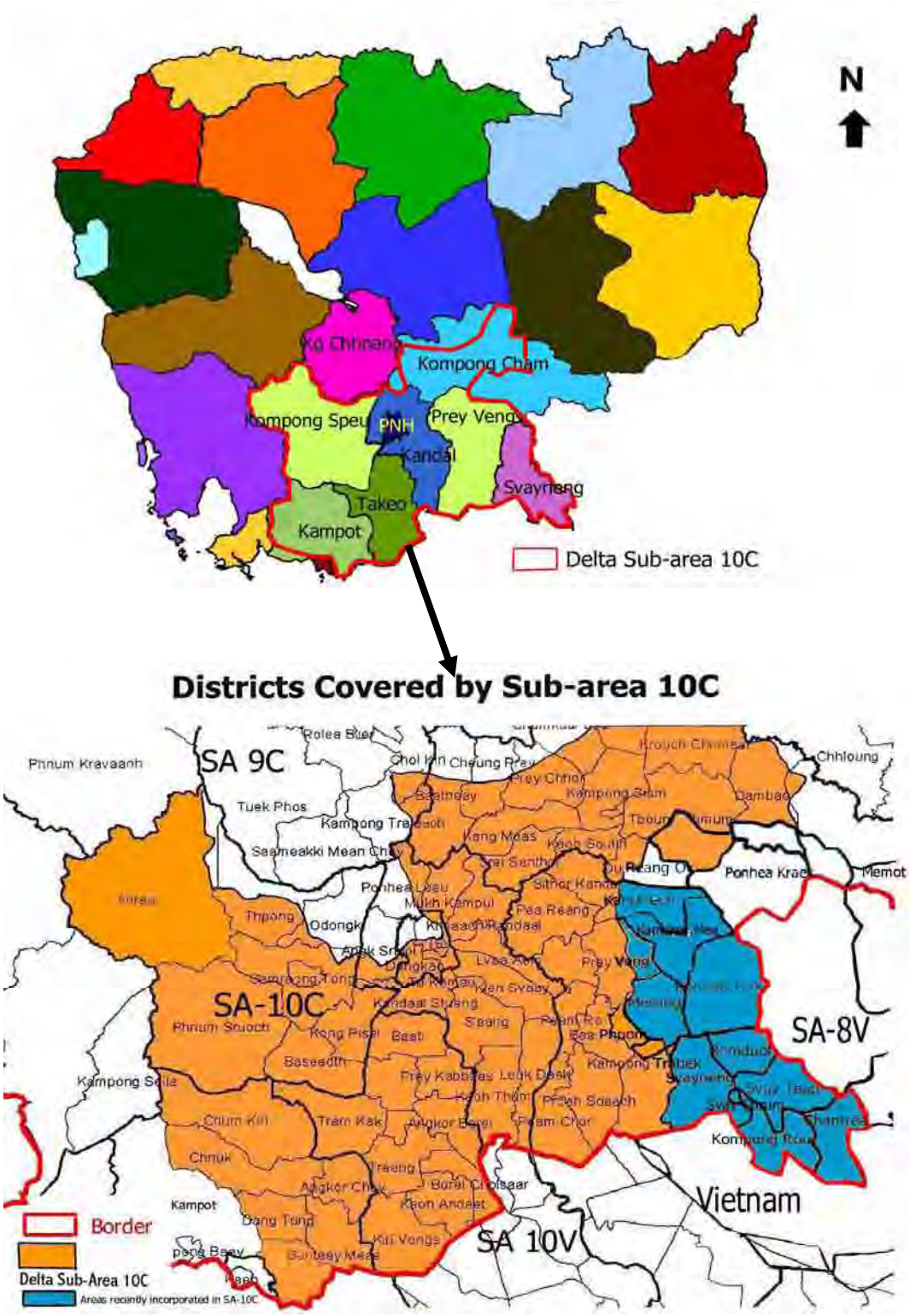
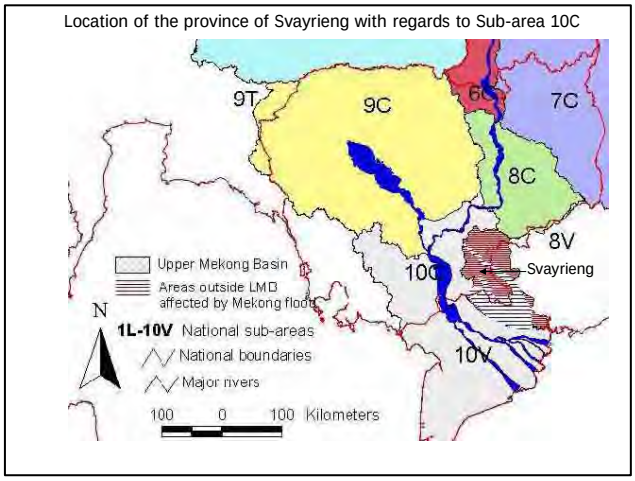
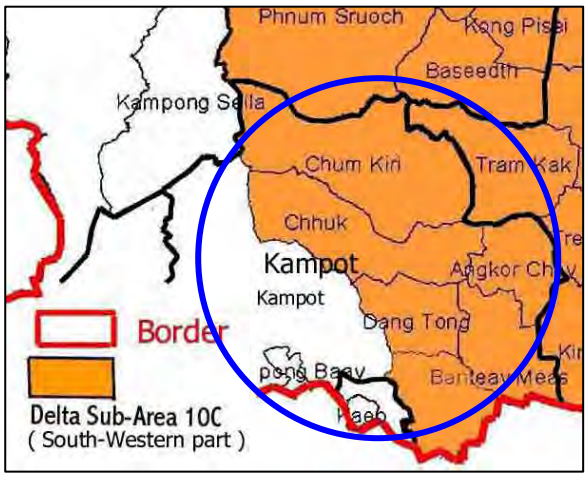


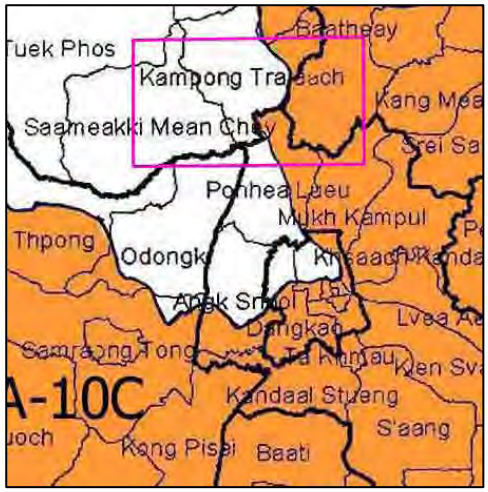
Figure 1: Provinces covered by the Sub-area 10C

Analysis

- The delineation of Sub-area 10C by the MRC-BDP is not consistent and needs to be revised. A number of problems with the current zoning of the area have been identified as follows:
  - Parts of Prey Veng and Svay Rieng provinces should be included within Sub-area 10C as per the Orientation Workshop results from February 2003 and confirmed in the MRC's letter No.0518 dated 21st May 2003.
  - The province and district boundaries are not accurately drawn or described, for example Kampong Trach in Kampot Province is described as "Kampong Tralaach" which is in Kampong Chhnang Province. The areas and proportions of the districts and provinces within Sub-area 10C are not accurate and must be corrected.

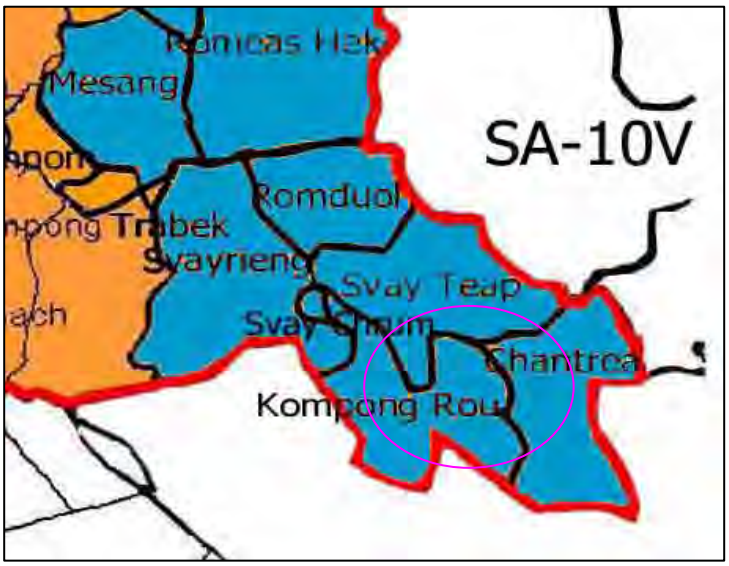






- As a result, it is difficult to determine accurate data and statistics for the Sub-area. The Sub-area must be better defined and checked by MRC-BDP in order for the report to be finalized.

- Another example of this un-consistency is that the district of Chantrea (Svay Rieng) is not mentioned on the BDP's list despite that this area actually composes the province of Svay Rieng (see above map).



- The major implication of this imprecise and arbitrary geographical delimitation is the extreme difficulty to decide whether such or data is relevant to the sub-area. For instance, population data, surface of cultivated crops, ratio, etc.

4.1.2. *Elevation*

The Mekong lowlands and plain of the Tonle Sap Lake are flat rice-growing areas at elevations below 50 m, much of which is prone to inundation in the annual wet-season floods. The river enters the sea through the Mekong Delta, a low-lying area (mostly below 10 m) which supports intensive rice cultivation.

With the exception of the Northwestern part of Kampong Speu province where there are areas with elevation between 100-200 m above sea level, the vast majority of the Delta Sub-area is located between 0 and 100 meters above sea level, thus forming the lowest part of the Lower Mekong Basin. The implication of this low elevation is that this area experiences serious flooding problems, impacting on the population's livelihood and activities.

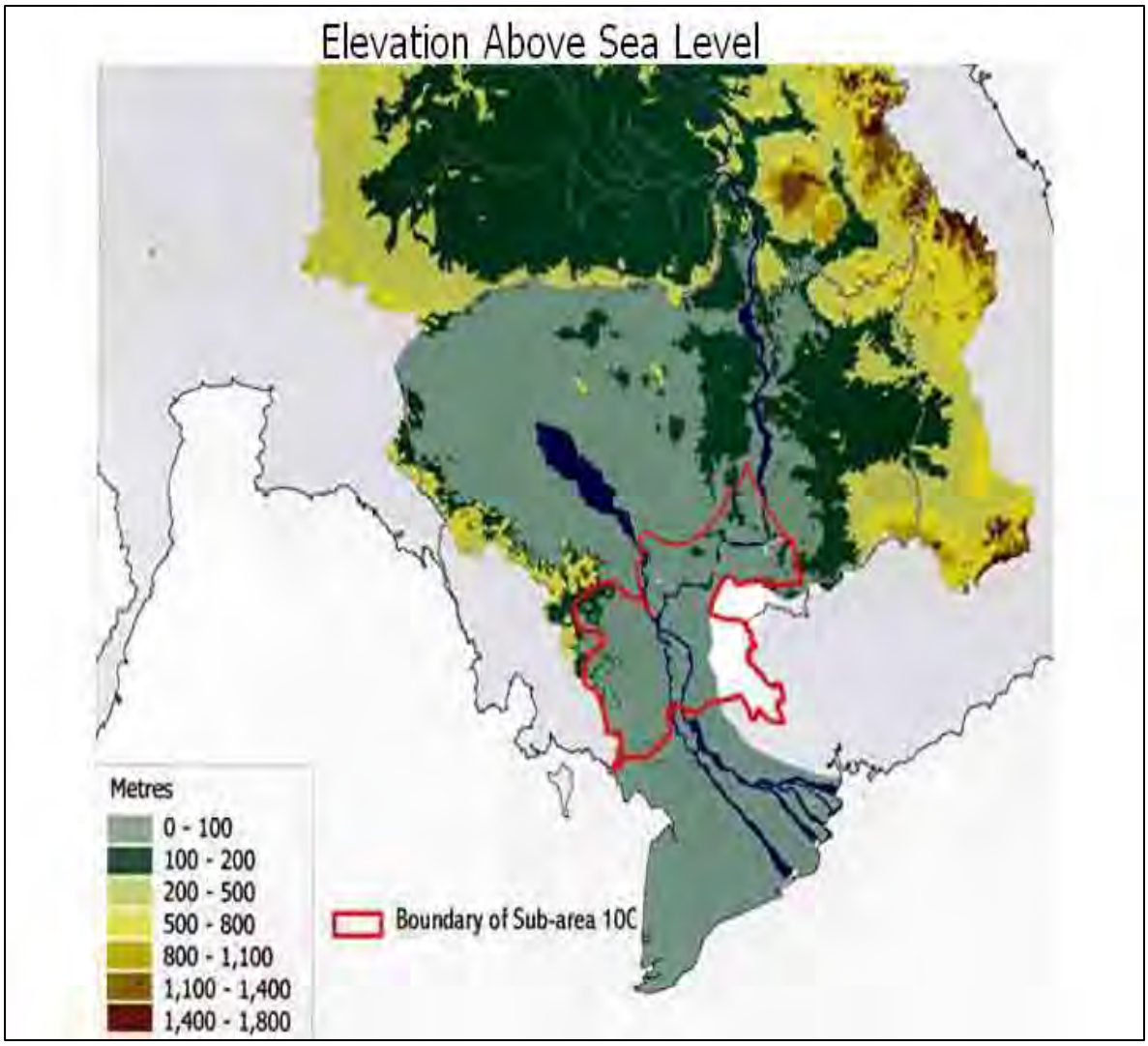


Figure 2: Elevation above Sea Level

4.1.3. *Soil*

According to FAO-UNESCO soil classification, Fluvisols cover a large area of the Mekong Delta. In the Delta area, soil characteristics are influenced by cumulative alluvial deposits, and seasonal water logging and fluctuating groundwater tables (Gleysols/Fluvisols/Vertisols). Acid-sulphate Fluvisols cover some 1.6 million ha in the Mekong Delta area of which a third are very acid and not suitable for agriculture (MRC/UNEP, 1997). There is a need to quantify how much of this area is within the Delta Sub-area as opposed to 10V Sub-area. Specific soil data relevant to the Delta Sub-area 10C are incomplete, e.g. the whole province of Svay Rieng.

There is a lot of controversy between agronomists and soil specialists on the suitability for paddy classification by MRC/UNEP. For instance, some areas that have been classified as not suitable are intensively used for rice cultivation with the support of irrigation and fertilization. On the other hand, some areas that have been identified as

very suitable contain some exceptional pockets where rice cultivation is poorly productive. One might better discuss the "*potential suitability for paddy*" to overcome this controversy.

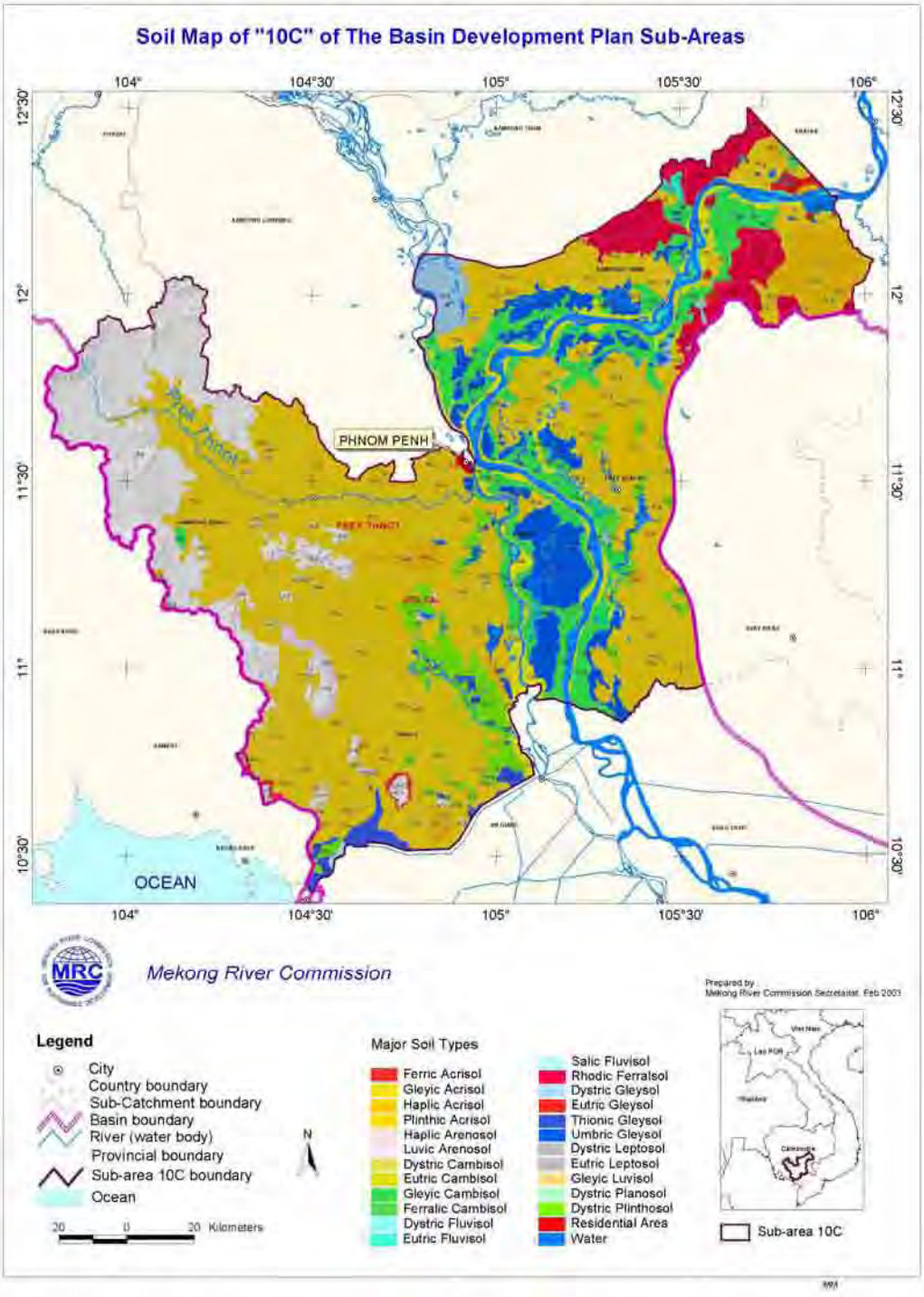


Figure 3: Soil Map of the Delta Sub-area

4.1.4. *Land Cover*

The vast majority of the Delta Sub-area is occupied by agricultural activities (40%). Forests including flooded forests cover about one third of the surface of the Sub-area. In addition to this, wetlands and woodlands within the sub-area can also be found but their surface area is not known. For this, there should be contact with the Geography Department of the Ministry of Land Management, Urban Planning and Construction, so that information on land use as well as various administrative and other data sets can be gathered. Statistics from MRC on land use give some additional indications.

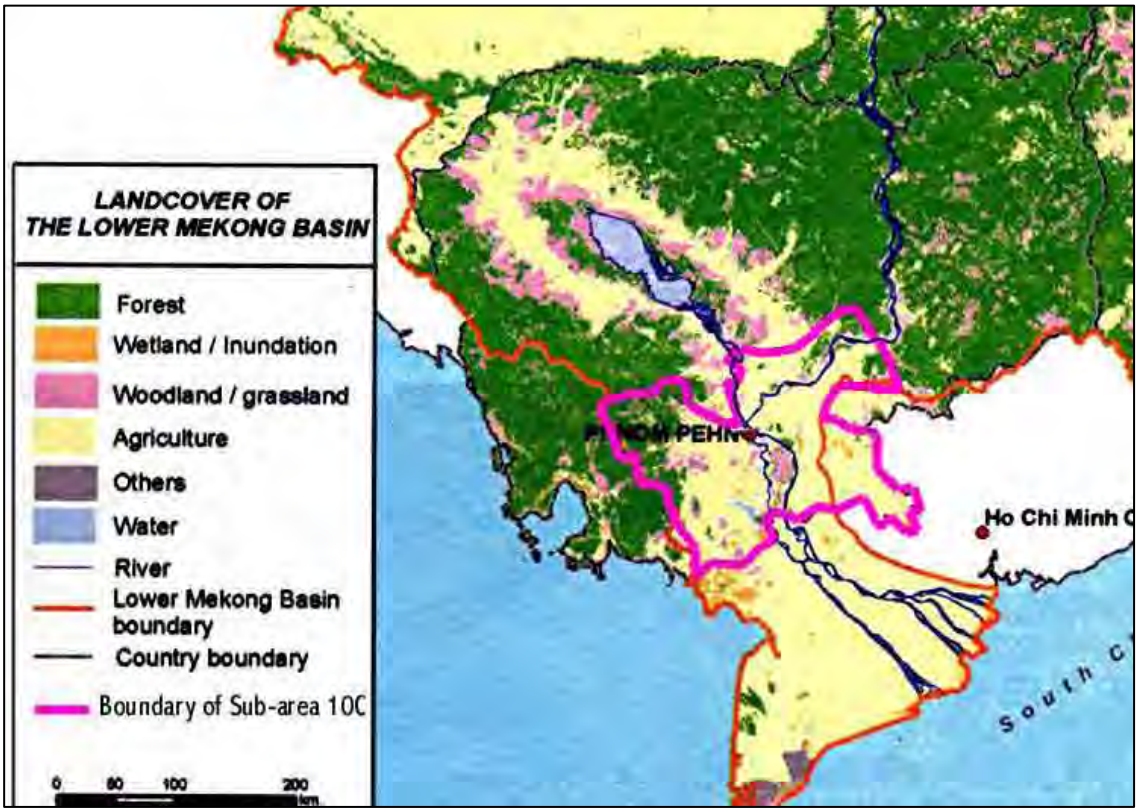


Figure 4: Land Cover of the Delta Sub-area

4.1.5. Land Use

According to 2002 figures, the Delta Sub-area 10C is predominantly devoted to human activities, namely agriculture, with about 40% of the surface covered (9,594 Km^2). Forests represent about 30% of the area of which 5% is occupied by flooded forests (1,147 Km^2). Flooded forests comprise 16% of the total forests area.

With the degradation of forests during the two past years under population pressure and economic development, change certainly occurs in the above proportion. Unfortunately, no consistent and accurate data is available to allow comparison.

If one compares the present situation to the situation in 1996-1997, land use has changed a lot in Cambodia: Agricultural areas have decreased from 13,969 Km^2 in 1996-97 to 9,594 Km^2 in year 2000, namely 31%, while the inundated forest has surprisingly

increased 2.5 times from 464 Km^2 up to 1,147 Km^2. According to the same source, forests (dense forest and open forest) have also increased from 5,377 Km^2 up to 6,077 km2, namely +13%.

Table 2: Land Use within the Delta Sub-area

Land Use	2002	
	Percentage	Estimate, Km^2
Agriculture	40	9,594
Forest	25	6,077
Flooded forest	5	1,147
Urban area	8	2,003
Others	22	5,550
Total	**100**	**24,371**

Source: MRC, 2002.

This is very likely the result of inaccurate source of information or poor data sets. There is a need to identify where the data sets came from to determine if they are credible. It surely cannot be that agriculture area has decreased and flooded forest areas have increased. More likely is that the classification method used changed the results.

Table 3: Land Use within the Delta Sub-area

Land Use	Area, Km^2	Percentage
Dense forest	2,928	11.6
Open forest	2,449	9.7
Re-growth	635	2.5
Inundated forest	464	1.8
Woodland	2,828	11.2
Grassland	422	1.7
Crop mosaic	154	0.6
Agricultural	13,969	55.2
Wetland / water	1,267	5.0
Other	191	0.8
Total	**25,307**	**100.0**

Source: MRC, 1999.

4.1.6. Floods

The Mekong river discharges more than 432 billion m3 of water yearly on average through Kratie with an average of 13,700 m3/s. Flood season occurs from June to November, with 80% of the annual flow volume. The maximum discharge at Kratie is 66,700 m^3/s, while the minimum discharge is 1,250 m3/s (CNMC, 2003).

About one third of the Delta Sub-area 10C is affected by long duration of flooding in 2000. Parts of Kandal and Prey Veng provinces were the most severely affected with 144-163 days of duration, while the western part of the province of Takeo suffered from an average number of 21-40 days of flood duration. Thus, large areas of the Sub-area are affected both positively (through the replenishment of soil fertility and influx of fish) and

negatively (through damage to infrastructure and crops) by flooding as a result of the topographical features of the Mekong Delta.

Figure 5: Map of Major Flood over the Delta Sub-area

Mekong River Commission

Extent of Flooding in Cambodia and the Vietnam Delta in 2000

Figure 6: Extent of Flooding in Cambodia and Vietnam Delta in 2000

In year 2000, about two third of the surface of the Delta Sub-area 10C is covered by flooding, thus affecting the livelihood of the population, e.g. rice cultivation, housing, animal raising, trading, etc.. This population already suffers from poverty and lack of food security, making them more and more vulnerable. Provinces bordered with the Mekong River are the most sensitive areas affected by flooding. According to the report by working groups of the Delta, the number of people affected by flooding in year 2000 was about 1,696,621 persons, equivalent to 13% of Cambodia's population (estimation based on 13 million total populations). Approximately 45,428 meters of flood protected dams was also completely destroyed. Physical infrastructure has been damaged by flooding as shown in the below table.

Table 4: Physical infrastructure damaged by flooding in 2000

Infrastructure	
House	18,099
Irrigated area (ha)	61,590
Irrigation System (m)	33,307
High way and road (km)	152,738
Bridge (No.)	226
Sewer, site (No.)	99
Dam (m)	55,283
Airport	0

Flood mitigation and management is a sound response to this problem. The RGC established the National Committee for Disaster Management (NCDM) in 1994 aiming at:

- Achieving an effective RGC inter-ministerial coordination system in disaster management, including prevention, mitigation, preparedness, response and rehabilitation, and
- Reducing, as a consequence, the impact of disasters on Cambodian communities.

A number of initiatives and organizations have worked with the NCDM to address the need to manage disasters more effectively and efficiently. These include DIPECHO (brief description) the MRC's Flood Mitigation and Management Programme, the USAID Flood Preparedness Project (insert more correct name and description for this) and others. The efforts to date have not fully addressed the needs and more comprehensive assistance is required to build capacity for disaster preparedness and management within the NCDM and other responsible line agencies.

Analysis:

- Flood management and mitigation requires well-trained and managed human resources and strong political willingness to put forward the national interest and provide humanitarian aid which, in the context of Cambodia, are often limited by lack of coordination between different lines agencies and their of capacity both in terms of human resources, equipment and infrastructure.

- The commonly held belief that flooding is increasing could be related to increasing temperatures from global climate change raising sea levels. Other human activities also can increase flooding such as deforestation in the upper watersheds, land degradation, changes in flood storage capacity, reclamation of floodplains and wetlands, rapid expansion of urban settlements and infrastructure and man-made modifications to river channels (MRC, 2003d).
- There are number of human activities that cause flooding in the Mekong Delta and those activities have been identified: deforestation, land degradation, changes in flood storage capacity, reclamation of floodplains and wetland, rapid expansion of urban settlements and infrastructure and man-made modification to river channels (MRC, 2003d). If technologically there are various tools to facilitate flood mitigation, national policies and regulations to curve down illegal and destructive activities on the environment are enforced with laxity due to weak local governance skills and ethics.

4.2. Population and Livelihoods

4.2.1. A Crowded Area with a Fast Population Growth

The Delta Sub-area 10C has always been the most populated area of the country with an average density of 202 pers./km2 in 1998. This average population density of the Delta SA increased to 213 pers./km2 in 2002, equivalent to +5.44% population increase in four year-period. This demographic feature has serious implication on socio-economic constraints of the Delta, including water demand, water consumption poor access to education, food security, pressure on the local natural resources, reproduction health challenge, etc.

Table 5: Land Area, Population and Density by Province (Delta SA-10C) in 1998

Province	1998	Density, prs/ Km^2	Land Area, Km^2
Takeo	790,168	222	3,562.70
Kandal	935,363	302	3,093.22
Phnom Penh	859,831	2,666	322.50
Kampong Speu	497,072	85	5,824.11
Prey Veng	614,927	194	3,173.95
Kampong Cham	1,013,670	164	6,173.12
Kampot	216,646	108	1,997.93
Koh Kong	2,642	12	223.20
Svay Rieng	478,252	161	2,966.00
Delta	**4,930,320**	**202**	**24,370.72**

Source: BDP Provincial Reports 2002-2003, excerpt from CNMC-BDP Sub-Area Studies and Analysis of Delta Sub-area 10C, March 2004.

Table 6: Land Area, Population and Density by Province (Delta SA-10C) in 2002

Province	2002	Density, prs/ Km^2	Land Area, Km^2
Takeo	848,953	238	3,562.70
Kandal	1,001,426	324	3,093.22
Phnom Penh	869,687	2,697	322.50
Kampong Speu	552,369	95	5,824.11
Prey Veng	680,199	214	3,173.95
Kampong Cham	1,016,155	165	6,173.12
Kampot	227,648	114	1,997.93
Koh Kong	2,544	11	223.20
Svay Rieng	529,340	178	2,966.00
Delta	**5,198,981**	**213**	**24,370.72**

Source: BDP Provincial Reports 2002-2003, excerpt from CNMC-BDP Sub-Area Studies and Analysis of Delta Sub-area 10C, March 2004.

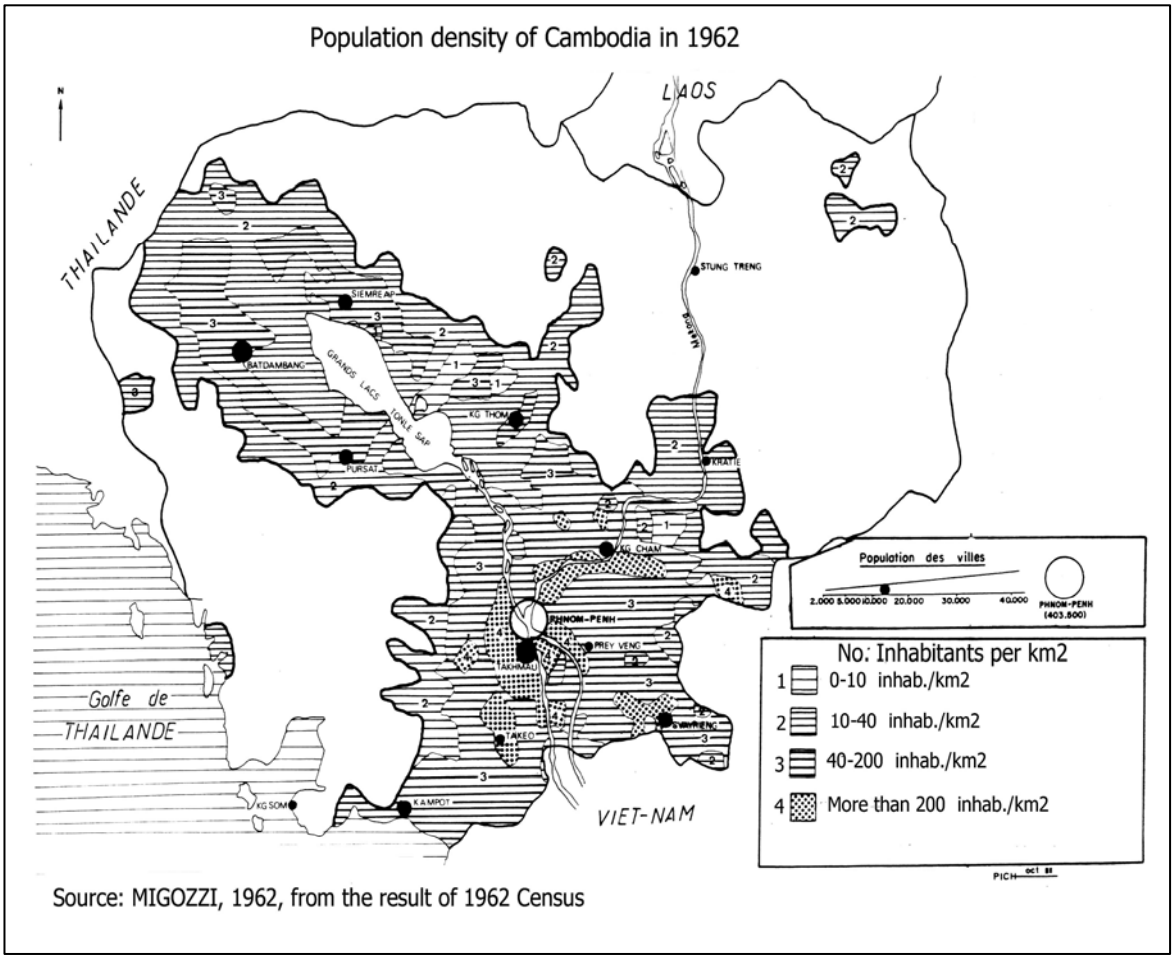
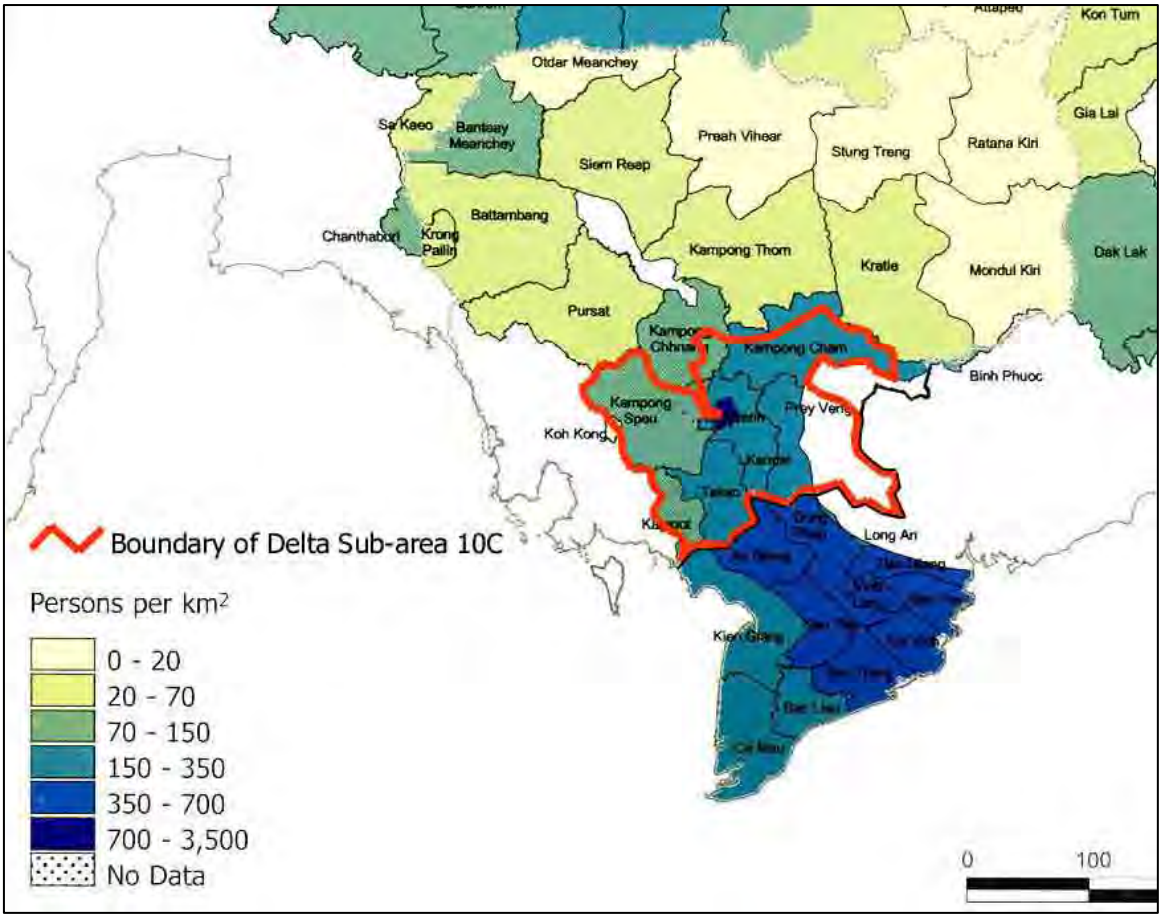


Figure 7: Population Density of Cambodia in 1962

In 1962, some pockets of the Delta area are densely populated, e.g. the Chaktomuk region around Phnom-Penh, around Takeo town, Svay Rieng Town and Southern Kampong Cham province.



Source: Social Atlas of the LMB, MRC-2003.

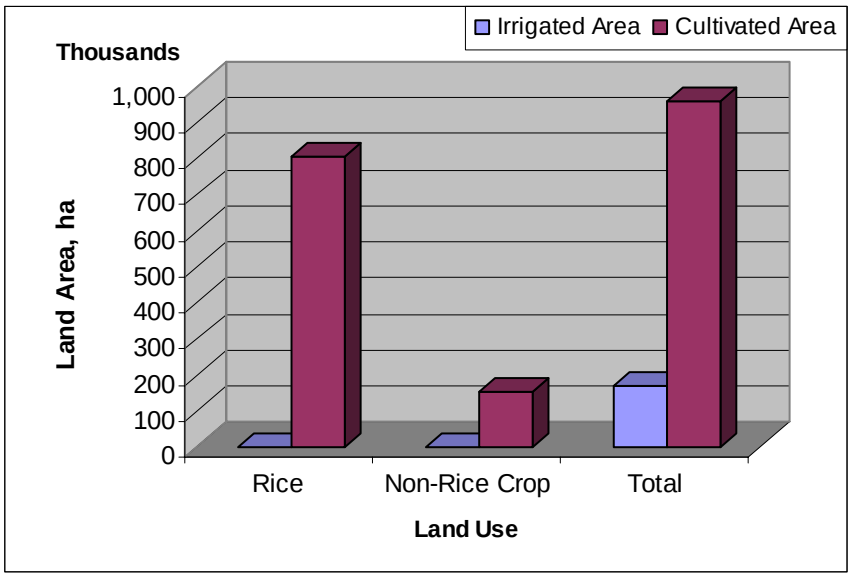
Figure 8: Population Density of Cambodia in 1998

In 1998, five provinces covered by the Sub-area 10C were densely populated with 150-350 persons per km^2: Takeo, Kandal, Prey Veng, Svay Rieng and Kampong Cham. The capital city, Phnom-Penh, has a density of 2,666 persons/km^2. Kampong Speu and Kampot provinces account 70-150 persons per km^2. These figures are quite high and very different from the northern and eastern provinces of Cambodia where average density is not higher than 20-70 persons per km^2.

In 2002, the Delta Sub-area had a population of 5,198,980 persons equivalent to 40% of the country's inhabitants. While this data is only an estimate because it does not take into account the population balance, it does raise questions about food availability, the way food is produced to sustain such a large population and the impact on the exploitation of natural resources to respond to this purpose.

4.2.2. Agriculture

According to 2002 data on land use, agriculture occupies 40% of the 10C Delta Sub-area. The majority of cultivated land is devoted to rain-fed rice farming. Irrigated area remains small due to the lack of irrigation infrastructure. Paddy rice is the main crop that benefits the most from irrigation. Even though accurate and updated data is not available on irrigated rice cultivation, fragmented information gathered from the provincial reports provides a basis for analysis.



Source: BDP Provincial Reports, 2002-2003

Figure 9: Proportion of Irrigated Area compared to Cultivated Area in the Delta SA

Irrigated area represents only 11% of the total cultivated area in the Delta Sub-area 10C. The total cultivated area mainly consists of rice crop (84%) while non-rice crops account for less than 16%.

Table 7: Land Area, Population and Density by Province (Delta SA-10C) in 2002

Province	Paddy Rice (ha)		Total (ha)	%
	Dry	Wet		
Takeo	54,000.00	186,000.00	240,000.00	24%
Kandal	5,678.49	76,557.39	82,235.88	8%
Phnom Penh	764.54	5,835.10	6,599.64	1%
Kampong Speu	90,387.00	913	91,300.00	9%
Prey Veng	39,000.00	154,700.00	193,700.00	20%
Kampong Cham	25,200.00	107,100.00	132,300.00	13%
Kampot	1,373.50	58,630.00	60,003.50	6%
Koh Kong	-	-	155.83	0%
Svay Rieng	10,376.00	169,500.00	179,876.00	18%
Total	**226,779.53**	**759,235.49**	**986,170.85**	**100%**
%	**23%**	**77%**	**100%**	

Source: BDP Provincial Reports, 2002-2003.

In the provinces comprising the Delta SA, wet season paddy rice (77%) is the predominant crop compared to dry season paddy rice (23%), in term of the total cultivated area. The provinces of Takeo, Prey Veng and Svay Rieng are the top three provinces in terms of area cultivated with 24%, 20% and 18% of the total area respectively. Paradoxically, these three provinces are the most affected by flooding every year in the Delta.

Besides paddy rice, other crops are also grown in the Delta, as shown in the below table. The total land area devoted to other crops is about 151,750 ha.

As opposed to rice cultivation, secondary crops are as much grown in the dry season (54%) as in the wet season (46%) with the support of irrigation. In the wet season, some of the secondary crops grown are consumed by the household (maize, cassava, and sweet potato with 38% of cultivated area) but most crops are grown for the market (62%). In the dry season, because of the labor intensive and higher cost constraints of irrigation, only 5.5% of the cultivated secondary cropping area is grown for household consumption. As food security is a major issue, the cropping during the wet season is most important therefore increasing irrigation during the wet season should be a priority.

Table 8: Area cultivated for non-rice crops by season within the Delta

Type of Crop	Cultivated Area (ha)		Total	Dry Crop, %	Wet Crop, %
	Dry	Wet			
Maize	2,723.73	21,031.10	23,754.83	13%	89%
Cassava	275.28	4,628.02	4,903.30	6%	94%
Sweet Potato	1,429.04	910.05	2,339.09	61%	39%
Vegetable	6,148.45	8,582.37	14,730.82	72%	58%
Mung Bean	986.32	11,634.41	12,620.73	8%	92%
Sesame	1.26	10,467.32	10,468.58	0%	100%
Sugar Cane	878.2	2,126.78	3,004.98	41%	71%
Others	69,411.14	10,517.79	79,928.93	87%	13%
Delta	**81,853.42**	**69,898.00**	**151,751.00**	**54%**	**46%**

Source: BDP Provincial Reports, 2002-2003.

4.2.3. Fisheries

4.2.3.1.An exceptional hydrological system ensuring food and income for a huge population: the Mekong River System

Cambodia's inland natural capture fisheries, based on the Mekong River and its tributaries and floodplains, are among the most productive and species-rich in the world, and have been exploited for centuries. The Mekong River System continues to provide its natural bounty of fish and other aquatic animals because it still contains large areas of

natural habitat, and is relatively unmodified by dams or other industrial activities that would alter its hydrology or water quality. The system's high productivity is based on a complex floodplain system, which is nurtured by the annual wet season monsoon which causes a single large flood lasting for several months between May and November. About 85-90% of the discharge is generated during the wet season; for example, at Kratie the Mekong River's maximum discharge is about 50 times its minimum.

The Tonle Sap Great Lake floodplains in the heart of Cambodia contain the largest continuous areas of natural wetland habitats remaining in the Mekong River System and the Great Lake is the largest permanent freshwater body in Southeast Asia. The Lake is connected to the Mekong by the Tonle Sap River in Phnom-Penh at the junction called Chaktomuk, where the Mekong, Tonle Sap and Bassac Rivers form a "**K**". At Phnom-Penh, the Mekong splits in two branches heading downstream – the main river and the Bassac River, before continuing to Vietnam, where it branches into nine rivers changing its name to Cuu Long, The Nine Dragons before spilling into the South China Sea over 4,000 km from its source in Tibet.

The Tonle Sap Great Lake is famous for the unique role it plays in regulating the Mekong River floodwaters. During the wet season, as the volume and height of the Mekong River rises, the flow down the Tonle Sap River reverses and the floodwaters pour into the Tonle Sap and its floodplains, enriching the flooded forest and releasing a plethora of nutrients and aquatic life to spawn. This is the crucible of the vital fisheries that are of critical importance for the national economy, ensuring livelihoods for more than one third of the country's population. It supports a huge population through its enormous fisheries productivity and water supply, and provides the last refuge for some of Asia's most globally significant biodiversity.

Snake head fish

Trey Krum (left)

Mixed white fishes

The hundreds of fish species which inhabit the river system may be classified as either "black fish" or "white fish". Black fish spend most or all of their lives on the floodplain, where the waters are often stained black as a result of the dissolution of humic materials from plants, whereas white fish spend most of their lives in the main river channels where

waters are turbid as a result of transport of sediment from the highlands upstream. Many of the larger white fishes – including many species of catfish and river carp - spend the dry season in deep pools upstream of the main floodplain areas, for example in the Mekong River and large tributaries in Kratie and Stung Treng provinces.

The Cambodian richness in fish resources has long been recognized, and attempts to earn revenues from them led to the practice of issuing fishery leases, the creation of fishing lots, and the introduction of the first fishery laws of the country (Petillot, 1911). Petillot also reported that in 1910 about 50,000 tons of fish products were exported from Cambodia as dried, salted, or live fish, as well as fish oil and paste. In the 1920s and 1930s Chinese traders were exporting some 25,000 tons of dried fish every year to Indonesia, roughly corresponding to 75,000 tons of fresh fish. Chevey and Le Poulain (1940) estimated total fish production in Cambodia to be 120,000 tons per year. Nowadays, large quantities are being exported to Thailand and Vietnam, mostly in fresh, dried (Trey Nguiet) or smoked form (Trey Chaar), or as fish past (Prahoc) or sauce (Toek Trey).

4.2.3.2. Fishery Resource Decline in Figures

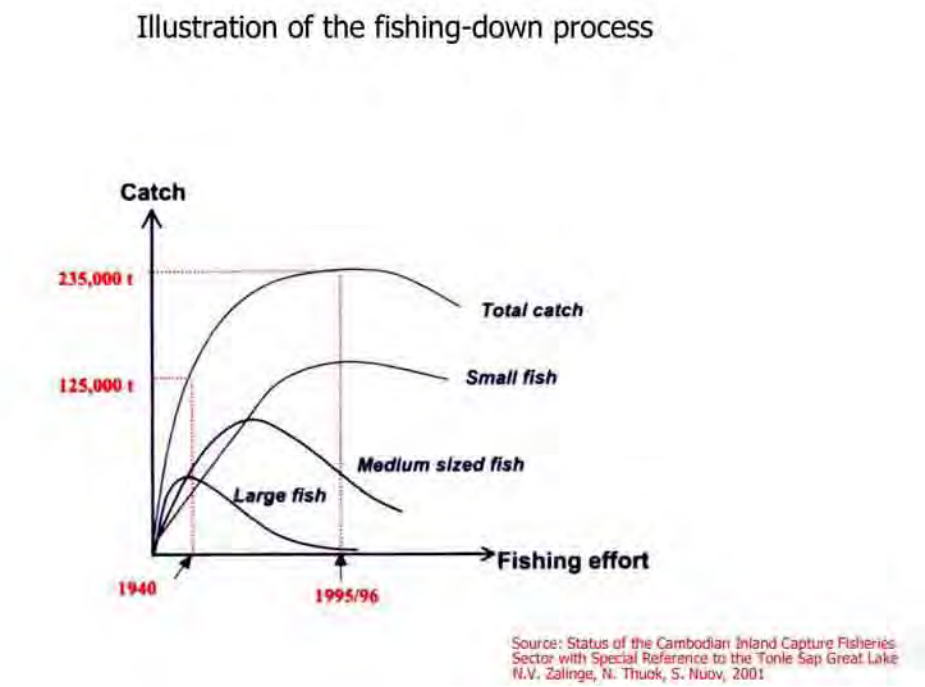


Figure 10: Illustration of the Fishing-Down Process

4.2.3.3. Depredation of the Eco-system supporting fishery resources

Indeed, these figures are useful in terms of illustrating the general trend in terms of land use, however one should not focus on the specific figures given the high degree of inaccuracy in the analysis. Unfortunately, the land cover analyses that have been done to date are not very accurate nor have they been subject to any ground truth or accuracy assessment. Thus, the most that can be said of them is that they are indicative.

Table 9: Areas of Various Types of Land and Water which Support Freshwater

Type of Land and Water Resources in Cambodia	Area (ha) 1985/87	Area (ha) 1992/93
Permanent water (river, lake, pond, etc.)	567,100	411,1000
Flooded forest	795,400	370,700
Flooded secondary forest	28,200	259,800
Flooded grassland	80,800	84,900
Receding and floating rice fields	17,500	29,300
Seasonally flooded crop fields	366,800	529,900
Swamp	12,200	1,400
Total	**1,868,000**	**1,687,100**

One can attempt to analyze these figures in terms of variation between 1987 and 1993. Results are displayed in the table below:

Table 10: Variation of Various Types of Land and Water between 1987 and 1993

Type of land, water resources in Cambodia	Area Variation 1987-1993 (%)	Estimate Average Variation per year (ha)
Permanent water (river, lake, pond etc.)	-27.5	- 26,000
Flooded forest	-53.4	-70,783
Flooded secondary forest	x 9 times	+38,600
Flooded grassland	+5.0	+683
Receding and floating rice fields	+67.5	+1,967
Seasonally flooded crop fields	+44.5	+27,183
Swamp	-88.5	-1,800
Total	**-9.7**	**-30,150**

Every year, between 1987 and 1993, the average area of eco-system supporting freshwater natural capture fish has declined around 10% equivalent to more than 30,000 ha. Flooded forest loss contributes most of the lost area: more than half of its area disappeared between 1985 and 1993, equivalent to approximately 70,000 ha per year. As a result to this destruction, flooded secondary forest is now in these locations. The area of flooded secondary forest has greatly increased in the six years, as a result of the degradation of the flooded forest for agriculture and wood collection. Receding and floating rice fields have also increased proportionally in the same period (around 2,000 ha annually).

Analysis of the Causes of Depredation of the Eco-system

Man's activities are cause of the depredation of the Eco-system supporting fisheries resources, through agriculture and deforestation.

This trend seems to be ineluctable with the population pressure, meaning more food needed and more space for settlements.

Other trans-boundary factors impacting on fisheries resources are the development of water resources projects, particularly dam and weir construction for hydroelectric power, resulting in changes in flows and flow patterns, increased or decreased turbidity and reduction in nutrient levels. Dams also impact on water quality, affecting downstream total suspended solids and nutrient levels, especially total phosphorus and dissolved oxygen levels. Oxygen-consuming decomposition of organic material mainly occurs at the bottom of reservoirs, and the bottom water can become hypoxic or even anoxic if the reservoir is stratified. If oxygen-depleted water is released from a dam, fish kills can occur downstream.

A further factor for consideration is the natural hydrological cycle, the ebb and flow of the waters and nutrients that provides the basis for the rich and vibrant pisciculture of the Mekong River System. The influx of water and nutrients followed by the withdrawal and stagnation of the dry season has created the diverse biota and conditions for the enormous annual explosion of marine life. Removing or altering these cycles would necessarily alter the basic conditions providing the basis for the fisheries that would inevitably threaten the resource.

4.2.4. People's Health

Commonly, life expectancy, health and particularly the health of women are important indicators of the quality of life, and have a significant impact on economic productivity and output. In order to alleviate poverty, a economic policy should aim at allowing benefits of development to reach more than just the small percentage of affluent people.

Diarrhea diseases and dengue fever are two of the major health issues in the Delta Sub-area and both are water-related. Diseases like HIV/AIDS have serious consequences for public health and for the success of development of the country. According to 2003 Social Atlas of the LMB (MRC, 2003c), Cambodia has had the highest prevalence rate of HIV/AIDS in the LMB and the Asia Pacific region as a whole, including 2.8% among the 15-49 year old population. The rates are highest among the populations of Phnom-Penh, and provinces close to Thailand where migration is intensive. Recent data suggest, however, that the situation may be stabilizing. According to the Ministry of Health's Plan for HIV/AIDS and Sexually Transmitted Infections (STI) for 2001-2005, more than 40% of brothel-based commercial sex workers are now HIV+ and only two of the 24 provinces and municipalities have lower than 20 percent prevalence among this group of women (CRD-CHHRA, 2001). Thus, efforts to develop the country must focus on providing alternative employment for the rural and urban poor who form the majority of sex workers while educating the male population on morality, ethics and prevention of transmission of diseases through sex.

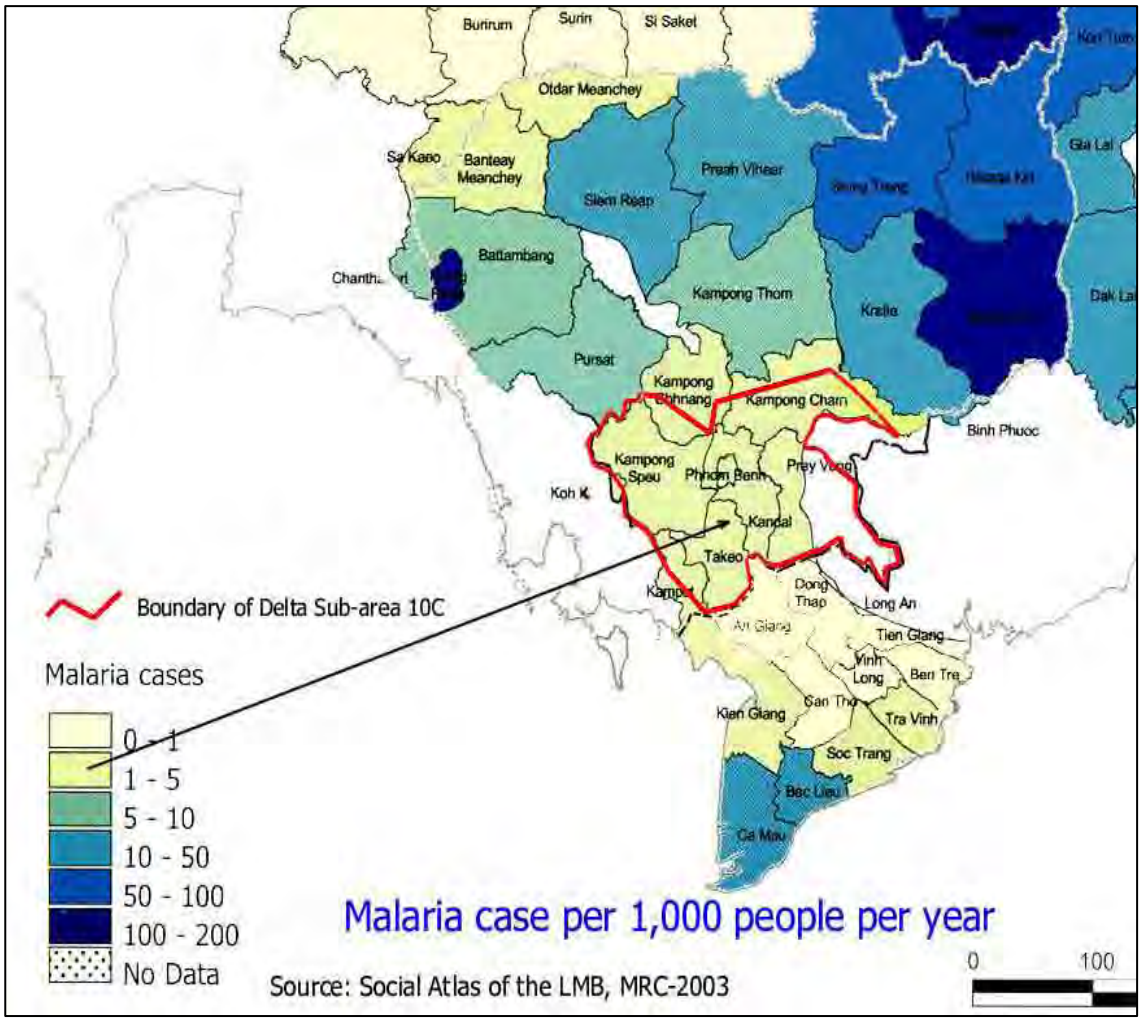


Figure 11: Malaria Case per 1,000 per Year

Regarding **life expectancy** in Cambodia, it is estimated that people are living 5 years longer than they did in 1990 with a national average of 54 years, one of the lowest in the LMB compared to Thailand (65-70 years) and the southern Vietnam Delta (65-70 years) (MRC, 2003c). But this figure hides many of the disparities between the provinces. Unfortunately, the lack of population data by province in Cambodia prevents a deeper analysis that would show the strong relationship between remote and poorest areas, and high prevalence of malaria. However, as shown in the map below, for the Delta Sub-area 10C, malaria is not a major health factor as there are few of the heavily forested areas where malaria breeds in the Sub-area.

Poor access to safe water is a major factor for the health of the population, especially children. The quality and accessibility of water supply varies widely across the Delta Sub-area. In the majority of Cambodian provinces, the proportion of the population with access to safe water is less than 25 percent, and there are large disparities between different areas. In the Delta Sub-area, the provinces of Kampong Speu, Kandal and Prey Veng range from 20 to 60 percent, while Kampot and Takeo provinces have less than 20% of population with access to safe water, as shown on the map below.

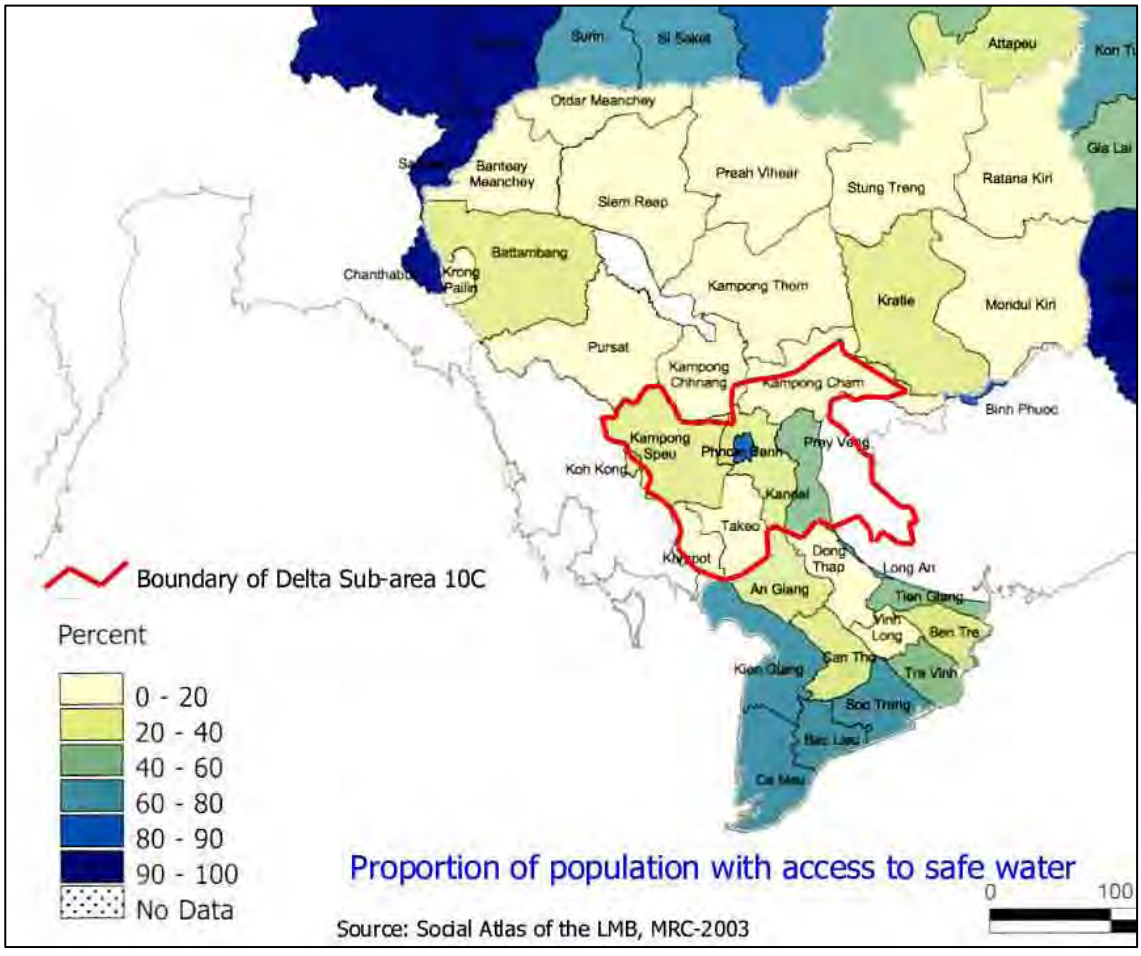


Figure 12: Proportion of Population with Access to Safe Water

Another issue of increasing importance is the increase in use of groundwater for irrigation. In some areas where the intensity of irrigation has grown rapidly, this has resulted in the lowering of the groundwater table, with the consequence of less water for domestic use and for drinking for people and animals. The use of irrigation in this area could also result in agricultural chemical contaminating the shallow perched groundwater table used by many for their source of domestic and drinking water with consequent effects on their health. Another issue that needs more study is the potential for arsenic contamination in the groundwater of the alluvial soils of the region.

A last consideration in the discussion is that water sources are also critical to the health of the livestock of the farmers. Disease rates and animal mortality soar when there are no good quality sources of water nearby. This has consequences for the family economy as the livestock often form the basis for the household accumulation of wealth and are necessary for draught power for agriculture.

4.3. Water and Related Resources

Water resources analysis is a complex work which requires availability of comprehensive, accurate and updated scientific data. In contrast to the neighboring countries of the Lower Mekong Basin, Thailand and Vietnam, Cambodia is a country that crucially lack necessary data. For instance, according to N. Bonheur-2003, hydrological data related to the rivers of the Tonle Sap basin and river are available for only one hydrological year as collected by Carbonnel and Guiscafre (1962-63). With the support of the MRC, there have been some gauging stations installed in some rivers of the basin. In the below paragraph, attempt is made to provide a state of existing data that has been collected from various sources. Only fragmentary information has been gathered, thus possibility for serious and comprehensive analysis is limited.

According the BDP Inception Report (MRC, 2002j), water resources analysis should comprise three main components:

- Availability of water
- Demand of water
- Use of water

4.3.1. Availability of Water

This can be defined as the flow of water into a sub-area from upstream, plus the (surface and groundwater) resources generated by net rainfall in the sub-area, minus the ecological demand within the area at its downstream boundary. The availability changes slowly, from one decade to the next, due to medium-term climate variations, or due to constructions of reservoirs or diversions. The availability can be measured, and/or determined by numerical modeling, with an accuracy that is conditioned by the coverage and quality of the basic hydrological data.

4.3.1.1. Rainfall and Surface Water

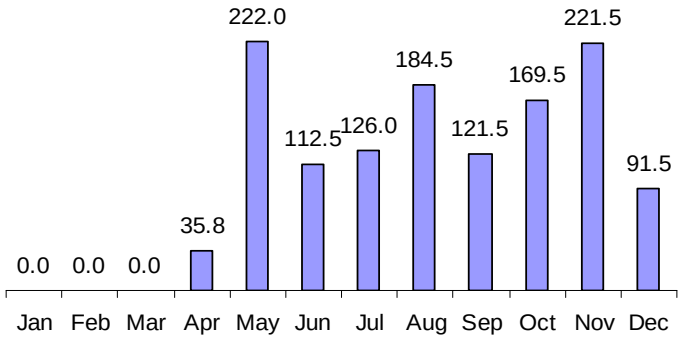
Cambodia has access to substantial surface water resources. On average, the annual inflow from upstream countries is estimated at 410 km^3 and the internally generated flow

90 km^3 per year (MOWRAM, 2003). In Cambodia, the Mekong River flows from the North to the South, over a distance of about 480 km. Its drainage basin covers about 86% of the land area of the country. The Mekong River brings yearly floods of about 475km^3, and before flowing downstream, inundates the lowlands and where the floodwaters enter partially the Great Lake and eventually flow down the Mekong and Bassac Rivers.

A summary of rainfall in different locations within the Delta is presented in the figures below. The rainy season occurs from May to October, which is the monsoon season. Annual mean of rainfall ranges from around 1,280 mm/year to 1,520 mm/year. Figures have shown that there are two peak mean rainfalls: one takes place in October which is near the end of rainy season; and the other generally occurs in May. The driest month is February.

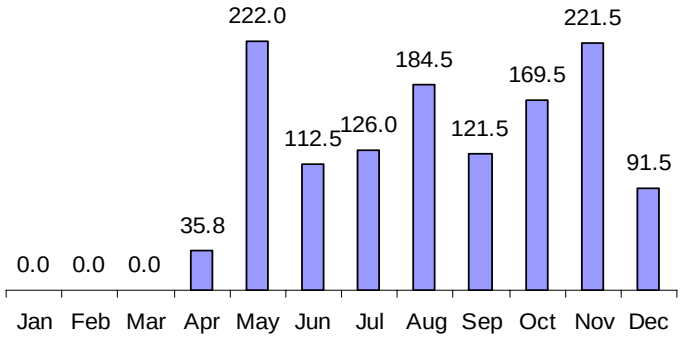
The average rainfall in Eastern part of the Sub-area Delta is high compared with other locations, ranging from 1,173.4 – 1,866.6 mm/year. The Southwest zone of the Sub-area generally has the smallest annual rainfall, ranging from 936.8 – 1,816.5 mm/year.

Rainfall at Phnom Penh City



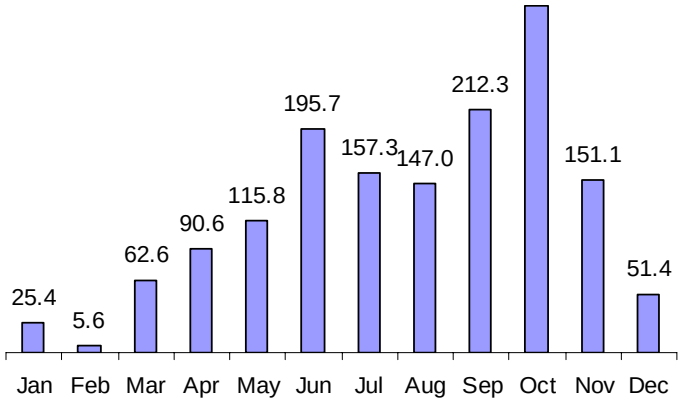
Monthly rainfall in mm/month, 1993-2002
Annual average: 1415 mm/year
Data: MOWRAM and PDWRM

Rainfall at Daun Keo, Takeo Province



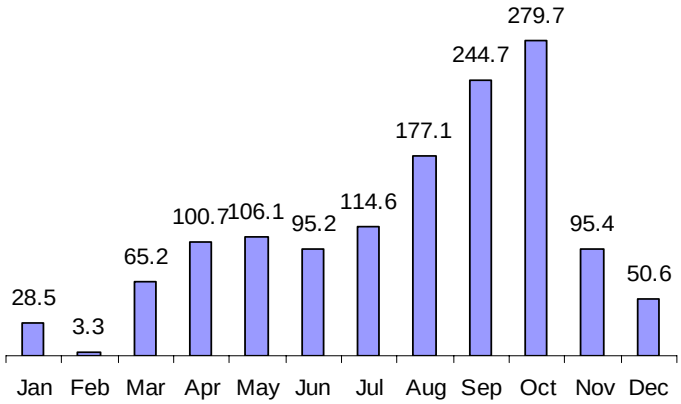
Monthly rainfall in mm/month, 1993-2002
Annual average: 1284.8 mm/year
Data: MOWRAM and PDWRM

Rainfall at Prey Veng



Monthly rainfall in mm/month, 1993-2002
Annual average: 1284.8 mm/year
Data: MOWRAM and PDWRM

Rainfall at Kampong Speu



Monthly rainfall in mm/month, 1993-2002
Annual average: 1360.9 mm/year
Data: MOWRAM and PDWRM

4.3.1.2. River Discharge

The discharge during the dry season period (April – May) in 2003 is shown in the table below. A study by JICA has indicated that the dry season flows in Cambodian floodplains are strongly affected by tidal fluctuation.

Table 11: Effects of Tidal Fluctuation to the Dry Season Flow

Station	Average Flow (m^3/sec)	Range of Fluctuation (m^3/sec)	Fluctuation Rate (percent)
Kampong Cham	1,600	100	6
Chrui Changvar	2,000	1,500	75
Neak Luong	3,000	3,000	100
Monivong Bridge	100	150	150

Source: WUP-JICA, 2004.

4.3.1.3. Groundwater

Groundwater is presently used for two main purposes: domestic and drinking water supply and irrigated agriculture. The groundwater resource within the country has been subject to a few investigations but has not been comprehensively studied to date such that serious analysis or conclusions can be drawn. Most provinces include significant areas where groundwater is used as the main source of domestic water supply. As of 2001, withdrawal of groundwater for domestic and drinking water supply was approximately 2,147 cubic meters per day (CNMC, 2003).

Table 12: Groundwater Withdrawal for Domestic Supply

Station	Pump Capacity (m^3/day)
Prey Veng	227
Kampong Cham	1,500
Svay Rieng	420

Source: CNMC, 2003.

4.3.1.4. Surface Water Extraction for Domestic Water Supply

The volume of domestic water supply for Phnom Penh city is much higher than that of provincial towns. The study by WUP-JICA has shown that the estimated amount of urban water usage is approximately 68 million m^3 per year. The water extraction at the station in Phnom Penh city is illustrated in the below table.

Table 13: Major River Intakes for Domestic Water Supply in Phnom Penh City

Station	River	Water Extraction (m^3/day)
Chrui Changvar	Mekong	65,000
Chang Kampong	Bassac	20,000
Phnom Penh Port	Tonle Sap	100,000

4.3.2. Water Demand and Use

According to Nielsen (2004), the water demand is the amount required for a given purpose. The demand can be based on the *present* or *future*, and it can be *actual* (i.e. related to an available infrastructure) or *potential* (assuming full infrastructural development and no raw water shortage). The *serviceable* (part of the) demand is limited both by infrastructure and raw water availability.

A distinction can be made between *consumptive demand* (for households, industries and agriculture), and *non-consumptive demand* (for fisheries, navigation, and environmental preservation).

4.3.2.1. Domestic Water Use

Domestic water use includes water for normal household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. Domestic water use also includes drinking water and bathing water for livestock – this is an important issue for rural livelihoods

Increase of domestic demand is mainly based on the population growth. Assuming that the annual domestic demand is between 20 m^3 and 100 m^3, a total demand for domestic water is in the range of 286,000m^3 per day and 1.4 million m^3 per day.
It is estimated that the domestic demand increased from 3.1m^3/s to 3.3m^3/s in 2002. The domestic water demand is shown in the below table.

Table 14: Domestic Water Demand

Population		Water Demand, m^3/day	
1998	**2002**	**1998**	**2002**
4,930,320	5,198,981	271,168	285,944

4.3.2.2. Industrial Demand

Water is necessary for all industrial activities, including cooling, processing or manufacturing operations, power generation, cleanup and other sanitary purposes, and fire protection. The quality and quantity of industrial water demand varies significantly by country, industry and particularly uses, ranging from high water quality for the beverage industry to brackish water or treated municipal effluent for cooling purposes.

According to the MRC-BDP Planning, Regional Sector Overview (2002), urban water usage is estimated at about 100 liters per person per day, for a total average annual supply of 36 million m³ for other urban centers in Cambodia. The total water usage represents about 0.01% of the flow in the Mekong River (WUP, 2001).

It is assumed that most Phnom Penh wastewater transported to the Delta will travel via the Bassac River. However, with the distance from Phnom Penh to the Vietnam border (about 110 km), the large amount of dilution from the major river flows and high water temperature (about 29 degrees Celsius) in the Bassac River, the rate of decomposition of any organic matter discharged from Phnom Penh will be rapidly broken down and organic types of pollution are not likely to reach the border of Vietnam (Hart, 2001).

Most manufacturing and warehouses in Phnom Penh are located along the embankment of the Tonle Sap River north of the town or at the Bassac River south of the town mixed with commercial and residential areas. Such locations allow direct access to river transport and high consumption of water (MRC, 2002i). The water requirement by industrial sector is based upon the size of the factory. An estimate of water use volume for different sizes and types of factories are as follows (CNMC, 2003):

- Major industry: 1,000 – 20,000 m^3/day (for instance: paper making, chemical manufacture, iron and steel production, oil refining etc.);

- Large scale industry: 100 – 500 m^3/day (food processing, vegetable washing, drinks bottling, ice making, chemical products etc.); and
- Medium and small scale industry: 50m^3/day.

4.3.2.3. Agriculture Use

Cambodia has inventoried 946 operating irrigation systems[2] which can service 256,120 ha of the 2 million ha wet season cultivated area. In the dry season, rice is grown on 225,000 ha and 143,490 ha of this are fully irrigated by receiving irrigation water from irrigation schemes. Hence, only 12% of the wet season rice is irrigable, the remainder being rainfed and just over half of the dry season crop is irrigated, the remainder being recession rice receiving supplementary irrigation from manually operated and diesel driven pumps. Very few of the irrigation schemes are capable of irrigating all year round.

Fully irrigated crops utilize approximately 10,000 m³/ha. Some irrigation engineers in Cambodia estimate that recession rice receives approximately 4,000 m³/ha of irrigated water.

The water consumption for rice is high compared to other crops. The total water consumption is dependent on crop type, stage of crop growth, soil type, irrigation method, and so on. The water consumption for different kinds of crops and for rice is presented in the table below.

Table 15: Water Consumption within a Critical Period

Activity	Water Flow (l/sec/ha)	Water Requirement (m^3/ha/month)	Crop Irrigation Life (month)	Critical Period Consumption (m^3/ha)
Irrigated rice	0.8	2,074	3.5	7,258
Upland crops	0.6	1,555	4	6,221
Fruit trees	0.4	1,037	4	4,147

Source: BDP, 2003.

Assuming that the water requirement during the critical period (February – May) for dry season irrigated rice and that for non-rice crops is approximately 0.8 l/sec/ha and 0.6 l/sec/ha respectively, hence the total water use for rice and non-rice crops is estimated at about 1,571 million m^3/month and 509 million m^3/month respectively.

Table 16: Water Consumption Within the Delta Sub-area During a Critical Period

Crop Type	Water Flow (l/sec/ha)	Water Consumption (m^3/month
Paddy rice	0.8	1,570,876,636
Non-rice crop	0.6	509,125,660
Total		**2,080,002,296**[3]

[2] The inventory of irrigation systems in Cambodia is not comprehensive and it is likely that there are significantly more systems and larger potentially irrigated areas than this.
[3] Svay Rieng province is not included.

Mekong River water is utilized for irrigation, hydropower generation, domestic and industrial purposes. Much of water emerging from hydropower stations is also consumed downstream for irrigation, domestic and industrial purposes. Irrigated agriculture is responsible for 80-90% of water abstractions from the Basin (FAP from MRC, 2002) and is utilized in the form of receding flood water storage, diversion of water from streams and from groundwater sources.

On a nationwide basis, the LMB countries do not fully utilize their renewable water resources. Renewable water resources are equal to the total precipitation in the country minus evapo-transpiration. Cambodia and Laos use only 1% of their total renewable water resources for agriculture while Vietnam and Thailand use 5 and 20% respectively. Based on these figures, an average Mekong River flow of 460 km³ each year can service the irrigation requirements of all LMB countries 11 fold. An annual Mekong river flow can also service approximately 64 million ha of fully irrigated rice based on a consumption of 10,000 m³/ha (1 meter of water) per crop. This compares with the 1999/2000 area of 2 million ha of dry season cropping in the LMB watersheds.

Therefore, there is no shortage of water in the Mekong River to service agriculture in its watersheds if all water is captured and redistributed when required. This is, of course, not the case, with a majority of water flowing through to the ocean during the wet season when crops receive most of their water requirements directly from rainfall. Water shortages may occur (especially in the Mekong Delta) during the months of February to May when water flows in the Mekong River are at their lowest. Crop irrigation is the major consumer.

4.3.2.4. Ecological Demand

Ecological demand (of water) is a minimum stream flow or water level required for prevention of irreversible ecological degradation. The ecological demand varies from year to year and from place to place. The flow must be high in the wet season in order to maintain a healthy environment; for instance, fish species mainly rely on annual floods for their reproduction.

According to the MRC (2003e), a value of 1 l/sec per km^2 has been applied as an indicator for ecological demand in the dry season for Kok River basin. At the regional level, it is an important aim to preserve the Mekong Delta as a freshwater regime. This requires maintenance of a certain minimum flow, estimated at 2 l/sec per km^2 (Nielsen, 2002).

4.3.2.5. Other Consumptions

According to the MRC (2003e), the consumption of irrigation water in the Mekong Delta fish ponds for aquaculture is approximately 6,000m^3/ha/month.

A study has shown that the total water use for tourists is much more than the local inhabitants, which affects the water use within the city and provincial towns. If the water use per tourist is approximately 0.5m^3/day, the total water use for the tourism sector

within the Delta Sub-area is estimated to be at 1.4 million cubic meters per year (including local and foreigner tourists).

Some figures on water demand and use
Total water demand/capita = 150 m³ per capita per year Share agriculture = 94% Share Municipal and Industrial = 6% Municipal and Industrial withdrawal 1990 = 78 million m³ Municipal and Industrial withdrawal 2020 = 187 million m³ (Source: Ringler, 2001 in MRC-BDP Planning Regional Sector Overview 2002) Total water demand = 0.5 Bm³ per year Internal water supply = 1,004 m³ per person Water for domestic use = 5% Water for industrial use = 1% Water for agricultural use = 94% These figures will change due to future development in the LMB that bring about changes in the river hydrology. (source: CNMC, 2003)

4.3.3. Major legal and policy documents pertaining to watershed management in Cambodia

- Land Law (endorsed in August 2001);
- Law on Commune Administration Management (endorsed in August 2000);
- Law in environmental protection and natural resource management (endorsed in November 1996);
- Forestry Law (already submitted to the Council of Ministers in July 2001, but has not yet passed);
- Sub-decree on forest concession management (signed by the Prime Minister in February 2002);
- Law on Water resources management (draft);
- National Water Resources Policy (endorsed by Council of Ministers in January 2004);
- Water Sector Roadmap (prepared by MOWRAM in July 2004);
- Decentralization and devolution Policy of the Ministry of Interior;
- 5 year socio-economic Development Plan (2001-2005); particularly relevant for poverty alleviation;
- Interim Poverty Reduction Strategy Paper;
- Agricultural Development Plan (2001-2005);

- Action Program for the Development of Agriculture in Cambodia (2001-2010;)
- Government Action Plan 2001, which includes a section specifically dealing with natural resources management;
- Draft Policy for Ethnic Minority People's Development, also called "Highland Policy" (Sept. 1997, not yet ratified by the Council of Ministers); and
- Forest Policy- currently being draft by a national working group.

4.3.4. Policy of Water Resources and Meteorology Development

To implement the programme of the Cambodia Royal Government and accelerate economic development, the Ministry of Water Resources and Meteorology has set four policies for social development and in particular poverty reduction, which are as follows:

- To increase the irrigated area of rice production from 16.6% to 20%, through water storage during the wet season for double crop production, with a view to increase job opportunities and income of the population in the rural areas.
- To take a leading role with regard to drainage, water conservation, water resources development to the benefit of the population by developing drainage systems and flood protection dikes.
- To study surface water and groundwater to ensure water quantity and quality management in an integrated manner and determine the balance between demand and water availability.
- To improve weather forecasts, hydrological forecasts and ensure the timely warning of natural disasters such as typhoons, floods and drought to the population in the whole country.

4.3.5. Government's Goals in the Water Resources Sector

1. To implement viable irrigation systems based on local cost recovery,
2. To develop hydropower, focusing on multipurpose projects
3. To increase the domestic technical capacity and databases needed for effective water resource management capacity.

Water resources management is addressed in section 11.9 in the current 5-year socio-economic development plan (2001-2005). Details are found in the separate policies and activity plans for each ministry, as presented in their respective 5-years plans and 3-years Public Investment Programs (PIPs).

The national targets for access to safe water are as follows:

- Rural population: from 29% in 2000 to 40% in 2005.
- Urban population: from 48% in 2000 to 87% in 2005.

4.3.6. Analysis

- Data gathered from diverse sources are fragmentary, inconsistent and vary widely from one source to another. This lack of capacity of the Cambodian institutions to produce accurate and reliable data on water resources (surface and groundwater) seriously impacts on any possibility to plan, manage and evaluate actions aiming at securing water availability for the population for better access to water and greater development opportunities, be they irrigated agriculture, fisheries, tourism, industry and/or navigation.
- Potential water availability is huge including groundwater, but the effective access of the population to water is limited because of weak management expertise of relevant institutions, lack of infrastructure and budget. Therefore, water is not available at when it is needed.
- Cambodia's challenge related to water is threefold; technological, institutional and social. Technologically, the main challenge is water control including flooding control and warning systems set up. The latest technologies based on satellite imagery and GIS are capable to assist man in forecasting and warning about some natural calamities and thus, to minimize their disastrous impacts on human activities. However, these technologies are expensive and require a corresponding level of technical capacity to be able to take advantage of them. Institutionally, there is a need to achieve the reforms so that competent human resources are employed and overlapping mandates between rival institutions reduced, for the sake of more efficient and effective water resource management and exploitation. Efforts in capacity building must continue and funds allocated to this task.

  Socially, the challenge is to enable equitable access to water resources to the population, especially the poorest and the rural inhabitants. Access to safe water should be nation-wide and a priority for further policy enforcement.
- The impressive panoply of existing laws, regulations and policies is conducive to rational and sustainable watersheds resources management on the condition that there is real and sufficient political willingness for enforcement.

4.4. Environment

Environmental concerns in the Delta Sub-area include:

4.4.1. Use of Fertilizer and Pesticides

Most farmers living within the Delta use different kinds of chemical fertilizers and pesticides to increase crop yields. There are so many kinds of chemical fertilizers and pesticides on the markets that the farmers can buy any kinds of chemical fertilizers and pesticides as they want. They do not clearly understand how to use the fertilizers and pesticides in proper manner. There are no instructions for the using of fertilizers and pesticides. As a consequence, farmers are severely affected by improper use of the fertilizers and pesticides.

4.4.2. Water Quality

According to the reports prepared by the Working Groups of each province within the Delta, the water quality for most provinces do not face any problem, save some provinces, including Kandal, Takeo and Kampot. These problems include: (i) Wastewater coming from small-scale industries located along the Bassac river; (ii) Tourism sector; for instance, there are a number of cottages built along the bank of the river for serving tourism activities; and (iii) wastewater coming from households, particularly municipal wastewater of Phnom Penh.

While these waste discharges can and should be treated, they do not comprise a major water quality issue due to their relatively small volume in comparison to the volume of the rivers.

4.4.3. Industrial Wastewater and Municipal Liquid Waste

All provinces within the Delta are rarely equipped with wastewater treatment plants for treatment of household liquid waste. Municipal liquid waste is discharged into rivers, streams, canals, etc. without any treatment methods. This may currently not pose any problems to the public health due to huge volume of water in the rivers, streams, and canals.

Most of the industries (small- and medium-scale) are also not equipped with the wastewater treatment facilities. They release the wastewater into municipal sewers and then into the rivers and streams. A few industries particularly garment and textile factories located in Phnom Penh city are equipped with the treatment plants. However, whether the end-of-pipe wastewater meets the required standards or not is not known. There is scope for strictly monitoring the wastewater coming from industries because they may contain a number of toxic or hazardous chemical compounds that could potentially affect the public health and the environment. The capacity of the government for monitoring the discharges from these factories is limited due to the lack of human, financial, technical and equipment resources available.

4.4.4. Solid Waste Management

Solid waste management in most provinces is very poor. Wastes are disposed of at open dumpsites without any treatment. Waste collection services are usually only available in the larger urban areas such as Phnom Penh. A large volume of waste is therefore dumped into the rivers, streams and canals or left in open areas where it is scattered by wind, runoff and animals and where leachate collects in the groundwater. Solid waste consists of different materials from different sources, including municipal waste, industrial waste, and medical waste. These different kinds of wastes are mixed together and disposed into the same open dumpsites.

The open dumpsites within some provinces are located in inundated areas; as a result, harmful substances from the sites impact on public health of those who live around the sites and the poor who scavenge for a living. The leachate formed by rain that falls on the waste drains away and also pollutes the surface and groundwater.

4.4.5. Ground Water Problem

Some provinces are currently facing problems of lowering of the groundwater table and reduced quantity and quality. The groundwater table is gradually getting lower from year to year. The decrease of groundwater level likely results from withdrawals that exceed the recharge, mostly as a result of the large increase in the use of groundwater for irrigation.

Another issue that has not as yet been well quantified is the potential for arsenic contamination in groundwater wells. Arsenic is commonly found to be a problem in alluvial soils similar to those of the Delta Sub-area, and there are some wells that have been tested and shown to have a high concentration of Arsenic so this is a concern. There is currently however not sufficient information to quantify the scale and extent of the problem.

4.5. Trends

4.5.1. Intensification of Aquaculture Production

Fisheries and aquaculture are significant economic activities for those who live along the Mekong River, particularly the Delta sub-area. Fish ponds and cage net are rarely developed in the Mekong River itself, but they can be found in the tributaries of the Mekong basin. It is estimated that 58,123 tons originates from catches in natural water-bodies and basin, while around 4,758 tons are produced from aquaculture every year in the Delta sub-area. A total value of the catches is estimated at approximately US$ 45 million[4].

Table 17: Freshwater and Aquaculture Fish Products

Province (entire)	Freshwater Fish Product, tons/year	Aquaculture Fish Product, tons/year
Takeo	11,182	808
Kandal	32,769	-
Phnom Penh	6,000	2,700
Kampong Speu	-	-
Prey Veng	2,082	830
Kampong Cham	4,300	420
Kampot	1,600	-
Koh Kong	190	-
Svay Rieng	4,367	144
Total	**62,490**	**4,902**

Source: McKenny & Tola, 2002.

[4] It is estimated that the value of the riverine fish capture is about US$ 0.68 per kilogram, while the value of aquaculture is approximately US$ 1.05 per kilogram (MRC-State of Basin Report, 2003)

The above table suggests that aquaculture fish product remains weak (7.3% of total catch). However, there is a huge potential for its development in the Delta, given the needs to be met.

Pond culture and farming fish in rice fields have been introduced by Department of Fisheries (DoF) for a few years. The idea is aimed at providing an important opportunity for poor farmers or households to improve nutrition and to increase their cash income generation. An estimated 124,880 families in the Delta have their own fish ponds. Below table presents communities and private companies engaged in fishery.

Table 18: Number of families, communities and companies involved in fishery activity

Province (entire)	Number of Families Engaged in Fishery	Number of Communities Engaged in Fishery	Number of Companies Engaged in Fishery
Takeo	17,535	62	-
Kandal	30,190	17	-
Phnom Penh	15,270	2	22
Kampong Speu	-	-	-
Prey Veng	43,450	22	167
Kampong Cham	11,030	15	17
Kampot	-	-	-
Koh Kong	7,405	5	-
Svay Rieng	86,051	5	-
Total	**210,931**	**128**	**206**

Source: McKenny & Tola, 2002.

More efforts have been made by the DoF to develop community fisheries, aiming at responding to fisheries management problems and conflicts between lot owners and small-scale fishers. The provinces of Takeo and Prey Veng seem to be the most dynamic in term of fishery community organization, with respectively 48.5% and 17% of communities engaged in Fishery among the 8 provinces and one municipality. Companies are the most entrepreneurial in Prey Veng with 81% engaged in Fishery.

Trends and Future Development of Fishery and Aquaculture:

- Establishment of protected flooded forest areas is the traditional approach to preserving fish and biodiversity. As being reported that the total land area covered by flooded forest is approximately 4.71 percent of the total land area within the Delta. There is therefore a scope for protecting the flooded forest area in order to increase the natural fish biodiversity. Destruction of flooded forest for fuel and conversion to rice fields or other purposes within the Sub-area Delta is rarely taken place. In the context of recent governmental policy aiming at stopping deforestation, there is hope for efficient protection of flooded forest against its conversion into agricultural areas.

- Most people living in the rural areas within the Delta rely upon fish and other aquatic animals for their food. Yet, the annual fish production does not meet the

requirements of those who live in the Delta. It is estimated that approximately 12 kg of fish is annually consumed by people within the Delta. The consumption within the Delta is much less than that within the LBM, which is about 36 kg/person/year. As a result, the aquaculture will increase in order to meet the need of the people as a whole and to reduce poverty that seriously affects rural areas.

- Increases in harvesting capacity, advances in fishing technology, and other illegal activities of fish catch have contributed to the decline of fish stocks in the Delta. As being reported, a number of fishing gear types and illegal fishing activities have been found in the tributaries of the Mekong River. This would lead to the decline of rare fish types which are species of global significance.

- The introduction of exotics from neighboring countries for aquaculture purposes tends to develop, and within a context of weak enforcement of existing laws, can be a serious threat for the indigenous biodiversity. In other words, risks from the uncontrolled introduction of exotic fish species include competition and displacement of indigenous fish species, reduced biodiversity, hybridization, loss of genetic diversity and the possible introduction of disease pathogens and parasites.

4.5.2. Increased Use of Pesticides and Fertilizers in the Delta

The agriculture sector is a primary direct source of incomes in the rural economy and has contributed about 40 percent of GDP. Therefore, the Government intents to promote a supportive policy environment for the agriculture, including provisions of core economic and social infrastructure and services that allow farmers to make their own investment and production decisions. The agriculture sector provokes labor-intensive growth and generates higher incomes for the poor living in rural areas as a whole and for those living in rural areas within the Delta in particular (Royal Government of Cambodia, 2001).

According to FAO (2001), the quantity of mineral fertilizer used in Cambodia increases from 300 metric tons in 1989 up to 7,900 metric tons in 1999. Furthermore, the weight of mineral fertilizer used per ha of agricultural land was multiplied by 21 within the same period (Ibid). There is no accurate data available on uses of various kinds in pesticides in Cambodia.

However, 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 percent depending upon the province, with a range of 40-100 percent 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 DTT, Dieldrin and similar chemicals have been found in fish across the basin (Monirith et al, 1999). However, investigation into a build-up of pesticide residues in the bodies of such fish has revealed that contaminant levels are well below the maximum safety levels specified by WHO (Ibid).

Pesticides can also cause environmental problems through build-up in the soil, toxicity to humans and the development of resistance on the part of pests. Water pollution by pesticides, herbicides and fertilizers is becoming a major concern for the Mekong fishery because it forms a biological barrier to the dispersion of eggs or the migration of fish larvae and adults. Fertilizer run-off into water bodies often results in eutrophication as the water becomes overly nutrient rich. If eutrophication may increase the yield of certain fish species, it is generally accompanied by a decline in the number of fish species and biodiversity. DDT levels are higher in fresh water fish than marine, suggesting that the DDT originated from inland river catchments. DDT is used extensively during the early rainy season to control insects, and mosquitoes in particular (T.S. Touch, 1996).

4.5.3. Water Resources Threatened in Terms of Quality and Quantity

Many sectors rely on water resources, e.g. agriculture, fish production, biodiversity, water supply, sanitation, transport and hydropower. The current trend is shortage of water supply in many areas, including domestic purposes. Serious competition for water is intensifying between fast growing population and irrigation development. Pollution of both surface and underground water is extensively provoked by industrialization pressure, urbanization and absence of repressive law against environment destructors.

Geo-hydraulic conflicts resulting from hydropower and dams construction by the riparian countries will arise in the near future, because both quality and quantity of water are affected. Hydropower involves dam building which requires water diversions. Conflict may arise between upstream countries and downstream countries because of water scarcity and/or unequal allocation. The most crucial is perhaps where a basically agricultural country risks loosing the access to the water sources and thereby being robbed of the chance of achieving food security, poverty alleviation, and possible economic growth (Öjendal, 2000). Furthermore, aggressive and hostile capture could lead to tensions and conflicts through population movements, group identity conflicts, economic deprivation and/or civil strife (Ibid).

The trans-boundary implications of hydropower project on water quality and quantity are numerous. Risks for riparian countries need to be objectively assessed.
The first risk of hydropower projects development in the upstream area of the Mekong River is the negative impact on the environment and society. Those risks have been duly identified as:

- Adverse impacts on the ecosystem (aquatic life, animals, birds, vegetation);
- Blocking of the flow of sediment;
- Negative impacts due to changing a river's flow pattern;

- Negative social impacts (resettlement, loss of livelihood);
- Loss of scenic landscapes (tourism potential);
- Negative impacts on water quality due to storage of water (eutrophication, lower temperatures for discharged water);
- Negative impacts to other users of water (navigation, fisheries);
- Problems during the construction period (noise, vibration, dust, traffic problems); and
- When associated with irrigation, land salinization and water logging.

The second type of risk is geo-political, i.e. the inevitable dependence of countries who do not possess hydropower upon those who develop hydropower projects. Cambodia is particularly vulnerable because it will certainly depend more and more on Thailand, Laos and Vietnam for power supply. A cut-off of power supply by power producers would seriously impede any possibility for Cambodia to achieve its development goal and strategies, e.g. to alleviate poverty, to improve the population livelihood, to welcome further foreign investments, to sustain tourism development, etc.

4.5.4. Intensification of Population Pressure through Migration

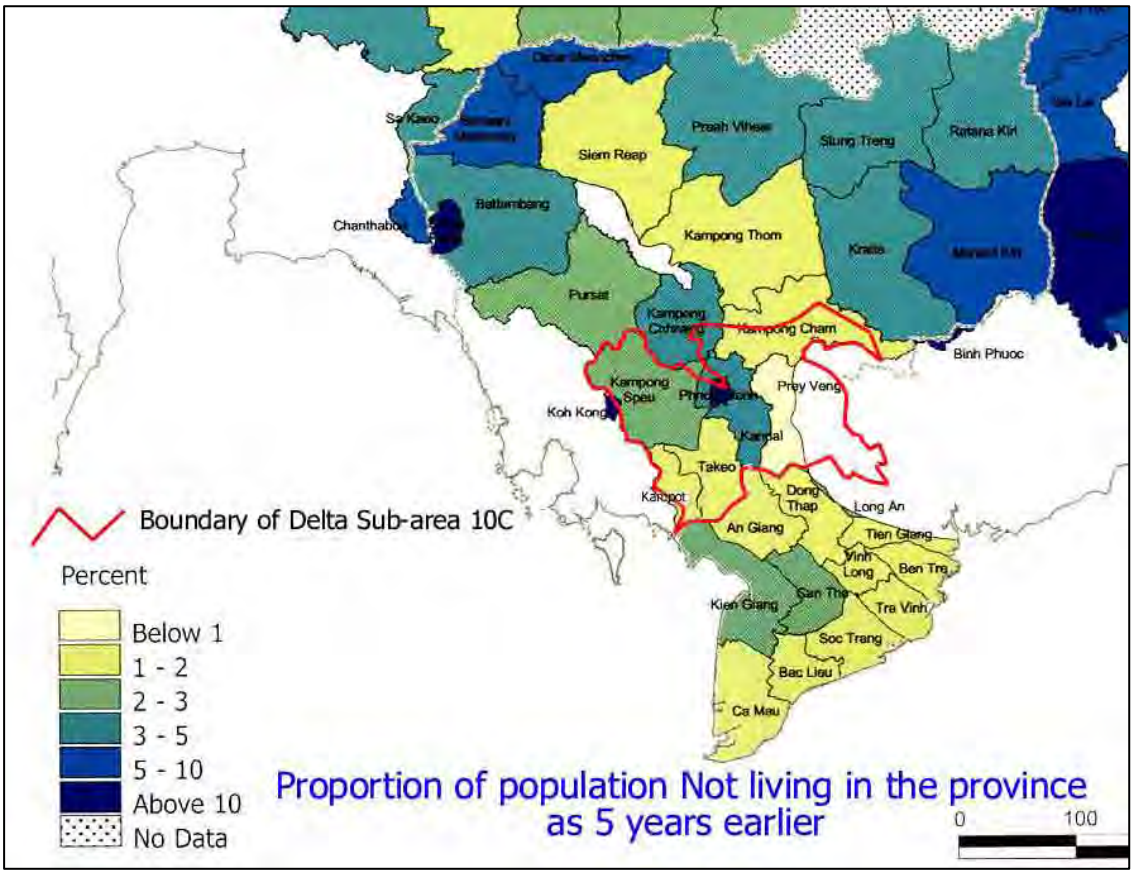
Development of tourism, infrastructure improvement and increased foreign investment are major factors encouraging migration from poor provinces towards urban areas where employment opportunities and facilities are created.

Based on the Cambodia Census 1998, this map – originated from the Social Atlas of the LMB – clearly indicates that within the Delta Sub-area, Phnom-Penh, Koh Kong and the provinces of Kampong Speu, Kandal and Kampong Chhnang are the most predominant area of migrant reception, with respectively 10%, 2-3% and 3-5% of immigrant population as 5 years earlier . The provinces of Takeo, Kampot, Prey Veng and Kampong Cham count less immigrants with 1-2% in average. No data is available for Svay Rieng.

Thus, migration is of concern in the Delta because it causes population pressure in the areas where the population density is already high, and where resources are sometimes over-exploited for sustaining livelihoods and economic purposes. There is a strong correlation between migration and employment opportunities, particularly in the sector of services and industry which are the most developed in urban areas. This reality provokes irresistible attraction of rural people whose livelihood is becoming more and more precarious under the pressure of poverty and natural calamities. Textile factories settled in the surroundings of the capital and other urban areas e.g. in Kampong Cham and Kampong Speu, constitute attractive poles for young population from rural and remote

areas. Young women with high labor productivity are predominantly drained from the countryside, sometimes for long time period and changing of employment many times. According to a recent study conducted by CRD (2004) with 1.500 respondents around Phnom-Penh, 67% of garment factory employees are aged between 18 and 24 year-old. 72% of them are single or never married and 22% are married. 78.5% have no child and only 12% have one child. Regarding the primary household size, 78% of them come from households composed of 4-9 persons. 94% of those girls are permanent employees. Around 40% of these employees were hired in each of these 2 year-periods, thus not so recently, meaning that they have started to leave the home-village quite a long time ago. The length of their previous job suggests that they have been absent from their home-village for quite a long period: 40% were at previous job less than one year and another 40% for 2 years and less.

Among the top 12 sending provinces of origin, one can find Prey Veng (18%), Kampong Cham (18%), Kandal (16%), Takeo (10%), Svay Rieng (10%) and Phnom-Penh (7%).



4.5.5. Aggravation of Vulnerability of the Poorest

Half of the villages have between 40-60% of the households below the poverty line with a peak of 80% in some areas (MRC, 2003c). Many households have no land holdings and are entirely dependant on fishing and foraging, with access to fishing areas often under dispute. If conflict and instability are major causes of poverty, impoverishment originates from poor access to health and education services, lack of land ownership, women's social deprivation and increasing vulnerability to natural calamities. Demographic pressure on the environment resulting in degradation is also a mechanism of impoverishment of the vulnerable in terms of limited access to resources. This trend is aggravated by the inadequacies of the governance system.

4.5.6. Navigation and Road Development

Owing to the presence of the Capital Phnom-Penh, the Delta Sub-area is a lively plate-form of inland and waterway transport networks. In Phnom-Penh, all the national roads are inter-connected and the Mekong River and the Tonle Sap River joint together before splitting into Bassac River and Mekong River that flow south towards the Mekong Delta in Southern Vietnam.

4.5.6.1. An Exceptional Waterways Network for Livelihood and Development of Trade

In the Cambodia Delta Sub-area in particular, and in the Lower Mekong Basin as a whole, water transport has traditionally been the principal means of travel for much of the population. Locating their communities on or near waterways has provided communities not only with an abundance of fish and fertile sediments for agriculture. It has also enabled them to trade with neighboring communities up and down the river. Not only is

waterway transport important for people living near rivers and streams in the basin, it is also becoming increasingly important for international trade.

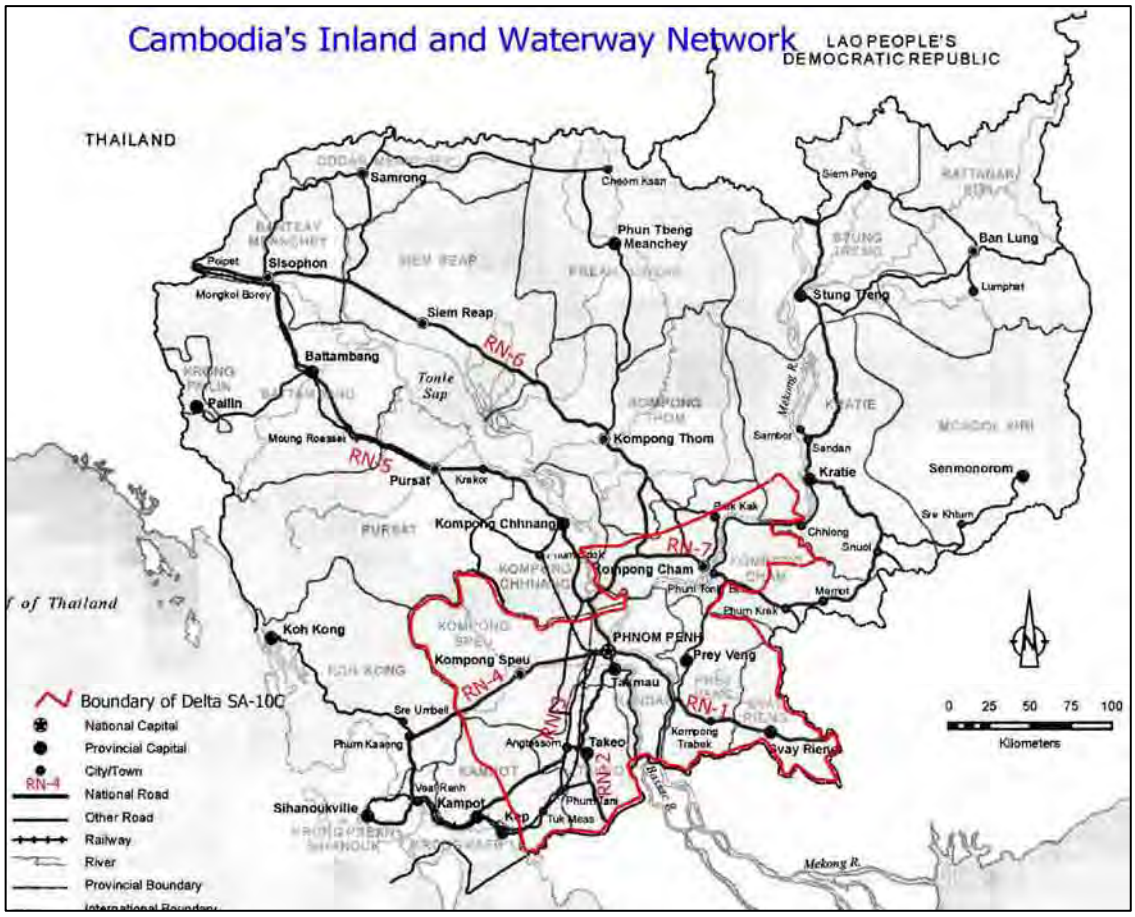


Figure 13: Cambodia's Inland and Waterway Network

4.5.6.2. Role of river transport to Poverty Alleviation

Another point is that despite its poor network, navigation remains an important opportunity of mobility for the majority of poor rural people in the Delta Sub-area. Available evidence suggests that the poorest communities in the Mekong Basin are rarely located along the Mekong River and its tributaries. In Cambodia particularly, the poorest communities (those with more than 40 percent of the population below the poverty line) live some distance from the river (UNWFP et al, 2001). Generally speaking, the communities along the Mekong River and its tributaries have less than 40 percent of their households below the poverty line (on average 25-40 percent), according to the UN-WFP-MoP-UNDP[5] (Feb. 2001). The exceptions are the communities bordering the Tonle Sap River and Lake.

[5] In this study entitled "Identifying Poor Areas in Cambodia", "poor households" have been defined as those with consumption expenditure below the 54,050 Riel (about 13.5 US$) per month estimated as necessary to purchase a 2,100 calorie food basket per day and to meet other minimal expenditures.

4.5.6.3. Government Polices, Plans, and Spending Priorities

Although the advantages of river transport are numerous, government polices, plans, and spending priorities continue to promote road, rail and air transport over inland water transport. The maximization of natural assets consisted of abundant water bodies implies development of navigation serving tourism, transportation, fishery and agricultural trade. Despite serious competition from inland transport via recently rehabilitated NR#1, NR#5, NR#6 and NR#7, navigation remains crucial for shipment between Phnom-Penh and the Delta region for fish, crop production, agricultural inputs, gasoline and heavy equipment.

The rehabilitation of Routes 5 and 6 have already reduced the travel times to the major towns in the Delta Sub-area by several hours. With the expected completion of the route between Ho Chi Minh City in Vietnam and Bangkok in Thailand and ASEAN plans to liberalize cross-border traffic flows, enormous changes will occur in terms of flows of people and goods, access to markets, knowledge and technology and the economy. This will completely recast all activities and mindsets of the Sub-area, both opening large opportunities and bringing with it many potential threats and dangers. Coping with this change will be a key trend for the foreseeable future.

Tourism in Siem Reap is an economic catalyst for both navigation and inland roads in the Delta Sub-area, even though the "Open Sky Policy" offers possibility for foreign tourists to directly fly from Bangkok to Angkor Watt.

4.5.6.4. Support by International Agencies

Support by international agencies for network transport improvement in the Delta Sub-area is diverse. Two main international development funding agencies are involved in the implementation of major transport infrastructure improvement projects which will have a significant impact on the development of an integrated transport network within the LMB as a whole, and within the Delta in particular.

In Cambodia, the Asian Development Bank, through its Greater Mekong Sub-region Programme, is funding the improvement one international highway linking Phnom-Penh with Ho Chi Minh City in Vietnam (105 km in Cambodia and 80 km in Vietnam), for an estimated cost of $ 125 million (MRC, 2003d).

The World Bank is implementing a number of projects, which may also be expected to enhance the intermodal linkages of the inland waterway system in the LMB. A Road Rehabilitation Project in Cambodia, involving upgrading 89.3 km of National Road 6 and 21.5 Km of National Road 3, as well as rehabilitation of urban streets in Phnom Penh and Sihanouk Ville and institutional strengthening and capacity building. This project is being implemented over five-year period, between 1999 and 2004, at an estimated cost of $48 million (Ibid)

4.5.6.5. Potential for increased international navigation

Apart from institutional impediments, there should be no reason why the port of Phnom-Penh should not capture a major share of international cargo traffic originating from, or bound for, countries to the northeast of Cambodia, especially China, Japan, the

Philippines and the Republic of Korea as well as to and from Singapore and Vietnam. I such traffic is to be distributed instead through Sihanouk Ville Port, a distance penalty of 490 km will be incurred. Currently, the direct river journey takes about the same time as a journey to Sihanouk Ville, but this is due to a prohibition on navigation of the river by night, as well as to delays associated with border crossing formalities. Elimination of these river transit delays would result in a time saving of at least 12 hours for the direct river journey over the Sihanouk Ville option (Ibid).

4.6. Tran-Boundary Issues

Identification and analysis of trans-boundary issues are crucial for planning and decision-making of the riparian Governments. The followings are the key trans-boundary issues identified for the BDP of the Delta Sub-area.

4.6.1. Environmental Degradation and Contamination



Deforestation impacts on the environment beyond the boundaries of the concerned country. The most direct environment consequences of deforestation are the depredation of the forest biota in the deforested area. Because forests are almost always more biologically diverse than the system with which they are replaced, this usually results in a local loss biodiversity, and potentially a reduction in global species diversity (MRC, 2003d).

An issue of great concern is the Lower Mekong Basin, and thus in the Delta Sub-area, has been the consequences of forest clearance on hydrology and related processes, i.e. flooding, soil erosion and mass soil movement. When mature forest is cleared, the hydrological consequences depend on the subsequent use of the land.

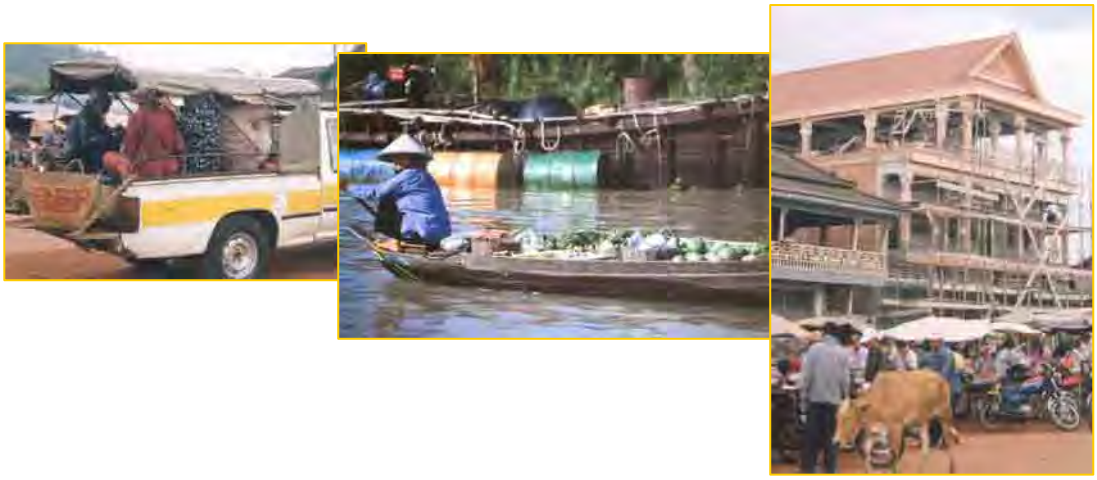
Deforestation also impacts on society and economy. Progressive disappearance of the flooded forest in the neighboring Tonle Sap Sub-area is a serious threat for fish reproduction and refuge where large numbers of people draw upon fishery resources for a high proportion of their subsistence and income needs. The agricultural encroachment that follows deforestation often causes the loss of traditional land use rights and traditional conservation mechanisms.

Water pollution by pesticides and chemical fertilizers under the development of intensive agriculture is another great concern. Even through persistent pesticides are banned in the riparian countries, 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 Mekong basin. In the delta of Mekong, there is concern over excessive fertilizer use affecting water quality and damaging integrated aquaculture operations.

Pesticides can also cause environmental problems through build-up in the soil, toxicity to human and the development of resistance on the part of pests.

4.6.2. Population migration



Migration is another concerning trans-boundary issue in terms of social and geo-political implications. The search for employment is a major cause of migration. Seasonal and semi-permanent migration to urban areas provides important income for households in rural areas. Several different types of migration appear to be taking place at the same time, as suggested by national level data from Cambodia and Thailand. The largest movements are between rural areas. People relocated from densely populated rural areas to remote ones to seek new economic opportunities. Economic development in the Lower Mekong Basin, especially in urban centers, creates strong attraction for rural people because jobs are more numerous, better paid and services are more developed.

The Delta Sub-area witnesses a significant population growth of 5.44% in a four-year period between 1998 and 2002. But the most remarkable in that the Delta hosts many provinces of the highest density in Cambodia with an average of 213 persons/km^2 in 2002. Phnom Penh presents a peak of 2,697 persons per km2 in 2002 while four years ago it counted 2,666 persons per km2, equivalent to a demographic increase of 1.14% during the same period.

Migration towards the Sub-area comprises internal rural migrants and trans-boundary migrants which statistics and legality remain a hot and controversial issue. Internal migration towards urban areas deals with population of very poor provinces - i.e. Prey Veng, Takeo and Svay Rieng - migrants are seeking job opportunities and better livelihoods. Foreign migrants are motivated by accessing the abundant fisheries resources and very open business opportunities after the liberalization of the political system since 1989. These migrants into the Delta Sub-area are primarily Vietnamese taking advantage

of the loose border controls and internal checks. In the northern and western provinces of Cambodia, Cambodian migrants go through the Thai border to seek employment opportunities or are exploited for prostitution or forced labor through human trafficking practices. Most of these victims originate from the poorest provinces of the southeast part of the country (Takeo, Prey Veng and Svay Rieng). There is little comprehensive and consistent data related to this migratory phenomenon.

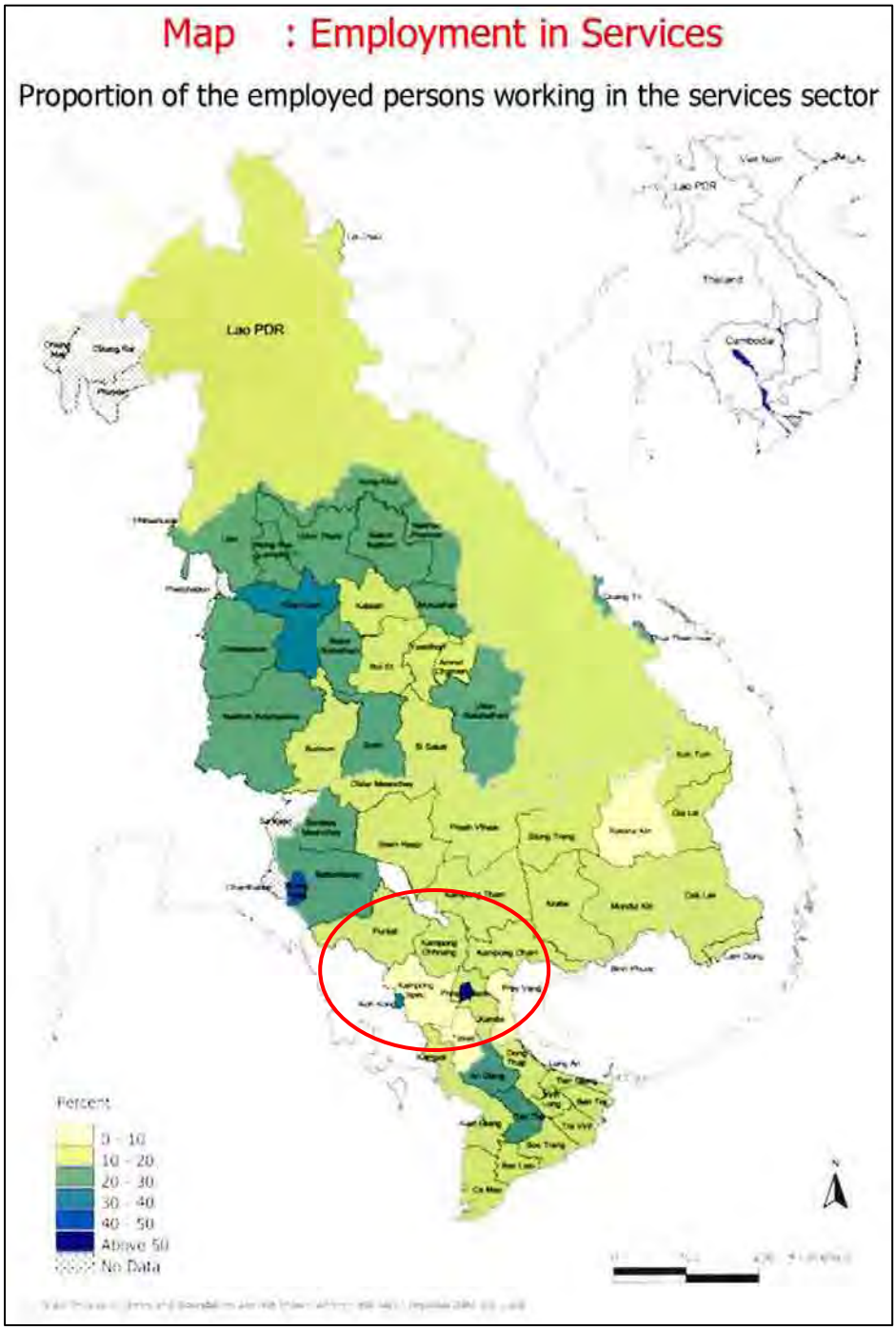


Figure 14: Proportion of the Employed Persons Working in the Services Sector

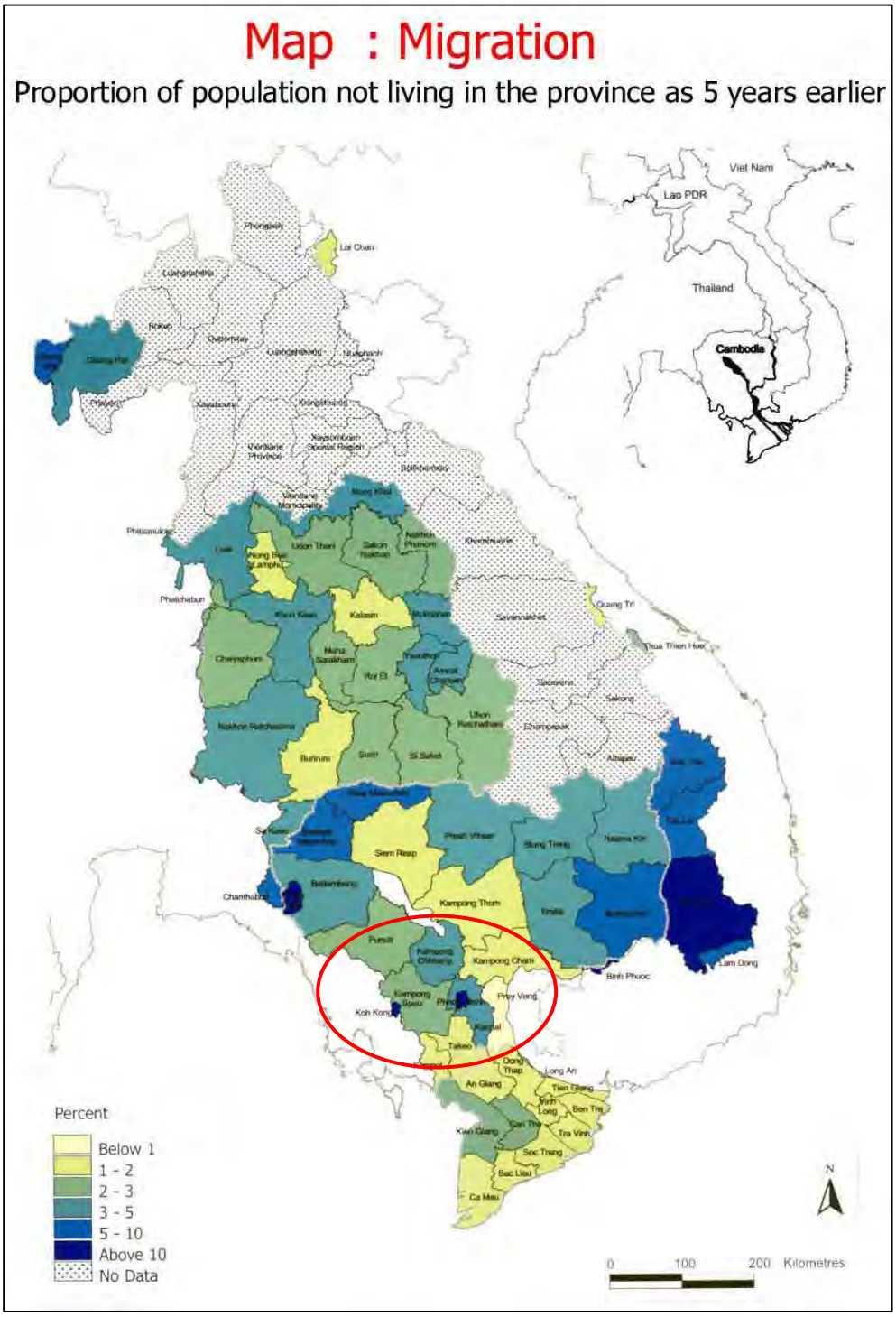


Figure 15: Proportion of the Employed Persons Working in the Services Sector

As a consequence of population migration, an urbanization boom will occur and develop, very often in an anarchic manner and to the detriment of the environment. By 2002, up to one third of the population in the Lower Mekong Basin is located in urban areas. This certainly results in loss of valuable agricultural land, increased cost to provide services such as water and sanitation, and, in the urban development in the floodplains, increased risks and costs associated with flooding.

Human migration also facilitates propagation of diseases which bypass economic, political, administrative or international boundaries. For instance, the rapid spread of HIV/AIDS, SARS and some other epidemics, for e.g. Avian Fever, is increased by the population movement all around the world, regionally and internally as one of the effects of migration supported by tourism industry development and waterway and inland transportation rehabilitation.

4.6.3. Fishery Resources Management

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4.6.3.1. Fishery Resources Decline in Figures

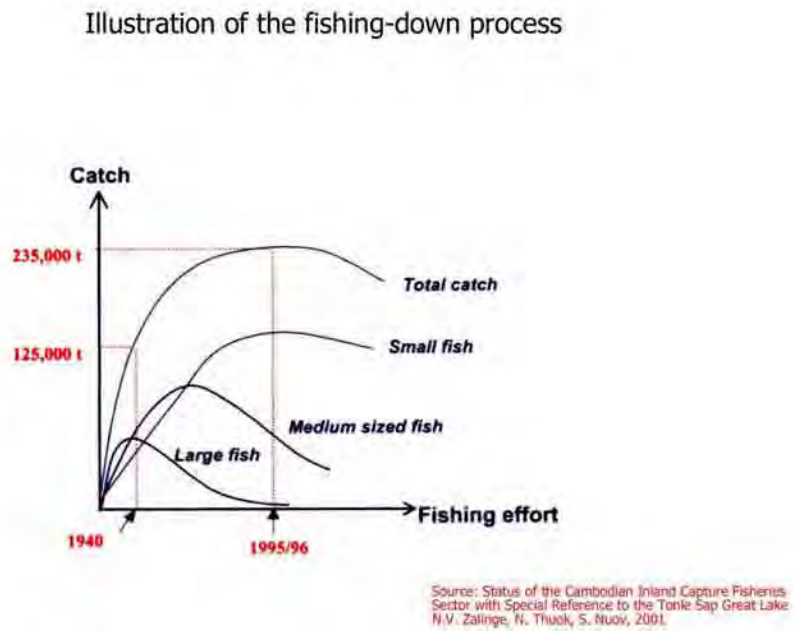


Figure 16: Illustration of the Fishing-Down Process

In 1940 the Tonle Sap Great Lake Region catch of 125,000 tons consisted mainly of large and medium size fish, while the 1995-96 catch of 235,000 tons contained hardly any large fish and was strongly dominated by small fish.

Table 19: Depredation of the Eco-System Supporting Fishery Resources

Type of Land and Water Resources in Cambodia	Area (ha) 1985/87	Area (ha) 1992/93
Permanent water (river, lake, pond, etc.)	567,100	411,1000
Flooded forest	795,400	370,700
Flooded secondary forest	28,200	259,800
Flooded grassland	80,800	84,900
Receding and floating rice fields	17,500	29,300
Seasonally flooded crop fields	366,800	529,900
Swamp	12,200	1,400
Total	**1,868,000**	**5,387,000**

Source: Ahmed et al, 1996.

Note: Beside and overall decline, there were significant changes in the area under different types of land and water resources which support fisheries between 1985/87 and 1992/93. The changes in the area under each type of resource can be attributed to loss of primary flooded forests and timing of the survey between the two periods.

These above figures could be analyzed in term of variation between 1987 and 1993. Results are displayed in the Table 20:

Table 20: Variation of Various Types of Land and Water between 1987 and 1993

Type of land, water resources in Cambodia	Area Variation 1987-1993 (%)	Estimate Average Variation per year (ha)
Permanent water (river, lake, pond etc.)	-27.5	- 26,000
Flooded forest	-53.4	-70,783
Flooded secondary forest	x 9 times	+38,600
Flooded grassland	+5.0	+683
Receding and floating rice fields	+67.5	+1,967
Seasonally flooded crop fields	+44.5	+27,183
Swamp	-88.5	-1,800
Total	**-9.7**	**-30,150**

Every year, between 1987 and 1993, the average area of eco-system which supports freshwater capture fish has declined 9.7%, equivalent to 30,150 ha. Flooded forest is the land use with the highest loss: 53.4% of its area disappeared between 1985 and 1993, equivalent to 70,783 ha per year. As a result to this destruction, flooded secondary forest occupies the space. Its area has increased by a factor of 9 in six years, meaning 38,600 ha increase per year. Receding and floating rice fields increased in area by 67.5% in the same period (1,967 ha annually), demonstrating that some of the flooded forest is permanently converted into agricultural fields.

Table 21: Fresh Fish Production, 1992-2000

Year	Fish Yield, tons
1992	68,900
1993	67,900
1994	65,000
1995	72,500
1996	63,510
1997	73,000
1998	75,700
1999	231,000*
2000	245,600*

Source: Touch & Bruce, 2000.
Note: (*): Include small-scale fishing.

4.6.3.2. Trans-boundary Factors Impacting on Fishery Resources

- Development of water resources, particularly dam and weir construction for hydroelectric power, result in drastic changes in water levels, increased turbidity and reduction in nutrient levels. Dams also impact upon water quality, affecting downstream total suspended solids and nutrient levels, especially total phosphorus and dissolved oxygen levels. Oxygen-consuming decomposition of organic material mainly occurs at the bottom, and the bottom water can become hypoxic or even anoxic if the reservoir is stratified. If oxygen-depleted bottom water is released from a dam, fish kills can occur downstream.

- The introduction of exotic fish species – if uncontrolled – represent a serious threat for biodiversity through hybridization, destruction of local species and competition for food and habitat. A good illustration of this is the introduction and the banning of freshwater species "Trey Chap" (Pirania sp.) from foreign countries for aquaculture purposes. Carnivorous and voracious, "Trey Chap" has caused significant damage to local species of fish.

- The increased and irrational use of chemical pesticides, herbicides and fertilizers in the agriculture sector is also causing harm to the fisheries habitat and aquatic eco-system, through eutrophication and water pollution by aggressive chemical molecules, some of which (e.g. DDT and Dieldrin) have been banned from use by WHO and other relevant international institutions, but not yet from production and commercialization.

4.6.4. Hydropower

4.6.4.1. Cambodia's Demand of Electrical Power

The country's demand of electrical power is projected to increase from 251 MW to 746 MW between 2000 and 2016. Previous feasibility study reveals potential hydropower in Pursat (3.5 MW) and Stung Sen (38 MW) (Bohneur, 2003).

4.6.4.2. Potential for Hydropower Development in the Mekong Basin

The total potential for feasible hydropower projects in the four Lower Mekong Basin countries is approximately 30,000 MW including 13,000 MW on the Mekong's Mainstream, and the remaining tributaries' potential (13,000 MW in Lao PDR's tributaries, 2,200 MW in Cambodia and 2,000 MW in Vietnam).

Table 22: List of Completed Hydropower Projects (10MW<)

Country	Name	Location	Capacity (MW)	Output (GWh/year)	Commissioning
China	Manwan	M	1,500	7,870	1993
	Dachaoshan	M	1,350	5,930	2001
Lao PDR	Nam Ngum	TR	150	900	1971-85
	Xeset	TR	45	150	1991
	Theun Hinboun	TR	210	1,645	1998
	Houay Ho	TR			
	Nam Leuk	TR	60	184	2000
Thailand	Sirindhorn	TR	36	115	1968
	Chulabhorn	TR	15	62	1971
	Ubolratana	TR	25	75	1966
	Pak Mun	TR	136	462	1997
Viet Nam	Dray Ling	TR	13	70	1995
	Yaly	TR	720	3,642	2000

Note: TR = Tributary, and M = Mainstream
Source: MRC, 2001.

Only 5% (1,600 MW) of the Lower Mekong's hydropower potential have been developed, and all projects are on the tributaries, not on the mainstream. There is also huge hydro potential in the Upper Mekong Basin. In Yunnan Province of the People's Republic of China, total hydro potential is an estimated 23,000 MW, and two projects, totalizing 2,850 MW, have already begun operating.

Figure 17: Completed Hydropower Projects in the Mekong Basin

4.6.4.3. Analysis of Trans-boundary Implications of Hydropower Projects

Obligation of consultation between countries:

In signing the 1995 Agreement that established the MRC, member countries all agreed that before any hydro project can be built on the mainstream of the Mekong, all four member countries must agree. Furthermore, the 1995 Agreement obligates member countries to ensure that no harmful effects will occur downstream in neighboring countries. One problem is that China and Myanmar are not signatory to the MRC Agreement: thus, China is building dams with a high storage capacity without consultation and participatory evaluation of impacts downstream, which puts downstream member countries in a position where they have to compensate for water capture carried out upstream without full understanding of the operations of the upstream dams or their likely impacts.

Risks for riparian countries:

The first risk of hydropower projects development in the upstream area of the Mekong River is the negative impact on the environment and society. Those risks have been duly identified as:

- Adverse impacts on the ecosystem (aquatic life, animals, birds, vegetation);
- Blocking of the flow of sediment;
- Negative impacts due to changing a river's flow pattern;
- Negative social impacts (resettlement, loss of livelihood);
- Loss of scenic landscapes (tourism potential);
- Negative impacts on water quality due to storage of water (eutrophication, lower temperatures for discharged water);
- Negative impacts to other users of water (navigation, fisheries);
- Problems during the construction period (noise, vibration, dust, traffic problems); and
- When associated with irrigation, land salinization and water logging.

The second type of risk is geo-political, i.e. the inevitable dependence of countries who do not possess hydropower upon those who develop hydropower projects. Cambodia is particularly vulnerable because it will depend on Thailand, Laos and Vietnam for power supply. A cut-off of power supply by power producers would seriously impede any possibility for Cambodia to achieve its development goal and strategies, to alleviate poverty, to improve the population livelihood, etc.

Geo-hydraulic conflicts:

Hydropower involves dam building which requires water diversions. Conflict may arise between upstream countries and downstream countries because of water scarcity and/or unequal allocation. The most crucial is perhaps where a basically agricultural country risks loosing the access to the water sources and thereby being robbed of the chance of

achieving food security, poverty alleviation, and possible economic growth (Öjendal, 2000). Furthermore, aggressive and hostile capture could lead to tensions and conflicts through population movements, group identity conflicts, economic deprivation and/or civil strife (Ibid).

Progress generated by Hydropower projects:

Quite a number of positive impacts of hydro projects deserve to be highlighted:

- Harnessing of a renewable natural resource;
- Reducing of the negative impacts that power generation has on the global environment (e.g. use of fossil fuels reduced, thus will lessen air and water pollution);
- Increasing the river's flow in the dry season, and reducing peak flow during the flood season;
- Increasing the availability of electrical power will stimulate economic development and improve people's living standards; and
- Revenues will be earned from the sale of power.

4.6.5. Soil and Water Conservation

The tenuous situation of most rural people stems from their difficult situation as subsistence rice farmers dependent on making a living from poor quality soils and uncertain and inconsistent rainfall. This is clearly identified usually by requests to solve the water problem with "irrigation". Yet often the problem is not just water shortage but flooding due to poor drainage, or pests associated with a drought period or low yields that prevent farmers from escaping the debt cycle caused by a failed crop.

A more holistic approach to these problems is to examine the situation within the framework of soil and water management and conservation. Cambodia was previously able to produce large surpluses of rice without major investments in irrigation reservoirs by utilizing local knowledge and resources and smaller investments to improve the rice cropping situation[6]. Many traditional techniques of soil and water control have been developed over the course of centuries of rice farming that involve flood spreading, water harvesting, storage, drainage, soil conservation through bundling and field leveling and improved crop management.

Numerous small-scale improvements in infrastructure are proven to work and contribute to the catchment's response to rainfall thereby contributing to the reduction of downstream flooding and sedimentation. In addition, the better soil and water conservation improves the viability and performance of larger investments in the watershed and reduces pressure for populations to migrate from tenuous economic situations to put more pressure on important areas like the Tonle Sap flooded forest or overcrowding urban areas.

[6] For example, during the "Sangkum Reastr Niyum" period of 1953-1969, a rural engineering department mobilized local people and leadership to work together on small-scale water resource projects appropriate to the village that gained good success for a relatively small investment.

The overall water balance within the sub-basins can be greatly improved through widespread application of these techniques that have the corollary effect of increasing the absorption of rainfall and runoff into the soils and thereby increasing the quantity of groundwater available. The groundwater provides the base flow in the rivers during the dry season, and thereby contributes the necessary volume to maintain the situation in the Mekong Delta area downstream from increasing encroachment of seawater.

Through careful management of the watersheds to maintain and conserve local resources, the environmental situation throughout the basin is improved and the local people's ability to respond to natural disasters is strengthened.

CHAPTER 5: THE AGENDA FOR DEVELOPMENT

5.1. Key Development Objectives

No.	Development Objectives	Short-Term (5-10 years)	Long-Term (20 years)
1.	To enhance economic sector	X	X
2.	To expand and promote development of irrigated agriculture	Small and medium scale	Large scale
3.	Water resource management	X	X
4.	Management and utilization of sustainable natural resources	X	X
5.	Human resources training	X	X
6.	Technical research for development	X	X
7.	To enhance transport infrastructure	X	X
8.	To promote the establishment of agricultural development community and water utilization community	X	
9.	To promote the establishment of agricultural development community union and water utilization community union		X
10.	To promote private sector	Small and medium scale	Large scale
11.	Development of information system and marketing infrastructure	X	X
12.	Development of processing industries	Small and medium scale	Large scale
13.	To enhance social and culture	X	X
14.	To conserve and upgrade existing tourism site	X	
15.	To identify agricultural production zones orientating to market and economic efficiency	X	X
16.	To promote management for liquid, gas and solid waste	50%	100%
17.	To promote management for agricultural soil quality and mitigate soil erosion	X	X
18.	To rehabilitate canals and existing irrigation system	X	
19.	To establish new canals for agricultural irrigation and transport		X
20.	To increase cropping seasons and increase production yields	X	
21.	To increase number of wells in rural area	X	
22.	To expand water supply system to outskirt of city	X	

23.	To establish clean water system in main district towns	X	
24.	To establish solid waste disposal sites in main cities	X	
25.	Food security will be ensured through upgrading and rehabilitation of existing reservoirs system (irrigation, flood mitigation and prevention)	X	
26.	To improve agricultural production processing and to expand local and international markets	X	
27.	Fifty per cent of rural population in Delta sub-area will have skills and techniques for processing agricultural produces to upgrade their living standard	X	
28.	Fifty per cent of population in Delta sub-area will receive daily clean water	X	
29.	Number of tourists will be increased by 20% due to the improvement of services and improvement of transport systems and resorts by ensuring environment protection and conservation	X	
30.	Income per capita for Delta sub-area will increase US$1,000		X
31.	Increase irrigated land by 30% (by 2009) in sub-area 10C by rehabilitation and expanding irrigation system	X	
32.	By 2009 water resource management system will be managed by 50%	X	
33.	To ensure 100% food security	X	
34.	To increase rice yield 3 to 3.5 tones/ha	X	
35.	To increase agro industry production for market (e.g. rubber, tobacco, soy bean, maize etc.)	X	
36.	To ensure irrigation for agricultural land	By 30%	Greater than 50%
37.	To increase aquaculture	X	
38.	To ensure 100% sustainable resource use in wet land areas	X	
39.	To protect flooded forest	70%	100%
40.	To identify conservation area for extinct animals in two places in Kandal and Takeo provinces	X	
41.	To expand clean water supply	50%	80%
42.	To promote waterway transport	X	
43.	To develop two hydro power plants with 20MW (Kampong Speu Kirirum 2)	X	
44.	To increase export of agricultural produces		X

5.2. Identification of Assets

Assets can be defined as resources as well as opportunities which rational exploitation is able to provide economic and social benefits to all layers of the society. The major assets of the Cambodian Delta Sub-area have been identified by the BDP Working Group as follows:

Sector	Assets Identified
Agriculture	Forest, inundated forest, chamcar, tobacco, plantations, grassland, freshwater fisheries, aquaculture, rubber, large area of arable land, replenishment of soil fertility from floods, and rare and endangered wildlife including water fowl, forest animals, fish.
Water Resources	Rivers, streams, the Mekong tributaries, lakes, canals, groundwater, ponds, reservoirs.
Mines	Gold, rock and stone, sand, clay, limestone, laterite, gravel, and coal.
Tourism	National Museum, Royal Palace, Kirirom National Parks, Bokor National Park, Tamao Mountain and Zoological Park, Oudong Mountain, Wat Phnom Temple, Phnom Da Mountain, Bati River, Tonle Bati Resort, Chiso Mountain, Phnom Pros-Phnom Srey Mountains, Bavet and Naga Casinos, Killing Fields and Tuol Sleng Prison, Golf Courses, Phnom Penh nightclubs, hotels and restaurants, Mekong River cruises, Ta Prohm Temple, Pochentong International Airport, etc..
Physical Infrastructures	Waterway and inland transportation new or in the process of rehabilitation, irrigation dykes, structures and canals, flood protection dams and polders, potential hydropower sites, water supply systems, sewerage systems, pump wells, air transportation, education and public health infrastructure.

Analysis:

- The Cambodian Delta Sub-area is a very diverse region in term of assets due to the numerous and varied watersheds and human settlements within the provinces concerned. The presence of the capital Phnom Penh provides a nexus for tourism, industry and business and is the seat of central government. The Chaktomuk area in Phnom-Penh is a highly productive fishing ground where are concentrated a number of fishing boats during the season. Furthermore, forests and mountainous relief particularly in the provinces of Kampong Speu and Kampot provide scenic vistas and rare biodiversity. The province of Takeo offers several tourism sites such as Phnom Chiso, Tonle Bati Temple, Tamao Mountain and Zoo.

- A synergy between sectors can be imagined so that tourism, for example, serves as a catalyst for other economic activities. For that to occur, close and constructive cooperation between ministries and institutions including the private

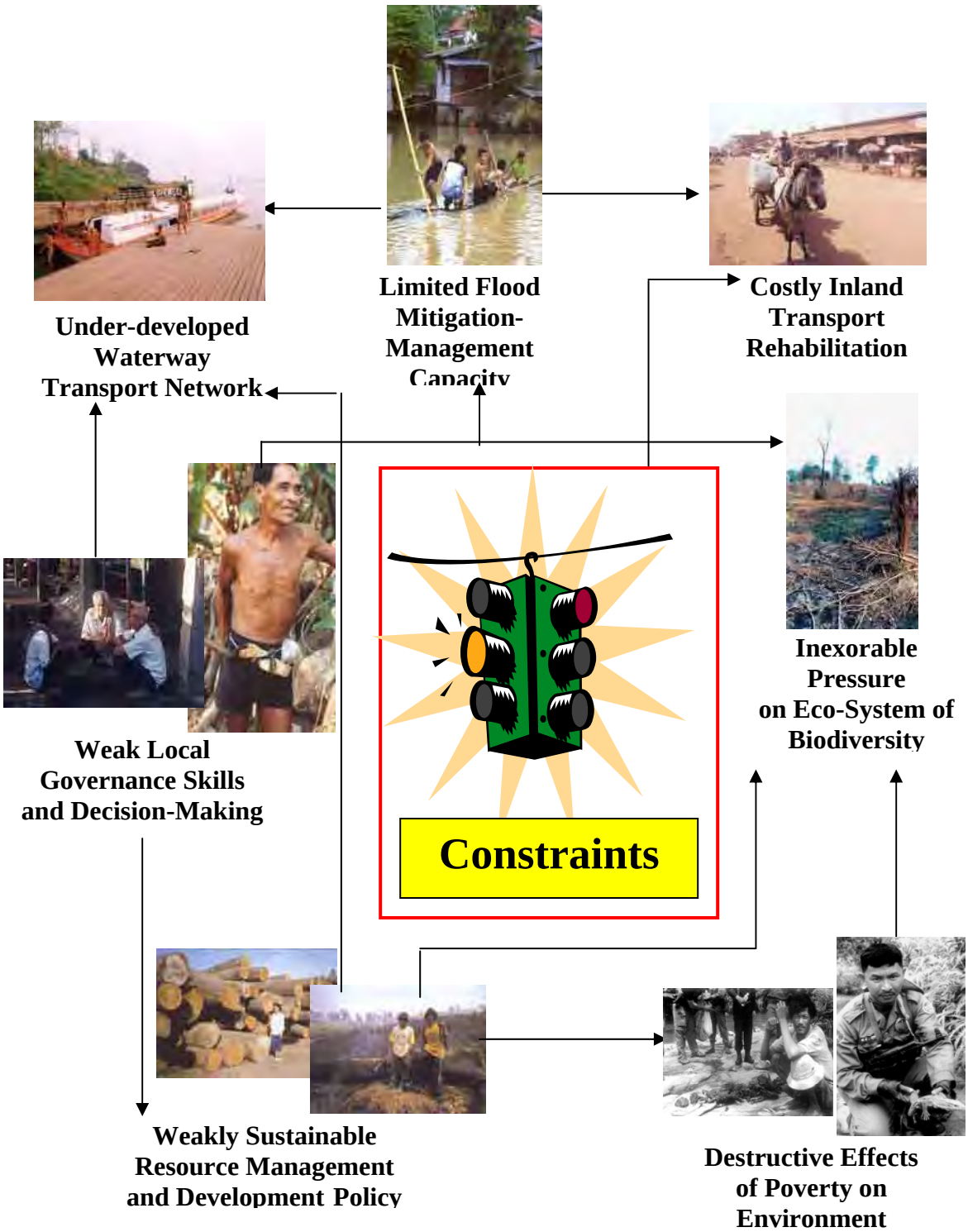
sector and the civil society should prevail over rivalries, bureaucracy and individualism.

– Foreign investment often provides a comfortable income to a limited group of influential and powerful individuals who are not much concerned about the common interest. Therefore, to maximize the benefit of the assets, the Government should ensure that the local people and the vulnerable are not marginalized, so that a fair sharing of benefits can be spread down to the lower levels and social peace and political stability preserved.

5.3. Needs and Priorities

– Strengthening and expanding agricultural sector
– Irrigation system
– Development of agricultural research system
– Road and waterway transportation systems
– Hydropower
– Agro-industry processing and processing craft
– Market for agricultural products
– Promote human resources development
– Expansion of clean water supply system
– Expansion of cities and markets
– Construction of solid waste disposal sites
– Protection of tourism areas
– Establishment of information network related with disaster
– Development of solid waste processing
– Establishment of site for liquid waste treatment in urban town
– Rivers, streams and canals rehabilitation
– Construction of saline intrusion system
– Repair and construct flood protection system
– Strengthen institutional education

5.4. Constraints



5.5. Risks of Intervention

Concerns and Priorities	Opportunities and Constraints	Interventions	Risks of intervention
Deforestation impacts on economy and society. Progressive disappearance of the flooded forest in the neighboring Tonle Sap Basin is a serious threat for fish reproduction and refuge where large numbers of people draw upon fishery resources for a high proportion of their subsistence and income needs. Flooded forest pays the highest tribute to this depredation: 54%	Presence of biodiversity eco-system is of interest for funding agencies. The unique ecosystem able to provide substantial and diverse resources to insure quality livelihoods. Strong conflict of interests. Weak local governance.	To prepare feasibility studies and project proposals for funding and submit to interested donors. To map and delineate which areas are to be preserved and which are allowed to be developed and to demarcate and patrol those areas designated for preservation. To develop alternative sources of income and employment for people responsible for degrading flooded forest. To what extent is this deforestation caused by outsiders (i.e. industrial interests who co-opt local people to develop the area, and those who live above the road coming down to farm in the flooded forest in the dry season? If the latter, then development/improvement of the upper areas will contribute to reducing pressure. To appeal to the highest powers to prevail upon them to reduce these activities and support the preservation of the remaining area. Another option is to publicize the problem so that public support is gained and pressure placed on these interests.	Dependence upon aid agencies and ban-king institutions. Over-exploitation of natural resources at the expense of the environment. Long process....

Concerns and Priorities	Opportunities and Constraints	Interventions	Risks of intervention
Industrial and anarchic exploitation are main causes of this depredation.	Enforcement of regulatory framework is challenged by impunity and highly profitable practices.	Capacity building and awareness raising on the issue.	Long process....
Decline of fishery resources is of great concern. Current captures contain hardly any large fish and was strongly dominated by small fish. Every year, between 1987 and 1993, the average area of eco-system which support fresh water capture fish has declined 9.7% equivalent to 30,150 ha.	Weak legal framework in Fishery Resources management and development.	To strengthen legal framework in fisheries resource management.	The long process does not fit with immediate individual interest.
	Weak local governance. Lack of government resources to conduct research and recommend measures.	To build capacity through "learning by doing", thus this intervention could best be combined with the intervention requesting assistance from the outside aid agencies as a means of addressing the core issues in a capacity-building and participatory manner.	
		Capacity building and awareness raising on the issue. Others who might be targeted include those who are damaging the resources as a whole, such as China (dam building on the upper Lancang/Mekong), those engaging in destructive fishing practices such as using illegal gears and explosive/electrical fishing.	
		It is best to formulate the problem and idea to solve it prior to approaching aid agencies in order to maintain more input and control of the solution.	Dependence on aid agencies.
	Overlapping mandate of acting institutions	To clarify respective mandates.	Conflict of interests.

Concerns and Priorities	Opportunities and Constraints	Interventions	Risks of intervention
There is an immediate need for poverty alleviation so that pressure on environment and fishery resources can be regulated and relieved. Prey Veng and Kampong Chhnang provinces have the highest rates of poverty in the Delta Sub-area with 15-20% and 10-15% respectively. No data is available for Svay Rieng, but one can assume that the poverty situation is similar to Prey Veng.	Tourism industry development will create a number of job opportunities. However how many of those opportunities are provided to the poorest people is the real question, because the poorest don't live where tourists tend to go for the most part. They are in a subsistence economy so don't produce things that tourists are interested in buying. They are the least trained and adapted to enter the service industry so are least likely to gain jobs from the tourist sector. The most concerning matter is the harm provoked by sex tourism industry on the most vulnerable people, especially young rural women and children (pedophilia). Road infrastructure improvement facilitate investments. Impacts on the poor remain to be assessed, but the expected results are to bring opportunities for the poor to access education and health services markets for their produce and to get to places where they can find seasonal jobs, knowledge and information.	Political appeals and campaigning: Appealing to the highest authorities appears to have an impact on returning control of some resources to the local people. This is often brought about through a campaign both through the media and other methods to raise public awareness and bring pressure on the authorities for change. To strategize tourism development plan to attract investment so that job opportunities are effectively enhanced.	Pressure on environment and social side-effects.

Concerns and Priorities	Opportunities and Constraints	Interventions	Risks of intervention
	Abundant fishery resources insure food security.	To enforce fishery res. management and development policy.	Conflict of interests.
	Even though rice is not very productive as yields are among the lowest in the region, there is certainly room for improvement. But other things should be considered such as using higher value rice varieties which, while bringing low yields, bring 2-3 times the price to farmers. The Delta sub-area is suited to the "Somali" fragrant rice in many locations, and twice the price is the equivalent of twice the yield. It is true that subsistence farmers are reluctant to diversify cropping until they have secured their main grain crop and so there needs to be serious efforts towards improving the main wet season rainfed crop that most farmers rely upon. Diversification will inevitably increase now through with the rehabilitation of the road network and connection to Thailand and Vietnam.	To develop irrigation system and infrastructure and fertilization programme. Despite the fact that there is no evidence of correlation between the potential for irrigation system and poverty, the farmers certainly contribute to smaller scale and less discrete methods of soil and water management, improved agricultural techniques, diversification and markets development.	No insurance for rice price due to competition of neighbor countries. Trained skills do not fit with labor market.
	A number of unqualified migrants.	To train and educate young people through non-formal education programme.	
	Weak provincial development policy and strategies.	To promote private sector investment through transparency, incentives and access to cheap and sufficient credit.	
	Difficulty in land law enforcement. Low salary/income.	To protect women from sex industry through law enforcement.	Long process....

Concerns and Priorities	Opportunities and Constraints	Interventions	Risks of intervention
Water pollution and solid waste disposal	No data available to know the state of water quality. Lack of resources of relevant institutions to tackle this issue. But the most pressing issue than institutions (that exist) are the facilities for solid and liquid waste disposal. Disposal of waste is a difficult issue requiring a choice of technology all of which have some negative impacts and overcoming local opposition to disposal sites the "NIMBY" syndrome "Not In My Back Yard". This is particularly acute and difficult with respect to toxic waste. Both those used in industries like agriculture (toxic pesticides) and illegal disposal of toxic industrial and solid waste from other countries which require enforcement of importation rules to prevent their entering the country. Increasing population pressure. Tourism development aggravates the problem. No waste recycling system to limit effects on environment. Lack of local understanding of pollution problem and impacts and widespread practice of littering.	To set up database on water quality and pollution. To clarify relevant government policy and strategies so that financial resources are mobilized. To enforce immigration law. To find balance between conservation needs and development policies. To enforce relevant government policy and strategies relevant to environment protection. To promote proper waste disposal and stopping littering through public information campaign.	Weak capacity pre-requires costly training of staff. Overlapping mandates leads to "laissez-faire". Costs for waste are high especially in comparison to dumping improperly. Corruption develops where opportunity to reduce costs or gain profit exists.

Concerns and Priorities	Opportunities and Constraints	Interventions	Risks of intervention
Wildlife sanctuary endangered by animal trafficking: Demand rising from neighboring and western countries increase pressure on local wildlife trade. Traditional medicine market encourages traders to capture wild animals in the reserve zone.	Attractive biodiversity and endemicity of fauna for research on preservation of endangered species.	To design appropriate research programme in partnership with funding agencies.	Low absorption capacity and scientific skills of local researchers.
	High potential in funding opportunities for preservation of fauna and environmental /ecological research. Impunity and collusion of powerful actors.	To develop research programme that fit with international concern.	Idem
		To enforce relevant government policy and strategies relevant to core zone protection. To continue ongoing campaigns against trafficking in wildlife and cultural property.	Conflict of interests.
Vulnerability to drought and flooding and crop failures.	Current production levels are low and could improve significantly without tremendous efforts.	Studies and research on traditional techniques and pilot projects to demonstrate their utility.	Small-scale efforts are less visible to donors and government so are lower priority.
	Irrigation infrastructure and land development have been handicapped by poor development of Khmer Rouge.	Proper engineering and rehabilitation of Khmer Rouge and other existing irrigation and drainage infrastructure.	Economic analysis of works is difficult.
	Flooding events are common both locally and basin-wide and appear to be increasing.	Examination of successful techniques in other countries such as “controlled drainage” and improved water management.	Many Khmer Rouge works are not economically viable or require significant investment when available funds are low.
	Understanding of traditional soil and water management techniques is limited due to losses of people and culture.	Promotion of small-scale techniques and improvement of agricultural extension services.	Low capacity and salaries of government staff.

Concerns and Priorities	Opportunities and Constraints	Interventions	Risks of intervention
Agro-industry development Food security and cash crop Small and Medium scale Enterprises Rural trade with Vietnam Watershed management Flood control and management and hydropower Irrigation	History of area is famous and proud legacy that could motivate restoration efforts.	Collection of required hydrological, meteorological economic and soils data required to improve designs. Working closely with local farmers to improve their situation and preparedness for disasters.	Lack of understanding of the value of data. Difficult and long process required to work with farmers on management entities. Lack of experience in these techniques.

5.6. Cross-Cutting Issues

5.6.1. Environment

– The commercial logging sector is characterized by active logging, often carried out on a cross-border basis. The demand for wood in Thailand and Vietnam, is a major factor driving logging in Cambodia and Lao PDR.

– Commercial forestry activity is often carried out on an unsustainable scale, with government regulatory controls sometime unable to prevent overexploitation**.**

– Increasing run off in logged areas can result in erosion, turbidity and sedimentation.

Table 23: Deforestation Rate in Lower Mekong Countries

Area	Deforestation Rate, %
Cambodia	0.50
Lao PDR	0.58
Thailand	0.40
Viet Nam	0.73
LMB	0.53

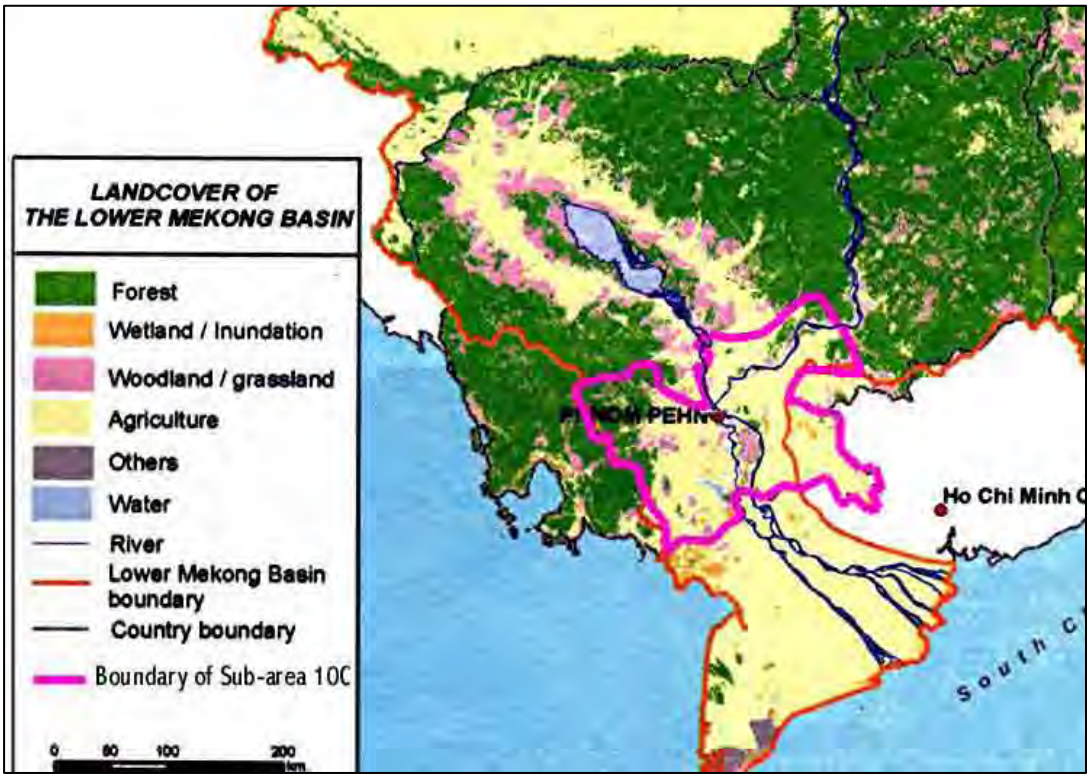
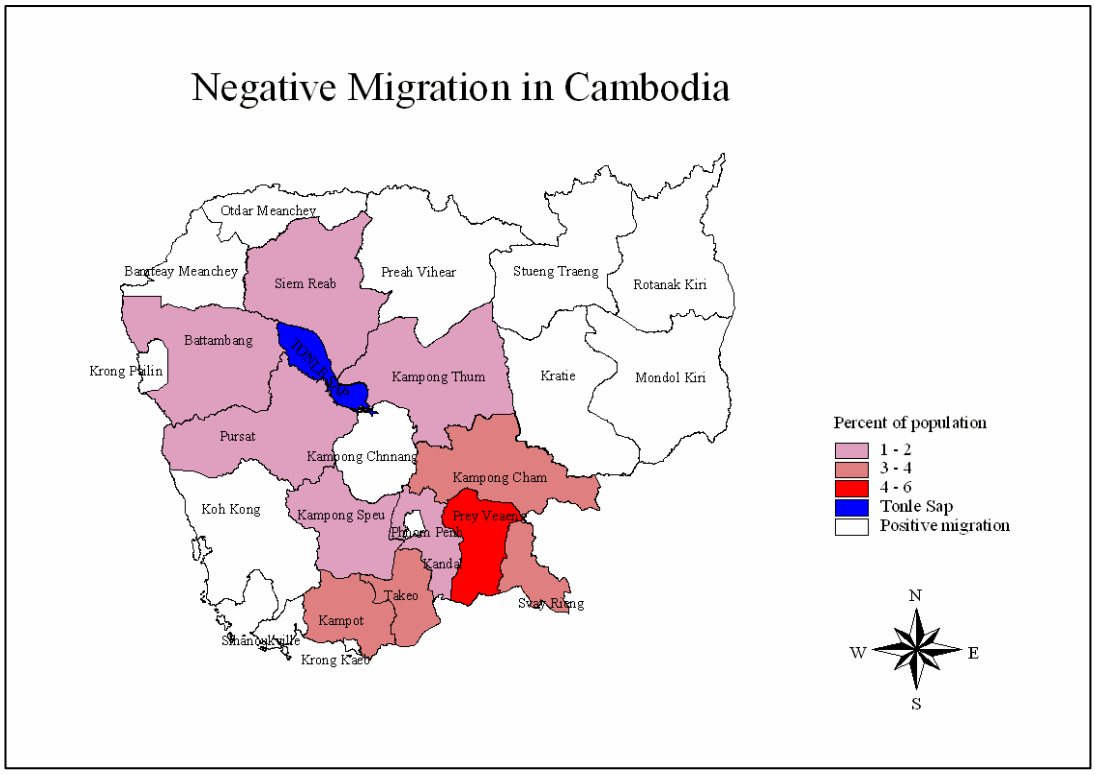


Figure 18: Land Cover of the Delta Sub-area

5.6.2. Population Pressure

Demographic pressure seriously impacts on resources exploitation which destructive practices impede equitable sharing of benefits. The population pressure on environment, by jeopardizing natural resources sustainability, is a major factor of aggravation of poverty for future generation.



Source: WUP-FIN

Figure 19: Negative Migration in Cambodia

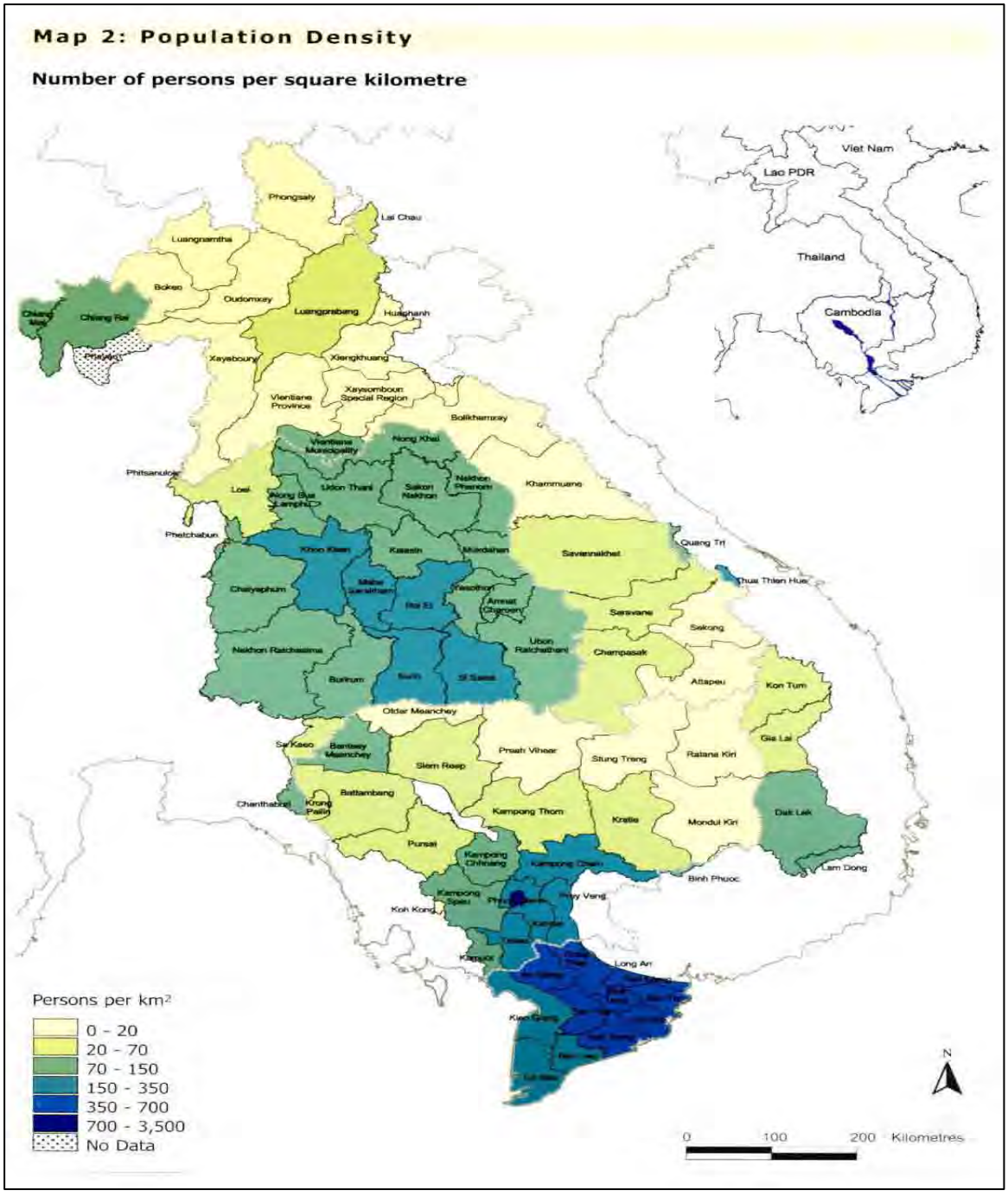


Figure 20: Population Density in LMB

5.6.3. Gender and Poverty

In Cambodia, women compose 65.9% of the economically active population and 54% of skilled agricultural actors and fishery workers (MRC, 2003d). No demographic data related to gender distribution is available in the Delta Sub-area. Women are vulnerable to deficient health care, HIV/AIDS, human trafficking and domestic violence.

Women literacy rate is 61.1% compared to 82.9% for men. Women have limited long-lasting employment opportunities.

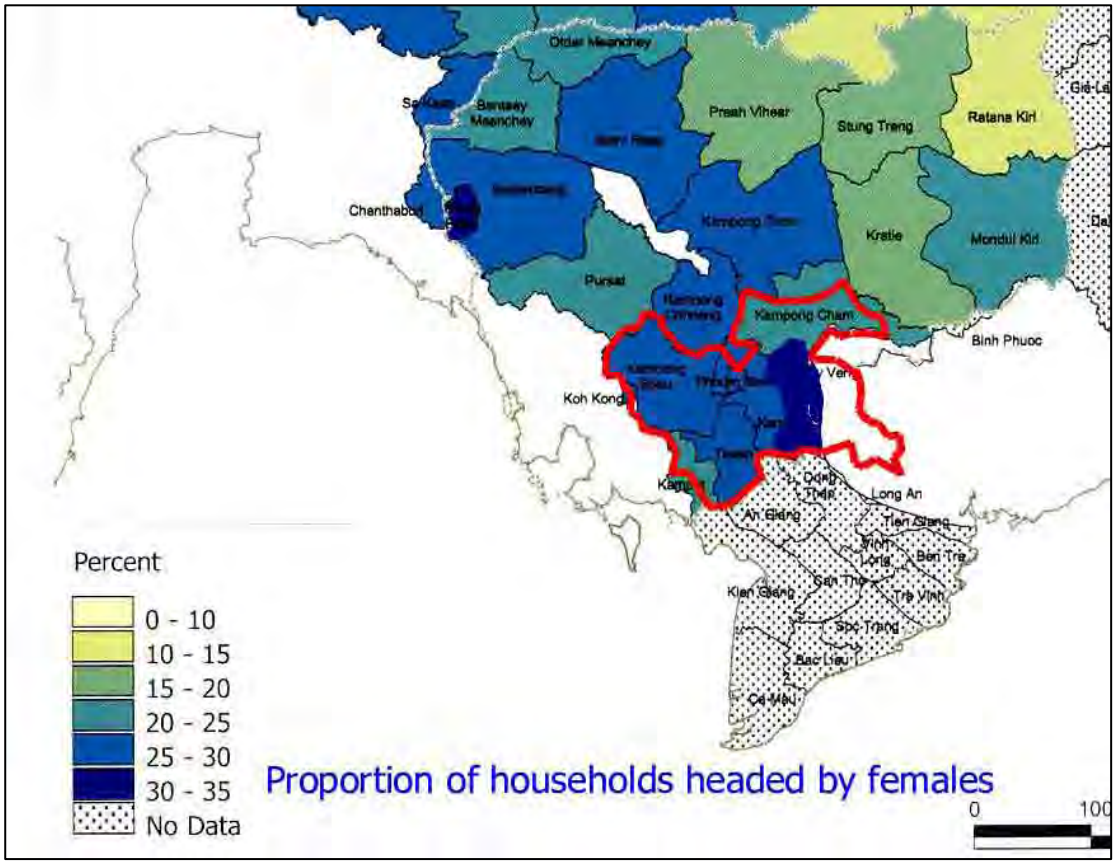


Figure 21: Proportion Households Headed by Female in the Delta Sub-Area

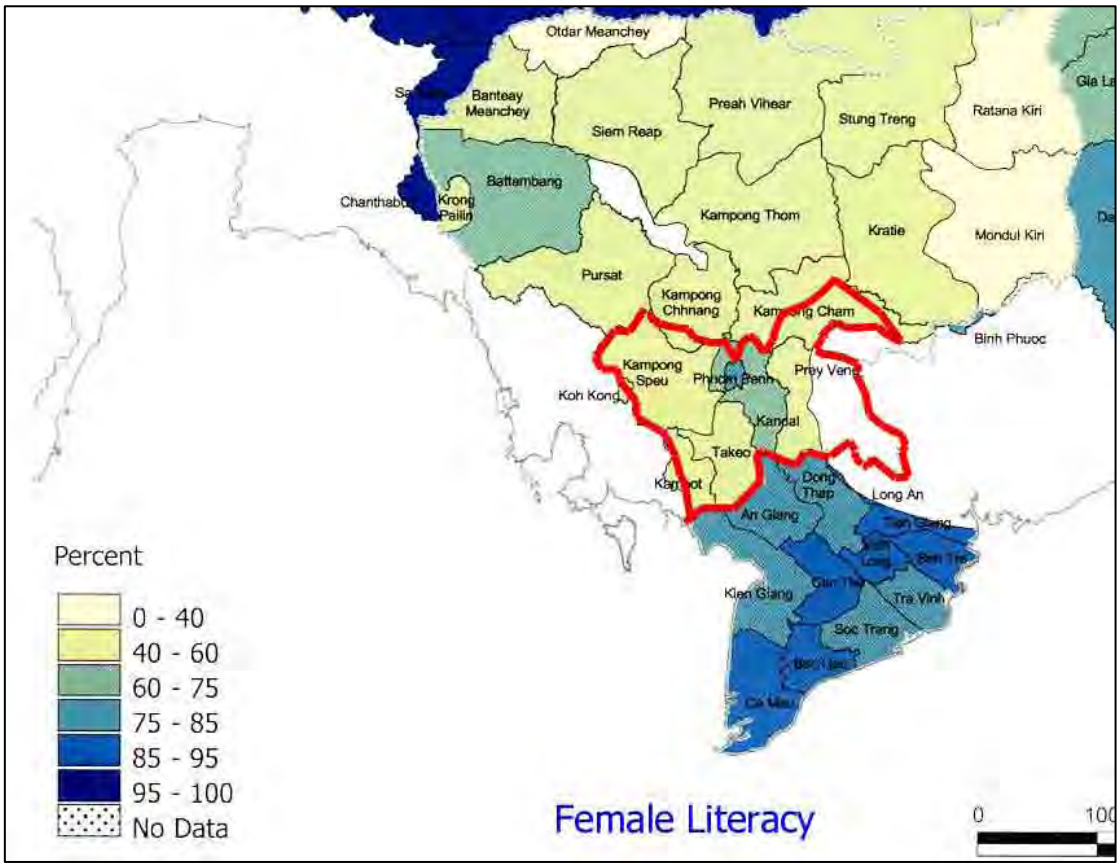


Figure 22: Female Literacy Rate in the Delta Sub-Area

5.6.4. Human Resources Development

Human resource development is one of the fundamental of the country's development. The creation of employment opportunities needs to be strongly supported by availability of well-trained people able to provide quality services.

Outside of Phnom-Penh, fewer than 20 percent of people of secondary school are enrolled in school. Most young people are working by this age, and the network of secondary school age is very sparse throughout much of the country. The average distance from a village to the nearest lower secondary school is estimated at 27 km, too far for daily travel (MOP, 1999).

Educated people often find that there are no jobs available for their skills due to the slow development of the private sector economy. This leads to frustration and loss of the resource as the people are not able to gain the experience needed to provide the benefit from their education.

The education system is not geared towards the needs of the employers. The rote learning method employed does not engender the analytical skills looked for by outside investors.

Post-secondary educational institutions of international standard and recognition do not exist within Cambodia. Students graduating from these institutions are too few to fill the large need for their quality of services.

Government staff with ability and training are often overworked; many leave for the private sector once trained resulting in a "brain drain". There is often no clear delineation between the public and private sector jobs of these staff with resultant confusion of roles, conflict of interest and lack of continuity in both sectors.

5.6.5. Public Participation

Public participation at all the levels, central, provincial, district and commune is a key factor of success in the context of decentralization. The many different aspects of civil society including the private sector need to be encouraged to join within the processes that are currently dominated by development agencies and government.

Gender is a major factor in public participation – as previously outlined in Issue #3, women's voices are seldom heard, particularly in comparison to their proportion of the population and workforce.

Participation is a key element in the success of all development – it allows design to incorporate local knowledge and concerns, people to gain ownership and makes long-term management and maintenance sustainable.

CHAPTER 6: STAKEHOLDERS AND DIALOGUE

Institutional capacity throughout the Royal Government of Cambodia (especially at the provincial, district and commune levels) is limited, because of the loss of almost an entire generation of people during the civil war, low salaries in the public service, run-down infrastructure, and other factors. To address this problem, the Government is implementing a variety of measures in administrative and governance reform. Capacity building is another concern with physical facilities and equipment, ongoing funding for operational expenses and human resources development required in MOWRAM, other water-related institutions, and the civil service as a whole. The RGC seeks a greater level of private sector and/or beneficiary involvement in water services provision (water supply, sanitation, hydropower, irrigation).

Given the difficult situation with respect to human resources and the identified widespread weakness in the concerned government agencies, a number of different efforts are required to gradually address these deficiencies. A key factor in overcoming the constraints is identifying them clearly. Some of these issues are discussed below.

6.1. The Cambodian Water Policy and Strategies

6.1.1. The Draft Water Sector Roadmap for Cambodia

Interesting initiatives to address the various water sector issues exist. For instance, a Draft Water Sector Roadmap for Cambodia has been presented by the Government to ADB and discussed in a consultation meeting on April 7th 2003. The roadmap summarizes the RGC's goals for the water sector in Cambodia and provides a basis for setting priorities and planning investment and development assistance. It also reviews the context provided by national goals for poverty reduction and socio-economic development. It provides an overview of the sector, and considers the issues and constraints that are faced. Finally it summarizes recent, current and planned activities and investment by international funding agencies. The road map does not actually define a single direction to go, but indicates the possible routes to many destinations, and the obstacles that must be overcome.

6.1.1.1. Sector Issues and Constraints

The key issues and constraints in the water sector have been classified in various ways by recent analyses, such as the National Water Sector Profile (MOWRAM, 2001). In this roadmap, issues are grouped into the following topics:

- Legislation and policy
- Institutional arrangements
- Institutional capacity
- Providing data and information
- Managing irrigation and drainage systems and other water-related infrastructure
- Mitigating the impacts of water-related hazards
- Managing competition for water and deteriorating water quality

- Conserving aquatic ecosystems and fisheries
- Managing international water resources
- Managing the coastal zone
- Financing water resources development and management

6.1.1.2. Summary of Issues and Constraints[7]

Legislation and policy

There is not at present a coherent body of water-related law, regulatory instruments, or policy. A draft Law on Water resources Management (WRM) is before the National Assembly, and a National Water Resources Policy is passed by the Council of Ministers in January 2004. Several sub-sectoral policies are at various stages of development or approval. Implementation of laws is generally weak, although advances are being made, e.g. in administering water pollution-related provisions of the Law on Environmental Protection and Natural Resources Management. The MOWRAM needs to develop the institutional capacity to administer the Law on WRM if/when it is passed.

Institutional arrangements

Several RGC line ministries have responsibilities for different aspects of water resources exploitation, while the CNMC deals with Cambodia's responsibilities under the Mekong Agreement. The MOWRAM was established in 1999 with a mandate to manage the Nation's water resources, but has directed its attention primarily towards irrigation and drainage (I&D). Inter-agency relationships tend to be competitive and uncooperative, although MOWRAM has reached formal agreements with several other ministries to delineate responsibilities. The RGC is devolving responsibilities to provincial and more local levels, which will require allocation of increased financial and trained human resources, to lessen reliance on non-governmental support. Institutional arrangements for managing I&D works are reasonably well-defined, with some lack of clarity regarding relative responsibilities of MOWRAM, MRD and MAFF for water management for agriculture. However, water management cannot be sustained because of limited government resources.

Institutional-Community capacity

Institutional capacity throughout the RGC (especially at sub-national levels) is limited, because of previously discussed problems in human resources development and management. The successful development of PPWSA as a public corporation is a good example of what is possible, and the RGC seeks a greater level of private sector and/or recruitment programme will be required, at both central and provincial/district levels, in areas such as water resources management, law enforcement, support for community

[7] Excerpt with some edits from: the Draft ADB "Roadmap" for the Cambodian Water Sector. Draft report on MRC participation in the ADB meeting on the Water Sector "Roadmap" for Cambodia, April 7th 2003.

groups, etc. This will assist the Ministry to evolve from a primarily construction and operation agency, to one that is able fully to carry out its mandate in water resources planning, management and regulation.

Providing data and information

The capacity of MOWRAM and other RGC agencies to provide the data and information required for design of water-related infrastructure, development and management of water resources, and management of extreme events (droughts and floods) is limited, although participation in international programmes in the dissemination of data and information about water resources and use (quantity and quality; surface water and groundwater), river basin characteristics, weather and climate is needed, in terms of a coordinated water and climate information strategy. Exchange of existing information among RGC institutions is not always efficient, because of a lack of awareness of what is available, a lack of formal mechanisms for obtaining access, and possessiveness regarding information assets. As a result, the heavy investment by international funding agencies in natural resources information has not been fully effective.

6.1.2. The National Water Policy

The National Water policy was passed by the Council of Ministers in January 2004. The National Water Resources Policy includes policies on exchange of data and information. Mechanisms and willingness to implement these policies will be required.

6.2. Analysis

If lack of human resource in terms of quantity and quality is recognized as the major factor of the institutional capacity weakness, a number of socio-political factors also impede national institutions from properly enforce existing law and regulations. In this context, there are a lot of limitations in the improvement of data accuracy and reliability, since statistics and figures generated by various institutions lack of consistency and comprehensiveness. Time, steady efforts, political willingness and success of public reform are prerequisites for change of mindset and behavior.

PART III

Sub-Area Scenarios and Development Strategies (Forum #2)

CHAPTER 7: KEY ISSUES

This chapter introduces economic and environmental development needs, opportunities and concerns for the Delta Sub-area. All main issues raised below resulted from the sub-area report, group discussions during the working sessions, Forum 1 and Forum 2.

7.1. Needs (20 year timeframe)

Irrigated Agriculture

1. Strengthening and expanding agricultural sector
2. Agro-industry processing and handicrafts
3. Irrigation system development
4. Maximized capacity of inland water use
5. Flood canal from Mekong or Bassac River to the poor water area
6. Sustainable use and management of agricultural land
7. Fragile soils improvement/management
8. Research and development system of agricultural science
9. Markets for agricultural products
10. Establish rural credit
11. Education and extension of agricultural techniques
12. Establish agricultural development community
13. Strengthen infrastructure
14. Human resources
15. Advanced agricultural production system
16. Enhance development of modern agricultural tools

Watershed management and natural resources

17. Protect the wetlands
18. Protect the river banks from erosion
19. Preserve and protect Chaktomuk area
20. Control siltation of the mainstream river and its tributaries
21. Rehabilitate rivers, streams and canals
22. Increase the natural forests by increasing reforestation
23. Strengthen law application and technique to protect the river bank
24. Balance groundwater exploitation between irrigation and rural water supply
25. Construction of saline intrusion system

Fisheries

26. Maintain the average of natural fish caught in the last 5 years
27. Increase natural fish stock
28. Strengthen the management of fishing community
29. Eradicate illegal fishing

30. Increased protection and preservation of flooded forests
31. Enhanced extension and application of fisheries law
32. Increased fish processing and seeking markets for products
33. Increased aquaculture

Water supply for domestic and industry

34. Expand and strengthen the safe water supply system for urban and rural areas
35. Promoting privatization in water supply sector
36. Solid and liquid waste management

Flood control

37. Flood control by establishing water release canal from the centre of Kandal, Takeo, Kampong Speu and Kampot provinces
38. Structural flood control: repair and construct flood protection system
39. Non-structural flood management
40. Establish disaster related-information network
41. Increase hydrological station
42. Increase regional cooperation in flood management

Navigation and transportation

43. Waterway, road and air transportation network

Tourism

44. Development of agro-tourism
45. Development of eco-tourism
46. Protection of tourism areas
47. Expansion and increase tourism areas
48. Increase extension of tourism information widely

Hydrology

49. Development of hydropower in Prek Thnot and Kirirom
50. Development of hydropower in other areas

Socio-economic issues

51. Food security
52. Increased incomes
53. Improving health and sanitation
54. Eradicate illiteracy
55. Improving gender balance
56. Access to electricity

57. Expanding the city and markets

Environmental issues

58. Construction of solid waste disposal sites
59. Control siltation of the mainstream river and its tributaries
60. Establishment of liquid waste treatment in urban towns
61. Development of solid waste processing
62. Increase people understanding about waste management
63. Preserve and protect Chaktomuk area

Human resources development

64. Strengthen institutional education
65. Promote human resources development
66. Increase efficiency in work and human resource management

Public participation

67. Opportunity to participate in the basin development plan
68. Opportunity to participate in the natural resource management and preservation
69. Organize agricultural development community (forestry, fisheries and water use)
70. Increase participation of people, donors and other organizations

Issues of institution and management

71. Strengthen institutional capacity and cooperation between institutions
72. Good governance, adequate number of institution according to the needs and high efficiency

7.2. Opportunities (20 year timeframe)

Irrigated Agriculture

1. Increase processing agro-industry and agro-business
2. Increase diversification of crops
3. Increase rice and agricultural production yields as well as quality
4. Increase off-farm income and job opportunities
5. Value-added processing of agricultural products by SMEs and cottage industry
6. Smallholder livestock development
7. Expand irrigation systems
8. Develop groundwater irrigation
9. Develop fee charging system for irrigation
10. Increase exportation potential of organic agricultural products
11. Increase farmers understanding capacity

12. Agricultural development communities (forestry, fisheries and water use)
13. Implement infrastructure and information systems for agricultural markets

Watershed management and natural resources

14. Preservation and management of the natural resources
15. Large scale water diversion from Mekong River across Svay Rieng Province

Fisheries

16. Increased aquaculture development
17. Maintain the stock of natural fish catch
18. Preserve the local fish species
19. Increase research in fisheries sector

Water supply for domestic and industry

20. Expand water supply and sanitation in urban and rural areas
21. Ensure water supply for industrial development
22. Promote private investment in the rural area

Hydrology

23. Establish hydropower dams
24. Promote private sector

Tourism

25. Increase tourism potential (qualities and services)
26. Development of agro-tourism
27. Development of eco-tourism
28. Protect the traditional culture
29. Increase off-farm income and job opportunities
30. Increase people income and livelihood

Navigation and transportation

31. Expanding road network and develop markets for agricultural products
32. Expand waterway along the main stream Mekong and Bassac rivers
33. Develop Cambodia-Vietnam cross-border navigation

Flood Control

34. Development of integrated flood, draught, irrigation and navigation management
35. Increase exploitation of flood advantage for sub-area development
36. Reduce disaster damages

Socio-economic issues

37. Ensure food security
38. Increase income
39. Increase local and international investments
40. Maintain and increase support of donors (national and international), NGOs and private sector
41. Promote micro-credit services
42. Increase people access to electricity

Environmental issues

43. Conserve the protected areas for preserving the ecology and development of ecotourism centers
44. Ensure environmental health
45. Sustainable development

Human resources development

46. Strengthen human resources
47. Improve human resources in techniques and technical areas

Public participation

48. Agricultural development communities (forestry, fisheries and water use)
49. Increase people's participation
50. Opportunity to participate in the basin development plan
51. Opportunity to participate in the natural resource management and preservation
52. Enhance implementation of decentralization system

Regional cooperation

53. Development of railway from Cambodia to Thailand and Vietnam
54. Development of national road Bangkok-Phnom Penh-Ho Chi Minh
55. ASEAN open Border and free Trade Policy

7.3. Concerns (20 year timeframe)

Irrigated Agriculture

1. Climate change
2. Environmental impacts due to ground water exploitation
3. Impacts from inadequate use of agro-chemicals
4. Limited human resources
5. Limited knowledge and skills of the farmers

6. Limited opportunities for application of advanced technologies
7. Land titling is costly and takes a long time
8. Limited efficiency of credit management
9. Health and population growth
10. Limited farmer participation

Watershed management and natural resources

11. Do not have clear policy and strategy for watershed management
12. Lack of data and study of hydrological system
13. Illegal logging and soil erosion
14. Efficiency of law execution is low
15. Expansion of agriculture depleting surface and groundwater
16. Mechanism for balancing between development and environment conservation is limited
17. Limited technological capacity

Fisheries

18. Illegal fishing methods and over fishing
19. Lost of fish habitats (clearing flooded forest for agriculture) and fish migration routes
20. Lost of natural fish species
21. Upstream Mekong dam development affects the water flow and ecology
22. Water pollution due to industrial development and advanced agriculture
23. Efficiency of law execution is low

Hydrology

24. Power and production means are costly
25. Lack of capital for development
26. Part of natural resources is lost

Tourism

27. Increase development of tourism will increase solid waste and water pollution
28. Social security has not been completely ensured
29. Expansion of contaminated and sex diseases

Water supply for domestic and industry

30. Water resources threatened (quantity and quality)
31. Change of water price and management

Navigation and transportation

32. Navigation system is not yet restored
33. Management of navigation system is limitedly efficient
34. Siltation of the river, streams and canals

Flood control

35. Changes of nature and river
36. Flood control system
37. Many construction of irrigation system in Vietnam

Socio-economic issues

38. Population pressure
39. Illegal settlement in the sub-area
40. Urbanization
41. Lack of budget
42. Lack of means and equipment
43. Limited market competition
44. Unemployment

Environmental issues

45. Floods and draughts incidence
46. Climate change
47. Water resource threatened
48. Environmental degradation and pollution – decline of natural resources, biodiversities and protected areas
49. Natural disaster
50. Impacts from hydropower development in the upstream
51. Overuse of agro-chemicals
52. Releasing of liquid waste to river
53. Issues of waste management (gas, liquid and solid wastes)
54. Increase of industrial wastes
55. Morphological change of the river, streams and lakes

Human resources development

56. Human resources management system is not yet well managed
57. Information system for market management is weak
58. Lack of information exchange systems within/between regions and sub-regions
59. Policy and salary level

Public participation

60. Limited public participation

Issues of institution and management

61. Coordination and cooperation between institutions are limited
62. Lack of investments
63. Efficiency of law execution is low
64. Overlap of responsibilities of institutions
65. Limited efficiency of loan management

CHAPTER 8: SCENARIOS AND ELEMENTS BY SECTOR

This chapter presents the results of the process to develop and refine the scenario elements (trends, risks, interventions) as undertaken by the Delta Sub-Area Working Group with the assistance of the Cambodian National Mekong Committee Basin Development Plan Team.

The chapter was prepared for the participants of the 2nd Stakeholder Forum for the Delta Sub-Area in order that the work could be reviewed by a wide range of stakeholders and to provide background on the basis for the development options, scenarios, strategies, and interventions that would be finalized during the forum.

8.1. Scenarios and Elements by Sector

8.1.1. Irrigated Agriculture

Trends	Risks	Interventions (Implementers & Donors)
Production of surplus instead of for consumption	Droughst and floods incidence	Agricultural Quality Improvement Project (MAFF – AusAID)
Increased agricultural production	Climate change	Cambodia-Australia Agricultural Extension Project (MAFF – AusAID)
Producing based on market demands	Changes in agricultural market	Agriculture Project (IFAD, FAO)
Demand of new food types	Soil nutrient degradation	Poverty reduction policy for agricultural sector
Agro-industry development: agricultural production, processing and trading	High cost of Genetic Modified Organism	ASDP Programme
Increasing diversification of cropping	International economic policy	APIP II (WB), RPRP, IFAD
Increasing agricultural intensification	Products competition with the neighboring countries – market crises	SEILA
Selection of crop varieties that require less water consumption	Outbreak of animal diseases	Animal prevention project (WHO)
Maximization of irrigated land, ha?		Private investment association in Agriculture
Strengthening water user		

community and agricultural development community		
Modernising agriculture		
Small-scale livestock development		

8.1.2. Watershed Management and Natural Resources

Trends	Risks	Interventions (Implementers & Donors)
Decrease of catchments area due to the expansion of farming	Degradation of river ecology	Community forestry Project (RGC – Concern)
Decrease of areas of natural forest due to expansion of farming	Water resource threatened	Forest Crime Monitoring Project (MAFF – WB)
Decrease of flooded forests	Changes of water flow - flood	Wetlands Classification Project (MRC-ANIDA)
Increasing community forestry development	Loss of biodiversities	Wildlife and Conservation Projects (MoE-WWF/WCS/FFI)
Strengthening forestry community		Cambodian Roadmap for Water Sector (MOWRAM-ADB)
Increasing erosion of earth cover		
Increasing of ground water use for agriculture and industries		National Water Strategies (MOWRAM – ADB)
Improving surface and ground water uses		Watershed Management Programme MRC-GTZ
Increase of sedimentation in rivers, streams, and canals		
Morphological change of Chaktomuk River		
Loss of natural resources		

8.1.3. Fisheries

Trends	Risks	Interventions (Implementers & Donors)
Extinction of some natural fish varieties	Loss of natural fish resources due to degradation of river ecology, loss of fish habitats, illegal fishing, climate change, overuse of agro-chemical	Improvement on Regulation and Management Framework of the Freshwater Fisheries MAFF-ADB)
Degradation of fish habitats: forest, flooded forest, wet land	Changes of flow regime due to Mekong upstream development	New Fisheries Law (MAFF – ADB)
Strengthening fisheries community	Impact of hydropower dam development	Fisheries Community
Intensification of aquaculture for export		Environment Law
Increase of family aquaculture		Land Administration Law
		Natural Resources Conservation Project (DANIDA-FAO)

8.1.4. Water Supply for Domestic and Industry

Trends	Risks	Interventions (Implementers & Donors)
Expansion of clean water supply service for increasing population, tourism sector and industry	Water resources threatened	Provincial and Peri-Urban Water Supply Project (MIME-ADB)
Increasing need for sewage and solid waste management	Floods and droughts incidence	Seila Programme (RGC-UNOPS, WB)
	Environment pollution	Rural Development Programme
	Degradation of water quality due to no waste management system	

8.1.5. Flood Control

Trends	Risks	Interventions (Implementers & Donors)
Changes in flood regime	Changes of flood regime	Emergency Flood and Flood Emergency Rehabilitation Projects (RGC-ADB/WB)
Increase exploitation of flood advantage for sub-area development	Impact on land ownership	Land Administration Law
	Increased population and migration continue	Flood Management and Mitigation Programme MRC
	Construction	
	Crops damage	

8.1.6. Navigation and Transportation

Trends	Risks	Interventions (Implementers & Donors)
Increased transportation through waterway, road and airway	Sedimentation of waterways	National Road No.1 Rehabilitation Projects (MPWT – ADB/WB)
Increased ports in provinces within the delta sub-area	High development of communication network and transportation through road, railway and airway	Neak Leoung Bridge Construction Project (MPWT-JICA)
Increasing need for navigation and waterway transport in tourism sector	Loss of biodiversities	Navigation Programme of MRC
	Environment pollution	
	Develop navigation cooperation with Vietnam	

8.1.7. Tourism

Trends	Risks	Interventions (Implementers & Donors)
Increasing number of tourists both national and international	Incidence of contaminated diseases	Governance/UNICEF
Development of ASEAN and GMS tourism	Increased introduction of foreign civilization	Environment Law
Increased tourist resorts	Environment pollution	National Programme for contaminated Diseases Prevention
Promote eco- and agro-tourism development		

8.1.8. Hydropower

Trends	Risks	Interventions (Implementers & Donors)
Higher electricity demand	Water shortage for operation	Water Resources Management Law
Development of hydropower at 3 sites: Kirirom, Prek Thnot and Kamchay	Low productivity of hydropower	Mekong Agreement 1995
Power generation by petrol and solar energy	Impact on fisheries sector	GMS Cooperation Framework
Changes of water flow regimes due to hydropower dams construction	Social, economic and environmental impacts of hydropower development	

8.2. Scenarios and Elements by Cross-Cutting Issues

8.2.1. Socio-Economic Issues

Trends	Risks	Interventions (Implementers & Donors)
Demographic pressure: growth rate 2-2.5%	Poverty	Seila Programme (RGC – UNOPS, WB)
Poverty of vulnerable people	Land conflict	Land Administration Law
Increased people migration	Urban migration – village abandon of rural people	Millennium Poverty Development Goals of Cambodia

Increasing of jobless persons	Increased sex trafficking and sex diseases	Poverty Reduction Strategies
Need for gender balance	Incidence of human and animal diseases	Socio-Economic Development Plan of the Royal Government of Cambodia
Access to sufficient water supply in rural and urban area	Lack of transparency and governance continue	
Land ownership conflict	Dependency on foreign aid	
Changes in living stile	Increased foreign ownership/overseas control	
Encourage economic growth		

8.2.2. Environmental Issues

Trends	Risks	Interventions (Implementers & Donors)
Water resource threatened	Droughts and floods	Seila Programme
Need to be protected from natural disaster	Water resources threatened	Natural Resources and Environmental Management Programme (RGC-DANIDA)
Gradually increasing use of chemical fertilizers and insecticides	Environment and natural resources degradation	Environment Law
Increase industries and waste	Increased liquid and solid wastes	Implementation of Agenda 21
Increase motorization use	Increasing of sedimentation in river, streams and canals	Protected Areas and Development MOE-IUCN
Increased construction and public infrastructure development	Morphological change of Chaktomouk river	Environment Programme MRC
	Increased degradation of land cover	

8.2.3. Human Resources Development

Trends	Risks	Interventions (Implementers & Donors)
Increasing needs of modern technology		
Increased capacity and understanding on natural resources and environmental management		
Development of data and information system (non collective data) and updating		

8.2.4. Public Participation

Trends	Risks	Interventions (Implementers & Donors)
Decentralization and deconcentration process on-going	Unclear process/approach	
Strengthen decentralization and deconcentration policies	Lack of participation from private sector in natural resources management and conservation	
Increase efficiency of public participation		
Implementation of River Basin Organization or Watershed Management Committee		

8.2.5. Issues of Institution and Management

Trends	Risks	Interventions (Implementers & Donors)
Issues of Institution and Management	***Regional Cooperation***	***International Cooperation in the Mekong and ASEAN Region***
Increased cooperation between the Mekong countries	Illegal settlement	ASEAN Open Border Policy and Free Trade (RGC-ASEAN)

ASEAN open borders policy enables interaction and development of cooperation network with the neighboring countries		Economic Cooperation Strategy between Cambodia, Lao, Myanmar and Thailand, namely (RGC): - trade and investment facilitation; - agricultural and industrial cooperation; - transport linkages; - tourism cooperation; and - human resources development
		1st and 2nd East-West Economic Corridor (RGC – ASEAN)
		Greater Mekong Sub-region Programme for tourism, navigation, agriculture and watershed management (RGC-ADB)
		Japanese Support to Mekong Region Development in the identified "Three Pillars of Concrete Actions" (RGC-JICA): - Enhancing economic cooperation; - Promoting trade and investment; and - Strengthening consultation and coordination.

CHAPTER 9: SUB-AREA DEVELOPMENT OBJECTIVES

9.1. Introduction

This chapter presents the results of the process to develop and refine the development objectives as undertaken by the Delta Sub-Area Working Group with the assistance of the Cambodian National Mekong Committee Basin Development Plan Team.

The chapter was prepared for the participants of the *2nd Stakeholder Forum* for the Delta Sub-Area in order that the work could be reviewed by a wide range of stakeholders, augmented and refined, and finalized for submission within the overall program of the Basin Development Plan.

The chapter takes as its starting point the preliminary development objectives as developed and presented in chapter 7 and chapter 8: ***Key Issues and Scenario Elements, Delta Sub-Area***. A two-step process is then presented whereby the preliminary development objectives are categorized and then reorganized in related groups. These groups provide an overall development objective with some sub-objectives and specific targets to be achieved within the 5- to 10-year and 20-year timeframes.

The results are then used as the basis for preparing strategies to achieve the development objectives as presented in chapter 10: ***Strategies, Delta Sub-Area***.

Finally, the objectives were consolidated, refined and subsequently improved by incorporating all comments and suggestions made by the participants during the *2nd Stakeholder Forum* for the Delta Sub-Area as presented in this chapter.

9.2. Organization and Grouping of Development Objectives

Development Objective 1: To Ensure Short-term and Long-term Food Security and Safety for the Poor

Sub-Objective 1.1:	Reduced crop failure risk and increased rice and other crop yields in order to meet the poorest people's basic grain security requirement and to enable them to move into the market economy.
Sub-Objective 1.2:	Increased cropping seasons per unit land-growing area and improved small-scale livestock production.
Sub-Objective 1.3:	Aquaculture promoted while critical resources of natural fisheries are conserved in the form of habitats and migration routes.
Sub-Objective 1.4	Sufficient off-farm employment available as well as other income generating and saving activities through services

provision in the forms of rural credit, agricultural extension, business skills and marketing information.

Specific Targets:

5-10 Years	20 Years
80% food security	100% food security
2.0-3.0 tons/ha average for rice	3.0-4.0 tons/ha average for rice
2 crops per year for rice and 20% for other crops	2 to 3 crops per year for rice and 40% for other crops
2 cattle, 10 poultry/family	5 cattle, 10 poultry/family
20% of farmers with access to mechanization	50% of farmers with access to mechanization
30,000 tons local aquaculture production	50,000 tons local aquaculture production
Sustain average natural catch of last 5 years	Sustain average natural catch of last 5 years
At least one member of family engage in off-farm income generating activities	At least one-thirds of family members found jobs in off-farm activities
Market number and size doubles	Bank branch facilities and credit services at Commune level

Development Objective 2: Increased Agricultural Production, Ensured Quality and Standard, and Diversified Products for the Markets

Sub-Objective 2.1: Improved cropping patterns, post-harvest technology and management.

Sub-Objective 2.2: Diversified agricultural production with industrial crops and vegetables and promoted value-added agro-processing industry.

Sub-Objective 2.3: Commercial agricultural production zones and specialized agricultural development communities established towards market-oriented economic efficiency.

Sub-Objective 2.4: Improved information system for agro-business and marketing network development for domestic, regional and international markets.

Specific Targets:

5-10 Years	20 Years
20% increase in grain production	50% increase in agricultural production
40% of some agricultural produce meets international standard and quality for exports	70% of some agricultural produce meets international standard and quality for exports
Domestic markets contain and use mostly locally produced vegetables, crops and meats	International hotels using all locally produced vegetables and meats
$40 millions foreign exports (esp. Thailand and Vietnam)	$70 millions foreign exports (esp. Thailand and Vietnam)
25% increase in diversified commercial industrial crop production	50% increase in diversified commercial industrial crop production
$70 million investment in agro-industry	$200 million investment in agro-industry
30% of producers access market information and networks, both domestically and regionally	60% of producers access market information and networks, both domestically and regionally

Development Objective 3: Improve the Utilization and Management of Water Resources and Soil

Sub-Objective 3.1: Secured domestic clean water supply and sanitation for both rural and urban areas.

Sub-Objective 3.2: Increased irrigated and drained areas by constructing small-scale irrigation structures, upgrading and rehabilitating existing water reservoirs and drainage systems in order to ease flooding and drought problem.

Sub-Objective 3.3: Groundwater resources measured and monitored and balance achieved between replenishment, increased use for irrigation and continued use for rural and urban water supply.

Sub-Objective 3.4: Efficient use and cost recovery for both domestic and industrial water supply and irrigation.

Sub-Objective 3.5: Wastewater treatment and proper management of liquid, gas and solid waste in urban areas.

Sub-Objective 3.6: Improved on-farm integrated soil fertility and water management.

Specific Targets:

5-10 Years	20 Years
50% access to safe water in rural areas	70% access to safe water in rural areas
80% access to safe water in urban areas	100% access to safe water in urban areas
30% improved sanitation in rural areas	50% improved sanitation in rural areas
50% improved sanitation in urban areas	85% improved sanitation in urban areas
All industry sufficiently supplied	All industry sufficiently supplied
10% urban wastewater treatment and management of solid and liquid disposal	50% urban wastewater treatment and management of solid and liquid disposal
200,000 ha irrigation and drainage area increase	600,000 ha irrigation and drainage area increase
25% increase in irrigation efficiency	50% increase in irrigation efficiency
10% sub-basin management committees established and functioning	50% sub-basin management committees established and functioning
One emergency aid event/province/year	One emergency aid event/sub-area/year

Development Objective 4: Sustainable and Sound Natural Resources and Environmental Management and Best Practices Established

Sub-Objective 4.1: Promoted integrated watershed management and maintained seasonal flow regime for all tributaries and equitable utilization and sustainable management of natural resources.

Sub-Objective 4.2: Wildlife sanctuaries and protected areas established and conserved, and riverbank and morphology of the Chaktomouk junction maintained.

Sub-Objective 4.3: Effective and sufficient legal and regulatory framework for natural resources and environment management in place and reinforced.

Sub-Objective 4.4: Flood events continue to provide beneficial effects while impacts are drastically reduced and managed through community awareness and preparedness.

Specific Targets:

5-10 Years	20 Years
50% of sub-catchments have management committees established and have adopted integrated watershed management	70% of sub-catchments have management committees established and 50% are functioning effectively
30% of local communities organized for natural resources use and environmental management	70% of local communities organized for natural resources use and environmental management
Hydro-meteorological data collection, mapping and studies completed in 50% of catchments	Hydro-meteorological database established and regularly operated, catchment studies and mapping completed for all catchments
Successful conservation pilot projects for uplands, soil and water management and floodplain protection implemented	Pilot approaches implemented over 50% of catchments
Flood preparedness plans established throughout affected areas and communities trained and mobilized.	Flood preparedness measures implemented annually with minimal loss and damage.

Development Objective 5: Promote Tourism as an Engine for Economic Growth and Opportunity for Off-farm Income Generating for Local People

Sub-Objective 5.1: Increased cultural tourism and expanded interest of visitors to wider areas while traditional and cultural values of local people are conserved with secured benefit to the local economy.

Sub-Objective 5.2: Eco-tourism and agro-tourism is promoted along the Mekong River and expanded to other attractive wildlife sanctuaries and protected areas, as a means of promoting conservation and uplifting livelihoods for local communities.

Sub-Objective 5.3: Improved service delivery and infrastructure and other associated tourism amenities in order to secure longer and more comfortable stays of visitors.

Specific Targets:

5-10 Years	20 Years
5 additional major ancient tourism sites developed and improved	Overall regional tourist network developed and strengthened
0.5 million tourists/year	1.0 million tourists/year
Average stay 3-4 days	Average stay 5-7 days
3 major eco-tourism sites developed and improved	5 major eco-tourism sites developed and improved
4 agro-tourism pilot areas developed and improved	5 major agro-tourism sites developed and improved

Development Objective 6: Enhanced River Transport and Power Infrastructure Developed as a Foundation for Economic Growth

Sub-Objective 6.1: Rehabilitated and new floodplain channels on and between the Mekong and Bassac Rivers for navigation routes, irrigation and drainage and promoted waterway transport and river ports rehabilitation and construction in the sub-area.

Sub-Objective 6.2: Development of electricity distribution network and preparation of feasibility studies and development of multi-purpose hydropower dams with due consideration of environmental sustainability, economic profitability and social justice.

Specific Targets:

5-10 Years	20 Years
1 new bridge constructed across the Mekong River and major issues relating to physical and legal issues addressed by Cambodia and Vietnam for navigation routes in the Mekong and Bassac river	100 sea vessels per year docked the Phnom Penh river port via the Mekong and Bassac navigation routes
2 feasibility studies for hydropower and potential site exploration	2 feasibility studies and 2 construction projects
2 floodplain channels rehabilitated with year–round navigation and irrigation	5 floodplain channels rehabilitated with year-round navigation and irrigation
3 river ports rehabilitated and improved	3 river ports rehabilitated and improved

along the Mekong river	and 2 newly constructed ports along the Mekong river
1 bridge across Bassac river in Kandal province constructed for ASEAN Highway	1 bridge across Chrey Thom river between Cambodia and Vietnam border constructed (National Road No. 21)

Development Objective 7: Strengthened Human Resources Development and Management and Institutional Capacity Built

Sub-Objective 7.1: Increased and equipped local communities with skills and techniques in farming, trading and processing of agricultural produce.

Sub-Objective 7.2: Increased awareness and participation of local communities, particularly women in the natural resource use and management.

Sub-Objective 7.3: Improved technical capability of provincial staff in the areas of natural resources and environmental management, planning, coordination.

Sub-Objective 7.4: Strengthened local research capacity and skills for natural resources and environmental management, planning and conservation, and established regional linkages with research and training institutions.

Specific Targets:

These are cross-cutting issues that are difficult to measure and monitor. They will be addressed by integrating human resources development and management into all project activities.

CHAPTER 10: SUB-AREA DEVELOPMENT STRATEGIES BY SECTOR

10.1. Introduction

This chapter presents the results of the process to develop and refine the strategies for achieving the development objectives as undertaken by the Delta Sub-Area Working Group with the assistance of the Cambodian National Mekong Committee Basin Development Plan Team.

The chapter was prepared for the participants of the *2nd Stakeholder Forum* for the Delta Sub-Area in order that the work could be reviewed by a wide range of stakeholders, augmented and refined, and finalized for submission within the overall program of the Basin Development Plan.

This chapter takes as its starting point the development objectives as presented in the chapter 9: ***Development Objectives, Delta Sub-Area***. A three-step process was undertaken. First, the individual sub-objectives were examined as the basis for preparing "brainstormed" strategies that would address the goals. Next, these strategies were grouped together on the basis of sectors and cross-cutting issues. The results of these first two processes are contained in the tables in the chapter 7 and chapter 8: ***Key Issues and Scenario Elements, Delta Sub-Area***. Finally, the strategies were consolidated, refined and subsequently improved by incorporating all comments and suggestions made by the participants during the *2nd Stakeholder Forum* for the Delta Sub-area, as presented in this chapter.

The sectors and cross-cutting issues are as follows:

A. Irrigated Agriculture
B. Fisheries/Aquaculture
C. Watershed Management
D. Tourism and Recreation
E. Water Supply, Waste Management and Sanitation
F. Hydropower
G. Navigation and Transport
H. Flood and Drought Control and Management
I. Environmental and Natural Resources Use and Management
J. Private Sector and Markets
K. Capacity Building and Human Resources Development
L. Stakeholder Participation
M. Trans-Boundary Issues

The results are then used as the basis for preparing interventions and project ideas as presented in the chapter 11***: Project Interventions and Ideas, Delta Sub-Area***.

10.2. Development of Strategies by Sector/Sub-Sector

A. Irrigated Agriculture

Address basic environmental constraints, intensify and diversify agriculture to achieve food security and to supply domestic, regional and international markets:

- Improve Develop small-, medium- and large-scale infrastructure for irrigation and drainage including groundwater irrigation, rehabilitation of existing schemes, construction of water storage reservoirs and canal networks throughout the floodplain, increasing drainage through the Vietnam-Cambodia border, feasibility study of diverting flow from the Mekong River through Svay Rieng Province and the Vaico River, and make best use the availability of surface water and promotion of groundwater study.
- Establish a research-extension and development programmes/centers for sustainable farming systems including mainstreaming environmental issues in agriculture, alleviating problem soils, landscape farming, soil-water and tillage management, green manuring, good quality of variety, soil and water conservation and post-processing techniques.
- Provide support services, inputs and markets to farmers by forming cooperative farmer organizations and linking them to credit, private sector SMEs and agro-industry, agro-business and improving the quality and outreach of government extension services.
- Promote private sector investment and cooperation in areas of comparative advantage through promotion and certification of organic farming, grassroots information provision on markets and technology, export promotion and tariff reduction, incentives and security for investors, transparency, and designation of agricultural production zones.
- Promote smallholder and commercial livestock production including the establishment of animal health laboratories at national level and hygiene slaughter houses in order to ensure the international standard of quality such as WTO and OIE and to satisfy the needs of domestic and foreign customers.

B. Fisheries/Aquaculture

Promote careful small-scale aquaculture development while ensuring the continued viability and health of natural capture fisheries:

- Extend existing aquaculture projects to smallholder farmers; provide access to fingerlings, techniques, feed and markets and training on environmental and economic management of small-scale aquaculture.
- Research into critical issues of natural capture fisheries and identification of important habitats and migration routes, a community-based management of their

conservation and educational campaign on non-destructive fishing methods and local fish species conservations.

- Cooperation, study and information sharing between riparian nations and sub-catchments to address critical natural fisheries issues of habitat, migration, water quality and flow regimes.

C. Watershed Management

Implement integrated watershed management to improve environmental management, water resources allocation, coordinate stakeholders and agencies, encourage adoption of international agreements and plans and assist in conflict resolution:

- Establish pilot projects in watersheds to develop and demonstrate a framework for cooperation among concerned agencies and stakeholders that incorporates bottom-up participatory processes and promotes soil and water conservation, preservation of biological resources, allocation of water resources between competing uses, promotion of cost recovery, and assists in coordination, planning and conflict resolution.
- Cooperate with watershed management organizations to address key natural resource issues of groundwater use and management, conservation of protected areas, wildlife reserves, forests, river ecology and wetlands, riverbank protection and maintenance of the morphology of the Chaktomouk junction and other critical portions which stretched along the National Roads, and to provide training and awareness-raising of best practices and important environmental issues.

D. Tourism and Recreation

Develop and expand attractive tourist sites, physical infrastructure and facilities:

- Expand, develop and improve archaeological and cultural sites by restoring and preserving the existing monuments and religious temples, improving physical infrastructure, security and accessibility to the sites.
- Develop eco- and agro-tourist sites along the Mekong River and in the other most attractive conservation areas by revitalizing local social and cultural events with improved festivals and annual programmes and linking with tourist networks and regional cooperation through ASEAN and GMS initiatives.

Maximize the benefits of tourism for upgrading the livelihood of the poor by involving local communities in income generation opportunities from tourism:

- Improve the delivery of tourist services by encouraging local communities and the private sector to work together for better provision of services by providing good and reliable information, accommodations, catering and transportation and by linking visitors to villages and promotion of site-specific local handicrafts.

- Community-based natural resource management with local ownership, responsibility and rights for common local resources including cooperation with commune councils and the watershed planning organization.

E. Water Supply, Waste Management and Sanitation

Expand and improve the quantity, accessibility and quality of water supply in urban and rural areas:

- Privatize the water supply in urban and peri-urban areas, including small- and medium-scale water supply systems using rainfall, groundwater and the surface water sources.
- Ensure the quantity and quality of rural water supply through monitoring and evaluation of water sources, increasing investment in water points and protection of the resource base.

Solid and liquid waste management in urban and rural areas:

- Develop a Master Plan for Solid, Liquid and Gas Waste Management and Processing including technical and zoning considerations, a legal framework for water quality and waste disposal, and an enforcement mechanism.
- Promote recycling and treatment of urban wastewater for wetlands, irrigated agriculture and soil quality improvement and encourage construction and use of sanitary latrines in rural areas.
- Invest in recycling and disposal of solid waste following sound environmental principles and cost recovery.

F. Hydropower

Progressively develop the coverage of the electrical grid and construct the hydropower dams with the best potential in the Sub-Area:

- Cooperate with other ASEAN member countries to extend the Regional Power Grid through transmission lines throughout the entire country, especially the remote areas.
- Develop provincial and rural electrification schemes through private sector fossil fuel generation and micro-hydropower in more remote areas with the participation of and cost recovery from the local communities.
- Select hydropower projects with the best potential for feasibility study with multi-purpose uses including irrigation and flood control, particularly the Prek Thnaut Hydropower Project, and construct if feasible while addressing negative social and environmental impacts.

G. Navigation and Transportation

Promote private and public sector investment in inland transportation in both urban and rural areas through studies, construction and maintenance of economically advantageous transport networks and facilities:

- Revitalize the competitiveness of Phnom Penh Port through cooperation with Vietnam to improve river navigation in the Mekong and Bassac River navigation routes including dredging, minor port and landing construction, rapid customs inspection, and simplified border and transit formalities.
- Encourage private sector financing of the construction and maintenance of a network of channels and ports in the floodplain with cost recovery from users from transport tolls and irrigation service fees.

H. Flood and Drought Control and Management

Reduce the economic, social and environmental damage that occurs as a result of floods, droughts, watershed degradation, erosion and sedimentation:

- Cooperation and exchange of information with the other Mekong River Basin countries in order to reduce the harmful effects of floods while maintaining the benefits for agriculture and soils, addressing overall watershed degradation and erosion, sedimentation and drought.
- Implement structural flood management measures including spreading and channeling floodwaters to address drought problems in some areas and improving drainage downstream where infrastructure causes flooding.
- Work with affected communities on non-structural flood management to provide protection against flood disasters and preparedness to deal with floods.
- Prepare early warning systems and flood information dissemination networks to allow communities and government agencies to be prepared in advance of flood events and deal with the impacts of flooding.

10.3. Development of Strategies by Cross-Cutting Issues

I. Environmental and Natural Resources Use and Management

Good Governance and Transparency in Natural Resources Development and Environmental Management:

- Address institutional and legal issues for development through improving and strengthening their frameworks, awareness-raising and reinforcement of the existing laws and regulations and their enforcement.
- Review current rules, standards and regulations, role and responsibilities and eliminate overlap and conflicts among different stakeholders particularly Line Agencies.

- Promote good governance in the management and conservation practice through media, education and training at sub-area, city, provincial and local levels, publicizing laws and awareness-raising and training among local communities.

J. Private Sector and Markets

Encourage increased Private Sector participation in the local economy, particularly in agri-business:

- Prepare the firm foundation, strong confidence and incentives for private sector investment by improving regulations and laws, reducing registration requirements and costs, decreasing informal payments, availability of credit with low interest, rural banking, mobilization of savings, training of entrepreneurs and providing local access to up-to-date market information.
- Adopt world standards and appropriate technologies to ensure products and quality are applicable for the future and usable in the present and ensure compliance with environmental covenants through regulations and enforcement.

K. Capacity Building and Human Resources Development

Strengthen human resources development and management and increase capacity building through public and private sector initiatives:

- Promote skills training programmes through cooperation between the Ministry of Labor and training and education institutes targeting small and medium enterprises and farming enterprises.
- Improved human resources management including identifying training needs, roles and responsibilities of staff, providing incentives, improving job placement and decentralizing trained and capable staff to provinces.
- Make “learning-by-doing” and on-the-job training an integral part of all project activities including selecting consultants with a demonstrated ability to work closely with national staff and build capacity.
- Identify key research issues and prioritize, with an emphasis on building upon local knowledge and incorporate research within project implementation to provide opportunities for staff to develop skills at national and provincial level.

L. Stakeholder Participation

Promote active participation of different stakeholders particularly women and the local communities in the entire process of decision-making, planning and management of natural resources and environment:

- Actively promote participation of women and involvement of women in leadership roles throughout project activity.

- Encourage local community participation in the process of development and management planning by ensuring their rights and obligation in the uses of natural resources and protection of the environment.
- Encourage participation of regional and international institutions for knowledge sharing, training and funding including academic exchanges and encourage students to participate in the research on natural science and technology.

M. Trans-Boundary Issues

Ensure constant and clear communications between riparian countries so that concerns of all are considered, information about natural resources, project activities and their potential impacts are shared in a timely manner and cooperation is enabled for issues of mutual interest:

- Prepare studies and forum for discussion of major water issues between the riparian countries including the potential diversion of the Mekong River through Svay Rieng, the infrastructure blocking flood drainage at the Vietnam border, the upstream development of dams in China and the diversions of flows into Northern and Northeastern Thai watersheds.
- Improve coordination and information sharing mechanisms between the riparian countries to allow timely flow of detailed information and early action to mitigate potential problems.
- Cooperate on natural resource management projects of mutual interest to riparian countries to develop closer ties between agencies and staff and foster learning and understanding.

CHAPTER 11: PROJECT IDEAS/INTERVENTION

11.1. Introduction

This chapter presents the results of the process to develop and refine the project interventions and ideas as undertaken by the Delta Sub-Area Working Group with the assistance of the Cambodian National Mekong Committee Basin Development Plan Team.

The chapter is prepared for the participants of the *2nd Stakeholder Forum* for the Delta Sub-Area in order that the work could be reviewed by a wide range of stakeholders, augmented and refined, and finalized for submission within the overall program of the Basin Development Plan. This chapter takes as its starting point the strategies as presented in the chapter 10: ***Strategies, Delta Sub-Area***. A two-step process follows where the first step examined the grouped strategies by sector and possible general project ideas were prepared as preliminary project ideas and interventions. In order to maximize the number of ideas, individual provinces are also going to submit additional ideas to form a Long-list from which to work.

The last step is to form a Short-list by taking out the project ideas that are not within the mandate of the BDP (i.e., trans-boundary, water-related and of regional significance) and better detail the remaining ideas to make them viable and unique in the context of the sub-area. In the prepared project ideas and interventions, sometimes a project will include elements from other groups, such as agriculture and irrigation while cross-cutting issues should be generally addressed within all project ideas.

The Project Ideas and Interventions presented are suggestions from the CNMC Development Plan Team that could form a basis for discussion during the *2nd Stakeholder Forum*. Finally, the Project Ideas and Interventions have been improved by incorporating all comments and suggestions made by the participants during the *2nd Stakeholder Forum* for the Delta Sub-area, as presented in this chapter.

11.2. Project Ideas/Interventions by Sector/Sub-Sector

A. Irrigated Agriculture

A.1. Major Project Feasibility Studies into diversion of Mekong River through Svay Rieng into the Vaico River, and from other Mekong tributaries to the areas facing water shortage, for the improvement of flood relief channels through the Vietnam border.

A.2. Delta Sub-area Water Resources Development Project including feasibility studies and implementation of small- and medium-scale irrigation and drainage projects including working with farmers to form Farmer Water User Communities (FWUCs) for maintenance, management and linking to agricultural extension for long-term viability.

A.3. Implementation of a New Floodplain Channel Project to demonstrate multi-purpose use for transport, irrigation and fishery, prove economic viability and test possibilities for Build-Operate-Transfer or Build-Own-Operate (BOT or BOO) methods.

A.4. Difficult Soils Improvement Project to research and develop means of overcoming the problem fertilizers, pesticide and soils prevalent in the area and thereby reduce poverty of farmers including research and extension and implementation of water control and soil improvement works.

A.5. Livestock Production Promotion Project including extension of good techniques and demonstration, promotion of green animal feeds, and strengthening the capacity of the animal health agents at the village level.

A.6. Agricultural Promotion Zone Project to identify location of comparative advantage and provide incentives to agro-industry, agro-business, SMEs and communities to develop production for export.

A.7. Groundwater Resource Maximization Project to research and monitor the quantity and quality of groundwater, its recharge, allocate sustainably between different uses and ensure against problems of arsenic and buildup of harmful deposits on soils.

A.8. Agricultural Export Production Project to promote production of high-value and quality rice varieties, organic produce and other agricultural products of comparative advantage and enable farmers to best gain opportunities through cooperatives and information networks.

A.9. Mekong Tributaries Rehabilitation and Construction Project to construct sluice gates and dredge their beds to allow sediment transportation for enrich soil fertility as well for natural fish growing and flood diversion.

B. Fisheries/Aquaculture

B.1. Smallholder Aquaculture Extension Project to extend techniques, inputs and credit to smallholders to allow them to engage in profitable aquaculture while promoting proper practice and good environmental management.

B.2. Natural Capture Fisheries Conservation Project to promote cooperation, studies, information sharing and promotion of good practices between riparian countries and identification of critical habitats and migratory pathways for community-based natural resource management.

B.3. Fishery Community Organization Project, Fish Migratory Routs Rehabilitation Project through dredging and Eliminating of Mimosa Shrub.

B.4. Community-based Sustainable Natural Resources Utilization to protect and conserve wetlands and biodiversity with participatory approach.

C. Watershed Management

C.1. Pilot Integrated Watershed Management Project in Vaico River Watershed with broad government agency cooperation including mapping of land use change, trends and resources, inventory of infrastructure and proposed/implemented projects, groundwater mapping, and a focus on the impacts and possibilities of the diversion from the Mekong River and drainage into Vietnam.

C.2. Pilot Integrated Watershed Management Project in Prek Thnaut Watershed focusing on hydro-meteorological and soils data collection, analysis and database management, inventory of irrigation and surface water systems, prioritization of investment and water availability, study on hydropower dam project potential, implementation of some irrigation projects with participatory methods.

C.3. Integrated Delta Sub-Basin Management Organization Project to coordinate efforts across different sectors especially flooding issues, large-scale project studies, groundwater, Chaktomuk Junction conservation and natural resource protection.

D. Tourism and Recreation

D.1. Cultural, Agricultural and Eco-Tourism Project to link the local culture events with agro and eco-tourism for improvement of the livelihood of the local communities and enabling opportunities for community-based critical habitat and culture protection, and increasing economic growth of the nation.

D.2. Community-Based Tourist and Natural Resources Management to maximize the benefits of tourism for upgrading the livelihood of the poor by involving local community in the income generation activities of this sector and in how to use and develop the natural resources with a social, economic and environmental balance.

D.3. Linking Tourist Network with ASEAN and GMS to protect the tourism and natural assets of the region, and strengthen the regional cooperation.

E. Water Supply, Waste Management and Sanitation

E.1. Rural Water Supply, Waste Management and Sanitation Project to improve and expand water supply service, efficient use and ensuring sanitation by managing and recycling the solid and liquid waste in the rural areas.

E.2. Urban Water Supply, Waste Management and Sanitation Project to improve and expand water supply service, efficient use and ensuring sanitation by managing and recycling the solid and liquid waste in the urban areas.

E.3. Improved Facility and Maintenance Project to increase awareness of sanitation issues, install toilets with appropriate technology and improve waste (both liquid and solid) disposal and management for a numbers of tourism sites such as Kean Svay.

F. Hydropower

F.1. Hydropower Dam Feasibility Study to understand, draw lessons learned and identify the best practices for hydropower development.

F.2. Prek Thnaut Hydropower Dam Development Project to satisfy the power needs for important development in the sub-area, and integrating water supply for irrigation in agriculture; and to cooperate with other ASEAN Members countries in establishment in the Regional Power Grid

G. Navigation and Transportation

G.1. Navigation Channel Improvement through Private Sector Financing of Dredging in Cambodia and Vietnam in both the Bassac and the Mekong Rivers in order to maintain all the year round navigability.

G.2. Rehabilitation the Competitiveness of Phnom Penh Port by reaching satisfactory agreements with Vietnam and simplifying the customs inspections, border and transit formalities.

G.3. Studies and Research on Expansion of Other River, Stream and Canal Transports and Port Location in order to rehabilitate and construct transport networks, prioritize projects for implementation, and construct a river port at the Tonle Boeut and other river ports at significant location along the Mekong river.

G.4. Rehabilitation, Maintenance and Expansion of Sub-area and Provincial Secondary and Tertiary Road Networks including (i) the preparation of technical studies to assess requirements and priorities for new linking roads with neighboring countries; and (ii) the establishment of road-bridge maintenance organizations.

H. Flood and Drought Control and Management

H.1. Studies and Research on Traditional Techniques and implement pilot projects to demonstrate their utility.

H.2. Proper Engineering and Rehabilitation of the Khmer Rouge and Other Existing Irrigation and Drainage Systems and other flood-proofing and drought reduction infrastructures.

H.3. Examination and Application of Successful Techniques and Engineering Structures in other countries such as flood and drought controlling and management and improved water management.

H.4. Re-Dredge Colmatage Canals and to Build Dikes, Bridges and Sluice Gates to protect the population, create safe and stable conditions for people, conserve the environment, and strengthen the capacity of flood drainage as well as irrigation.

a) Rehabilitation of 42 colmatage canals with gates on the left of the Mekong River from Kampong Cham to Neak Luong.

b) Rehabilitation of other additional 14 colmatage canals with gates along the Mekong River and Bassac River.

c) Close off the gates until 1st August to protect human lives, infrastructures and crops from early flood.

H.5. To Develop the Long Terms Flood and Drought Control Plans for the Mekong Delta is how to allocate or distribute the huge flood inflow to the Mekong River and its tributaries during the flood season from the upstream of the Delta and how much will the water be stored within the Delta, main rivers and canals. How much the excess floodwater can be diverted to the Gulf of Thailand or to the Vaico River. The possible 4 alternatives projects recommended by the Korea Water Resources Corporation (KOWACO) in association with the Korea Agricultural and Rural Infrastructure Corporation (KARICO) for long-term flood control plan for the Delta are:

a) Diversion canal with dikes to be used as transportation rout from Takeo to the Gulf of Thailand (west Bassac river area in Cambodia).

b) Diversion canal with dikes from Kampong Cham to Tonle Sap river (Tonle Sap area).

c) Diversion canal with dikes from Neak Luong to West Vaico river (East Mekong river area in Cambodia).

d) Gated colmatage canal system in Cambodian Delta.

H.6. Construct medium- and large-scale water storage reservoirs and establish agro-meteorological stations in some particular locations.

The benefits of these projects are: flood control, development of agricultural production, fish migration, irrigation, water supply, navigation, road transportation, industrial center and tourism development.

11.3. Project Ideas/Interventions by Cross-Cutting Issues

J. Private Sector and Markets

J.1. Foundation for Market Support and Development Project including research and market study to identify comparative advantage, international and regional marketing promotion of local products, promotional material development, and study on appropriate

credit and tax incentives and encouragement for domestic private sector targeted to Small and Medium Enterprises (SMEs).

J.2. Physical Infrastructure Development through construction of new markets to broaden the marketing business and network within the sub-area.

K. Capacity Building and Human Resource Development

K.1. Mekong River Basin Key Issues Awareness Raising, Training and Educational Project including media campaign to target specific practices or issues of importance, education campaign in schools, training and advocacy for senior officials on water management, ecology and gender, conferences and workshops on basin-wide issues and participatory research for community-based natural resource management.

K.2. Human Resource Development and Management (HRD/HRM) Project including training and active promotion of women in leadership roles, preparation of HRD/HRM strategy and plan, links to regional and international institutes, internship programme for students, and roundtable forum for interagency cooperation to work towards rationalization of roles and responsibilities.

CHAPTER 12: PROPOSED PROJECT IDEAS

The following is the list of projects ideas proposed by the Delta Sub-area working group and other external stakeholders as the results of the Second Stakeholder Forum, which need to be included in the long list of the MRC-BDP program of the 4 countries (Cambodia, Laos, Thailand and Vietnam).

This list still opens and waits for other development projects, which will be proposed by Sub-area working group and other stakeholders after completion of Forum 2. To propose these development projects, requesters have to prepare their own projects using Pro-forma (PIN) prepared by MRC-BDP Team for preparing the long list.

Project Name	Project Beneficiary	Project Description	Interface with MRC	Project Implementation	Time Frame (year)	Budget, US$
Kampong Cham						
1. Development of Flood Protected Dam	The project will: – Protect 12,000 families from flood; – Protect the provincial town from flood; and – Protect physical infrastructure from flood.	The project aims at protecting river bank erosion, which causes damage to physical infrastructure in the provincial town.	Flood Management and Mitigation Programme of MRC	Coordinated by CNMC and implemented by PDWRAM	3	External: 2,300,000 RGC: 200,000
2. Restoration of Angkor Ban Stream	The project will facilitate drainage water and provide farmers with sufficient water for cultivation.	The shallow stream causes interruption of fish migration from Mekong River to Tonle Sap river during the wet season.	Fisheries Programme of MRC	Implemented by PDAFF	3 months	External: 40,000 RGC: 10,000
Takeo						
Drought Mitigation	The project will: – Protect 2,745 families from flood; – Irrigate 5,000ha of dry season; and – Facilitate inland water navigation.	The project aims at dredging part of Stung Takeo (16 km length). Stung Takeo is presently shallow and dried. Farmers are facing water during dry season.	Flood Management and Mitigation Programme of MRC	Coordinated by CNMC and implemented by PDWRAM	6	External: 3,500,000 RGC: 300,000
Svay Rieng						
1. Flood Protected System from Tonle Waiko	The project prevents flood from Tonle Waiko and provides sufficient water to farmers during the dry season.	The project is located along Cambodia and Vietnam border (120 km length).	Agriculture, Irrigation and Forestry Programme of MRC	Coordinated by CNMC and implemented by PDWRAM	10	External: 34,000,000 RGC: 6,000,000

Project Name	Project Beneficiary	Project Description	Interface with MRC	Project Implementation	Time Frame (year)	Budget, US$
2. Restoration and Development of Tonle Waiko	The project mitigates flood damages and provides sufficient water to farmers during dry season. Beneficiaries: 300,000 persons	The project is located between Svay Rieng and Prey Veng province. The project aims at dredging canal of 80 km in length.	Agriculture, Irrigation and Forestry Programme of MRC	Coordinated by CNMC and implemented by PDWRAM	10	External: 26,000,000 RGC: 4,000,000
Kandal						
Restoration of Stung Touch	The project can irrigate 12,000 ha of cultivated area. Beneficiaries: 70,000 persons	The project is located in Kandal province. The project will provide sufficient water to farmers and increase agricultural productivity. The project also mitigates flood during the wet season.	Agriculture, Irrigation and Forestry Programme of MRC	Coordinated by CNMC and implemented by PDWRAM	5	8,000,000
Prey Veng						
Development of Rice Cultivation	The project can mitigate agricultural production damaged by flood and drought. The agricultural proclivity will be increased.	Rice yield in Prey Veng is low due to insufficient water. Development of irrigation system is crucial to supply adequate water for agriculture and increase agricultural productivity.	Agriculture, Irrigation and Forestry Programme of MRC	Coordinated by CNMC and implemented by PDAFF	10	External: 2,700,000 RGC: 300,000

Project Name	Project Beneficiary	Project Description	Interface with MRC	Project Implementation	Time Frame (year)	Budget, US$
Phnom Penh						
1. Development of Sewage System	The project aims at protecting water from pollution.	After completion of the project, rainwater and wastewater from city will be split before releasing into streams.	Environment Programme of MRC	Implemented by Municipality of Phnom Penh (MPP) in collaboration with Municipality of Public Works and Transportation (MPWT) and Municipality of Water Resources and Meteorology (MWRM)	5	7,000,000
2. Development of Sewage System	The project aims at preventing flood caused by wastewater.	Sewage system at north of Phnom Penh will be constructed.	Environment Programme of MRC	Implemented by MPP in collaboration with MPWT and MWRM	2	1,000,000
3. Development of Reservoir and canals	The project can mitigate flood threatening to Phnom Penh city.	The project is located at Tomnob Kabsrov and aims at constructing reservoir and canals in order to mitigate flood during the wet season.	Environment Programme of MRC	Implemented by MPP in collaboration with MPWT and MWRM	3	4,000,000

Project Name	Project Beneficiary	Project Description	Interface with MRC	Project Implementation	Time Frame (year)	Budget, US$
Delta Sub-area						
Identification of Agricultural Land and Crops		The project aims at identifying kinds of crops that are suitable for growing in proper areas. It has been encountered that some kinds of crops can not be grown on land without quality; otherwise, the yield would be low. Identifying proper agricultural land for growing high value crops is therefore necessary. This will increase farmers' incomes and reduce poverty of farmers living in remote areas.	Agriculture, Irrigation and Forestry Programme of MRC	Coordinated by CNMC & MAFF and implemented by PDAFFs of the Delta Sub-area	3	3,500,000

CHAPTER 13: GLOSSARY

Acid soils (or sulphur acid soils): Soils that have been rendered acid due to formation of sulphuric acid by oxygenation of pyrite (natural iron sulphide, FeS_2), often due to human interference (lowering of the groundwater table by drainage, or excavation of ponds for aquaculture). Such soils are unsuited for cultivation, effluents leaking from such areas can be poisonous to fish (because acid can dissolve aluminium), and the process can be practically irreversible.

Alluvial: Formed by river sediments. An alluvial river flows in a landscape formed by its own sediments.

Analysis (of hydrological data): Processing, involving a sometimes comprehensive transformation and interpretation, in order to arrive at some desired knowledge. Data analysis is often carried out stage-wise and in different contexts: On-line processing in the field, off-line processing, further synthesisation for model input, etc. In general, data analysis involves both hidden and explicit assumptions about the relation between primary data and final results. (As one example, a flow rate in a river can be calculated assuming that the current measurements were made simultaneously, even if they took a whole day). Such assumptions can affect both the accuracy and the validity of the results. A suitable quality is supported by an adequate transparency of the analysis.

Aquaculture: Cultivation, aiming at commercial production, of aquatic plants or animals, such as fish, prawns, shellfish, etc.

Aquaculture: Cultivation, aiming at commercial production, of aquatic plants or animals, such as fish, prawns, shellfish, etc.

Basic minimum needs: These can comprise food and water, shelter, primary education, vital health care, and personal integrity.

Biodiversity: The number of species (of plant and animals) that actually live in an area (or biotope) where they belong. Agenda 21 (Chapter 17.7) states about coastal biodiversity: 'Coastal States, with the support of international organizations, upon request, should undertake measures to maintain biological diversity and productivity of marine species and habitats under national jurisdiction. Inter alia, these measures might include: surveys of marine biodiversity, inventories of endangered species and critical coastal and marine habitats; establishment and management of protected areas; and support of scientific research and dissemination of its results'.

Brackish water: A mixture of sea water and freshwater, found at places where inland waters discharge into the sea: River mouths, fjords, estuaries, lagoons, inland seas, etc. The salinity will be higher than nil, but lower than the ocean salinity of 35 PPT. Stratification is common in brackish areas, and the salinity will often vary highly, both in time and place.

Catchment (or drainage area): An area (delineated by a watershed) that drains through a specific river cross-section.

Development objective (or overall objective, or development goal, or mission): A desired future situation, which is supported by a plan (or programme or project) that is targeted towards it. The plan (or programme or project) cannot in itself assure achievement of the development objective - this is subject to a number of assumptions on related developments that are outside the control of the plan (or programme or project). Some authors recommend that only one development objective be applied from case to case, and that it be specified in time, space and quantity. See also immediate objective.

Discharge: Net flow or net sediment transport through a fixed cross-section of a river.

Dispersion: Mass transport determined by the transverse current velocity gradient and the concentration gradient (and always in the direction of the concentration gradient).

Driving force: A circumstance that has a major (positive or negative) influence on pursuance of a set of planning goals. It can be physical, climatic, economic, social or political, and can appear as a trend, a cycle, or an event. A driving force cannot be fully controlled by the participants in the planning process. It can be unpredictable, or not well understood, or even unknown.

Dublin Principles (from International Conference of Water and the Environment, Dublin 1992): (1) Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment; (2) water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels; (3) women play a central role in the provision, management and safeguarding of water; (4) water has an economic value in all its competing uses and should be recognized as an economic good.

Ecological demand of stream flow: The minimum stream flow required for prevention of irreversible ecological degradation. This value varies over the year and from one place to another. To maintain a healthy environment, the flow must be higher in the wet season than in the dry season, because many aquatic species have annual cycles that reflect their natural habitat. Sometimes, the water-level is critical, rather that the flow rate.

Endemic: Occurring only in one specific geographical area (for example one country, one river basin, or one island).

Eutrophication: Excessive supply of nutrients, resulting in a high primary production. Eutrophication can have negative ecological effects, such as large fluctuations of dissolved oxygen between night and day, or damage to benthic vegetation due to shading by algae.

Flow: Volume transport per time unit (for example through a cross-section of a river).

Frequency: Number of cycles (or units or events) per unit time.

Gauging: Measuring at a fixed point; a gauge is a measuring device (e.g. for water-level or pressure).

Gross domestic product (GDP): the total output of goods and services for final use produced by an economy, by both residents and non-residents, regardless of the allocation to domestic and foreign claims. It does not include deductions for depreciation of physical capital or depletion and degradation of natural resources.

Immediate objective: The intended situation that is achieved as the direct result of orderly implementation of a plan (or programme or project). The immediate objective is the result of a number of outputs, which, between them, are necessary and adequate for achieving the immediate objective. Some authors recommend a maximum of 3 immediate objectives, and that these are specified in time, space, quantity, quality and target group. See also development objective.

Integrated farming: An area-intensive and labor-intensive combination of different parallel productions, like a fish pond, paddy, fruit trees, livestock, cash crops and vegetables. Integrated farming can give yields that highly exceed monoculture yields.

Integrated Water Resources Management (as defined by Global Water Partnership): A process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

Opportunity costs: The cost difference between one course of action and another (better) course of action. In a wider sense, the implications of one course of action relative to alternative strategies. In development projects, the opportunity costs can reflect the time lag from when a new technology emerges and until it becomes available to the target group. There is often an opportunity cost related to doing nothing.

Photosynthesis: The primary production (by plants, algae and some bacteria) of simple carbohydrates (such as sugar), normally from (inorganic) carbon dioxide, and using energy supplied by the sun.

Phytoplankton: Photosynthetic aquatic microorganisms (algae).

Pollutant: A compound that is harmful or otherwise undesired in the environment, either absolutely, or at an elevated concentration level. See also contaminant and xenobiotic compound.

Pollution: Release to the environment of a substance that can harm it.

Salinity (of sea water): Relative mass of the salt contents, given in PPT (parts per thousand) (kg per 1,000 kg), or in PSU (practical salinity units) (which is very nearly the same as PPT).

Scenario: A hypothetical combination of events and physical conditions, describing a possible future situation.

Sector planning: Planning for a specific source of income, like agriculture, fisheries, hydropower, industry, service, tourism, etc.

Seepage: Slow movement of water in the ground, or from the ground to the surface.

Stakeholder: A person, group or institution that has a particular interest in an activity, project, programme or policy. This includes both intended beneficiaries and intermediaries, winners and losers, and those involved in, or excluded from the decision-making process. A key stakeholder is one who can significantly influence or who is otherwise important to the success of the activity, project, programme or policy.

Strategy: (1) A conceptual plan for how to reach a goal; (2) a plan, method or series of actions designed to achieve a specific goal or objective.

Subsistence economy: An economy in which agricultural, hunting and other activities are undertaken primarily to meet household consumption requirements.

Transparency (of a procedure): The insight conveyed to the data user about how the data were produced, for example for assessing the validity of the data for a given, possibly unforeseen, purpose. An acceptable transparency is obtained by documentation and can be supported by using standard procedures.

Vector-borne disease: A disease transmitted by an organism (for example malaria).

Water availability: The flow into an area from upstream, plus the (surface and groundwater) resources generated by net rainfall in the sub-area, minus the ecological demand within the area and at its downstream boundary. The availability changes slowly, from one decade to the next, due to medium-term climate variations, or due construction of reservoirs or diversions. The availability can be measured, and/or determined by numerical modeling, often with a high accuracy (subject to the coverage and quality of the basic hydrological data).

Water demand: The amount of water required for a given purpose, for example liter per person per day, or mm per crop. The demand can be present or future, and it can be actual (i.e. related to an available infrastructure) or potential (assuming full infrastructural development and no water shortage). The serviceable (part of the) demand is limited both by infrastructure and water availability.

Water pricing: A tool for management of water allocation between areas, sectors and individual users, assuming that an 'optimal' allocation (or just a sustainable allocation) can be determined on the basis of a water price that reflects the full costs (and hereby the full value) of water (for example, in economic theory, by charging the full costs and relying on free market mechanisms for allocation). Such a strategy can improve water efficiencies and reduce waste of water. It will often give preference to industrial allocations rather than irrigation. See valuation and cost of water.

Watershed: A line in the landscape (e.g. a ridge) that delineates a catchment. The surface runoff on each side of the watershed will proceed towards different locations.

Wetland: An area that is covered by water in at least a part of the year. A wetland can represent a special ecological habitat, sometimes with a high biodiversity, and can serve as a fish breeding ground. The Ramsar convention defines wetlands quite broadly as 'areas of marsh, fen, peat-land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including marine areas with a depth less than 6 m at low tide'.

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